Hawaii Range Complex

Final Environmental Impact Statement/
Overseas Environmental Impact Statement (EIS/OEIS)

Volume 2 of 5: Chapters 4-11

May 2008

Coordinator
Hawaii Range Complex
Pacific Missile Range Facility
P.O. Box 128
Kekaha, Kauai, Hawaii 96752-0128

HAWAII RANGE COMPLEX
FINAL ENVIRONMENTAL IMPACT STATEMENT/
OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

Volume 2 of 5

MAY 2008

Coordinator
Hawaii Range Complex
Pacific Missile Range Facility
P.O. Box 128
Kekaha, Kauai, Hawaii 96752-0128

COVER SHEET
FINAL ENVIRONMENTAL IMPACT STATEMENT/
OVERSEAS ENVIRONMENTAL IMPACT STATEMENT
HAWAII RANGE COMPLEX (HRC)

Lead Agency for the EIS:	U.S. Department of the Navy
Title of the Proposed Action:	Hawaii Range Complex
Affected Jurisdiction:	Kauai, Honolulu, Maui, and Hawaii Counties
Designation:	Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS)

Abstract

This Final EIS/OEIS has been prepared by the U.S. Department of the Navy (Navy) in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code § 4321 et seq.); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [CFR] §§ 1500-1508); Navy Procedures for Implementing NEPA (32 CFR § 775); and Executive Order 12114 (EO 12114), *Environmental Effects Abroad of Major Federal Actions*. The Navy has identified the need to support and conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) activities in the Hawaii Range Complex (HRC). The alternatives—the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3—are analyzed in this Final EIS/OEIS. All alternatives include an analysis of potential environmental impacts associated with the use of mid-frequency active (MFA) and high-frequency active (HFA) sonar. The No-action Alternative stands as no change from current levels of HRC usage and includes HRC training, support, and RDT&E activities, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises. Alternative 1 includes all ongoing training associated with the No-action Alternative, an increased tempo and frequency of such training (including increases in MFA and HFA sonar use), a new training event (Field Carrier Landing Practice), enhanced and future RDT&E activities, enhancements to optimize HRC capabilities, and an increased number of Major Exercises. Alternative 2 includes all of the training associated with Alternative 1 plus additional increases in the tempo and frequency of training (including additional increases in MFA and HFA sonar use), enhanced RDT&E activities, future RDT&E activities, and additional Major Exercises, such as supporting three Strike Groups training at the same time. Alternative 3 would include all of the training and RDT&E activities associated with Alternative 2. The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events, future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Alternative 3 is the Navy's preferred alternative.

This Final EIS/OEIS addresses potential environmental impacts that result from activities that occur under the No-action Alternative and proposed activities that would occur under Alternatives 1, 2, and 3. This EIS/OEIS also addresses changes and associated environmental analyses that were presented in the Supplement to the Draft EIS/OEIS. Environmental resource topics evaluated include air quality, airspace, biological resources (open ocean, offshore, and onshore), cultural resources, geology and soils, hazardous materials and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

Prepared by:	U.S. Department of Defense, Department of the Navy
Point of Contact:	Pacific Missile Range Facility Public Affairs Officer
	P.O. Box 128, Kekaha, Hawaii, 96752, (866) 767-3347

May 2008

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

TABLE OF CONTENTS

Volume 1

Volume 2

Page

Volume 3

Page

Volume 4

Page

Volume 5

APPENDICES

Page

FIGURES

TABLES

Page

EXHIBITS

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 Environmental Consequences

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter describes potential environmental consequences at each location that may be affected by the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3. The same resource areas addressed in Chapter 3.0 for each location are addressed in this chapter. The following sections address the potential for impacts on each environmental resource and its attributes by activity and sub-activities identified in Chapter 2.0.

Environmental consequences are discussed according to location; the Open Ocean Area is discussed first, followed by offshore and onshore discussion organized by island locations from west to east: Northwestern Hawaiian Islands, Kauai, Oahu, Maui, and Hawaii. For organizational purposes, discussions about Niihau and Kaula (although separate islands) are included under the Kauai heading because they are part of Kauai County. Similarly, discussions about Molokai are included under the Maui heading because it is part of Maui County. The last section discusses the Hawaiian Islands Humpback Whale National Marine Sanctuary. The page headers in this chapter identify which location is discussed. The rationale for not addressing certain resources for a given location is provided under each location. Table 4-1 lists each location and the section where each of the resources is addressed.

Potential environmental effects described in this section focus on the continuation of combinations of unit-level training and research, development, test, and evaluation (RDT&E) in the Hawaii Range Complex (HRC) (No-action Alternative) that have been occurring for decades and the effects of implementing Alternatives 1, 2, and 3 to the No-action Alternative. The environmental consequences assessment in the Environmental Impact Statement (EIS)/Overseas EIS (OEIS) includes estimates of the potential direct and indirect effects, long- and short-term effects, and irreversible and irretrievable resource commitments.

This EIS/OEIS describes measures required to mitigate adverse impacts. The EIS/OEIS also identifies those measures already committed to as part of current unit-level training and RDT&E, and additional mitigations (if any) which could reasonably be expected to reduce impacts if Alternative 1, 2, or 3 is implemented.

Table 4-1. Chapter 4.0 Locations and Resources

Location	Air Quality	Airspace	Biological Resources	Cultural Resources	Geology & Soils	Hazardous Materials & Waste	Health & Safety	Land Use	Noise	Socioeconomics	Transportation	Utilities	Water Resources
Open Ocean		4.1.1	4.1.2	4.1.3		4.1.4	4.1.5		4.1.6				4.1.7
Northwestern Hawaiian Islands Offshore			4.2.1.1										
Northwestern Hawaiian Islands Onshore			4.2.2.1	4.2.2.2									
Kauai Offshore													
PMRF-Offshore			4.3.1.1.1	4.3.1.1.2						4.3.1.1.3	4.3.1.1.4		
Niihau-Offshore			4.3.1.2.1										
Kaula-Offshore			4.3.1.3.1	4.3.1.3.2									
Kauai Onshore													
PMRF/Main Base	4.3.2.1.1	4.3.2.1.2	4.3.2.1.3	4.3.2.1.4	4.3.2.1.5	4.3.2.1.6	4.3.2.1.7	4.3.2.1.8	4.3.2.1.9	4.3.2.1.10	4.3.2.1.11	4.3.2.1.12	4.3.2.1.13
Makaha Ridge	4.3.2.2.1		4.3.2.2.2	4.3.2.2.3		4.3.2.2.4	4.3.2.2.5						
Kokee	4.3.2.3.1		4.3.2.3.2			4.3.2.3.3	4.3.2.3.4						
HIANG Kokee			4.3.2.4.1										
Kamokala Magazines						4.3.2.5.1	4.3.2.5.2						
Port Allen*													
Kikiaola Small Boat Harbor*													
Mt. Kahili*													
Niihau			4.3.2.9.1			4.3.2.9.2	4.3.2.9.3						
Kaula		4.3.2.10.1	4.3.2.10.2	4.3.2.10.3	4.3.2.10.4		4.3.2.10.5	4.3.2.10.6					
Oahu Offshore													
Puuloa Underwater Range-Offshore			4.4.1.1.1	4.4.1.1.2		4.4.1.1.3	4.4.1.1.4						
Naval Defensive Sea Area-Offshore			4.4.1.2.1	4.4.1.2.2			4.4.1.2.3						
Marine Corps Base Hawaii-Offshore			4.4.1.3.1	4.4.1.3.2									
Marine Corps Training Area/Bellows-Offshore			4.4.1.4.1	4.4.1.4.2									
Makua Military Reservation-Offshore			4.4.1.5.1	4.4.1.5.2									
Dillingham Military Reservation-Offshore			4.4.1.6.1	4.4.1.6.2									
Ewa Training Minefield-Offshore			4.4.1.7.1			4.4.1.7.2	4.4.1.7.3						
Barbers Point Underwater Range-Offshore			4.4.1.8.1			4.4.1.8.2	4.4.1.8.3						
NUWC SESEF-Offshore			4.4.1.9.1				4.4.1.9.2						
NUWC FORACS-Offshore			4.4.1.10.1				4.4.1.10.2						
Oahu Onshore													
Naval Station Pearl Harbor			4.4.2.1.1	4.4.2.1.2						4.4.2.1.3			
Ford Island			4.4.2.2.1	4.4.2.2.2									4.4.2.2.3
Naval Inactive Ship Maintenance Facility, Pearl Harbor			4.4.2.3.1			4.4.2.3.2							4.4.2.3.3
EOD Land Range NAVMAG Pearl Harbor West Loch			4.4.2.4.1	4.4.2.4.2	4.4.2.4.3		4.4.2.4.4						4.4.2.4.5
Lima Landing			4.4.2.5.1	4.4.2.5.2		4.4.2.5.3	4.4.2.5.4						
USCG Station Barbers Point/Kalaeola Airport		4.4.2.6.1	4.4.2.6.2										
Marine Corps Base Hawaii		4.4.2.7.1	4.4.2.7.2	4.4.2.7.3					4.4.2.7.4	4.4.2.7.5			
Marine Corps Training Area/Bellows			4.4.2.8.1	4.4.2.8.2									
Hickam Air Force Base		4.4.2.9.1	4.4.2.9.2										
Wheeler Army Airfield		4.4.2.10.1	4.4.2.10.2										
Makua Military Reservation			4.4.2.11.1	4.4.2.11.2			4.4.2.11.3		4.4.2.11.4				
Kahuku Training Area			4.4.2.12.1	4.4.2.12.2									
Dillingham Military Reservation			4.4.2.13.1	4.4.2.13.2									
Keehi Lagoon*													
Kaena Point*													
Mt. Kaala*													
Wheeler Network Segment Control/PMRF Communication Site*													
Mauna Kapu Communication Site*													
Makua Radio/Repeater/Cable Head*													
Maui Offshore													
Maui Offshore			4.5.1.1.1										
Shallow-water Minefield Sonar Training Area-Offshore*													
Maui Onshore													
Maui Space Surveillance Site*													
Maui High Performance Computing Center*													
Sandia Maui Haleakala Facility*													
Molokai Mobile Transmitter Site*													
Hawaii Offshore													
Kawaihae Pier			4.6.1.1.1										
Hawaii Onshore													
Pohakuloa Training Area		4.6.2.1.1	4.6.2.1.2	4.6.2.1.3			4.6.2.1.4		4.6.2.1.5				
Bradshaw Army Airfield		4.6.2.2.1	4.6.2.2.2	4.6.2.2.3									
Kawaihae Pier			4.6.2.3.1										
Hawaiian Islands Humpback Whale National Marine Sanctuary			4.7.1										

*A review of the 13 environmental resources against program activities determined there would be no impacts from site activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.1 OPEN OCEAN AREA

Table 4.1-1 lists ongoing training and RDT&E for the No-action Alternative and proposed training and RDT&E for Alternatives 1, 2, and 3 in the Open Ocean Area. Alternative 3 is the preferred alternative.

Table 4.1-1. Training and RDT&E Activities in the Open Ocean Area

Training	Research, Development, Test, and Evaluation (RDT&E)
• Air Combat Maneuver (ACM) • Air-to-Air Missile Exercise (A-A MISSILEX) • Surface-to-Air Gunnery Exercise (S-A GUNEX) • Surface-to-Air Missile Exercise (S-A MISSILEX) • Chaff Exercise (CHAFFEX) • Naval Surface Fire Support Exercise (NSFS)[1] • Visit, Board, Search, and Seizure (VBSS) • Surface-to-Surface Gunnery Exercise (S-S GUNEX)[1] • Surface-to-Surface Missile Exercise (S-S MISSILEX)[1] • Air-to-Surface Gunnery Exercise (A-S GUNEX) • Air-to-Surface Missile Exercise (A-S MISSILEX)[1] • Bombing Exercise (BOMBEX) (Sea)[1] • Sinking Exercise (SINKEX)[1] • Anti-Surface Warfare (ASUW) Torpedo Exercise (TORPEX) (Submarine-Surface) • Anti-Submarine Warfare (ASW) Tracking Exercise (TRACKEX)[2] • ASW TORPEX[2] • Major Integrated ASW Training Exercise[2] • Electronic Combat Operations • Mine Countermeasures Exercise (MCM) • Mine Neutralization[1] • Swimmer Insertion/Extraction • Command and Control (C2) (Sea) • Demolition Exercises (Sea) • Extended Echo Ranging/Improved Extended Echo Ranging (EER/IEER)[1]	• Anti-Air Warfare RDT&E • Anti-Submarine Warfare • Combat System Ship Qualification Trial • Electronic Combat/Electronic Warfare (EC/EW) • High-Frequency Radio Signals • Missile Defense • Shipboard Electronic Systems Evaluation Facility (SESEF) Quick Look • SESEF System Performance Test • Additional Chemical Simulant (Alternative 1) • Intercept Targets Launched into Pacific Missile Range Facility (PMRF) Controlled Area (Alternative 1) • Launched SM-6 from Sea-Based Platform (AEGIS) (Alternative 1) • Test Unmanned Surface Vehicles (Alternative 1) • Test Unmanned Aerial Vehicles (Alternative 1) • Test Hypersonic Vehicles (Alternative 1) • Portable Undersea Tracking Range (Alternative 1) • Large Area Tracking Range Upgrade (Alternative 1) • Enhanced Electronic Warfare Training (Alternative 1) • Expanded Training Capability for Transient Air Wings (Alternative 1) • Directed Energy (Alternative 2/3) • Advanced Hypersonic Weapon (Alternative 2/3)

Notes: 1. Modeled for explosives
2. Modeled for sonar

4.1.1 AIRSPACE—OPEN OCEAN

The potential impacts on airspace in the Open Ocean Area are discussed in terms of conflicts with the use of controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields.

4.1.1.1 NO-ACTION ALTERNATIVE (AIRSPACE—OPEN OCEAN)

4.1.1.1.1 HRC Training—No-action Alternative

The ongoing, continuing HRC training that could affect airspace includes mine laying, Surface-to-Surface Gunnery Exercises (S-S GUNEX), Surface-to-Surface Missile Exercises (S-S MISSILEX), Air-to-Surface Gunnery Exercises (A-S GUNEX), Air-to-Surface Missile Exercises

(A-S MISSILEX), Bombing Exercises (BOMBEX), Sinking Exercises (SINKEX), Anti-Submarine Warfare (ASW), Air Combat Maneuvers (ACM), Air-to-Air Missile Exercises (A-A MISSILEX), Electronic Countermeasures (ECM), Surface-to-Air Gunnery Exercises (S-A GUNEX), Surface-to-Air Missile Exercises (S-A MISSILEX), Naval Surface Fire Support (NSFS), Flare Exercises, Chaff Exercises (CHAFFEX), and Extended Echo Ranging/Improved Extended Echo Ranging (EER/IEER) Exercises as listed in Table 2.2.2.1-1.

Controlled and Uncontrolled Airspace

The Navy can accomplish the No-action Alternative without modifications or need for additional airspace to accommodate continuing training.

Special Use Airspace

Ongoing, continuing training identified above will continue to use the existing Open Ocean Area special use airspace including Warning Areas and Air Traffic Control Assigned Airspace (ATCAA) shown on Figure 3.1.1-1. Although the nature and intensity of use varies over time and by individual special use airspace area, the continuing training represents precisely the kinds of events for which the special use airspace was created. The Warning Areas are designed and set aside by the Federal Aviation Administration (FAA) to accommodate training that presents a hazard to other aircraft. As such, the continuing training does not conflict with any airspace use plans, policies, and controls. The ATCAA has been developed by the FAA to facilitate the management of aircraft moving between and adjacent to other special use airspace areas.

En Route Airways and Jet Routes

Numerous instrument flight rules (IFR), en route low altitude air traffic service routes, and IFR en route high altitude oceanic routes are used by commercial aircraft that pass through the region of influence (see Figure 3.1.1-1). However, the region of influence is relatively remote from the majority of jet routes that traverse the northern Pacific Ocean. The Navy coordinates closely with the FAA to avoid conflicts with commercial aviation.

The low altitude airways that pass through a Warning Area include V7 (through W-190), V15 (through W-188), and V16 (through W-186). There are no oceanic routes that pass through a Warning Area. Several low altitude airways pass below the Pali ATCAA near Oahu. The floor of the Pali ATCAA is above the ceiling of the low altitude routes. Two low altitude airways pass above the ceiling of the Mela North ATCAA. Navy training involving aircraft in the Open Ocean Area is conducted away from en route airways and jet routes to minimize potential airspace conflicts.

Use of the low altitude airways and high-altitude jet routes comes under the control of the Honolulu and Oakland Air Route Traffic Control Centers (ARTCCs). In addition, the Navy surveys the airspace involved in each training event either by radar or patrol aircraft. Safety regulations dictate that hazardous activities will be suspended by the Navy when it is known that any non-participating aircraft has entered any part of a training activity danger zone. The suspension lasts until the non-participating entrant has left the area or a thorough check of the suspected area has been performed. Consequently, there are no impacts on non-military aircraft.

The continuing training will be conducted in compliance with Department of Defense (DoD) Directive 4540.1, as directed by Office of the Chief of Naval Operations Instruction (OPNAVINST) 3770.4A, which specifies procedures for conducting Aircraft Operations and for missile/projectile firing. Missile and projectile firing areas shall be selected so that trajectories are clear of established oceanic air routes or areas of known surface or air activity. In addition, before conducting training that is potentially hazardous to non-participating aircraft, Notices to Airmen (NOTAMs) published by the FAA will be sent in accordance with the conditions of the directive specified in OPNAVINST 3721.20A. The increasing adoption of "Free Flight" by commercial aircraft could make the airspace coordination task somewhat more difficult, but this will still be handled by the issuance of NOTAMs. As noted in Chapter 3.0, with the full implementation of this program, the amount of clear airspace in the region of influence may decrease as pilots, whenever practical, choose their own route and file a flight plan that follows the most efficient and economical route.

All airspace outside the territorial limits is located in international airspace. Because the Open Ocean Area airspace use region of influence is in international airspace, the procedures outlined in International Civil Aviation Authority (ICAO) Document 444, *Rules of the Air and Air Traffic Services* are followed. The FAA acts as the U.S. agent for aeronautical information to the ICAO, and air traffic in the over-water region of influence is managed by the Honolulu ARTCC, and to a lesser extent, the Oakland ARTCC.

As noted above, continuing training will use the existing Open Ocean Area special use airspace and will not require either: (1) a change to an existing or planned IFR minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a visual flight rules (VFR) operation to change from a regular flight course or altitude. Consequently, there are no airspace conflicts.

Airports and Airfields

There are no airports and airfields in the Open Ocean Area region of influence.

4.1.1.1.2 HRC RDT&E Activities—No-action Alternative

The ongoing RDT&E activities that could affect airspace include missile defense ballistic missile target flights and interceptor activities, A-S MISSILEX, A-A MISSILEX, S-A MISSILEX, and S-S MISSILEX. RDT&E activities are conducted in Pacific Missile Range Facility (PMRF) Warning Areas and the Temporary Operating Area (TOA), as shown on Figure 3.1.1-1. Table 2.2.2.5-1 lists the RDT&E activities that are a part of the No-action Alternative. Missile launches from PMRF and Kauai Test Facility will move into Open Ocean Areas soon after launch.

Controlled and Uncontrolled Airspace

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate continuing training. Typically target and interceptor missiles will be above flight level (FL) 600 within minutes of the rocket motor firing. As such, all other local flight activities will occur at sufficient distance and altitude that the target missile and interceptor missiles will be little noticed. However, activation of the proposed stationary altitude reservation (ALTRV) procedures, where the FAA provides separation between non-participating aircraft and the missile flight test activities in the TOA for use of the airspace identified in Figure 3.1.1-1, will impact the controlled airspace available for use by non-participating aircraft for the duration of the ALTRV—usually for a matter of a few hours, with a backup day reserved for the same hours. The airspace in the TOA is not heavily used by commercial aircraft, and is far removed from the en route airways and jet routes crossing the North Pacific Ocean. The relatively sparse use of the area by commercial aircraft and the advance coordination with the FAA regarding ALTRV requirements results in minimal impacts on controlled and uncontrolled airspace from RDT&E activities.

Special Use Airspace

Ongoing RDT&E activities identified above will continue to utilize the existing Open Ocean Area special use airspace including PMRF Warning Areas shown on Figure 3.1.1-1.

Missile intercepts will continue to be conducted within either the existing special use airspace in Warning Area W-188 and W-186 controlled by PMRF or within the TOA shown in the inset on Figure 3.1.1-1. Similarly, intercept impact debris will be contained within these same areas. Missiles coming into the TOA from various locations can overfly the Papahānaumokuākea Marine National Monument. At this point in their flight, the boosters follow a ballistic trajectory and will not impact the monument. For select intercept missions, the potential exists for limited debris to fall into the Open Ocean Area off Necker and Nihoa in the Papahānaumokuākea Marine National Monument. Although the nature and intensity of use varies over time and by individual special use airspace area, the proposed activities do not represent a direct special use airspace impact due to the nature of the special use airspace and the planning and coordination between the Navy and the FAA, as described below.

Warning Areas consist of airspace over international waters in which hazardous activity may be conducted. The Warning Areas are designed and set aside by the FAA to accommodate activities that present a hazard to other aircraft. Similarly, the use of ALTRV procedures—as authorized by the Central Altitude Reservation Function, an air traffic service facility, or appropriate ARTCC (the Oakland ARTCC for the TOA)—for airspace use under prescribed conditions in the TOA will not impact special use airspace. According to the FAA Handbook, 7610.44, ALTRVs may encompass certain rocket and missile activities, and other special activities, as may be authorized by FAA approval procedures.

PMRF will coordinate with the Honolulu or Oakland ARTCC military operations specialist assigned to handle such matters and the airspace coordinator at the Honolulu Center Radar Approach using ALTRV request procedures. After receiving the proper information on each test flight, a hazard pattern will be constructed and superimposed on a chart depicting the area of activities. Ensuring that the hazard pattern will not encroach any land mass, this area is then plotted using minimum points (latitude-longitude) to form a rectangular area. This plotted area is then faxed to the military operations specialist at Honolulu or Oakland ARTCC requesting airspace with the following information: area point (latitude-longitude); date and time for primary and backup (month, day, year, Zulu time); and altitude. A copy is sent to the Honolulu Center Radar Approach Control. A follow-up phone call is made after 48 hours to verify receipt of the fax. When approval of the request of the airspace is received from the military operations specialist at Honolulu or Oakland ARTCC, PMRF will submit an ALTRV request to Central Altitude Reservation Function, which publishes the ALTRV 72 hours prior to the flight test. With these coordination and planning procedures in place, the RDT&E activities do not conflict with any airspace use plans, policies, and controls.

En Route Airways and Jet Routes

Two IFR en route low altitude airways are used by commercial aircraft that pass through the PMRF Warning Areas. The two low altitude airways are V15 (through W-188), and V16 (through W-186). Use of these low altitude airways comes under the control of the Honolulu ARTCC. In addition, during a training event, provision is made for surveillance of the affected airspace either by radar or patrol aircraft. Safety regulations dictate that hazardous activities will be suspended when it is known that any non-participating aircraft has entered any part of the training danger zone until the non-participating entrant has left the area or a thorough check of the suspected area has been performed. Therefore, potential impacts on civilian aircraft are avoided.

The airways and jet routes that traverse the Open Ocean Area airspace region of influence have the potential to be affected by RDT&E activities. However, target and defensive missile launches and missile intercepts will be conducted in compliance with DoD Directive 4540.1, as enclosed by OPNAVINST 3770.4A. DoD Directive 4540.1 specifies procedures for conducting missile and projectile firing, namely "firing areas shall be selected so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (DoD Directive 4540.1, § E5).

Before conducting a missile launch and/or intercept test, NOTAMs will be sent in accordance with the conditions of the directive specified in OPNAVINST 3721.20. In addition, to satisfy airspace safety requirements, the responsible commander will obtain approval from the Administrator, FAA, through the appropriate Navy airspace representative. Provision is made for surveillance of the affected airspace either by radar or patrol aircraft. In addition, safety regulations dictate that hazardous activities will be suspended when it is known that any non-participating aircraft have entered any part of the danger zone until the non-participating entrant has left the area or a thorough check of the suspected area has been performed.

In addition to the reasons cited above, there is a scheduling agency identified for each piece of special use airspace that will be used. The procedures for scheduling each piece of airspace are performed in accordance with letters of agreement with the controlling FAA facility, and the Honolulu and Oakland ARTCCs. Schedules are provided to the FAA facility as agreed among the agencies involved. Aircraft transiting the Open Ocean Area region of influence on one of the low-altitude airways and/or high-altitude jet routes that will be affected by flight test activities will be notified of any necessary rerouting before departing their originating airport and will be able to take on additional fuel before takeoff. Real-time airspace management involves the release of airspace to the FAA when the airspace is not in use or when extraordinary events occur that require drastic action, such as weather requiring additional airspace.

The FAA ARTCCs are responsible for air traffic flow control or management to transition air traffic. The ARTCCs provide separation services to aircraft operating on IFR flight plans and principally during the en route phases of the flight. They also provide traffic and weather advisories to airborne aircraft. Hazardous military activities are contained within the over-water Warning Areas or by using ALTRV procedures in the TOA to ensure non-participating traffic is advised or separated accordingly.

Continuing RDT&E activities will use the existing Open Ocean Area special use airspace and will not require either: (1) a change to an existing or planned IFR minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a VFR operation to change from a regular flight course or altitude. Consequently, there are no airspace conflicts.

Airports and Airfields

There are no airports and airfields in the Open Ocean Area region of influence.

4.1.1.1.3 Major Exercises—No-action Alternative

Major Exercises such as Rim of the Pacific (RIMPAC) and Undersea Warfare Exercise (USWEX), include combinations of unit-level training and, in some cases, RDT&E activities that have been occurring in the HRC for decades. Therefore, potential impacts from a Major Exercise on the open ocean airspace will be similar to those described above for training and the RDT&E activities. The No-action Alternative includes one RIMPAC exercise (with a single aircraft carrier) and up to five USWEXs. RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. Each of the USWEXs, up to five per year, will include coordination with the FAA well in advance of each 3- or 4-day exercise.

The advance planning and coordination with the FAA regarding ALTRV requirements for missile tests, scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, results in minimal impacts on airspace from Major Exercises.

4.1.1.2 ALTERNATIVE 1 (AIRSPACE—OPEN OCEAN)

4.1.1.2.1 Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 would include increases in the number of training events as shown in Table 2.2.2.3.1-1. Training would occur in the same locations as identified for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to those described in Section 4.1.1.1 for the No-action Alternative. The total number of training events that affect airspace would increase by approximately 16 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. Training would continue to utilize the existing Open Ocean Area special use airspace including the PMRF and Oahu Warning Areas and ATCAA shown on Figure 3.1.1-1. By appropriately containing hazardous military activities within the over-water Warning Areas or coordinating the use of the ATCAA areas, non-participating traffic is advised or separated accordingly. Therefore, potential impacts on all airspace users are minimized.

As noted above, continuing training will use the existing Open Ocean Area special use airspace and will not require either: (1) a change to an existing or planned IFR minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a VFR operation to change from a regular flight course or altitude. The increase in training under Alternative 1 would require an increase in coordination and scheduling by the Navy and the FAA. The increase in training would be readily accommodated within the existing airspace. Consequently, there are no airspace conflicts.

4.1.1.2.2 Enhanced and Future RDT&E Activities—Alternative 1

The proposed activities include interceptor targets launched from Wake Island, Kwajalein Atoll, or Vandenberg AFB into the TOA; Standard Missile-6 (SM-6) launches from a sea-based platform; and high speed and unmanned aerial vehicle testing. The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes would be similar to that described above for missile launches in Section 4.1.1.1.2. The intercept areas would be in the Open Ocean Area and TOA.

Alternative 1 would include increases in the number of RDT&E activities as shown in Table 2.2.2.5-1. RDT&E activities would occur in the same locations as for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described in Section 4.1.1.1 for the No-action Alternative. The total number of RDT&E activities that may affect airspace would increase by approximately 6 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. The RDT&E activities would continue to utilize the existing Open Ocean Area special use airspace including the PMRF Warning Areas and ATCAA and TOA shown on Figure 3.1.1-1. By appropriately containing hazardous military activities within the over-water Warning Areas or coordinating the use of the ATCAA areas, or using ALTRV procedures in the TOA, non-participating traffic is advised or separated accordingly. The relatively sparse use of the area by commercial aircraft and the advance coordination with the FAA regarding ALTRV requirements results in minimal impacts on controlled and uncontrolled airspace from RDT&E activities. The small increase in RDT&E activities under Alternative 1 would require a minor increase in coordination and scheduling by the Navy and the FAA. The increased RDT&E activities would be readily accommodated within the existing airspace.

4.1.1.2.3 HRC Enhancements—Alternative 1

Range safety for high-energy lasers at PMRF could affect airspace. Depending on the intensity of the lasers, nomenclature would need to be added to aeronautical charts, and certain test events could require NOTAMs and Notices to Mariners (NOTMARs).

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described above for missile launches. The establishment of laser range operational procedures, including horizontal and vertical buffers, would minimize potential impacts on aircraft. All activities would be in accordance with American National Standards Institute (ANSI) Z136.1, *Safe Use of Lasers*, which has been adopted by DoD as the governing standard for laser safety. Additional information on range safety for high-energy lasers is in Section 4.1.5, Health and Safety.

4.1.1.2.4 Major Exercises—Alternative 1

Major Exercises, such as RIMPAC and USWEX, include combinations of unit-level training and, in some cases, RDT&E activities that have been occurring in the HRC for decades. Therefore, potential impacts from a Major Exercise on the open ocean airspace would be similar to those described for training and the RDT&E activities under the No-action Alternative. RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in

March of the year prior to each RIMPAC. Each of the USWEXs, up to six per year, would include coordination with the FAA well in advance of each 3- or 4-day exercise.

The advance planning and coordination with the FAA regarding ALTRV requirements for missile tests, scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, results in minimal impacts on airspace from Major Exercises. The increase from one aircraft carrier to two during RIMPAC under Alternative 1 would require a minor increase in coordination and scheduling by the Navy and the FAA. The increased training would be readily accommodated within the existing airspace.

4.1.1.3 ALTERNATIVE 2 (AIRSPACE—OPEN OCEAN)

4.1.1.3.1 Increased Tempo and Frequency of Training—Alternative 2

Alternative 2 would include increases in the number of training events as shown on Table 2.2.2.3-1. Training would occur in the same locations as for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described in Section 4.1.1.1 for the No-action Alternative. The total number of training events that affect airspace would increase by approximately 22 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. Training would continue to use the existing Open Ocean Area special use airspace including the PMRF and Oahu Warning Areas and ATCAA shown on Figure 3.1.1-1. By appropriately containing hazardous military activities within the over-water Warning Areas or coordinating the use of the ATCAA areas, non-participating traffic is advised or separated accordingly, thus avoiding adverse impacts on the low altitude airways and high-altitude jet routes in the region of influence.

Alternative 2 would also include increases in the number of RDT&E activities including missile defense ballistic missile target flights, Terminal High Altitude Area Defense (THAAD) interceptor activities, A-S MISSILEX, A-A MISSILEX, S-A MISSILEX, and S-S MISSILEX. RDT&E activities would occur in the same locations as for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described in Section 4.1.1.1 for the No-action Alternative. The total number of RDT&E activities that may affect airspace would increase by approximately 16 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. The RDT&E activities would continue to use the existing Open Ocean Area special use airspace including the PMRF Warning Areas, ATCAA, and TOA shown on Figure 3.1.1-1. By appropriately containing hazardous military activities within the over-water Warning Areas or coordinating the use of the ATCAA areas, or using ALTRV procedures in the TOA, non-participating traffic would be advised or separated accordingly, thus avoiding adverse impacts on the low altitude airways and high-altitude jet routes in the region of influence. Due to the planning and coordination required for the use of special use airspace, the small increase in the tempo and frequency of training would be readily accommodated within the existing special use airspace.

As noted above, continuing training will use the existing Open Ocean Area special use airspace and will not require either: (1) a change to an existing or planned IFR minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a VFR operation to change from a regular flight course or altitude. The increase in training under Alternative 1 would require an increase in coordination and scheduling by the Navy and the FAA. The increase in training would be readily accommodated within the existing airspace. Consequently, there are no airspace conflicts.

4.1.1.3.2 Enhanced and Future RDT&E Activities—Alternative 2

Future RDT&E activities include a Maritime Directed Energy Test Center at PMRF and the Advanced Hypersonic Weapon test program.

The Directed Energy Test Center, which may include a High-Energy Laser Program, would have minimal impacts on airspace due to the required electromagnetic radiation/electromagnetic interference (EMR/EMI) coordination process. As discussed in Section 4.1.1.2.3, high-energy lasers at PMRF could affect airspace. Depending on the intensity of the lasers, nomenclature would need to be added to aeronautical charts, and certain test events could require NOTAMs and NOTMARs. The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described earlier for missile launches. The establishment of laser range operational procedures, including horizontal and vertical buffers, would minimize potential impacts on aircraft. All activities would be in accordance with ANSI Z136.1, *Safe Use of Lasers*, which has been adopted by DoD as the governing standard for laser safety. Additional information on range safety for high-energy lasers is in Section 4.1.5, Health and Safety.

The Advanced Hypersonic Weapon tests would be similar to a ballistic missile test. Potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described earlier for missile launches.

4.1.1.3.3 Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Exercise consisting of training that involves Navy assets engaging in a schedule of events battle scenario, with U.S. forces pitted against a notional opposition force. Participants use and build upon previously gained training skill sets to maintain and improve the proficiency needed for a mission-capable, deployment-ready unit. The exercise would occur over a 5- to 10-day period. The Multiple Strike Group training would involve many of the training events identified and evaluated under Sections 4.1.1.1 and 4.1.1.2, No-action Alternative and Alternative 1, including mine laying, S-S GUNEX, A-S GUNEX, S-S MISSILEX, A-S MISSILEX, BOMBEX, SINKEX, EER/IEER, ACM, A-A MISSILEX, ECM, S-A GUNEX, S-A MISSILEX, NSFS, Flare Exercises, and CHAFFEX.

Additional training includes Maritime Interdiction and Air Interdiction of Maritime Targets. These events would include a U.S. surface action group consisting of Navy surface combatants, Military Sea-Lift Command ships, and a Coast Guard Cutter. Opposition forces would consist of Navy frigates, cruisers, and destroyers, carrier air wing aircraft from the three Navy aircraft carriers, and Air Force fighter aircraft. All coordinated training would take place within the

PMRF and Oahu Warning Areas and other areas as required. The exercise may include Air Force aircraft that would operate from Hickam Air Force Base (AFB), and carrier air wing aircraft that would operate from their respective aircraft carriers. The aircraft would coordinate efforts with opposition force surface ships to locate, target, and simulate strikes against the U.S. surface action group.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described in Section 4.1.1.1 for the No-action Alternative. The additional types of training described in the previous paragraphs are similar to and would occur in the same areas as some of the training analyzed under the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. The Multiple Strike Group Exercises and training identified above would continue to use the existing Open Ocean Area special use airspace including the PMRF and Oahu Warning Areas and ATCAA shown on Figure 3.1.1-1. By appropriately containing hazardous military activities within the over-water Warning Areas or coordinating the use of the ATCAA areas, non-participating traffic would be advised or separated accordingly, thus avoiding adverse impacts on the low altitude airways and high-altitude jet routes in the region of influence.

The advance planning and coordination with the FAA regarding scheduling of special use airspace and coordination of Navy training relative to en route airways and jet routes would result in minimal impacts on airspace from a Multiple Strike Group exercise. The use of three aircraft carriers during the 10-day exercise would require an increase in coordination and scheduling by the Navy and the FAA. The increased training would be readily accommodated within the existing airspace.

4.1.1.4 ALTERNATIVE 3 (AIRSPACE—OPEN OCEAN)

The difference between Alternative 2 and Alternative 3 is the amount of mid-frequency active/high frequency active (MFA/HFA) sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.1.2 BIOLOGICAL RESOURCES—OPEN OCEAN

Generally, impacts on biological resources are evaluated as potential losses to populations of species of concern or to important habitat resources. Criteria for assessing potential impacts on marine biological resources are based on the following:

- Loss of habitat (destruction, degradation, denial, competition)
- Over-harvesting or excessive take (accidental or intentional death, injury)
- Harassment

- Increases in exposure or susceptibility to disease and predation
- Decrease in breeding success

Collision with ordnance, missile debris, or vessels; release of contaminants from munitions constituents or expended range materials; sound; or human contact could potentially cause impacts. Impacts are considered substantial if they have the potential to result in reduction of population size of Federally listed threatened or endangered species, degradation of biologically important unique habitat, or reduction in capacity of a habitat to support species.

This section includes the following biological resource topics:

- Coral (Biological Resources—Open Ocean)
- Fish (Biological Resources—Open Ocean)
- Sea Turtles (Biological Resources—Open Ocean)
- Marine Mammals (Biological Resources—Open Ocean)
- Methodology for Analyzing Impacts on Marine Mammals
- Marine Mammals No-action Alternative (Biological Resources—Open Ocean)
- Marine Mammals Alternative 1 (Biological Resources—Open Ocean)
- Marine Mammals Alternative 2 (Biological Resources—Open Ocean)
- Marine Mammals Alternative 3 (Biological Resources—Open Ocean)
- Marine Mammal Mortality Request

4.1.2.1 CORAL (BIOLOGICAL RESOURCES—OPEN OCEAN)

4.1.2.1.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Coral—Biological Resources—Open Ocean)

As shown on Figure 3.1.2.1-1, deep sea coral within the Open Ocean Area is located in deep water and is limited in areal extent. The potential for impacts on these deep water corals from Navy training and RDT&E activities would be very limited. The Navy activities would not result in any direct impacts on the coral or degradation of water/sediment quality in the vicinity of the corals. The probability of intercept debris from a MISSILEX or expended materials from GUNEX, BOMBEX, EER/IEER, or SINKEX affecting any coral is extremely small. In addition, the debris and expended materials are spread out over a wide area so that even in the unlikely event the debris or expended materials lands on the coral, the pieces would be diffused and negligible. There is no deep water coral located in the area where SINKEX is typically conducted. Because the potential for impacts on deep sea coral is so remote, further discussion is unnecessary.

New proposed activities will be located in areas with no known coral concentration when possible. In areas that have not been mapped for coral presence, the Navy will develop appropriate habitat data and any necessary Best Management Practices and mitigations in coordination with National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). The Navy will continue to work with regulatory agencies throughout the planning and development process to minimize the potential for impacts on coral.

4.1.2.2 FISH (BIOLOGICAL RESOURCES—OPEN OCEAN)

In this section, the approach to the assessment of effects on fish is presented, as well as a review of the literature on potential effects common to most activities. These include noise disturbance and underwater detonations. Effects on fish and the distances at which behavioral effects can occur depend on the nature of the sound, the hearing ability of the fish, and species-specific behavioral responses to sound. Changes in fish behavior can, at times, reduce their catchability and thus affect fisheries.

There are two types of sound sources that are of major concern to fish and fisheries: (1) strong underwater shock pulses that can cause physical damage to fish, and (2) underwater sounds that could cause disturbance to fish and affect their biology or catchability by fishers. The following methods were used to assess potential effects of noise on fish. Received noise levels that correspond to the various types of effects on fish were evaluated. Effects include physical damage to fish, short-term behavioral reactions, long-term behavioral reactions, and changes in distribution.

Effects of Human-Generated Sound on Fish

There have been very few studies on the effects that human-generated sound may have on fish. These have been reviewed in a number of places (e.g., National Research Council 1994, 2003, Popper 2003, Popper et al. 2004, Hastings and Popper 2005), and some more recent experimental studies have provided additional insight into the issues (e.g., Govoni et al. 2003, McCauley et al. 2003, Popper et al. 2005, 2007, Song et al., 2005). Most investigations, however, have been in the gray literature (non peer-reviewed reports – see Hastings and Popper, 2005 for an extensive critical review of this material). While some of these studies provide insight into effects of sound on fish, as mentioned earlier, the majority of the gray literature studies often lack appropriate controls, statistical rigor, and/or expert analysis of the results.

There are a wide range of potential effects on fish that range from no effect at all (e.g., the fish does not detect the sound or it "ignores" the sound) to immediate mortality. In between these extremes are a range of potential effects that parallel the potential effects on fish that were illustrated by Richardson et al. (1995a). These include, but may not be limited to:

- No effect behaviorally or physiologically: The animal may not detect the signal, or the signal is not one that would elicit any response from the fish.
- Small and inconsequential behavioral effects: Fish may show a temporary "awareness" of the presence of the sound but soon return to normal activities.
- Behavioral changes that result in the fish moving from its current site: This may involve leaving a feeding or breeding ground. This effect may be temporary, in that the fish return to the site after some period of time (perhaps after a period of acclimation or when the sound terminates), or permanent.
- Temporary loss of hearing (often called Temporary Threshold Shift – TTS): This recovers over minutes, hours, or days.
- Physical damage to auditory or non-auditory tissues (e.g., swim bladder, blood vessels, brain): The damage may be only temporary, and the tissue "heals" with little impact on

fish survival, or it may be more long-term, permanent, or may result in death. Death from physical damage could be a direct effect of the tissue damage or the result of the fish being more subject to predation than a healthy individual.

Studies on effects on hearing have generally been of two types. In one set of studies, the investigators exposed fish to long-term increases in background noise to determine if there are changes in hearing, growth, or survival of the fish. Such studies were directed at developing some understanding of how fish might be affected if they lived in an area with constant and increasing shipping or in the presence of a wind farm, or in areas where there are long-term acoustic tests. Other similar environments might be aquaculture facilities or large marine aquaria. In most of these studies examining long-term exposure, the sound intensity was well below any that might be expected to have immediate damage to fish (e.g., damage tissues such as the swim bladder or blood vessels).

In the second type of studies, fish were exposed to short-duration but high-intensity signals such as might be found near a high-intensity sonar, pile driving, or seismic airgun survey. The investigators in such studies were examining whether there was not only hearing loss and other long-term effects, but also short-term effects that could result in death to the exposed fish.

Effects of Long-Duration Increases in Background Sounds on Fish

Effects of long-duration relatively low intensity sounds (e.g., below 170–180 decibels (dB) re 1 micropascal (µPa) received level ([RL]) indicate that there is little or no effect of long-term exposure on hearing generalists (e.g., Scholik and Yan, 2001, Amoser and Ladich, 2003, Smith et al., 2004a,b, Wysocki et al., 2007). The longest of these studies exposed young rainbow trout (*Oncorhynchus mykiss*) to a level of noise equivalent to one that fish would experience in an aquaculture facility (e.g., on the order of 150 dB re 1 µPa RL) for about 9 months. The investigators found no effect on hearing or on any other measures including growth and effects on the immune system as compared to fish raised at 110 dB re 1 µPa RL. The sound level used in the study would be equivalent to ambient sound in the same environment without the presence of pumps and other noise sources of an aquaculture facility (Wysocki et al., 2007).

Studies on hearing specialists have shown that there is some hearing loss after several days or weeks of exposure to increased background sounds, although the hearing loss seems to recover (e.g., Scholik and Yan, 2002; Smith et al., 2004b, 2006). Smith et al. (2004a, 2006) investigated the goldfish (*Carassius auratus*). They exposed fish to noise at 170 dB re 1 µPa and there was a clear relationship between the level of the exposure sound and the amount of hearing loss. There was also a direct correlation of level of hearing loss and the duration of exposure, up to 24-hours, after which time the maximum hearing loss was found.

Similarly, Wysocki and Ladich (2005) investigated the influence of noise exposure on the auditory sensitivity of two freshwater hearing specialists, the goldfish and the lined Raphael catfish (*Platydoras costatus*), and on a freshwater hearing generalist, a sunfish (*Lepomis gibbosus*). Baseline thresholds showed greatest hearing sensitivity around 0.5 kilohertz (kHz) in the goldfish and catfish and at 0.1 kHz in the sunfish. For the hearing specialists (goldfish and catfish), continuous white noise of 130 dB re 1 µPa RL resulted in a significant threshold shift of 23 to 44 dB. In contrast, the auditory thresholds in the hearing generalist (sunfish) declined by 7 to 11 dB.

In summary, and while data are limited to a few freshwater species, it appears that some increase in ambient noise level, even to above 170 dB re 1 µPa does not permanently alter the hearing ability of the hearing generalist species studied, even if the increase in sound level is for an extended period of time. However, this may not be the case for all hearing generalists, though it is likely that any temporary hearing loss in such species would be considerably less than for specialists receiving the same noise exposure. But, it is critical to note that more extensive data are needed on additional species, and if there are places where the ambient levels exceed 170–180 dB, it would be important to do a quantitative study of effects of long-term sound exposure at these levels.

It is also clear that there is a larger temporary hearing loss in hearing specialists. Again, however, extrapolation from the few freshwater species to other species (freshwater or marine) must be done with caution until there are data for a wider range of species, and especially species with other types of hearing specializations than those found in the species studied to date (all of which are otophysan fishes and have the same specializations to enhance hearing).

Effects of High Intensity Sounds on Fish

There is a small group of studies that discusses effects of high intensity sound on fish. However, as discussed in Hastings and Popper (2005), much of this literature has not been peer reviewed, and there are substantial issues with regard to the actual effects of these sounds on fish. More recently, however, there have been two studies of the effects of high intensity sound on fish that, using experimental approaches, provided insight into overall effects of these sounds on hearing and on auditory and non-auditory tissues. One study tested effects of seismic airguns, a highly impulsive and intense sound source, while the other study examined the effects of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar. Since these studies are the first that examined effects on hearing and physiology, they will be discussed in some detail. These studies not only provide important data, but also suggest ways in which future experiments need to be conducted. This discussion will be followed by a brief overview of other studies that have been done, some of which may provide a small degree of insight into potential effects of human-generated sound on fish.

Effects of Seismic Airguns on Fish

Popper et al. (2005; Song et al., 2006) examined the effects of exposure to a seismic airgun array on three species of fish found in the Mackenzie River Delta near Inuvik, Northwest Territories, Canada. The species included a hearing specialist, the lake chub (*Couesius plumbeus*), and two hearing generalists, the northern pike (*Esox lucius*), and the broad whitefish (*Coregonus nasus*) (a salmonid). In this study, fish in cages were exposed to 5 or 20 shots from a 730 in^3 (12,000 cc) calibrated airgun array. And, unlike earlier studies, the received exposure levels were not only determined for root-mean-square (rms) sound pressure level (SPL), but also for peak sound levels and for sound equivalent levels (SELs) (e.g., average mean peak SPL 207 dB re 1 µPa RL; mean rms sound level 197 dB re 1 µPa RL; mean SEL 177 dB re 1 $\mu Pa^2 s$).

The results showed a temporary hearing loss for both lake chub and northern pike, but not for the broad whitefish, to both 5 and 20 airgun shots. Hearing loss was on the order of 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18 hours after sound exposure. While a full pathological study was not conducted, fish of all three species survived the sound exposure and were alive more than 24 hours after exposure. Those fish of all three species had intact swim bladders and there was no apparent external or internal damage to other body tissues (e.g., no bleeding or grossly damaged tissues), although it is important to note that the observer in this case (unlike in the following LFA study) was not a trained pathologist. Recent examination of the ear tissues by an expert pathologist showed no damage to sensory hair cells in any of the fish exposed to sound (Song et al., 2006).

A critical result of this study was that it demonstrated differences in the effects of airguns on the hearing thresholds of different species. In effect, these results substantiate the argument made by Hastings et al. (1996) and McCauley et al. (2003) that it is difficult to extrapolate between species with regard to the effects of intense sounds.

Experiments conducted by Skalski et al. (1992), Dalen and Raknes (1985), Dalen and Knutsen (1986), and Engas et al. (1996) demonstrated that some fish were forced to the bottom and others driven from the area in response to low-frequency airgun noise. The authors speculated that catch per unit effort would return to normal quickly in their experimental area because behavior of the fish returned to normal minutes after the sounds ceased.

Effects of SURTASS LFA Sonar on Fish

Popper et al. (2007) studied the effect of SURTASS LFA on hearing, the structure of the ear, and select non-auditory systems in the rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*) (also Halvorsen et al., 2006).

The SURTASS LFA sonar study was conducted in an acoustic free-field environment that enabled the investigators to have a calibrated sound source and to monitor the sound field throughout the experiments. In brief, experimental fish were placed in a test tank, lowered to depth, and exposed to LFA sonar for 324 or 648 seconds, an exposure duration that is far greater than any fish in the wild would get since, in the wild, the sound source is on a vessel moving past the far slower swimming fish. For a single tone, the maximum RL was approximately 193 dB re 1 μPa at 196 Hz and the level was uniform within the test tank to within approximately ±3 dB. The signals were produced by a single SURTASS LFA sonar transmitter giving an approximate source level of 215 dB. Following exposure, hearing was measured in the test animals. Animals were also sacrificed for examination of auditory and non-auditory tissues to determine any non-hearing effects. All results from experimental animals were compared to results obtained from baseline control and control animals.

A number of results came from this study. Most importantly, no fish died as a result of exposure to the experimental source signals. Fish all appeared healthy and active until they were sacrificed or returned to the fish farm from which they were purchased. In addition, the study employed the expertise of an expert fish pathologist who used double-blind methods to analyze the tissues of the fish exposed to the sonar source, and compared these to control animals. The results clearly showed that there were no pathological effects from sound exposure including no effects on all major body tissues (brain, swim bladder, heart, liver, gonads, blood, etc.). There was no damage to the swim bladder and no bleeding as a result of LFA sonar exposure. Furthermore, there were no short- or long-term effects on ear tissue (Popper et al., 2007, also Kane et al., in preparation).

Moreover, behavior of caged fish after sound exposure was no different than that prior to tests. It is critical to note, however, that behavior of fish in a cage in no way suggests anything about how fish would respond to a comparable signal in the wild. Just as the behavior of humans exposed to a noxious stimulus might show different behavior if in a closed room as compared to being out-of-doors, it is likely that the behaviors shown by fish to stimuli will also differ, depending upon their environment.

The study also incorporated effects of sound exposure on hearing both immediately post exposure and for several days thereafter to determine if there were any long-term effects, or if hearing loss showed up at some point post exposure. Catfish and some specimens of rainbow trout showed 10-20 dB of hearing loss immediately after exposure to the LFA sonar when compared to baseline and control animals; however, another group of rainbow trout showed no hearing loss. Recovery in trout took at least 48 hours, but studies could not be completed. The different results between rainbow trout groups is difficult to understand, but may be due to developmental or genetic differences in the various groups of fish. Catfish hearing returned to, or close to, normal within about 24 hours.

Additional Sonar Data

While there are no other data on the effects of sonar on fish, there are two recent unpublished reports of some relevance since it examined the effects on fish of a mid-frequency sonar (1.5 to 6.5 kHz) on larval and juvenile fish of several species (Jørgensen et al., 2005, Kvadsheim and Sevaldsen, 2005). In this study, larval and juvenile fish were exposed to simulated sonar signals in order to investigate potential effects on survival, development, and behavior. The study used herring (*Clupea harengus*) (standard lengths 2 to 5 centimeters [cm]), Atlantic cod (*Gadus morhua*) (standard length 2 and 6 cm), saithe (*Pollachius virens*) (4 cm), and spotted wolffish (*Anarhichas minor*) (4 cm) at different developmental stages.

Fish were placed in plastic bags 3 m from the sonar source and exposed to between four and 100 pulses of 1-second duration of pure tones at 1.5, 4 and 6.5 kHz. Sound levels at the location of the fish ranged from 150 to 189 dB. There were no effects on fish behavior during or after exposure to sound (other than some startle or panic movements by herring for sounds at 1.5 kHz) and there were no effects on behavior, growth (length and weight), or survival of fish kept as long as 34 days post exposure. All exposed animals were compared to controls that received similar treatment except for actual exposure to the sound. Excellent pathology of internal organs showed no damage as a result of sound exposure. The only exception to almost full survival was exposure of two groups of herring tested with SPLs of 189 dB, where there was a post-exposure mortality of 20 to 30 percent. While these were statistically significant losses, it is important to note that this sound level was only tested once and so it is not known if this increased mortality was due to the level of the test signal or to other unknown factors.

In a follow-up unpublished analysis of these data, Kvadsheim and Sevaldsen (2005) sought to understand whether the mid-frequency continuous wave (CW) signals used by Jørgensen et al. (2005) would have a significant impact on larvae and juveniles in the wild exposed to this sonar. The investigators concluded that the extent of damage/death induced by the sonar would be below the level of loss of larval and juvenile fish from natural causes, and so no concerns should be raised. The only issue they did suggest needs to be considered is when the CW signal is at the resonance frequency of the swim bladders of small clupeids. If this is the case, the investigators predict (based on minimal data that is in need of replication) that such sounds might increase the mortality of small clupeids that have swim bladders that would resonate.

Other High Intensity Sources

A number of other sources have been examined for potential effects on fish. These have been critically and thoroughly reviewed recently by Hastings and Popper (2005) and so only brief mention will be made of a number of such studies.

One of the sources of most concern is pile driving, as occurs during the building of bridges, piers, off-shore wind farms, and the like. There have been a number of studies that suggest that the sounds from pile driving, and particularly from driving of larger piles, kill fish that are very close to the source. The source levels in such cases often exceed 230 dB re 1 µPa (peak) and there is some evidence of tissue damage accompanying exposure (e.g., Caltrans 2001, 2004, reviewed in Hastings and Popper 2005). However, there is reason for concern in analysis of such data since, in many cases, the only dead fish that were observed were those that came to the surface. It is not clear whether fish that did not come to the surface survived the exposure to the sounds, or died and were carried away by currents.

There are also a number of gray literature experimental studies that placed fish in cages at different distances from the pile driving operations and attempted to measure mortality and tissue damage as a result of sound exposure. However, in most cases the studies' (e.g., Caltrans 2001, 2004, Abbott et al. 2002, 2005, Nedwell et al. 2003) work was done with few or no controls, and the behavioral and histopathological observations done very crudely (the exception being Abbott et al. 2005). As a consequence of these limited and unpublished data, it is not possible to know the real effects of pile driving on fish.

In a widely cited unpublished report, Turnpenny et al. (1994) examined the behavior of three species of fish in a pool in response to different sounds. While this report has been cited repeatedly as being the basis for concern about the effects of human-generated sound on fish, there are substantial issues with the work that make the results unusable for helping understand the potential effects of any sound on fish, including mid- and high-frequency sounds. The problem with this study is that there was a complete lack of calibration of the sound field at different frequencies and depths in the test tank, as discussed in detail in Hastings and Popper (2005). The issue is that in enclosed chambers that have an interface with air, such as tanks and pools used by Turnpenny et al., the sound field is known to be very complex and will change significantly with frequency and depth. Thus, it is impossible to know the stimulus that was actually received by the fish. Moreover, the work done by Turnpenny et al. was not replicated by the investigators even within the study, and so it is not known if the results were artifact, or were a consequence of some uncalibrated aspects of the sound field that cannot be related, in any way, to human-generated high intensity sounds in the field, at any frequency range.

Several additional studies have examined effects of high intensity sounds on the ear. While there was no effect on ear tissue in either the SURTASS LFA study (Popper et al., 2007) or the study of effects of seismic airguns on hearing (Popper et al., 2005, Song et al., 2006), three earlier studies suggested that there may be some loss of sensory hair cells due to high intensity sources. However, none of these studies concurrently investigated effects on hearing or non-auditory tissues. Enger (1981) showed some loss of sensory cells after exposure to pure tones in the Atlantic cod. A similar result was shown for the lagena of the oscar (*Astronotus oscellatus*), a cichlid fish, after an hour of continuous exposure (Hastings et al., 1996). In neither study was the hair cell loss more than a relatively small percent of the total sensory hair cells in the hearing organs.

Most recently, McCauley et al. (2003) showed loss of a small percent of sensory hair cells in the saccule (the only end organ studied) of the pink snapper (*Pagrus auratus*), and this loss continued to increase (but never to become a major proportion of sensory cells) for up to at least 53 days post exposure. It is not known if this hair cell loss, or the ones in the Atlantic cod or oscar, would result in hearing loss since fish have tens or even hundreds of thousands of sensory hair cells in each otolithic organ (Popper and Hoxter, 1984, Lombarte and Popper, 1994) and only a small portion were affected by the sound. The question remains as to why McCauley et al. (2003) found damage to sensory hair cells while Popper et al. (2005) did not. The problem is that there are so many differences in the studies, including species, precise sound source, spectrum of the sound (the Popper et al. 2005 study was in relatively shallow water with poor low-frequency propagation), that it is hard to even speculate.

Beyond these studies, there have also been questions raised as to the effects of other sound sources such as shipping, wind farm operations, and the like. However, there are limited or no data on actual effects of the sounds produced by these sources on any aspect of fish biology.

Intraspecific Variation in Effects

One unexpected finding in several of the recent studies is that there appears to be variation in the effects of sound, and on hearing, that may be a correlated with environment, developmental history, or even genetics.

During the aforementioned LFA sonar study on rainbow trout, Popper et al. (2007) found that some fish showed a hearing loss, but other animals, obtained a year later but from the same supplier and handled precisely as the fish used in the earlier part of the study, showed no hearing loss. The conclusion reached by Popper et al. (2007) was that the differences in responses may have been related to differences in genetic stock or some aspect of early development in the two groups of fish studied.

The idea of a developmental effect was strengthened by findings of Wysocki et al. (2007) who found differences in hearing sensitivity of rainbow trout that were from the same genetic stock, but that were treated slightly differently in the egg stage. This is further supported by studies on hatchery-reared Chinook salmon (*Oncorhynchus tshawytscha*) which showed that some animals from the same stock and age class had statistical differences in their hearing capabilities that were statistically correlated with differences in otolith structure (Oxman et al., 2007). While a clear correlation could not be made between these differences in otolith structure and specific factors, there is strong reason to believe that the differences resulted from environmental effects during development.

The conclusion one must reach from these findings is that there is not only variation in effects of intense sound sources on different species, but that there may also be differences based on genetics or development. Indeed, one can go even further and suggest that there may ultimately be differences in effects of sound on fish (or lack of effects) that are related to fish age as well as development and genetics since it was shown by Popper et al. (2005) that identical seismic airgun exposures had very different effects on hearing in young-of-the-year northern pike and sexually mature animals.

Effects of Anthropogenic Sound on Behavior

There have been very few studies of the effects of anthropogenic sounds on the behavior of wild (unrestrained) fishes. This includes not only immediate effects on fish that are close to the source but also effects on fish that are further from the source.

Several studies have demonstrated that human-generated sounds may affect the behavior of at least a few species of fish. Engås et al. (1996) and Engås and Løkkeborg (2002) examined movement of fish during and after a seismic airgun study although they were not able to actually observe the behavior of fish per se. Instead, they measured catch rate of haddock and Atlantic cod as an indicator of fish behavior. These investigators found that there was a significant decline in catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) that lasted for several days after termination of airgun use. Catch rate subsequently returned to normal. The conclusion reached by the investigators was that the decline in catch rate resulted from the fish moving away from the fishing site as a result of the airgun sounds. However, the investigators did not actually observe behavior, and it is possible that the fish just changed depth. Another alternative explanation is that the airguns actually killed the fish in the area, and the return to normal catch rate occurred because of other fish entering the fishing areas.

More recent work from the same group (Slotte et al., 2004) showed parallel results for several additional pelagic species including blue whiting and Norwegian spring spawning herring. However, unlike earlier studies from this group, Slotte et al. used fishing sonar to observe behavior of the local fish schools. They reported that fishes in the area of the airguns appeared to go to greater depths after the airgun exposure compared to their vertical position prior to the airgun usage. Moreover, the abundance of animals 30-50 km away from the ensonification increased, suggesting that migrating fish would not enter the zone of seismic activity. It should be pointed out that the results of these studies have been refuted by Gausland (2003) who, in a non peer-reviewed study, suggested that catch decline was from factors other than exposure to airguns and that the data were not statistically different than the normal variation in catch rates over several seasons.

Similarly Skalski et al. (1992) showed a 52 percent decrease in rockfish (*Sebastes* sp.) catch when the area of catch was exposed to a single airgun emission at 186-191 dB re 1 µPa (mean peak level) (see also Pearson et al., 1987, 1992). They also demonstrated that fishes would show a startle response to sounds as low as 160 dB, but this level of sound did not appear to elicit decline in catch.

Wardle et al. (2001) used a video system to examine the behaviors of fish and invertebrates on a coral reef in response to emissions from seismic airguns that were carefully calibrated and measured to have a peak level of 210 dB re 1 µPa at 16 m from the source and 195 dB re 1 µPa at 109 m from the source. They found no substantial or permanent changes in the behavior of the fish or invertebrates on the reef throughout the course of the study, and no animals appeared to leave the reef. There was no indication of any observed damage to the animals.

Culik et al. (2001) and Gearin et al. (2000) studied how noise may affect fish behavior by looking at the effects of mid-frequency sound produced by acoustic devices designed to deter marine mammals from gillnet fisheries. Gearin et al. (2000) studied responses of adult sockeye salmon (*Oncorhynchus nerka*) and sturgeon (*Acipenser* sp.) to pinger sounds. They found that fish did not exhibit any reaction or behavior change to the onset of the sounds of pingers that produced broadband energy with peaks at 2 kHz or 20 kHz. This demonstrated that the alarm was either inaudible to the salmon and sturgeon, or that neither species was disturbed by the mid-frequency sound (Gearin et al., 2000). Based on hearing threshold data (Table 3.1.2.2.3.2-1), it is highly likely that the salmonids did not hear the sounds.

Culik et al. (2001) did a very limited number of experiments to determine catch rate of herring (*Clupea harengus*) in the presence of pingers producing sounds that overlapped the frequency range of hearing of herring (2.7 kHz to over 160 kHz). They found no change in catch rate in gill nets with or without the higher frequency (> 20 kHz) sounds present, although there was an increase in catch rate with the signals from 2.7 kHz to 19 kHz (a different source than the higher frequency source). The results could mean that the fish did not "pay attention" to the higher frequency sound or that they did not hear it, but that lower frequency sounds may be attractive to fish. At the same time, it should be noted that there were no behavioral observations on the fish, and so how the fish actually responded when they detected the sound is not known.

The low-frequency (<2 kHz) sounds of large vessels or accelerating small vessels usually caused an initial avoidance response among the herring. The startle response was observed occasionally. Avoidance ended within 10 seconds of the "departure" of the vessel. After the initial response, 25 percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound of the small boat. Chapman and Hawkins (1969) also noted that fish adjust rapidly to high underwater sound levels, and Schwartz and Greer (1984) found no reactions to an echosounder and playbacks of sonar signals which were much higher than that of the MFA in the Proposed Action.

Masking

Any sound detectable by a fish can have an impact on behavior by preventing the fish from hearing biologically important sounds including those produced by prey or predators (Myrberg 1980, Popper et al. 2003). This inability to perceive biologically relevant sounds as a result of the presence of other sounds is called masking. Masking may take place whenever the received level of a signal heard by an animal exceeds ambient noise levels or the hearing threshold of the animal. Masking is found among all vertebrate groups, and the auditory system in all vertebrates, including fishes, is capable of limiting the effects of masking signals, especially when they are in a different frequency range than the signal of biological relevance (Fay, 1988, Fay and Megela-Simmons 1999).

One of the problems with existing fish masking data is that the bulk of the studies have been done with goldfish, a freshwater hearing specialist. The data on other species are much less extensive. As a result, less is known about masking in non-specialist and marine species. Tavolga (1974a, b) studied the effects of noise on pure-tone detection in two non-specialists and found that the masking effect was generally a linear function of masking level, independent of frequency. In addition, Buerkle (1968, 1969) studied five frequency bandwidths for Atlantic cod in the 20 to 340 Hz region and showed masking in all hearing ranges. Chapman and Hawkins (1973) found that ambient noise at higher sea states in the ocean have masking effects in cod, haddock, and Pollock, and similar results were suggested for several sciaenid species by Ramcharitar and Popper (2004). Thus, based on limited data, it appears that for fish, as for mammals, masking may be most problematic in the frequency region of the signal of the masker. Thus, for mid-frequency sonars, which are well outside the range of hearing of most all fish species, there is little likelihood of masking taking place for biologically relevant signals to fish since the fish will not hear the masker.

There have been a few field studies which may suggest that masking could have an impact on wild fish. Gannon et al. (2005) showed that bottlenose dolphins (*Tursiops truncatus*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Bottlenose dolphins employ a variety of vocalizations during social communication including low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their hearing is best below 1 kHz, and there is some indication that toadfish have reduced levels of calling when bottlenose dolphins approach (Remage-Healey et al. 2006). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich et al. 2000). Results of the Luczkovich et al. (2000) study, however, must be viewed with caution because it is not clear what sound may have elicited the silver perch response (Ramcharitar et al. 2006a).

Of considerable concern is that human-generated sounds could mask the ability of fish to use communication sounds, especially when the fish are communicating over some distance. In effect, the masking sound may limit the distance over which fish can communicate, thereby having an impact on important components of the behavior of fish. For example, the sciaenids, which are primarily inshore species, are probably the most active sound producers among fish, and the sounds produced by males are used to “call” females to breeding sights (Ramcharitar et al. 2001; reviewed in Ramcharitar et al. 2006a). If the females are not able to hear the reproductive sounds of the males, this could have a significant impact on the reproductive success of a population of sciaenids.

Also potentially vulnerable to masking is navigation by larval fish, although the data to support such an idea are still exceedingly limited. There is indication that larvae of some species may have the potential to navigate to juvenile and adult habitat by listening for sounds emitted from a reef (either due to animal sounds or non-biological sources such as surf action) (e.g., Higgs 2005). In a study of an Australian reef system, the sound signature emitted from fish choruses was between 0.8 and 1.6 kHz (Cato 1978) and could be detected by hydrophones 5 to 8 km (3 to 4 NM) from the reef (McCauley and Cato 2000). This bandwidth is within the detectable bandwidth of adults and larvae of the few species of reef fish that have been studied (Kenyon 1996, Myrberg 1980). At the same time, it has not been demonstrated conclusively that sound, or sound alone, is an attractant of larval fish to a reef, and the number of species tested has been very limited. Moreover, there is also evidence that larval fish may be using other kinds of sensory cues, such as chemical signals, instead of, or alongside of, sound (e.g., Atema et al. 2002, Higgs et al. 2005).

Finally, it should be noted that even if a masker prevents a larval (or any) fish from hearing biologically relevant sounds for a short period of time (e.g., while a sonar-emitting ship is passing), this may have no biological effect on the fish since they would be able to detect the relevant sounds before and after the masking, and thus would likely be able to find the source of the sounds.

Stress

Although an increase in background sound may cause stress in humans, there have been few studies on fish (e.g., Smith et al. 2004a, Remage-Healey et al. 2006, Wysocki et al. 2006, 2007). There is some indication of physiological effects on fish such as a change in hormone levels and altered behavior in some (Pickering 1981, Smith et al. 2004a, b), but not all, species tested to date (e.g., Wysocki et al. 2007). Sverdrup et al. (1994) found that Atlantic salmon subjected to up to 10 explosions to simulate seismic blasts released primary stress hormones, adrenaline and cortisol, as a biochemical response. There was no mortality. All experimental subjects returned to their normal physiological levels within 72 hours of exposure. Since stress affects human health, it seems reasonable that stress from loud sound may impact fish health, but available information is too limited to adequately address the issue.

Eggs and Larvae

One additional area of concern is whether high intensity sounds may have an impact on eggs and larvae of fish. Eggs and larvae do not move very much and so must be considered as a stationary object with regard to a moving navy sound source. Thus, the time for impact of sound is relatively small since there is no movement relative to the Navy vessel.

There have been few studies on effects of sound on eggs and larvae (reviewed extensively in Hastings and Popper 2005) and there are no definitive conclusions to be reached. At the same time, many of the studies have used non-acoustic mechanical signals such as dropping the eggs and larvae or subjecting them to explosions (e.g., Jensen and Alderice 1983, 1989, Dwyer et al. 1993). Other studies have placed the eggs and/or larvae in very small chambers (e.g., Banner and Hyatt 1973) where the acoustics are not suitable for comparison with what might happen in a free sound field (and even in the small chambers, results are highly equivocal).

Several studies did examine effects of sounds on fish eggs and larvae. One non peer-reviewed study using sounds from 115-140 dB (re 1 µPa, peak) on eggs and embryos in Lake Pend Oreille (Idaho) reported normal survival or hatching, but few data were provided to evaluate the results (Bennett et al., 1994). In another study, Kostyuchenko (1973) reported damage to eggs of several marine species at up to 20 m from a source designed to mimic seismic airguns, but few data were given as to effects. Similarly, Booman et al. (1996) investigated the effects of seismic airguns on eggs, larvae, and fry and found significant mortality in several different marine species (Atlantic cod, saithe, herring) at a variety of ages, but only when the specimens were within about 5 m of the source. The most substantial effects were to fish that were within 1.4 m of the source. While the authors suggested damage to some cells such as those of the lateral line, few data were reported and the study is in need of replication. Moreover, it should be noted that the eggs and larvae were very close to the airgun array, and at such close distances the particle velocity of the signal would be exceedingly large. However, the received sound pressure and particle velocity were not measured in this study.

Conclusions - Effects

The data obtained to date on effects of sound on fish are very limited both in terms of number of well-controlled studies and in number of species tested. Moreover, there are significant limits in the range of data available for any particular type of sound source. And finally, most of the data currently available has little to do with actual behavior of fish in response to sound in their normal environment. There is also almost nothing known about stress effects of any kind(s) of sound on fish.

Mortality and Damage to Non-auditory Tissues

The results to date show only the most limited mortality, and then only when fish are very close to an intense sound source. Thus, whereas there is evidence that fish within a few meters of a pile driving operation will potentially be killed, very limited data (and data from poorly designed experiments) suggest that fish further from the source are not killed, and may not be harmed. It should be noted, however, that these and other studies showing mortality (to any sound source) need to be extended and replicated in order to understand the effects of the most intense sound on fish.

It is also becoming a bit clearer (again, albeit from very few studies) that those species of fish tested at a distance from the source where the sound level is below source level, show no mortality and possibly no long-term effects. Of course, it is recognized that it is very difficult to extrapolate from the data available (e.g., Popper et al. 2005, 2007) since only a few sound types have been tested, and even within a single sound type there have to be questions about effects of multiple exposures and duration of exposure. Still, the results to date are of considerable interest and importance, and clearly show that exposure to many types of loud sounds may have little or no affect on fish. And, if one considers that the vast majority of fish exposed to a loud sound are probably some distance from a source, where the sound level has attenuated considerably, one can start to predict that only a very small number of animals in a large population will ever be killed or damaged by sounds.

Effects on Fish Behavior

The more critical issue, however, is the effect of human-generated sound on the behavior of wild animals, and whether exposure to the sounds will alter the behavior of fish in a manner that will affect its way of living – such as where it tries to find food or how well it can find a mate. With the exception of just a few field studies, there are no data on behavioral effects, and most of these studies are very limited in scope and all are related to seismic airguns. Because of the limited ways in which behavior of fish in these studies were “observed” (often by doing catch rates, which tell nothing about how fish really react to a sound), there really are no data on the most critical questions regarding behavior.

Indeed, the fundamental questions are how fish behave during and after exposure to a sound as compared to their “normal” pre-exposure behavior. This requires observations of a large number of animals over a large area for a considerable period of time before and after exposure to sound sources, as well as during exposure. Only with such data is it possible to tell how sounds affect overall behavior (including movement) of animals.

Increased Background Sound

In addition to questions about how fish movements change in response to sounds, there are also questions as to whether any increase in background sound has an effect on more subtle aspects of behavior, such as the ability of a fish to hear a potential mate or predator, or to glean information about its general environment. There is a body of literature that shows that the sound detection ability of fish can be “masked” by the presence of other sounds within the range of hearing of the fish. Just as a human has trouble hearing another person as the room they are in gets noisier, it is likely that the same effect occurs for fish (as well as all other animals). In effect, acoustic communication and orientation of fish may potentially be restricted by noise regimes in their environment that are within the hearing range of the fish.

While it is possible to suggest behavioral effects on fish, there have been few laboratory, and no field, studies to show the nature of any effects of increased background noise on fish behavior. At the same time, it is clear from the literature on masking in fish, as for other vertebrates, that the major effect on hearing is when the added sound is within the hearing range of the animal. Moreover, the bulk of the masking effect is at frequencies around that of the masker. Thus, a 2 kHz masker will only mask detection of sounds around 2 kHz, and a 500 Hz masker will primarily impact hearing in a band around 500 Hz.

As a consequence, if there is a background sound of 2 kHz, as might be expected from some mid-frequency sonars, and the fish in question does not hear at that frequency, there will be no masking, and no affect on any kind of behavior. Moreover, since the bulk of fish communication sounds are well below 1 kHz (e.g., Zelick et al. 1999), even if a fish is exposed to a 2 kHz masker which affects hearing at around 2 kHz, detection of biologically relevant sounds (e.g., of mates) will not be masked.

Indeed, many of the human-generated sounds in the marine environment are outside the detection range of most species of marine fish studied to date (see Figure 3.1.2.2.3.1-1 and Table 3.1.2.2.3.2-1). In particular, it appears that the majority of marine species have hearing ranges that are well below the frequencies of the mid- and high-frequency range of the operational sonars used in Navy exercises, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid- and high-frequencies, such as the clupeids (herrings, shads, and relatives), do not have their best sensitivities in the range of the operational sonars. Additionally, vocal marine fish largely communicate below the range of mid- and high-frequency levels used in Navy exercises.

Implications of Temporary Hearing Loss (TTS)

Another related issue is the impact of temporary hearing loss, referred to as temporary threshold shift (TTS), on fish. This effect has been demonstrated in several fish species where investigators used exposure to either long-term increased background levels (e.g., Smith et al. 2004a) or intense, but short-term, sounds (e.g., Popper et al. 2005), as discussed above. At the same time, there is no evidence of permanent hearing loss (e.g., deafness), often referred to in the mammalian literature as permanent threshold shift (PTS), in fish. Indeed, unlike in mammals where deafness often occurs as a result of the death and thus permanent loss of sensory hair cells, sensory hair cells of the ear in fish are replaced after they are damaged or killed (Lombarte et al., 1993, Smith et al., 2006). As a consequence, any hearing loss in fish may be as temporary as the time course needed to repair or replace the sensory cells that were damaged or destroyed (e.g., Smith et al., 2006).

TTS in fish, as in mammals, is defined as a recoverable hearing loss. Generally there is recovery to normal hearing levels, but the time-course for recovery depends on the intensity and duration of the TTS-evoking signal. There are no data that allows one to “model” expected TTS in fish for different signals, and developing such a model will require far more data than currently available. Moreover, the data would have to be from a large number of fish species since there is so much variability in hearing capabilities and in auditory structure.

A fundamentally critical question regarding TTS is how much the temporary loss of hearing would impact survival of fish. During a period of hearing loss, fish will potentially be less sensitive to sounds produced by predators or prey, or to other acoustic information about their environment. The question then becomes how much TTS is behaviorally significant for survival. However, there have yet to be any studies that examine this issue.

At the same time, the majority of marine fish species are hearing generalists and so cannot hear mid- and high-frequency sonar. Thus, there is little or no likelihood of there being TTS as a result of exposure to these sonars, or any other source above 1.5 kHz. It is possible that mid-frequency sonars are detectable by some hearing specialists such as a number of sciaenid species and clupeids. However, the likelihood of TTS in these species is small since the duration of exposure of animals to a moving source is probably very low since exposure to a maximum sound level (generally well below the source level) would only be for a few seconds as the navy vessel moves by.

Stress

While the major questions on effects of sound relate to behavior of fish in the wild, a more subtle issue is whether the sounds potentially affect the animal through increased stress. In effect, even when there are no apparent direct effects on fish as manifest by hearing loss, tissue damage, or changes in behavior, it is possible that there are more subtle effects on the endocrine or immune systems that could, over a long period of time, decrease the survival or reproductive success of animals. While there have been a few studies that have looked at things such as cortisol levels in response to sound, these studies have been very limited in scope and in species studied.

Eggs and Larvae

Finally, while eggs and larvae must be of concern, the few studies of the effects of sounds on eggs and larvae do not lead to any conclusions with how sound would impact survival. And of the few potentially useful studies, most were done with sources that are very different than sonar. Instead, they employed seismic airguns or mechanical shock. While a few results suggest some potential effects on eggs and larvae, such studies need to be replicated and designed to ask direct questions about whether sounds, and particularly mid- and high-frequency sounds, would have any potential impact on eggs and larvae.

Effects of Impulsive Sounds

There are few studies on the effects of impulsive sounds on fish, and no studies that incorporated mid- or high-frequency signals. The most comprehensive studies using impulsive sounds are from seismic airguns (e.g., Popper et al. 2005, Song et al. 2006). Additional studies have included those on pile driving (reviewed in Hastings and Popper 2005) and explosives (e.g., Yelverton et al. 1975, Keevin et al. 1997, Govoni et al. 2003; reviewed in Hastings and Popper 2005).

As discussed earlier, the airgun studies on very few species resulted in a small hearing loss in several species, with complete recovery within 18 hours (Popper et al. 2005). Other species showed no hearing loss with the same exposure. There appeared to be no effects on the structure of the ear (Song et al., 2006), and a limited examination of non-auditory tissues, including the swim bladder, showed no apparent damage (Popper et al., 2005). One other study of effects of an airgun exposure showed some damage to the sensory cells of the ear (McCauley et al., 2003), but it is hard to understand the differences between the two studies. However, the two studies had different methods of exposing fish, and used different species.

There are other studies that have demonstrated some behavioral effects on fish during airgun exposure used in seismic exploration (e.g., Pearson et al., 1987, 1992, Engås et al., 1996, Engås and Løkkeborg, 2002, Slotte et al., 2004), but the data are limited and it would be very difficult to extrapolate to other species, as well as to other sound sources.

Explosive Sources

A number of studies have examined the effects of explosives on fish. These are reviewed in detail in Hastings and Popper (2005). One of the real problems with these studies is that they are highly variable and so extrapolation from one study to another, or to other sources, such as those used by the Navy, is not really possible. While many of these studies show that fish are killed if they are near the source, and there are some suggestions that there is a correlation between size of the fish and death (Yelverton et al., 1975), little is known about the very important issues of non-mortality damage in the short- and long-term, and nothing is known about effects on behavior of fish.

The major issue in explosives is that the gas oscillations induced in the swim bladder or other air bubble in fishes caused by high sound pressure levels can potentially result in tearing or rupturing of the chamber. This has been suggested to occur in some (but not all) species in several gray literature unpublished reports on effects of explosives (e.g., Alpin 1947; Coker and Hollis, 1950; Gaspin 1975; Yelverton et al., 1975), whereas other published studies do not show such rupture (e.g., the very well done peer reviewed study by Govoni et al., 2003). Key variables that appear to control the physical interaction of sound with fishes include the size of the fish relative to the wavelength of sound, mass of the fish, anatomical variation, and location of the fish in the water column relative to the sound source (e.g., Yelverton et al., 1975, Govoni et al., 2003).

Explosive blast pressure waves consist of an extremely high peak pressure with very rapid rise times (< 1 millisecond [ms]). Yelverton et al. (1975) exposed eight different species of freshwater fish to blasts of 1-lb spheres of Pentolite in an artificial pond. The test specimens ranged from 0.02 g (guppy) to 744 g (large carp) body mass and included small and large animals from each species. The fish were exposed to blasts having extremely high peak overpressures with varying impulse lengths. The investigators found what appears to be a direct correlation between body mass and the magnitude of the "impulse," characterized by the product of peak overpressure and the time it took the overpressure to rise and fall back to zero (units in psi-ms), which caused 50 percent mortality (see Hastings and Popper 2005 for detailed analysis).

One issue raised by Yelverton et al. (1975) was whether there was a difference in lethality between fish which have their swim bladders connected by a duct to the gut and fish which do not have such an opening. The issue is that it is potentially possible that a fish with such a connection could rapidly release gas from the swim bladder on compression, thereby not increasing its internal pressure. However, Yelverton et al. (1975) found no correlation between lethal effects on fish and the presence or lack of connection to the gut.

While these data suggest that fishes with both types of swim bladders are affected in the same way by explosive blasts, this may not be the case for other types of sounds, and especially those with longer rise or fall times that would allow time for a biomechanical response of the swim bladder (Hastings and Popper, 2005). Moreover, there is some evidence that the effects of explosives on fishes without a swim bladder are less than those on fishes with a swim bladder (e.g., Gaspin, 1975; Goertner et al., 1994; Keevin et al., 1997). Thus, if internal damage is, even in part, an indirect result of swim bladder (or other air bubble) damage, fishes without this organ may show very different secondary effects after exposure to high sound pressure levels. Still, it must be understood that the data on effects of impulsive sources and explosives on fish are limited in number and quality of the studies, and in the diversity of fish species studied. Thus, extrapolation from the few studies available to other species or other devices must be done with the utmost caution.

In a more recent published report, Govoni et al. (2003) found damage to a number of organs in juvenile pinfish (*Lagodon rhomboids*) and spot (*Leiostomus xanthurus*) when they were exposed to submarine detonations at a distance of 3.6 m, and most of the effects, according to the authors, were sublethal. Effects on other organ systems that would be considered irreversible (and presumably lethal) only occurred in a small percentage of fish exposed to the explosives. Moreover, there was virtually no effect on the same sized animals when they were at a distance of 7.5 m, and more pinfish than spot were affected.

Based upon currently available data it is not possible to predict specific effects of Navy impulsive sources on fish. At the same time, there are several results that are at least suggestive of potential effects that result in death or damage. First, there are data from impulsive sources such as pile driving and seismic airguns that indicate that any mortality declines with distance, presumably because of lower signal levels. Second, there is also evidence from studies of explosives (Yelverton et al., 1975) that smaller animals are more affected than larger animals. Finally, there is also some evidence that fish without an air bubble, such as flatfish and sharks and rays, are less likely to be affected by explosives and other sources than are fish with a swim bladder or other air bubble.

Yet, as indicated for other sources, the evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is non-existent. Thus, we still do not know if the presence of an explosion or an impulsive source at some distance, while not physically harming a fish, will alter its behavior in any significant way.

General Conclusions of Sounds on Fish

As discussed, the extent of data, and particularly scientifically peer-reviewed data, on the effects of high intensity sounds on fish is exceedingly limited. Some of these limitations include:

- Types of sources tested;
- Effects of individual sources as they vary by such things as intensity, repetition rate, spectrum, distance to the animal, etc.;
- Number of species tested with any particular source;
- The ability to extrapolate between species that are anatomically, physiologically, and/or taxonomically, different;
- Potential differences, even within a species as related to fish size (and mass) and/or developmental history;
- Differences in the sound field at the fish, even when studies have used the same type of sound source (e.g., seismic airgun);

- Poor quality experimental design and controls in many of the studies to date;
- Lack of behavioral studies that examine the effects on, and responses of, fish in their natural habitat to high intensity signals;
- Lack of studies on how sound may impact stress, and the short- and long-term effects of acoustic stress on fish; and
- Lack of studies on eggs and larvae that specifically use sounds of interest to the Navy.

At the same time, in considering potential sources that are in the mid- and high-frequency range, a number of potential effects are clearly eliminated. Most significantly, since the vast majority of fish species studied to date are hearing generalists and cannot hear sounds above 500 to 1,500 Hz (depending upon the species), there are not likely to be behavioral effects on these species from higher frequency sounds.

Moreover, even those fish species that may hear above 1.5 kHz, such as a few sciaenids and the clupeids (and relatives), have relatively poor hearing above 1.5 kHz as compared to their hearing sensitivity at lower frequencies. Thus, it is reasonable to suggest that even among the species that have hearing ranges that overlap with some mid- and high-frequency sounds, it is likely that the fish will only actually hear the sounds if the fish and source are very close to one another. And, finally, since the vast majority of sounds that are of biological relevance to fish are below 1 kHz (e.g., Zelick et al., 1999; Ladich and Popper, 2004), even if a fish detects a mid- or high-frequency sound, these sounds will not mask detection of lower frequency biologically relevant sounds.

Thus, a reasonable conclusion, even without more data, is that there will be few, and more likely no, impacts on the behavior of fish.

At the same time, it is possible that very intense mid- and high-frequency signals, and particularly explosives, could have a physical impact on fish, resulting in damage to the swim bladder and other organ systems. However, even these kinds of effects have only been shown in a few cases in response to explosives, and only when the fish has been very close to the source. Such effects have never been shown to any Navy sonar. Moreover, at greater distances (the distance clearly would depend on the intensity of the signal from the source) there appears to be little or no impact on fish, and particularly no impact on fish that do not have a swim bladder or other air bubble that would be affected by rapid pressure changes.

Underwater Detonations

Underwater detonations are possible during SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS. The weapons used in most missile and Live Fire Exercises pose little risk to fish unless the fish were near the surface at the point of impact. Machine guns (50 caliber) and close-in weapons systems (anti-missile systems) fire exclusively non-explosive ammunition. The same applies to larger weapons firing inert ordnance for training (e.g., 5-inch guns and 76-mm guns). The rounds pose an extremely low risk of a direct hit and potential to directly affect a marine species. Target area clearance procedures will again reduce this risk. A SINKEX uses a variety of live fire weapons. These rounds pose a risk only at the point of impact.

Several factors determine a fish's susceptibility to harm from underwater detonations. Most injuries in fish involve damage to air- or gas-containing organs (i.e., the swim bladder). Fish with swim bladders are vulnerable to effects of explosives, while fish without swim bladders are much more resistant (Yelverton, 1981; Young, 1991). Research has focused on the effects on the swim bladder from underwater detonations but not the ears of fish (Edds-Walton and Finneran, 2006).

For underwater demolition training, the effects on fish from a given amount of explosive depend on location, season, and many other factors. O'Keeffe (1984) provides charts that allow estimation of the potential effect on swim-bladder fish using a damage prediction method developed by Goertner (1982). O'Keeffe's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish, explosive shot, frequency content). Table 4.1.2.2-1 lists the estimated maximum effects ranges using O'Keeffe's (1984) method for an 8-pound (lb) explosion at source depths of 1.7 fathoms (10 ft).

Table 4.1.2.2-1. Maximum Fish-Effects Ranges

Fish Weight	10 Percent Mortality Range (in feet)
1 ounce	518.3
1 pound	208.9
30 pounds	155.2

Source: O'Keefe, 1984

Potential impacts on fish from underwater demolition detonations would be negligible. A small number of fish are expected to be injured by detonation of explosive, and some fish located in proximity to the initial detonations can be expected to die. However, the overall impacts on water column habitat would be localized and transient. As training begins, the natural reaction of fish in the vicinity would be to leave the area. When training events are completed, the fish stock would be expected to return to the area.

Essential Fish Habitat

This section briefly discusses the potential impacts by the proposed actions to EFH and managed species. Despite nearshore and offshore designations of the HRC, species within all Fisheries Management Plans (FMPs) may utilize both nearshore and offshore areas during their lives, as eggs and larvae for most species are planktonic and can occur in nearshore and offshore waters, while adults may be present in nearshore and/or offshore waters. Therefore, all project activities can potentially affect a lifestage of a managed species.

Adverse effects are defined as any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810(a)).

Permanent, adverse impacts on EFH components are not anticipated since operations are conducted to avoid potential impacts; however, there are temporary unavoidable impacts associated with several operations that may result in temporary and localized impacts. In addition, a single operation may potentially have multiple effects on EFH. The current and proposed operations in the HRC have the potential to result in the following impacts:

- Physical disruption of open ocean habitat
- Physical destruction or adverse modification of benthic habitats
- Alteration of water or sediment quality from debris or discharge
- Cumulative impacts

Each impact and operation associated with those impacts are discussed in a separate document, *Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex EIS/OEIS* (U.S. Department of the Navy, 2007b) and a summary for each proposed activity is provided. Potential impacts on FMP species include direct and indirect effects from sonar and shock waves (see discussion above and EFH document, U.S. Department of the Navy, 2007a). Numerous operations may affect benthic habitats from debris, and there may also be temporary impacts on water quality from increased turbidity or release of materials. However, due to the mitigation measures implemented to protect sensitive habitats, and the localized and temporary impacts of the Proposed Action and alternatives, it is concluded that the potential impact of the Proposed Action and alternatives on EFH for the five major FMPs and their associated management units would be minimal.

4.1.2.2.1 No-action Alternative (Fish—Biological Resources—Open Ocean)

The No-action Alternative includes a total of 1,167 hours of MFA surface ship sonar and the associated Directional Command Activated Sonobuoy System (DICASS) sonobuoy, MK-48 torpedo (an HFA source), dipping sonar, and submarine sonar (see Appendix J for a detailed description). Underwater detonations are possible during SINKEX, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS. The abundance and diversity of fish within the HRC will not measurably decrease as a result of implementation of the No-action Alternative.

HRC Training—No-action Alternative

Sonar

ASW training in HRC other than during Major Exercises includes ASW Tracking Exercise (TRACKEX) and ASW Torpedo Exercise (TORPEX) as described in Table 2.2.2.3-1 and Appendix D. The annual sonar for TRACKEX and TORPEX includes 360 hours of AN/SQS 53 and 75 hours of AN/SQS 56 MFA surface ship sonar, associated sonobuoys, MK-48 torpedo HFA sonar, dipping sonar, and submarine sonar.

HRC RDT&E Activities—No-action Alternative

Other sources such as unmanned aerial vehicles (UAVs), underwater communications, and electronic warfare systems that may be deployed in the ocean are beyond the frequency range or intensity level to affect fish. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and short durations (<1.5 hours). These activities will have minimal effects on fish.

Major Exercises—No-action Alternative

RIMPAC and USWEX

The training events and impacts from RIMPAC Exercises have been summarized in the RIMPAC 2006 Supplement to the 2002 RIMPAC Environmental Assessment (EA) (U.S. Department of the Navy, Commander Third Fleet, 2006). The No-action Alternative modeling included 399 hours of AN/SQS 53 and 133 hours of AN/SQS 56 surface ship sonar and associated dipping sonar, sonobuoys, and MK-48 torpedoes per RIMPAC (conducted every other year).

The training events and impacts on fish from USWEX Exercises have been summarized in the USWEX Programmatic EA/Overseas EA (OEA) (U.S. Department of the Navy, 2007b). The No-action Alternative USWEX modeling included 525 hours of AN/SQS 53 and 175 hours of AN/SQS 56 MFA sonar and associated dipping sonar and sonobuoys per year.

The potential impacts on fish from RIMPAC and USWEX sonar and underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS will be similar to those described above for the HRC training.

4.1.2.2.2 Alternative 1 (Fish—Biological Resources—Open Ocean)

The increased training and RDT&E activities under Alternative 1 results in a total of 2,339 hours of MFA surface ship sonar plus the associated DICASS sonobuoy, MK-48 torpedo (an HFA source), dipping sonar, and submarine sonar (see Appendix J for a detailed description). Underwater detonations are possible during SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS.

Tempo and Frequency of Training—Alternative 1

Under Alternative 1, ASW training in HRC other than during Major Exercises includes ASW TRACKEX and ASW TORPEX as described in Table 2.2.2.3-1 and Appendix D. The annual sonar for TRACKEX and TORPEX includes 360 hours of AN/SQS 53 and 75 hours of AN/SQS 56 MFA surface ship sonar plus associated sonobuoys, MK-48 torpedo HFA sonar, dipping sonar, and submarine sonar. Potential impacts on fish from sonar and underwater detonations under Alternative 1 would be similar to those described under the No-action Alternative. Although the number of hours of underwater detonations would increase, the impacts would still be minimal.

Enhanced RDT&E Activities—Alternative 1

There are no new RDT&E activities proposed that would affect fish. Sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean are at frequency ranges or intensity levels that have no affect on fish. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and short durations (<1.5 hours). These activities would have minimal effects on fish.

Future RDT&E Activities—Alternative 1

There are no new or future RDT&E activities proposed that would affect marine animals. Sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean are generally transmitting above the frequency range or below the intensity level to affect marine animals. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and are generally of short durations (<1.5 hours). These activities would have minimal effects on fish.

HRC Enhancements—Alternative 1

There are no new HRC enhancements proposed that would affect fish. Other sources such as the Portable Undersea Tracking Range, underwater communications, and electronic warfare systems that may be deployed in the ocean are at frequency ranges or intensity levels that have no affect on fish. The Navy will continue to work with the regulatory agencies throughout the planning and development process to minimize the potential for impacts on fish.

Major Exercises—Alternative 1

RIMPAC and USWEX

The training events and impacts on fish from RIMPAC Exercises have been summarized in the RIMPAC 2006 Supplement to the 2002 RIMPAC EA (U.S. Department of the Navy, Commander Third Fleet, 2006). Alternative 1 assumes two Strike Groups and 798 hours of AN/SQS 53 and 266 hours of AN/SQS 56 MFA sonar plus associated dipping sonar, sonobuoys, and MK-48 torpedoes HFA sonar per two carrier RIMPAC (conducted every other year).

The training events and impacts on fish from USWEX Exercises have been summarized in the USWEX Programmatic EA/OEA (U.S. Department of the Navy, 2007b). Alternative 1 assumes 630 hours of AN/SQS 53 and 210 hours of AN/SQS 56 MFA sonar plus associated dipping sonar and sonobuoys for six USWEXs per year. Although the number of hours of sonar and the number of underwater detonations would increase over the No-action Alternative, the impacts would still be minimal considering the few fish species that would be able to detect sound in the frequencies of the Proposed Action and the limited exposure of juvenile fish with swim bladder resonance in the frequencies of the sound sources.

Essential Fish Habitat

Impacts on EFH are expected to be similar to those described previously for the No-action Alternative (see Section 4.1.2.2.1), and the small change in the number of exercises would not change those predictions (see *Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex EIS/OEIS* [U.S. Department of the Navy, 2007b]).

4.1.2.2.3 Alternative 2 (Fish—Biological Resources—Open Ocean)

The increased training and RDT&E activities under Alternative 2 result in an increase in the number of hours of ASW training. Alternative 2 includes a total of 3,283 hours of MFA surface ship sonar plus the associated DICASS sonobuoy, MK-48 torpedo (an HFA source), dipping sonar, and submarine sonar (see Appendix J for a detailed description). Underwater detonations are possible during SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS.

Tempo and Frequency of Training—Alternative 2

ASW training for Alternative 2 other than during Major Exercises includes ASW TRACKEX and ASW TORPEX as described in Table 2.2.2.3-1 and Appendix D. The annual sonar for TRACKEX and TORPEX includes 360 hours of AN/SQS 53 and 75 hours of AN/SQS 56 MFA surface ship sonar plus associated sonobuoys, MK-48 torpedo HFA sonar, dipping sonar, and submarine sonar. Potential impacts on fish from sonar and underwater detonations under Alternative 2 would be similar to those described under the No-action Alternative. Although the number of hours of sonar and the number of underwater detonations would increase over the No-action Alternative, the impacts would still be minimal.

Enhanced RDT&E Activities—Alternative 2

There are no new RDT&E activities proposed that would affect fish. Sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean at the frequency ranges or intensity levels that have no affect on fish. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and short durations (<1.5 hours). These activities would have minimal effects on fish.

Future RDT&E Activities—Alternative 2

There are no new or future RDT&E activities proposed that would affect marine animals. Noise sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean are generally transmitting above the frequency range or below the intensity level to affect marine animals. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and are generally of short durations (<1.5 hours). These activities would have minimal effects on fish.

HRC Enhancements—Alternative 2

There are no new HRC enhancements proposed that would affect fish. Other sources such as underwater communications and electronic warfare systems that may be deployed in the ocean are at frequency ranges or intensity levels that have no affect on fish.

Major Exercises—Alternative 2

RIMPAC

The training events and impacts on fish from RIMPAC Exercises have been summarized in the RIMPAC 2006 Supplement to the 2002 RIMPAC EA (U.S. Department of the Navy, Commander Third Fleet, 2006). Alternative 2 assumes two Strike Groups and 798 hours of AN/SQS 53 and 266 hours of AN/SQS 56 MFA sonar plus dipping sonar, sonobuoys, and MK-48 torpedoes HFA sonar per two carrier RIMPAC (conducted every other year).

USWEX

The training events and impacts on fish from USWEX Exercises have been summarized in the USWEX Programmatic EA/OEA (U.S. Department of the Navy, 2007b). Alternative 2 assumes 630 hours of AN/SQS 53 and 210 hours of AN/SQS 56 MFA sonar plus dipping sonar and sonobuoys for six USWEXs per year. Although the number of hours of sonar and the number of underwater detonations would increase over the No-action Alternative, the impacts would still be minimal considering the few fish species that would be able to detect sound in the frequencies of the Proposed Action and the limited exposure of juvenile fish with swim bladder resonance in the frequencies of the sound sources.

Additional Major Exercise—Multiple Strike Group Training

With the addition of this Major Exercise, up to three Strike Groups would conduct training simultaneously in the HRC. The Strike Groups would not be homeported in Hawaii, but would stop in Hawaii en route to a final destination. The Strike Groups would be in Hawaii for up to 10 days per Multiple Strike Group exercise. Training would be provided to submarine, ship, and aircraft crews in tactics, techniques, and procedures for ASW, Defensive Counter Air, Maritime Interdiction, and operational level Command and Control (C2) of maritime forces. The Multiple Strike Group Exercise would include 708 hours of AN/SQS 53 and 236 hours of AN/SQS 56 MFA sonar, associated sonobuoys, dipping sonar, *and* MK-48 torpedo HFA sonar. Although the number of hours of sonar and the number of underwater detonations would increase over Alternative 1, the impacts would still be minimal.

Essential Fish Habitat

Impacts on EFH are expected to be similar to those described previously for the No- action Alternative (see Section 4.1.2.2.1), and the small change in the number of exercises would not change those predictions (see *Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex EIS/OEIS* [U.S. Department of the Navy, 2007b]).

4.1.2.2.4 Alternative 3 (Fish—Biological Resources—Open Ocean)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on fish from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2, Section 4.1.2.2.3.

4.1.2.3 SEA TURTLES (BIOLOGICAL RESOURCES—OPEN OCEAN)

Sonar

Extrapolation from human and marine mammal data to turtles is inappropriate given the morphological differences between the auditory systems of mammals and turtles. However, the measured hearing threshold for green turtles (and by extrapolation from this species to other hardshelled sea turtles; at least the olive ridley, loggerhead, and hawksbill) is only slightly lower than the maximum levels to which these species could be exposed. Given the lack of audiometric information, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown, but would likely follow those of other sea turtles. It is not likely that a temporary threshold shift would occur at such a small margin over threshold in any species. Therefore, no threshold shifts in green, olive ridley, loggerhead, hawksbill, or leatherback turtles are expected.

As described in Chapter 3.0, sea turtle hearing is generally most sensitive between 100 Hz to 800 Hz for hard shell turtles, frequencies that are at the lower end of the sound spectrum. Although low-frequency hearing has not been studied in many sea turtle species, most of those that have been tested exhibit low audiometric and behavioral sensitivity to low-frequency sound. It appears, therefore, that if there were the potential for the MFA/HFA sonar to increase masking effects of any sea turtle species, it would be expected to be minimal as most sea turtle species are apparently low-frequency specialists. The use of low-frequency sources is not part of the Proposed Action in the HRC EIS/OEIS. Any potential role of long-range acoustical perception in sea turtles has not been studied. Anecdotal information, however, suggests that the acoustic signature of a turtle's natal beach might serve as a cue for nesting returns. Again, however, the sources used in the HRC are above sea turtle's most sensitive hearing range.

As demonstrated by Jessop et al. (2002) for breeding adult male green turtles, there is a complex relationship between stress/physiological state and plasma hormone responses. Even if sea turtles were able to sense the sonar output, it is unlikely that any physiological stress leading to endocrine and corticosteroid imbalances would result over the long term (allostatic loading) (McEwen and Lashley, 2002). Although there may be many hours of active ASW sonar events, the active "pings" of the sonar generally only occur only twice a minute, as it is necessary for the ASW operators to listen for the return echo of the sonar ping before another ping is transmitted. Given the time between pings and relative high ship speed in comparison to turtles and the relatively low hearing sensitivity even within the frequency ranges that sea turtles hear best, which is for the most part below the frequency range of MFA/HFA sonar, it is unlikely that sea turtles would be affected by this type of sonar. Based on the current available data, MFA/HFA sonar use would not affect sea turtles.

Potential Non-Acoustic Impacts

Ship Strikes

The Navy has adopted standard operating procedures (SOPs) that reduce the potential for collisions between surface vessels and sea turtles (See Chapter 6.0). On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel during at-sea movements. If a sea turtle is sighted, appropriate action will be taken to avoid the animal. Given the SOPs and the relative few number of turtles and Navy vessels in the open ocean, the Navy believes collisions with sea turtles are unlikely. A study of green sea turtle strandings in the Hawaiian Archipelago from 1982-2003 showed that boat strikes and shark attacks each accounted for 2.7 percent of the 3,732 green sea turtle strandings (boat strikes are in general from small craft). Green turtle strandings attributable to boat strike were more likely from Kauai and Oahu. The most common cause of the strandings was the tumor-forming disease, fibropapillomatosis (28 percent); 49 percent of the strandings could not be attributed to any known cause (Chaloupka et al, 2004).

Torpedo Guidance Wire

The potential entanglement impact of MK-48 torpedo control wires on sea turtles is very low because the control wire is very thin (approximately 0.02 in) and has a relatively low breaking strength. In addition, when the wire is released or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling.

Torpedo Strike Impact

Given the relatively small size of sea turtles, there is negligible risk that a turtle could be struck by a torpedo during ASW training events. The potential for any harm or harassment to sea turtles is extremely low.

Because some torpedo air launch accessories remain in the marine environment, the potential for impacting sea turtles through ingestion or entanglement has been previously analyzed. Ingestion of pieces of the launch accessories is unlikely because most of those are large and metallic and will sink rapidly (U.S. Department of the Navy, 1996a).

MK-48 Torpedo Flex Hoses

The Navy analyzed the potential for the flex hoses to impact sea turtles and marine mammals. The analysis concluded that the potential entanglement impact on marine animals would be insignificant for reasons similar to those stated for the potential entanglement impact of control wires (U.S. Department of the Navy, 1996b).

Sonobuoy and Other Parachutes

Sonobuoys, lightweight torpedoes, and other devices deployed from aircraft use nylon parachutes of varying sizes. At water impact, the parachute assembly is jettisoned and sinks away from the exercise weapon or target. The parachute assembly would potentially be at the surface for a short time before sinking to the sea floor. Many large sea turtles subsist mainly on jellyfish, and the incidence of plastic bags being found in dead turtles indicates that the turtles may mistake floating plastic bags for jellyfish (Cottingham, 1989). Sea turtles also ingest pieces of polystyrene foam, monofilament fishing line, and several other kinds of synthetic drift items. However, the parachutes used on the proposed HRC are large in comparison with these animals' normal food items, and would be very difficult to ingest. Overall, the possibility of sea turtles ingesting nylon parachute fabric or being entangled in parachute assemblies is very remote.

Potential Underwater Detonation Impacts

Events involving underwater detonation involve EER/IEER, MINEX, MISSILEX, BOMBEX, SINKEX, GUNEX, and NSFS. Criteria and thresholds for estimating the impacts on marine mammals and sea turtles from a single underwater detonation event were defined and publicly vetted through the National Environmental Policy Act (NEPA) process during the environmental assessments for the two Navy ship-shock trials: the SEAWOLF Final EIS (FEIS) (U.S. Department of the Navy 1998a) and the Churchill FEIS (U.S. Department of the Navy, 2001b). During the analysis of the effects of explosions on marine mammals and sea turtles conducted by the Navy for the Churchill EIS, analysts compared the injury levels reported by the best of these experiments to the injury levels that would be predicted using the modified Goertner method and found them to be similar (U.S. Department of the Navy, 2001b, Goertner 1982). The criteria and thresholds for injury and harassment, which are the same for both sea turtles and marine mammals, are summarized in Table 4.1.2.3-1.

Table 4.1.2.3-1. Summary of Criteria and Acoustic Thresholds for Underwater Detonation Impacts on Sea Turtles and Marine Mammals

Harassment Level	Criterion	Threshold
Level A Harassment Mortality	Onset of severe lung injury	"Goertner" modified positive impulse indexed to 31 psi-ms
Injury	Tympanic membrane rupture	50 percent rate of rupture 205 dB re 1 μPa^2-s (Energy Flux Density)
Injury	Onset of slight lung injury	Goertner Modified Positive Impulse Indexed to 13 psi-ms
Level B Harassment Non-Injury	Onset Temporary Threshold Shift (TTS) (Dual Criteria)	182 dB re 1 μPa^2-s (Energy Flux Density) in any 1/3-octave band at frequencies above 100 Hz for all toothed whales (e.g., sperm whales, beaked whales); above 10 Hz for all baleen whales
Non-Injury	Onset of TTS (Dual Criteria)	23 psi peak pressure level (for small explosives; less than 2,000 lb NEW)
Non-Injury	Sub-TTS behavioral disturbance	177 dB re 1 μPa^2-s (Energy Flux Density) for multiple successive explosions

Notes: psi = pounds per square inch
μPa^2-s = squared micropascal-second
Hz = hertz
psi-ms = pounds per square inch-milliseconds
dB = decibel
NEW = net explosive weight

Injury Thresholds

When analyzing underwater detonations, two criteria are used for injury: onset of slight lung injury and 50 percent eardrum rupture (tympanic membrane [TM] rupture). These criteria are considered indicative of the onset of injury. The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 26.9 lb), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-millisecond (ms) in the (U.S. Department of the Navy, 2001b). This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury. The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an energy level value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998) indicates a 30 percent incidence of permanent threshold shift [PTS] at the same threshold).

The criterion for marine mammal mortality when analyzing underwater detonations used in the Churchill FEIS is "onset of severe lung injury." This is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset of severe lung injury is counted as a lethal exposure. The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms." Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, the CHURCHILL FEIS used the mass of a calf dolphin (at 26.9 lb), so that the threshold index is 30.5 psi-ms.

Harassment Thresholds

There are two thresholds for non-injurious harassment from underwater explosives. The first is temporary threshold shift (TTS), which is a temporary, recoverable, loss of hearing sensitivity (National Marine Fisheries Service, 2001a; U.S. Department of the Navy, 2001b). The second threshold, termed "sub-TTS," applies to multiple explosions in succession (separated by less than 2 seconds). The sub-TTS threshold is used to account for behavioral disturbance significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS.

There are dual criteria for TTS when analyzing underwater detonations. The first is 182 dB re 1 squared micropascal-second (μPa^2-s) maximum Energy Flux Density Level (EL) level in any 1/3-octave band at frequencies >100 Hz for marine mammals and sea turtles. The second criterion for impact analysis when considering underwater detonations and a TTS threshold is 12 pounds per square inch (psi) peak pressure that was developed for 10,000-lb charges as part of the Churchill FEIS (U.S. Department of the Navy, 2001b; National Oceanic and Atmospheric Administration, 2005 and 2006h). It was introduced to provide a safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). Navy policy is to use a 23 psi criterion for explosive charges less than 2,000 lb and the 12 psi criterion for explosive charges larger than 2,000 lb. All explosives modeled for the HRC EIS/OEIS are less than 1,500 lb.

Harassment Threshold for Multiple Successive Explosions (MSE)

There may be rare occasions when MSE are part of a static location event such as during MINEX, MISSILEX, BOMBEX, SINKEX, GUNEX, and NSFS (when using other than inert weapons). For these events, the Churchill FEIS approach was extended to cover MSE events occurring at the same static location. For MSE exposures, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot; this is consistent with the treatment of multiple arrivals in Churchill. For positive impulse, it is consistent with Churchill FEIS to use the maximum value over all impulses received.

For MSE, the acoustic criterion for sub-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The sub-TTS threshold is derived following the approach of the Churchill FEIS for the energy-based TTS threshold.

The research on pure-tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided a threshold of 192 dB re 1 μPa^2-s as the lowest TTS value. This value for pure-tone exposures is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1 μPa^2-s in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure-tone research generally began five dB lower than those causing TTS. The sub-TTS threshold is therefore derived by subtracting five dB from the 182 dB re 1 μPa2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1 μPa^2-s (EL) sub-TTS behavioral disturbance threshold for MSE.

Preliminary modeling undertaken for other Navy compliance documents using the sub-TTS threshold of 177 dB has demonstrated that for events involving MSE using small (NEW) explosives (MINEX, GUNEX, NSFS, and underwater detonation), the footprint of the threshold for explosives onset TTS criteria based on the 23 psi pressure component dominates and supersedes any exposures at a received level involving the 177 dB EL threshold. Restated in another manner, modeling for the sub-TTS threshold should not result in any estimated impacts that are not already quantified under the larger footprint of the 23 psi criteria for small MSE. Given that modeling for sub-TTS should not, therefore, result in any additional harassment takes for MINEX, GUNEX, NSFS, and underwater detonation, analysis of potential for behavioral disturbance using the sub-TTS criteria was not undertaken for these events (MINEX, GUNEX, NSFS, and underwater detonation).

For the remainder of the MSE events (BOMBEX, SINKEX, and MISSILEX) where the sub-TTS exposures may need to be considered, these potential behavioral disturbances were estimated by extrapolation from the acoustic modeling results for the explosives TTS threshold (182 dB re 1 μPa^2-s in any 1/3 octave band). To account for the 5 dB lower sub-TTS threshold, a factor of 3.17 was applied to the TTS modeled numbers in order to extrapolate the number of sub-TTS exposures estimated for MSE events. This multiplication factor is used calculate the increased area represented by the difference between the 177 dB sub-TTS threshold and the modeled 182 dB threshold. The factor is based on the increased range 5 dB would propagate (assuming spherical spreading), where the range increases by approximately 1.78 times, resulting in a circular area increase of approximately 3.17 times that of the modeled results at 182 dB.

Potential overlap of exposures from multiple explosive events within a 24-hour period was not taken into consideration in the modeling resulting in the potential for some double counting of exposures. However, because an animal would generally move away from the area following the first explosion, the overlap is likely to be minimal.

It should be emphasized that there is a lead time for set up and clearance of any area before an event using explosives takes place (this may be 30 minutes for an underwater detonation to several hours for a SINKEX). There will, therefore, be a long period of rather intense activity before the event occurs when the area is under observation and before any detonation or live fire occurs. Ordnance cannot be released until the target area is determined clear. In addition, the event is immediately halted if sea turtles are observed within the target area and the training is delayed until the animal clears the area. These mitigation factors to determine if the area is clear, serve to minimize the risk of harming sea turtles and marine mammals.

4.1.2.3.1 No-action Alternative (Sea Turtles—Biological Resources—Open Ocean)

HRC Training—No-action Alternative

As discussed in detail above, MFA/HFA sonar use would not affect sea turtles.

Underwater detonations are possible during SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS. The weapons used in most exercises utilizing inert ordnance pose little risk to sea turtles unless they were to be near the surface at the point of impact. A turtle would have to be near the point of projectile impact to be in the affected area. Given the density of water, and the variable direction and energy loss of projectiles hitting the water, there is no accurate average answer in regard to a specific “area” or “depth.” Machine guns (0.50 caliber) and the close-in weapons systems (anti-missile systems) fire exclusively non-explosive ammunition. The same applies to larger weapons firing inert ordnance for training. Target area clearance procedures will reduce the potential for impacting a sea turtle such that impacts on sea turtles from exercises utilizing inert ordnance will be highly unlikely.

Exercises that utilize explosive ordnance pose a greater risk to sea turtles; however, the area affected by the explosive is relatively small, and target area clearance procedures will further reduce the potential for such an extremely unlikely event to occur.

Individual pieces of debris from ballistic missile intercept tests are dispersed over a large area. While a direct hit from a piece of debris would impact sea a turtle at the surface, it is extremely unlikely that this would ever occur.

The explosive payload of an EER/IEER buoy is suspended below the surface at a depth where sea turtles are unlikely to be present in the open ocean. Given the size of the ocean, It is unlikely that a sea turtle will be present in the vicinity of an EER/IEER buoy when detonated. In addition, in the rare event that a turtle is present when an EER/IEER is detonated, the depth of the approximately 4-lb charge will likely preclude there being any adverse effects.

HRC RDT&E Activities—No-action Alternative

RDT&E activities will not affect sea turtles.

Major Exercises—No-action Alternative

Underwater detonations during RIMPAC and USWEX will be similar to those described under HRC Training. Impacts on sea turtles are not anticipated given range clearance procedures, the low density of sea turtles, and the temporary nature and episodic number of the events involved.

Compliance under ESA for Sea Turtles

In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS for the ongoing activities in the HRC. The Navy finds that these activities are not likely to affect green, olive ridley, loggerhead, hawksbill, or leatherback sea turtles.

4.1.2.3.2 Alternative 1 (Sea Turtles—Biological Resources—Open Ocean)

The increased training and RDT&E activities under Alternative 1 result in an increase in the number of underwater detonations during SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NFSF.

Increased Tempo and Frequency of Training—Alternative 1

Although the number of underwater detonations would increase, due to the clearance requirements for underwater detonations and exercises involving explosives, sea turtles would not be within the area, and therefore impacts are not anticipated.

Enhanced RDT&E Activities—Alternative 1

Enhanced RDT&E activities would not affect sea turtles.

Future RDT&E Activities—Alternative 1

There are no future RDT&E activities that would affect sea turtles.

HRC Enhancements—Alternative 1

There are no new HRC enhancements that would affect sea turtles. The Navy will develop appropriate habitat data and any necessary Best Management Practices and mitigations in coordination with NMFS and USFWS for new activities. The Navy will continue to work with regulatory agencies throughout the planning and development process to minimize the potential for impacts on sea turtles.

Major Exercises—Alternative 1

Underwater detonations during RIMPAC and USWEX would be similar to those described under the No-action Alternative. Due to the clearance requirements for underwater detonations and exercises involving explosives, sea turtles would not be within the area and therefore impacts are not anticipated.

Compliance under ESA for Sea Turtles

In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS for the proposed and ongoing activities in the HRC under Alternative 1. The Navy finds that these activities are not likely to affect green, olive ridley, loggerhead, hawksbill, or leatherback sea turtles.

4.1.2.3.3 Alternative 2 (Sea Turtles—Biological Resources—Open Ocean)

The increased training and RDT&E activities under Alternative 2 result in an increase in the number of underwater detonations during SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS.

Increased Tempo and Frequency of Training—Alternative 2

Although the number of underwater detonations would increase, due to the clearance requirements for underwater detonations and exercises involving explosives, sea turtles would not be within the area, and therefore impacts are not anticipated.

Enhanced and Future RDT&E Activities—Alternative 2

There are no enhanced or future RDT&E activities that would affect sea turtles.

HRC Enhancements—Alternative 2

There are no new HRC enhancements that would affect sea turtles.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would conduct training simultaneously in the HRC. Underwater detonations during the Multiple Strike Group training would be similar to those described under the No-action Alternative for RIMPAC and USWEX. Due to the clearance requirements for underwater detonations and exercises involving explosives, sea turtles would not be within the area, and therefore impacts are not anticipated.

Compliance under ESA for Sea Turtles

In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS for the proposed and ongoing activities in the HRC under Alternative 2. The Navy finds that these activities are not likely to affect green, olive ridley, loggerhead, hawksbill, or leatherback sea turtles.

4.1.2.3.4 Alternative 3 (Sea Turtles—Biological Resources—Open Ocean)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhance RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on sea turtles from MFA/HFA sonar usage determined for Alternative 3 are discussed in the No-action Alternative, Section 4.1.2.3.1. Potential effects on sea turtles from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2, Section 4.1.2.3.3.

In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS for the proposed and ongoing activities in the HRC under Alternative 3 as the preferred alternative. The Navy finds that these activities are not likely to affect green, olive ridley, loggerhead, hawksbill, or leatherback sea turtles.

4.1.2.4 MARINE MAMMALS (BIOLOGICAL RESOURCES—OPEN OCEAN)

Potential impacts on marine mammals from Navy actions can occur from sources that are non-acoustic (i.e., ship strikes) and acoustic with sonar and underwater detonations being the primary acoustic concern. The Navy has and is continuing to conduct research on the effect of sound on marine mammals, the modeling of sound effects on marine mammals in areas of Navy training, and methods of reducing impacts through monitoring of marine mammals, sound reduction, and the use of mitigation measures (Chapter 6.0).

This section includes a discussion of the following topics for assessing potential impacts on marine mammals from Navy actions identified in Chapter 2.0:

- Potential Non-Acoustic Impacts
- Potential Sonar and Explosive Impacts

- Analytical Framework for Assessing Marine Mammal Response to Active Sonar
- Regulatory Framework
- Integration of Regulatory and Biological Frameworks
- Criteria and Thresholds for Physiological Effects
- Other Physiological Effects Considered
- Previous Criteria and Thresholds for Behavioral Effects
- Summary of Existing Credible Scientific Evidence Relevant to Assessing Behavioral Effects
- Cetacean Stranding Events
- Marine Mammal Mitigation Measures Related to Acoustic and Explosive Exposures
- Sonar Marine Mammal Modeling
- Explosive Source Marine Mammal Modeling

Marine Mammal Habitat

The primary source of potential marine mammal habitat impact during training and RDT&E activities within the HRC is underwater sound resulting from ASW, MISSILEX and testing, LFX (e.g., 5-inch guns) events, aerial bombardment, and underwater detonations. However, the sound does not constitute a long-term physical alteration of the water column or bottom topography, as the occurrences are of limited duration and are intermittent in time given that surface vessels associated with training move continuously and relatively rapidly through any given area. Other sources that may impact marine mammal habitat were considered and potentially include the introduction of fuel, debris, expended materials, ordnance, and chemical residues into the water column. The effects of each of these components were considered in this EIS/OEIS. Critical Habitat within the HRC for the Hawaiian monk seal was designated for beaches, sand spits, and bays out to the 20-fathom line (120 ft) for the Northwestern Hawaiian Islands (National Marine Fisheries Service, 1988). With the exception of a portion of Penguin Banks, the Hawaiian Islands Humpback Whale National Marine Sanctuary is located within 12 nautical miles (nm) of the islands, and potential impacts are discussed in the sections of this document that deal with each island.

4.1.2.4.1 Potential Non-Acoustic Impacts

Non-acoustic activities and equipment that were analyzed for potential impact on marine mammals during Navy training are discussed in this section and include ship strikes, torpedo guidance wire, torpedo strike impact, torpedo air launch accessories, MK-48 torpedo flex hoses, sonobuoys, and other expendable devices.

Ship Strikes

Ship strikes to marine mammals can cause major wounds and may occasionally cause fatalities. Whale-watching tours are becoming increasingly popular, and ship strikes have risen in recent years. In the Hawaiian Islands, ship strikes of the humpback whale are of particular concern. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated January 2007 [National Marine Fisheries Service, 2007d]), there were nine reported collisions with humpback whales in 2006 (none involved the Navy .These collisions can also occur with commercial or Navy ships. All types of ships can hit whales, and much of the time the marine mammal is either seen too late to avoid a collision, not observed until the collision occurs, or not detected.

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale). In addition, some baleen whales, such as the northern right whale and fin whale, swim slowly and seem generally unresponsive to ship sound, making them more susceptible to ship strikes (Nowacek et al., 2004). North Pacific right whales are primarily found in the Arctic, and there are only a few recorded sightings near the Hawaiian Islands (U.S. Department of the Navy, 2005a). Fin whales are rarely seen in Hawaiian Island waters (Barlow, 2006). Most baleen whales are rare in the Hawaiian Islands with the exception of the humpback whale that occurs seasonally and generally close to shore, within 25 nm of shore (Mobley, 2004; U.S. Department of the Navy, 2005a). Hawaii is the breeding ground for humpback whales, and there are also many calves present. While calves spend a lot of time at the surface, potentially increasing their vulnerability to ship strikes, they are also very active and often breech or create disturbances at the surface raising their probability of detection.

Ship strikes with whales are a recognized source of whale mortality worldwide. Of the 11 species known to be hit by ships, the most frequently reported is the fin whale, although there have been no recent incidents of ship strikes on fin whales in the Hawaiian Islands. Whale-watching tours are becoming increasingly popular, and ship strikes have risen in recent years. In the Hawaiian Islands, ship strikes of the humpback whale are of particular concern. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated January 2007[National Marine Fisheries Service, 2007d]), there were nine reported ship strikes with humpback whales in 2006. Whale watching could also have an effect on whales by distracting them from important biological activities such as nursing and breeding (see Katona and Kraus, 1999 for discussion of potential impacts from whale watching).

A review of recent reports on ship strikes provides some insight regarding the types of whales, locations and vessels involved, but also reveals significant gaps in the data. The Large Whale Ship Strike Database provides a summary of the 292 worldwide confirmed or possible whale/ship strikes from 1975 through 2002 (Jensen and Silber, 2003). The report notes that the database represents a minimum number of collisions, because the vast majority probably go undetected or unreported. In contrast, Navy vessels are likely to detect any strike that does occur, and they are required to report all ship strikes involving marine mammals. Overall, the percentages of Navy traffic relative to overall large shipping traffic are very small (on the order of 2 percent).

The ability of a ship to avoid a collision and to detect a collision depends on a variety of factors, including environmental conditions, ship design, size, and manning. The majority of ships participating in HRC training activities, such as Navy destroyers, have a number of advantages for avoiding ship strikes as compared to most commercial merchant vessels including the following:

- Navy ships have their bridges positioned forward, offering good visibility ahead of the bow.

- Crew size is much larger than that of merchant ships allowing for more potential observers on the bridge.
- Dedicated lookouts are posted during a training activity scanning the ocean for anything detectible in the water; anything detected is reported to the Officer of the Deck.
- Navy lookouts receive extensive training including Marine Species Awareness Training designed to provide marine species detection cues and information necessary to detect marine mammals.
- Navy ships are generally much more maneuverable than commercial merchant vessels.

The National Oceanic and Atmospheric Administration (NOAA) continues to review all shipping activities and their relationship to cumulative effects, in particular on large whale species. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated January 2007[[National Marine Fisheries Service, 2007d]), the factors that contribute to ship strikes of whales are not clear, nor is it understood why some species appear more vulnerable than others. Nonetheless, the number of known ship strikes indicate that deaths and injuries from ships and shipping activities remain a threat to endangered large whale species.

The Navy has adopted standard SOPs that reduce the potential for ship strikes with surfaced marine mammals (See Chapter 6.0). At all times when ships are underway, there are trained observers on watch scanning the area around the ship. If a marine mammal is sighted, appropriate action will be taken to avoid the animal. Collisions with cetaceans and pinnipeds are not expected.

Torpedo Guidance Wire

The potential entanglement impact of MK-48 torpedo control wires on marine mammals is very low for the following reasons. The control wire is very thin (approximately 0.02 inch) and has a relatively low breaking strength. Even with the exception of a chance encounter with the control wire while it was sinking to the sea floor (at an estimated rate of 0.5 ft per second), a marine animal would not be vulnerable to entanglement given the low breaking strength.

- The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a catenary droop (U.S. Department of the Navy, 1996a). When the wire is released or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literature (U.S. Department of the Navy, 1996a). Although Heezen (1957, as cited in U.S. Department of the Navy, 1996a) theorized that the entanglement of marine mammals with undersea telecommunication cables was a direct result of the mammal coming into contact with loops in the cable (e.g., swimming through loops that then tightened around the mammal), this should not be the case for the thin torpedo guidance wires. The potential for any harm or harassment to these species is extremely low.

Torpedo Strike Impact

There is negligible risk that a marine mammal could be struck by a torpedo during ASW training events. This conclusion is based on a review of ASW torpedo design features. The torpedoes are specifically designed to ignore false targets. As a result, their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals. They do not detect or home to marine mammals. In addition, there has never been a reconditioned torpedo (numbered in the thousands) that inadvertently struck a marine mammal, which would have been apparent given the fragile nature of the components at the head of the torpedo.

Torpedo Air Launch Accessories

Because some torpedo air launch accessories remain in the marine environment, the potential for impacting marine mammals through ingestion or entanglement has been previously analyzed. Ingestion of pieces of the launch accessories is unlikely because most of those are large and metallic and will sink rapidly (U.S. Department of the Navy, 1996a). With the exception of a chance encounter as the air launch accessories sink to the bottom, marine animals would only be vulnerable to entanglement or ingestion impacts if their diving and feeding behaviors place them in contact with the sea floor.

In previous studies, the Naval Ocean Systems Center identified two potential impacts of the MK-50 torpedo air launch accessories (Naval Ocean Systems Center, 1990). As the air launch accessories for the MK-46 torpedo are similar in function, materials, and size to those of the MK-50 torpedo, the following potential impacts identified by the Naval Ocean Systems Center are applicable to both torpedoes (U.S. Department of the Navy, 1996a):

- Upon water entry and engine startup, the air stabilizer would be released from the torpedo and sink to the bottom. Bottom currents may cause the air stabilizer canopy to billow, potentially posing an entanglement threat to marine animals that feed on the bottom. However, the canopy is large and highly visible compared to materials such as gill nets and nylon fishing line in which marine animals may become entangled. Thus, entanglement of marine animals in the canopy or suspension lines would be unlikely.
- Non-floating air launch accessories ranges in length from 11 to 44 inches. Because of the relatively large size of this accessory, the potential risk for ingestion of this accessory by marine animals other than bottom-feeding whales would be small. The probability of a whale coming in contact with and ingesting the air launch accessories likewise would be small.

MK-48 Torpedo Flex Hoses

The Navy analyzed the potential for the flex hoses to impact marine mammals. The analysis concluded that the potential entanglement impact on marine animals would be insignificant for reasons similar to those stated for the potential entanglement impact of control wires, specifically (U.S. Department of the Navy, 1996b):

- Due to its weight, the flex hose would rapidly sink to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine animal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.

- Due to its stiffness, the 250-ft-long flex hose would not form loops that could entangle marine animals.

Sonobuoy and Other Parachutes

Sonobuoys, lightweight torpedoes, and other devices deployed from aircraft use nylon parachutes of varying sizes. At water impact, the parachute assembly is jettisoned and sinks away from the exercise weapon or target. The parachute assembly would potentially be at the surface for a short time before sinking to the sea floor.

Marine mammals are also subject to entanglement in marine trash, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Entanglement and the eventual drowning of a marine mammal in a parachute assembly would be unlikely, since the parachute would have to land directly on an animal, or an animal would have to swim into it before it sinks. The potential for a marine mammal to encounter an expended parachute assembly is extremely low, given the generally low probability of a marine mammal being in the immediate location of deployment. If bottom currents are present, the canopy may billow and pose an entanglement threat to marine animals with bottom-feeding habits; however, given the extreme depth in the majority of the HRC, the probability of a marine mammal encountering a parachute assembly on the sea floor and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

Overall, the possibility of marine mammals ingesting nylon parachute fabric or being entangled in parachute assemblies is very remote.

4.1.2.4.2 Potential Sonar and Explosive Impacts

ASW is a primary warfare area for Navy patrol ships (surface and submarines), aircraft, and ASW helicopters. ASW aircrews must practice using sensors, including electro-optical devices, radar, magnetic anomaly detectors, sonar (including helicopter dipping sonar and both active and passive sonobuoys) in both the deep and shallow water environment. The training events being analyzed for Alternative 1 are not new and have taken place in the HRC over the past 60 years with no significant changes in the sonar equipment output in the last 30 years. Although there may be many hours of active ASW sonar events, the approximate 1-second "ping" of the sonar generally occurs no more often than twice a minute. The intermediate time when the sonar is passive is necessary so the sonar operators can detect/listen for sonar ping reflections.

The approach for estimating potential acoustic effects from ASW training within the HRC on cetacean species makes use of the methodology that was developed in cooperation with NOAA for the Navy's Undersea Warfare Training Range (USWTR) Draft OEIS/EIS (2005), USWEX Programmatic EA/OEA (U.S. Department of the Navy, 2007b), RIMPAC EA/OEA (U.S. Department of the Navy, Commander Third Fleet, 2006), and Composite Training Unit Exercise (COMPTUEX) / Joint Task Force Exercise (JTFEX) EA/OEA (U.S. Department of the Navy, 2007c). In addition, the approach for estimating potential acoustic effects from HRC training activities on marine mammals incorporates comments received on these previous documents. The NMFS and other commenters recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects.

Training that results in potential impacts from explosives include NSFS Exercise and GUNEX (5-inch and 76-mm guns when using non-inert rounds); MISSILEX (Penguin, Maverick, and Harpoon missiles); BOMBEX (MK-82, MK-83, MK-84 when using non-inert bombs); EER/IEER (explosive charge); SINKEX (multiple ordnance); and Mine Neutralization (up to a 20-lb explosive charge).

The Difference Between MFA/HFA Sonar and Low-Frequency Active Sonar

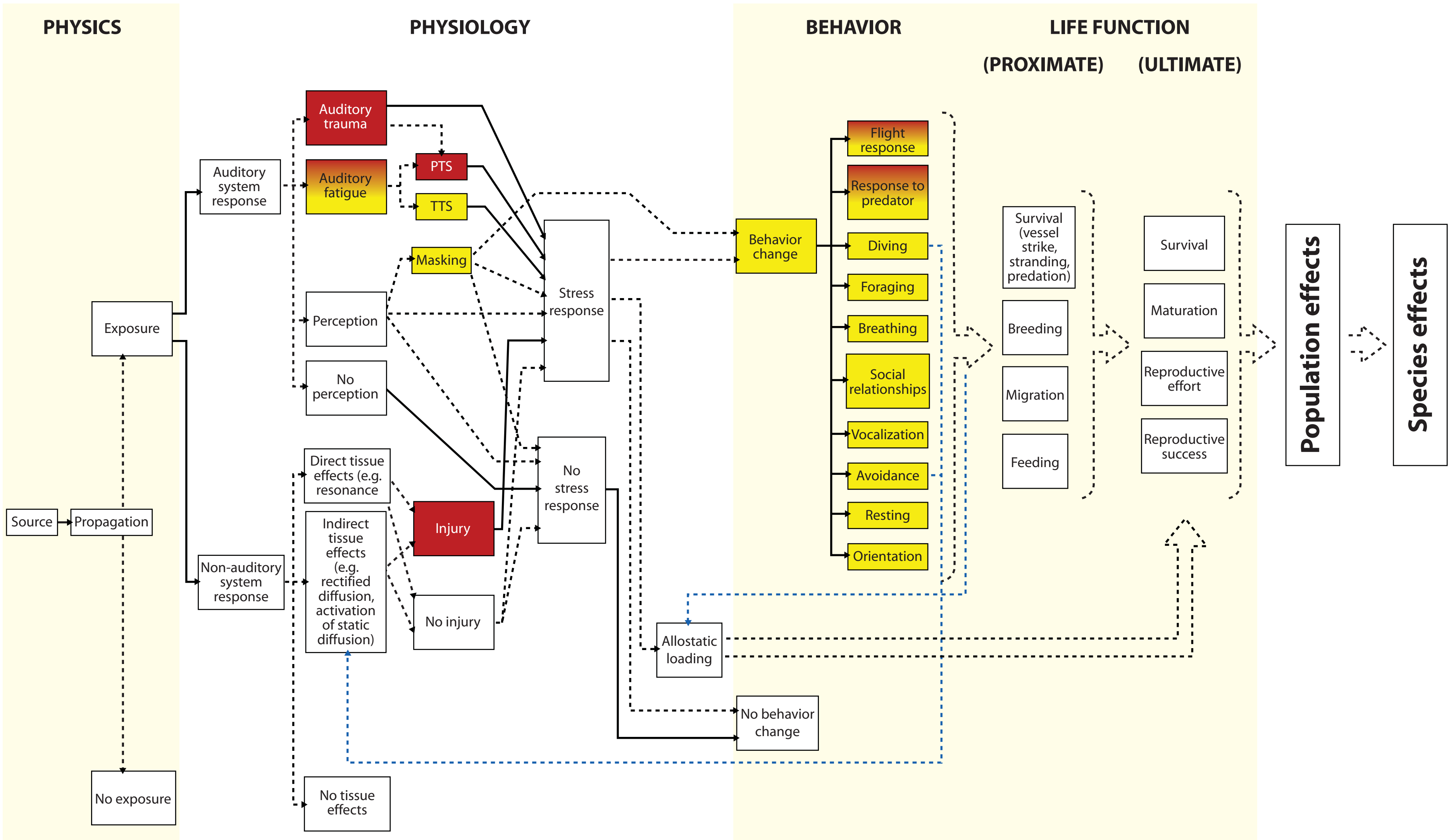
There is some confusion stemming from materials presented in reference to use of low-frequency active (LFA) sonar, which is not an action being proposed by this EIS/OEIS. MFA sonar operates in a range between 1 kHz to 10 kHz and HFA operates in a frequency range above 10 kHz. A LFA sonar system typically conducts sonar activities between 0.1 kHz to 0.5 kHz. An existing Navy LFA sonar system is the SURTASS LFA. The typical SURTASS LFA sonar signal is not a constant tone, but rather a transmission of various waveforms that vary in frequency and duration. A complete sequence of sound transmissions from LFA can last for as short as 6 seconds to as long as 100 seconds. A typical MFA/HFA sonar ping lasts approximately less than 1 second. The use of LFA is not part HRC EIS/OEIS Proposed Action.

4.1.2.4.3 Analytical Framework for Assessing Marine Mammal Response to Active Sonar

As summarized by the National Research Council, the possibility that human-generated sound could harm marine mammals or significantly interfere with their “normal” activities is an issue of increasing concern (National Research Council, 2005). This section evaluates the potential for the specific Navy acoustic sources used in the HRC to result in harassment of marine mammals.

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging, there are many unknowns in assessing the effects and significance of the response of marine mammals to sound exposures (National Research Council, 2005). For this reason, the Navy enlisted the expertise of NMFS as the cooperating agency. Their input assisted the Navy in developing a conceptual analytical framework for evaluating what sound levels marine mammals might receive as a result of Navy training actions at HRC, whether marine mammals might respond to these exposures, and whether that response might have a mode of action on the biology or ecology of marine mammals such that the response should be considered a potential harassment. From this framework of evaluating the potential for harassment incidents to occur, an assessment of whether acoustic sources might impact populations, stocks, or species of marine mammals can be conducted.

The conceptual analytical framework (Figure 4.1.2.4.3-1) presents an overview of how the MFA/HFA sonar sources used during training are assessed to evaluate the potential for marine mammals to be exposed to an acoustic source, the potential for that exposure to result in a physiological effect or behavioral response by an animal, and the assessment of whether that



EXPLANATION

Conceptual Marine Mammal Protection Action Analytical Framework

Figure 4.1.2.4.3-1

response may result in a consequence that constitutes harassment in accordance with Marine Mammal Protection Act (MMPA) definitions. As shown on the figure, the Navy has developed acoustic models to predict when Navy training and RDT&E activities could result in injury or behavioral disturbance. Total energy models are used to predict exposures that could result in either behavioral effects or physiological effects resulting in injury or temporary physiological changes. Risk function models using sound pressure levels are used to predict exposures that could result in behavioral effects.

Each exposure could result in a wide range of potential direct physiological effects, which could then lead to a behavioral response. For the purposes of this analysis all PTS exposures are assumed to result in injury (MMPA Level A harassment), and all TTS exposures are assumed to result in significant behavioral effects (MMPA Level B harassment). The other physiological effects are also considered in the analysis, although it is unlikely that they rise to the level of injury. The potential direct effects of physiological responses which may lead to behavioral exposures are considered in light of the biology and ecology of each species in order to arrive at the mode of action or result of the potential direct effect. The intensity of the resulting mode of action can then be used to determine if the natural behavioral patterns are abandoned or significantly altered.

Finally, the physiological and behavioral responses are reviewed in light of the population effects in order to determine the potential for effects on stocks or species.

The general analytical framework for analyzing potential effects of acoustic exposures on Endangered Species Act (ESA) listed species was developed by NMFS as presented in the Biological Opinion for RIMPAC 2006 and for the USWEX Programmatic EA/OEA (National Marine Fisheries Service, 2006a, 2007b). The framework is similar to the framework presented in Figure 4.1.2.4.3-1 in that the exposures calculated by the energy level and risk function models are used to evaluate a number of proximate responses and the resulting modes of action. The fitness consequences could then be determined for individuals and populations.

The first step in the conceptual model is to estimate the potential for marine mammals to be exposed to a Navy acoustic source. Three questions are answered in this “acoustic modeling” step:

1. **What action will occur?** This requires identification of all acoustic sources that would be used in the exercises and the specific outputs of those sources. This information is provided in Appendix J.

2. **Where and when will the action occur?** The place and season of the action are important to:
   - Determine which marine mammal species are likely to be present. Species occurrence and density data (Chapter 3.0) are used to determine the subset of marine mammals that may be present when an acoustic source is operational. The species occurrence information is provided in Chapter 3.0 and the density data is provided in Appendix J.

   - Predict the underwater acoustic environment that would be encountered. The acoustic environment here refers to environmental factors that influence the propagation of underwater sound. Acoustic parameters influenced by the place, season, and time are described in Appendix J.

3. **How many marine mammals are predicted to be exposed to sound from the acoustic sources?** Sound propagation models are used to predict the received exposure level from an acoustic source, and these are coupled with species distribution and density data to estimate the accumulated received energy and sound pressure level that could be considered as potential harassment. Appendix J describes the acoustic modeling and Sections 4.1.2.5, 4.1.2.6, and 4.1.2.7 present the number of exposures predicted by the modeling.

The next steps in the analytical framework evaluate whether the sound exposures predicted by the acoustic model might cause a physiological response in a marine mammal, and if that response might cause a change in behavior. Harassment includes the concepts of potential injury (Level A Harassment) and behavioral disturbance (Level B harassment). The response assessment portion of the analytical framework examines the following question:

4. **Which potential acoustic exposures might result in harassment of marine mammals?** The predicted acoustic exposures are first considered within the context of the species biology (e.g., can a marine mammal detect the sound, and is that mammal likely to respond to that sound?). Next, if a response is predicted, what type of physiological change will occur (e.g., auditory trauma or fatigue, tissue effects from bubble formation or resonance). If a physiological change has occurred will there be a stress response (i.e., increases in heart rate, hormonal activity, respiration rate and awareness) followed by change in behavior (e.g., flight response or avoidance, changes in diving, foraging, or vocalization patterns or social behavior). Next, how will changes in behavior affect proximate life functions (e.g., survival, breeding, migration, and feeding) and ultimate life functions (e.g., survival, maturation, reproductive effort, and reproductive success). Ultimately determine, if possible with available information, what population or species/stock effects may occur. If a response is predicted, will it potentially be considered "harassment" in accordance with MMPA harassment definitions? For example, if a response to the acoustic exposure has a mode of action that results in a consequence for an individual, such as interruption of feeding, that response or repeated occurrence of that response could be considered "abandonment or significant alteration of natural behavioral patterns," and therefore the exposure(s) would cause Level B harassment.

Section 4.1.2.4.3 reviews the regulatory framework and premise for the Navy/NMFS marine mammal response analytical framework. Sections 4.1.2.5, 4.1.2.6, 4.1.2.7, and 4.1.2.8 include the analysis by species/stock for the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3, presenting relevant information about the species biology and ecology to provide a context for assessing whether modeled exposures might result in incidental harassment. Each alternative includes a discussion of estimated effects on ESA listed species and a section on non-ESA listed species. The potential for harassment is considered within the context of the affected marine mammal population to assess the fitness consequence under the ESA. Particular focus on recruitment and survival are provided to analyze whether the effects of the action can be considered to have negligible impact on species or stocks under MMPA.

Literature Searches for Relevant Analytical Information

Literature searches were conducted to collect relevant reference material using published and unpublished sources. These include peer published journal articles, book chapters, monitoring or mitigation reports, Federal Register notices, environmental documents and workshop or conference reports. Recently, due to the increased concern over acoustic effects on marine animals, more information on the effects of a variety of underwater sound sources on marine animals has become available.

Literature searches using the Library of Congress' First Search and Dissertation Abstracts databases, SCOPUS, Web of Science, BioOne, Oceanic Abstracts, Cambridge Abstract's Aquatic Sciences, University of California MYLVYL, Biosis, Zoological Record Plus and Fisheries Abstracts (ASFA) database services. Specific journals that often publish marine mammal related publications (Aquatic Mammals, Journal of Mammalogy, Canadian Journal of Zoology, Marine Mammal Science), ecology (Ambio, Bioscience, Journal of Animal Ecology, Journal of Applied Ecology, Journal of the Marine Biological Association of the UK, Marine Pollution Bulletin), and bioacoustics (Journal of the Acoustical Society of America) were regularly searched for new publications. References were also obtained by contacting in the appropriate researchers in the field (commercial and academic researchers) and resource agencies (e.g. NMFS, USFWS). This allowed us to collect gray literature reports and submitted or in-press journal articles.

4.1.2.4.4 Regulatory Framework

The MMPA and ESA prohibit the unauthorized harassment of marine mammals and endangered species, and provide the regulatory processes for authorization for any such harassment that might occur incidental to an otherwise lawful activity.

The regulatory framework for estimating potential acoustic effects from HRC ASW training activities on cetacean species makes use of the methodology that was developed in cooperation with NOAA for the Navy's *Undersea Warfare Training Range (USWTR) Draft Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS),* (U.S. Department of the Navy, Commander, U.S. Atlantic Fleet, 2005). Via response comment letter to USWTR received from NMFS January 30, 2006, NMFS concurred with the use of EL for the determination of physiological effects on marine mammals. Therefore, this methodology is used to estimate the annual exposure of marine mammals that may be considered Level A harassment or Level B harassment as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential acoustic effects from HRC training activities on marine mammals makes use of the comments received on the Navy's USWTR Draft OEIS/EIS (U.S. Department of the Navy, Commander, U.S. Atlantic Fleet, 2005) and the *2006 Rim of the Pacific Supplemental Overseas Environmental Assessment* (U.S. Department of the Navy, 2006a). NMFS and other commenters recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects. As a result of these comments, this document uses a risk function approach to evaluate the potential for behavioral effects. A number of Navy actions and NOAA rulings have helped to qualify possible events deemed as "harassment" under the MMPA. As stated previously, "harassment" under the MMPA includes both potential injury (Level A), and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). NMFS also includes mortality as a possible outcome to consider in addition to

Level A and Level B harassment. The acoustic effects analysis and exposure calculations are based on the following premises:

- Harassment that may result from Navy training described in the HRC EIS/OEIS is unintentional and incidental to those training events.
- This HRC EIS/OEIS uses an unambiguous definition of injury as defined in the USWTR Draft OEIS/EIS (U.S. Department of the Navy, Commander, U.S. Atlantic Fleet, 2005), *2006 Rim of the Pacific Supplemental Overseas Environmental Assessment* (U.S. Department of the Navy, 2006a), and in previous rulings (National Oceanic and Atmospheric Administration, 2001; 2002a): injury occurs when any biological tissue is destroyed or lost as a result of the action.
- Behavioral disruption might result in subsequent injury and injury may cause a subsequent behavioral disruption, so Level A and Level B harassment categories (defined below) can overlap and are not necessarily mutually exclusive. However, by prior ruling (National Oceanic and Atmospheric Administration, 2001; 2006b), this HRC EIS/OEIS analysis assumes that Level A and B do not overlap.
- An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is counted as a single take (see National Oceanic and Atmospheric Administration, 2001; 2006b). An animal whose behavior is disrupted by an injury has already been counted as a Level A harassment and will not also be counted as a Level B harassment. Based on the consideration of two different acoustic modeling methodologies to assess the potential for sound exposures that might result in behavioral disturbance, it is possible that the model would count a Level B TTS exposure and a Level B behavioral exposure for the same animal. Although this approach calculates the maximum potential for behavioral disturbance incidents, it is considered conservative because the actual incidents of disturbance are expected to be lower.
- The acoustic effects analysis is based on primary exposures of the action. Secondary, or indirect, effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior, while possible, can only be reliably predicted in circumstances where the responses have been well documented. Consideration of secondary effects would result in Level A exposures being considered Level B exposures, and vice versa, since Level A exposure (assumed to be Level A harassment and injury) has the potential to disrupt behavior resulting in Level B harassment. In like manner, temporary physiological or behavioral disruption (Level B exposures) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of exposures. For beaked whales, where a connection between behavioral disruption by MFA/HFA sonar and injury to beaked whales is considered a possibility (under specific operational and environmental parameters), secondary effects are considered in the discussion for each species.

4.1.2.4.5 Integration of Regulatory and Biological Frameworks

This section presents a biological framework within which potential effects can be categorized and then related to the existing regulatory framework for MMPA and ESA. The information presented in Sections 4.1.2.4.6 and 4.1.2.4.7 is used to develop specific numerical exposure thresholds and risk function curves. Exposure thresholds and risk function curves are combined with sound propagation models and species distribution data to estimate the potential exposures as presented for the No-action Alternative in Section 4.1.2.5; Alternative 1 in Section 4.1.2.6; Alternative 2 in Section 4.1.2.7; and Alternative 3 in Section 4.1.2.8.

Physiological and Behavioral Effects

Sound exposure may affect multiple biological traits of a marine animal. The biological framework proposed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed according to MMPA and ESA regulations.

Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological impact may not be observable over short periods of observation. However, ecological information is considered in the analysis of the effects of individual species.

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. A physiological effect may range from the most significant of impacts (i.e., mortality and serious injury) to lesser effects that would define the lower end of the physiological impact range, such as the non-injurious distortion of auditory tissues.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA and ESA implementing regulations and Public Law (PL) 108—136 (2004).

In this EIS/OEIS the term "normal" is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic acoustic sources. As a result, this EIS/OEIS uses the following definitions:

- A physiological effect is a variation in an animal's respiratory, endocrine, hormonal, circulatory, neurological, or reproductive activity and processes, beyond the animal's normal range of variability, in response to human activity or to an exposure to a stimulus such as active sonar.

- A behavioral effect is a variation in the pattern of an animal's breathing, feeding, resting, migratory, intraspecific behavior (such as reproduction, mating, territorial, rearing, and agonistic behavior), and interspecific behavior, beyond the animal's normal pattern of variability in response to human activity or to an exposure to a stimulus such as active sonar.

The definitions of physiological effect and behavioral effect used here are specific to this EIS/OEIS and should not be confused with more global definitions applied to the field of biology or to existing Federal law. It is reasonable to expect some physiological effects on result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

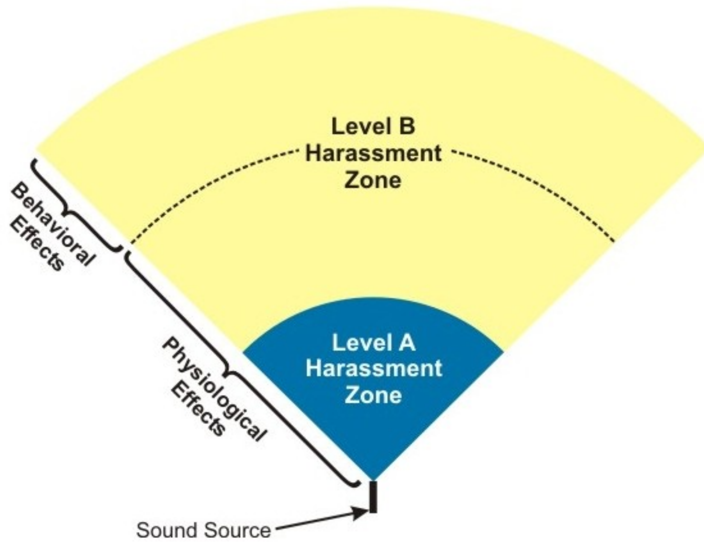
The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the exposure source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on the received sound level. Behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented. (Southall et al., 2007) However, to provide a tractable approach to predicting acoustic effects that is relevant to the regulatory terms of behavioral disruption, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source.

MMPA Level A and Level B Harassment

Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness events, Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury defined in previous rule (National Oceanic and Atmospheric Administration, 2001; 2002a), is the destruction or loss of biological tissue. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (National Oceanic and Atmospheric Administration, 2001), all injuries (slight to severe) are considered Level A harassment.

PL 108-136 (2004) amended the MMPA definition of Level B harassment for military readiness events, which applies to this action. For military readiness events, Level B harassment is now defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered." Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

The volumes of ocean in which Level A and Level B harassment is predicted to occur are described as harassment zones. All marine mammals predicted to be in a zone are considered exposed to effects that could result in the corresponding level of harassment. Figure 4.1.2.4.5-1 illustrates harassment zones extending from a hypothetical, directional sound source.



Note: This figure is for illustrative purposes only and does not represent the sizes or shapes of the actual harassment zones

Figure 4.1.2.4.5-1. Harassment Zones Extending from a Hypothetical, Directional Sound Source

The Level A harassment zone extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A harassment zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes account of all more serious injuries by inclusion within the Level A harassment zone. The threshold used to define the outer limit of the Level A harassment zone is given in Section 4.1.2.4.6.

The Level B harassment zone begins just beyond the point of slightest injury and extends outward from that point to include all animals that may possibly experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue. The animals predicted to be in this zone are assumed to experience Level B harassment by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior. The criterion and threshold used to define the outer limit of physiological effects leading to Level B harassment are given in Section 4.1.2.4.6. As described earlier, some behavioral effects occur without an accompanying physiological effect. The risk function that is used to define the non-physiological behavioral effects that constitute potential Level B harassment is described in Section 4.1.2.4.9 and Appendix J.

The Navy's most powerful MFA surface ship sonar, the AN/SQS 53, has a nominal source level of 235 dB re 1 μPa at 1 m. The estimated distance to a received level at the TTS threshold (195 dB SEL) – from a 235 dB source level (a nominal 53C ping) having 1-second duration – is approximately 180 yards. The estimated distance to a received level at the PTS threshold (a 215 dB SEL) is approximately 11 yards from the 235 dB sound source. To reiterate this important point, with the sonar producing a 1-second ping at a source level 235 dB, a marine mammal would have to be within 180 yards of the sonar dome (the bow of the ship) to be exposed to a 195 dB SEL, which is the threshold for a temporary threshold shift in hearing. The Navy's standard operating procedures or mitigation measures incorporate a shutdown of sonar if marine mammals come within 200 yards of an MFA and this is after two power-down steps at 1,000 yards and 500 yards.

ESA Harm and Harassment

ESA regulations define harm as "an act which actually kills or injures" fish or wildlife (50 Code of Federal Regulations [CFR] § 222.102). ESA regulations define harassment as an "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR § 17.3). Under ESA there are also behavioral effects that exceed the normal daily variation in behavior, but which arise without an accompanying physiological effect.

<u>Auditory Tissues as Indicators of Physiological Effects</u>

The mammalian auditory system, including those of marine mammals, consists of the outer ear (vestigial in cetaceans), middle ear, inner ear, and central nervous system (Ketten 1998). Sound waves are transmitted through the middle ear to fluids within the inner ear, except in cetaceans. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to over-stimulation by sound exposure (Yost and Nielson, 1994).

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost and Nielson, 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a sound-induced threshold shift, or simply a threshold shift (TS) (Miller, 1974). A threshold shift may be either permanent, in which case it is termed a PTS, or it may be temporary, in which case it is termed a TTS. Still lower levels of sound may result in auditory masking, which may interfere with an animal's ability to hear other concurrent sounds.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, PTS and TTS are used here as the biological indicators of physiological effects. TTS is the first indication of physiological non-injurious change and is not physical injury. The remainder of this section is, therefore, focused on TSs, including PTSs and TTSs. Because masking (without a resulting TS) is not associated with abnormal physiological function, it is not considered a physiological effect in this analysis, but rather a potential behavioral effect.

Noise-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1966; Ward, 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller, 1974). The amount of TS just after exposure is called the initial TS. If the TS eventually returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time post-exposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al., 1998). For example, TTS_2 means a TTS measured 2 minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 4.1.2.4.5-2 shows two hypothetical TSs, one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

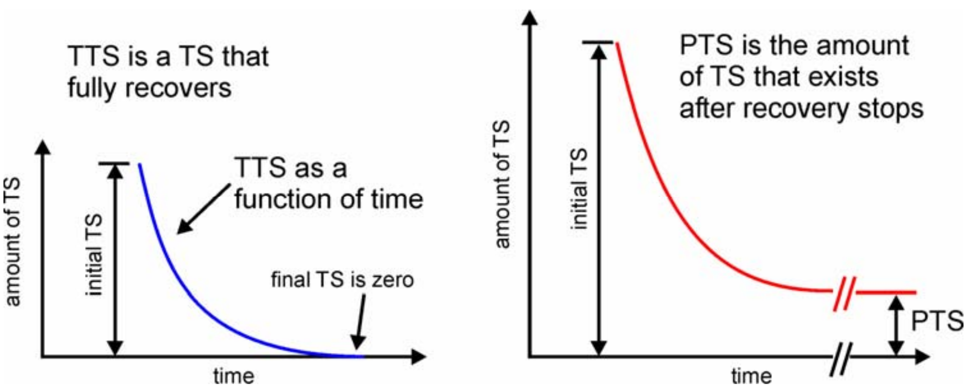


Figure 4.1.2.4.5-2. Hypothetical Temporary and Permanent Threshold Shifts

PTS, TTS, and Harassment Zones

PTS is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In the Draft EIS/OEIS, the smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A harassment zone.

TTS is recoverable and, as in recent rulings (National Oceanic and Atmospheric Administration, 2001, 2002a), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. Because it is considered non-injurious (there is no tissue damage), the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it.

Therefore, in the HRC, TTS is considered as a Level B harassment resulting from physiological effects on the auditory system.

4.1.2.4.6 Criteria and Thresholds for Physiological Effects

This section presents the effect criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. Section 4.1.2.4.5 identified the tissues of the ear as being the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. This section is, therefore, focused on criteria and thresholds to predict PTS and TTS in marine mammals.

Marine mammal ears are functionally and structurally similar to terrestrial mammal ears; however, there are important differences (Ketten, 1998). The most appropriate information from which to develop PTS/TTS criteria for marine mammals would be experimental measurements of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. Because of the ethical issues presented, PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be extrapolated using TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this authorization request are then presented. This is followed by discussions of EL, the relationship between EL and SPL, and the use of SPL and EL in previous environmental compliance documents.

Energy Flux Density Level and Sound Pressure Level

Energy Flux Density Level (EL) is measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re 1 μPa^2-s for underwater sound and dB re (20 μPa)^2-s for airborne sound.

Sound Pressure Level (SPL) is a measure of the root-mean square, or “effective,” sound pressure in decibels. SPL is expressed in dB re 1 μPa for underwater sound and dB re 20 μPa for airborne sound.

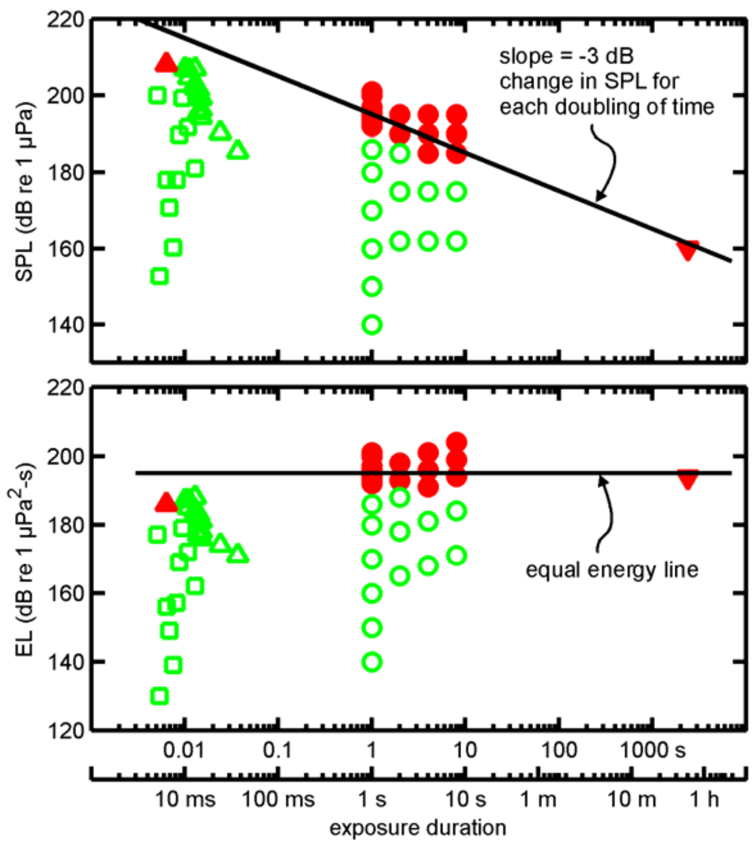
<u>TTS in Marine Mammals</u>

A number of investigators have measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels—exposure levels sufficient to cause a just-measurable amount of TTS—often defined as 6 dB of TTS (for example, Schlundt et al., 2000). The existing cetacean TTS data are summarized in the following bullets.

- **Schlundt et al. (2000)** reported the results of TTS experiments conducted with bottlenose dolphins and beluga exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kHz, SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 μPa (EL = 192 to 201 dB re 1 μPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 μPa and 195 dB re 1 μPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two belugas) make the Schlundt et al. (2000) data the most directly relevant TTS information for the scenarios described in the HRC EIS/OEIS.
- **Finneran et al. (2001, 2003, 2005)** described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 μPa^2-s. These results were consistent with the data of Schlundt et al. (2000) and showed that the Schlundt et al. (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.
- **Nachtigall et al. (2003)** measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall et al. (2003a) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of sound with SPL 179 dB re 1 μPa (EL about 213 dB re μPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 μPa. Nachtigall et al. (2004) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of sound with SPL 160 dB re 1 μPa (EL about 193 to 195 dB re 1 μPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall et al. (2003). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.
- **Finneran et al. (2000, 2002)** conducted TTS experiments with dolphins and belugas exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic waterguns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.
- **Kastak et al. (1999a, 2005)** conducted TTS experiments with three species of pinnipeds, California sea lion, northern elephant seal and a Pacific harbor seal, exposed to continuous underwater sounds at levels of 80 and 95 dB SPL at 2.5 and 3.5 kHz for up to 50 minutes. Mean TTS shifts of up to 12.2 dB occurred with the harbor seals showing the largest shift of 28.1 dB. Increasing the sound duration had a greater effect on TTS than increasing the sound level from 80 to 95 dB.

Figure 4.1.2.4.6-1 shows the existing TTS data for cetaceans (dolphins and belugas). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran et al., 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt et al. (2000) and the results of Finneran et al. (2003). The inverted triangle represents data from Nachtigall et al. (2004).

Figure 4.1.2.4.6-1 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration.



Legend: Filled symbol: Exposure that produced TTS, Open symbol: Exposure that did not produce TTS
Squares: Impulsive test results from Finneran et al., 2000, Triangles: Impulsive test results from Finneran et al., 2002a, Circles: 3, 10, and 20-kHz data from Schlundt et al. (2000) and results of Finneran et al. (2003), and Inverted triangle: Data from Nachtigall et al., 2004.

Figure 4.1.2.4.6-1. Existing TTS Data for Cetaceans

The solid line in the upper panel of Figure 4.1.2.4.6-1 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 μPa and the exposure duration is 1 second. Since EL = SPL + 10log10 (duration), doubling the duration *increases* the EL by 3 dB. Subtracting 3 dB from the SPL *decreases* the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an *equal energy line*—all points on the line have the same EL, which is, in this case, 195 dB re 1 μPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 μPa^2-s. The equal energy line at 195 dB re 1 μPa^2-s fits the tonal and sound data (the non-impulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.

In summary, the existing cetacean TTS data show that, for the species studied and sounds (non-impulsive) of interest, the following is true:

- The growth and recovery of TTS are analogous to those in land mammals. This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1966; Ward, 1997).
- SPL by itself is not a good predictor of onset-TTS, since the amount of TTS depends on both SPL and duration.
- Exposure EL is correlated with the amount of TTS and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).
- An energy flux density level of 195 dB re 1 μPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure.

Relationship between TTS and PTS

Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS_2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (e.g., Kryter et al., 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS—how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward, 1960; Ward et al., 1958, 1959). Ward et al. (1959) also reported slower recovery times when TTS_2 approached and exceeded 50 dB, suggesting that

50 dB of TTS_2 may represent a "critical" TTS. Miller et al. (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter et al. (1966) stated: "A TTS_2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent." These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few minutes to hours), TTS_2 varies with the logarithm of exposure time (Ward et al., 1958, 1959; Quaranta et al., 1998). For shorter exposure durations the growth of TTS with exposure time appears to be less rapid (Miller, 1974; Keeler, 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders et al., 1977; Mills et al., 1979).

Ward et al. (1958, 1959) provided detailed information on the growth of TTS in humans. Ward et al. presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 4.1.2.4.6-2 shows results from Ward et al. (1958, 1959) plotted as the amount of TTS_2 versus the exposure EL. The data in Figure 4.1.2.4.6-2(a) are from broadband (75 Hz to 10 kHz) sound exposures with durations of 12 to 102 minutes (Ward et al., 1958). The symbols represent mean TTS_2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 4.1.2.4.6-2(a) is approximately 1.5 dB TTS_2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS_2.

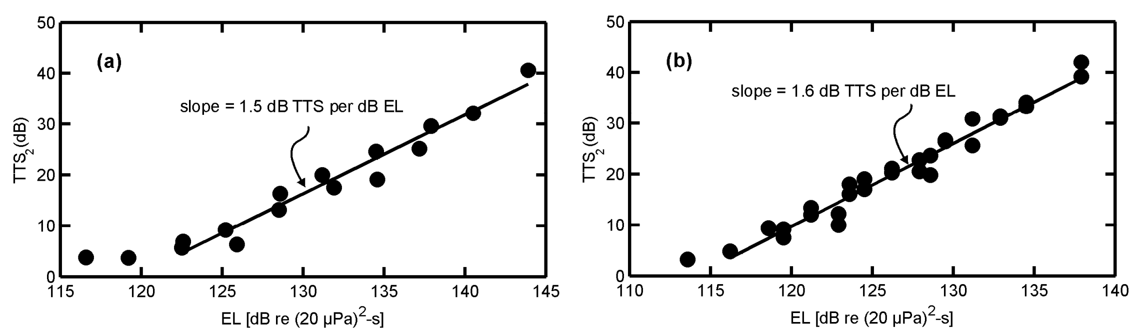


Figure 4.1.2.4.6-2. Growth of TTS versus the Exposure EL (from Ward et al., 1958, 1959)

The data in Figure 4.1.2.4.6-2(b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 minutes (Ward et al., 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest exposure EL. The results are similar to those shown in Figure

4.1.2.4.6-2(a). The slope of the regression line fit to the mean TTS data was 1.6 dB TTS_2/dB EL. A similar procedure was carried out for the remaining data from Ward et al. *(*1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS_2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS_2 per dB increase in exposure EL is the upper range of values from Ward et al. (1958, 1959) and gives the most conservative estimate—it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation. To summarize:

- In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:
  - Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
  - Estimating the growth rate of TTS—how much additional TTS is produced by an increase in exposure level.
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative estimate is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.
- Data from Ward et al. *(*1958, 1959) reveal a linear relationship between TTS_2 and exposure EL. A value of 1.6 dB TTS_2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous-type sounds.
- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

Threshold Levels for Harassment to Cetaceans from Physiological Effects

For this specified action, sound exposure thresholds for TTS and PTS are as presented in the following text box:

195 dB re 1 μPa^2-s received EL for TTS

215 dB re 1 μPa^2-s received EL for PTS

Cetaceans predicted to receive a sound exposure with EL of 215 dB re 1 μPa^2-s or greater are assumed to experience PTS and are counted as Level A harassment. Cetaceans predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 μPa^2-s but less than 215 dB re 1 μPa^2-s are assumed to experience TTS and are counted as Level B harassment.

Derivation of an Effect Threshold for Cetaceans

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 μPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2000, 2003) and the long-duration sound data from Nachtigall et al. (2003, 2004). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s.

The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959).

Use of EL for Physiological Effect Thresholds

Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

$$EL = SPL + 10\log10(\text{duration})$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL. Since mammalian TS data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure.

Therefore, estimates are conservative because recovery is not taken into account—intermittent exposures are considered comparable to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 μPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 μPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 μPa and duration = 1 second.
- Two pings with SPL = 189 dB re 1 μPa and duration = 2 seconds.

Previous Use of EL for Physiological Effects

Energy measures have been used as a part of dual criteria for cetacean auditory effects in shock trials, which only involve impulsive-type sounds (U.S. Department of the Navy, 1998a, 2001b). These actions used 192 dB re 1 μPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 μPa^2-s reference point differs from the threshold of 195 dB re 1 μPa^2-s used in this HRC EIS/OEIS. The 192 dB re 1 μPa^2-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 μPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 μPa^2-s value was reduced to 182 dB re 1 μPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al., 2001, 2003; Nachtigall et al., 2003, 2004). The HRC EIS/OEIS, therefore, uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 μPa^2-s), instead of the minimum of 192 dB re 1 μPa^2-s. From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor—the “best unbiased estimator”—of the EL at which onset-TTS should occur; predicting the number of exposures in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of exposures by onset-TTS over all of those exercises. Use of the minimum value would calculate the maximum potential of exposures because many animals counted would not have experienced onset-TTS. Further, there is no logical limiting minimum value of the distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates.

Summary of Physiological Effects Criteria for Cetacea

PTS and TTS are used as the criteria for physiological effects resulting in injury (Level A harassment) and disturbance (Level B harassment), respectively. Sound exposure thresholds for TTS and PTS in Cetacea are 195 dB re 1 μPa^2-s received EL for TTS and 215 dB re 1 μPa^2-s received EL for PTS. The TTS threshold is primarily based on cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on extrapolations from terrestrial mammal data indicating that PTS occurs at 40 dB or more of TS, and that TS growth occurring at a rate of approximately 1.6 dB/dB increase in exposure EL. The application of the model results to estimate marine mammal exposures for each species is discussed in Sections 4.1.2.5, 4.1.2.6, and 4.1.2.7.

Summary of Physiological Effects Criteria for Monk Seals

PTS and TTS are used as the criteria for physiological effects resulting in injury (Level A harassment) and disturbance (Level B harassment), respectively for the Hawaiian monk seal. As noted previously, research by Kastak et al. (1999a; 2005) provided estimates of the average SEL (EFD level) for onset-TTS for a harbor seal, sea lion, and Northern Elephant seal. Although the duration for exposure sessions duration is well beyond those typically used with tactical sonars, the frequency ranges are similar (2.5 kHz to 3.5 kHz). This data provides good estimates for the onset of TTS in pinnipeds since the researchers tested different combinations of SPL and exposure duration, and plotted the growth of TTS with an increasing energy exposure level.

Of the three pinniped groups studied by Kastak et al., elephant seals are the most closely related to the Hawaiian monk seal (the family *Monachinae*). The onset-TTS number, provided by Kastak et al. for elephant seals and used to analyze impacts on monk seals in this document, is 204 dB re 1μPa^2-s. Using the same rationale described previously for the establishment of the PTS threshold based on odontocete onset-TTS (20 dB up from onset-TTS), the PTS threshold for monk seals used in the HRC analysis is 224 dB re 1μPa^2-s.

Application of Physiological Effect Criteria for Mysticetes

Information on auditory function in mysticetes is extremely lacking. Sensitivity to low-frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system. Baleen whales are estimated to hear from 15 Hz to 20 kHz, with good sensitivity from 20 Hz to 2 kHz (Ketten, 1998). Filter-bank models of the humpback whale's ear have been developed from anatomical features of the humpback's ear and optimization techniques (Houser et al., 2001). The results suggest that humpbacks are sensitive to frequencies between 700 Hz and 10 kHz, and maximum sensitivity is between 2 kHz and 6 kHz. Research involving the recording of humpback vocalizations has found harmonics in the range up to 24~~0~~ kHz (Au et al. 2001; 2006). These results do not, however, indicate that humpbacks can actually hear those high-frequency harmonics and given that sound of that frequency attenuates rapidly over distance, those sounds would not serve as a means of communication over distance. There are no cases where the absolute sensitivity for any baleen whale species has been modeled or determined. Furthermore, there is no indication of what sorts of sound exposure may produce threshold shifts in these animals. As a result, the thresholds and criteria established for odontocetes is used to analyze potential affects from sonar use in mysticetes.

4.1.2.4.7 Other Physiological Effects Considered

The criteria and thresholds for PTS and TTS developed for odontocetes for this activity are also used for mysticetes. This generalization is based on the assumption that the empirical data at hand are representative of both groups until data collection on mysticete species shows otherwise. For the frequencies of interest for this action, there is no evidence that the total amount of energy required to induce onset-TTS and onset-PTS in mysticetes is different than that required for odontocetes.

Stress

A possible stressor for marine mammals exposed to sound, including MFA/HFA sonar, is the effect on health and physiological stress (Fair and Becker, 2000). A stimulus may cause a number of behavioral and physiological responses such as an elevated heart rate, increases in endocrine and neurological function, and decreased immune function, particularly if the animal perceives the stimulus as life threatening (Seyle, 1950; Moberg, 2000; Sapolsky, 2005). The primary response to the stressor is to move away to avoid continued exposure. Next the animal's physiological response to a stressor is to engage the autonomic nervous system with the classic "fight or flight" response. This includes changes in the cardiovascular system (increased heart rate), the gastrointestinal system (decreased digestion), the exocrine glands (increased hormone output), and the adrenal glands (increased norepinephrine). These physiological and hormonal responses are short lived and may not have significant long-term effects on an animal's health or fitness. Generally these short-term responses are not detrimental to the animal except when the health of the animal is already compromised by disease, starvation, or parasites; or the animal is chronically exposed to a stressor.

Exposure to chronic or high intensity sound sources can cause physiological stress. Acoustic exposures and physiological responses have been shown to cause stress responses (elevated respiration and increased heart rates) in humans (Jansen, 1998). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper et al. (1998) reported on the physiological stress responses of osprey to low-level aircraft noise. Krausman et al. (2004) reported on the auditory (TTS) and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith et al. (2004a, 2004b) recorded sound-induced physiological stress responses in a hearing-specialist fish that was associated with TTS. Welch and Welch (1970), reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Most of these responses to sound sources or other stimuli have been studied extensively in terrestrial animals but are much more difficult to determine in marine mammals. Increases in heart rate are a common reaction to acoustic disturbance in marine mammals (Miksis et al., 2001) as are small increases in the hormones norepinephrine, epinephrine, and dopamine (Romano et al., 2002; 2004). Increases in cortical steroids are more difficult to determine because blood collection procedures will also cause stress (Romano et al., 2002; 2004). A recent study, Chase Encirclement Stress Studies (CHESS), was conducted by NMFS on chronic stress effects in small odontocetes affected by the Eastern Tropical Pacific tuna fishery (Forney et al., 2002). Analysis was conducted on blood constituents, immune function, reproductive parameters, heart rate, and body temperature of small odontocetes that had been pursued and encircled by tuna fishing boats. Some effects were noted, including lower pregnancy rates, increases in norepinephrine, dopamine, ACTH and cortisol levels, heart lesions and an increase in fin and surface temperature when chased for over 75 minutes but with no change in core body temperature (Forney et al., 2002). These stress effects in small cetaceans that were actively pursued (sometimes for over 75 minutes) were relatively small and difficult to discern. It is unlikely that marine mammals exposed to MFA/HFA sonar would be exposed as long as the cetaceans in the CHESS study and would not be pursued by the Navy ships; therefore, stress effects would be minimal from the short-term exposure to sonar.

Acoustically Mediated Bubble Growth and Decompression Sickness

One suggested cause of stranding in marine mammals is by rectified diffusion (Crum and Mao, 1996), which is the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with a gas, such as nitrogen, which makes up approximately 78 percent of air. It is unlikely that the short duration of sonar pings would be able to drive bubble growth to any substantial size, if such a phenomenon occurs. Laboratory studies exposed blood and tissues for 2-3 hours to pressure and then to HFA sonar to develop bubbles *in vitro* (Crum and Mao, 2004). However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time and exposed to a continuous sound source for bubbles to become of a problematic size.

Repetitive diving in a trained marine mammal caused the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure but no decompression sickness symptoms were reported (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals (for example, beaked whales) are hypothetically predicted to induce greater nitrogen supersaturation (Houser et al., 2001). Studies have shown that marine mammal lung structure (both pinnipeds and cetaceans) facilitates collapse of the lungs at depths deeper than approximately 162 ft (Kooyman et al., 1970). Collapse of the lungs would force air into the non-air exchanging areas of the lungs (into the bronchioles away from the alveoli), thus significantly decreasing nitrogen diffusion into the body. Deep diving pinnipeds such as the northern elephant seal (*Mirounga angustirostris*) and Weddell seal (*Leptonychotes weddellii*) typically exhale before long deep dives, further reducing air volume in the lungs (Kooyman, et al., 1970) but cetaceans may not exhale on diving but use that air in the nasal passages for vocalizations (including echolocation in odontocetes).

Another hypothesis suggests that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Cox et al. (2006), with experts in the field of marine mammal behavior, diving, physiology, respiration physiology, pathology, anatomy, and bio-acoustics considered this to be a plausible hypothesis but required further investigation. Conversely, Fahlman et al. (2006) suggested that diving bradycardia (reduction in heart rate and circulation to the tissues), lung collapse, and slow ascent rates would reduce nitrogen uptake and thus reduce the risk of decompression sickness by 50 percent in models of marine mammals. Recent information on the diving profiles of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawaii (Baird et al., 2006) showed slower ascent rates than descent rates, but Tyack et al. (2006) showed that while these species do dive deeply (regularly exceed depths of 2,620 ft) and for long periods (48 to 68 minutes), they have significantly slower ascent rates than descent rates. Tyack et al. (2006) reported rapid ascents from deep dives in Cuvier's and Blainville's beaked whales but concluded that the natural diving behavior of beaked whales precluded them from having problems with nitrogen gas surpersaturation and embolisms. Zimmer and Tyack (2007) presented a model that suggested that repetitive shallow diving by beaked whales that may occur in response to a predator, would be above the depth for lung collapse and therefore could cause decompression sickness. There is no evidence that beaked whales dive in this manner in response to predators or sound sources and other marine mammals such as Antarctic and Galapagos fur seals, and pantropical spotted dolphins make repetitive shallow dives with no apparent decompression sickness (Kooyman and Trillmich, 1984; Kooyman et al., 1984; Baird et al., 2001).

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004; Evans and Miller, 2003). To date, ELs predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated (National Oceanic and Atmospheric Administration, 2002b). Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003), there is no conclusive evidence of this and complicating factors associated with introduction of gas into the venous system during necropsy or lesions occur as a result of physical trauma during stranding on the shoreline. Rommel et al (2006) reviewed several hypothetical causes of strandings in beaked whales and concluded that “It is important to note that no current hypothesis of pathogenic mechanisms resulting in acoustically-related strandings is proven.” According to Rommel et al. (2006) “The lesions observed in beaked whales that mass stranded in the Canary Islands in 2002 are consistent with, but not diagnostic of, decompression sickness.” Because evidence supporting decompression sickness in marine mammals exposed to mid- and high-frequency active sonar is debatable, no marine mammals addressed in this EIS/OEIS are given special treatment due to the possibility for acoustically mediated bubble growth.

Resonance

Another suggested cause of injury in marine mammals is air cavity resonance due to sonar exposure. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration—the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (for example, lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (National Oceanic and Atmospheric Administration, 2002b). They modeled and evaluated the likelihood that Navy MFA sonar caused resonance effects in beaked whales that eventually led to their stranding (U.S. Department of Commerce and U.S. Department of the Navy, 2001). The frequencies at which resonance was predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations due to the resonance effect were not considered to be of sufficient amplitude to cause tissue damage. This EIS/OEIS assumes that similar phenomenon would not be problematic in other cetacean species.

Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure.

Historically, principal masking concerns have been with prevailing background sound levels from natural and manmade sources (for example, Richardson et al., 1995a). Dominant examples of the latter are the accumulated sound from merchant ships and sound of seismic surveys. Both cover a wide frequency band and are long in duration.

HRC ASW training occurs in areas that are away from harbors but may include heavily traveled shipping lanes, although that is a small portion of the overall range complex. The loudest underwater sounds in the training area are those produced by sonars that are in the mid-frequency and high-frequency range.

The most dominant underwater sounds in the Hawaiian Islands during the 6-month November to April period, when humpback whales are present, are the vocalizations of the humpback whales. As detailed in Au et al. (2000), the ambient sound pressure level of 120 dB (SPL) occurs during this period as a result of thousands of whale "songs" having source levels as high as 174 dB SPL and other whale vocalizations and noises (e.g., flipper slaps) having source levels as high as 192 dB SPL (Richardson et al., 1995b).

The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal, frequency, and spatial domains. In particular, the pulse lengths are short, the duty cycle low (number of pings per minute are low), the total number of hours of operation per year small, and the tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave). Finally, high levels of sound are confined to a volume around the source and are constrained by propagation attenuation rates at mid- and high frequencies, and consist of relative short (generally less than a second) pulse lengths. For the reasons outlined above, the chance of sonar operations causing masking effects is considered negligible.

4.1.2.4.8 Previous Criteria and Thresholds for Behavioral Effects

The necessary information to conduct an assessment of behavioral effects for each species resulting from exposure to MFAS is incomplete and unavailable at this time due to the paucity of empirical data. The Navy has funded, and will continue to fund, research efforts to develop this data, but such an undertaking will require years to complete. The unavailability of such information is relevant to the ability to develop species-specific behavioral effects criterion. The science of understanding the effects of sound on marine mammals is dynamic, and the Navy is committed to the use of the best available science for evaluating potential effects from training and testing activities.

This section presents the previous effect criteria and thresholds for behavioral effects of sound leading to behavioral disturbance, and summarizes existing credible scientific evidence which is relevant to evaluating behavioral disturbance. Since TTS was and continues to be used as the biological indicator for onset of a physiological effect leading to behavioral disturbance, behavioral effects criteria are applied to exposure levels at or below those causing TTS that will result in a behavioral disturbance.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendible to the development of effect criteria and thresholds for marine mammals. For example, "annoyance" is one of several criteria used to define impact on humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a non-verbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exist (review by Richardson et al., 1995a; Southall et al., 2007); however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the MFA/HFA sonars to be used in the HRC. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (National Research Council, 2003).

History of Assessing Potential Harassment from Behavioral Effects

The prior Navy Letter of Authorization (LOA) and Incidental Harassment Authorization (IHA) requests for the Undersea Warfare Training Range (USWTR) and the Rim of the Pacific (RIMPAC) MFA sonar training respectively relied on behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances to develop a criterion and threshold for behavioral effects of sound based on energy flux density. These data are described in detail in Schlundt et al. (2000), Finneran et al., 2001; 2003 and Finneran and Schlundt 2004. Finneran and Schlundt (2004) analyzed behavioral observations from related TTS studies (Schlundt *et al*., 2000; Finneran *et* al. 2001, 2003) to calculate behavioral reactions as a function of known noise exposure. During the TTS experiments, four dolphins and two white whales were exposed during a total of 224 sessions to 1-s pulses between 160 and 204 dB re 1 µPa (root-mean-square SPL), at 0.4, 3, 10, 20 and 75 kHz. Finneran and Schlundt (2004) evaluated the behavioral observations in each session and determined whether a "behavioral alteration" (ranging from modifications of response behavior during hearing sessions to attacking the experimental equipment) occurred. For each frequency, the percentage of sessions in which behavioral alterations occurred was calculated as a function of received noise SPL. By pooling data across individuals and test frequencies, respective SPL levels coincident with responses by 25, 50, and 75 percent behavioral alteration were documented. 190 dB re 1 μPa^2-s (SEL) is the point at which 50 percent of the animals exposed to 3, 10, and 20 kHz tones were deemed to respond with some behavioral alteration, and the threshold that the Navy originally proposed for sub-TTS behavioral disturbance. These data represented the best available data at the time those activities were proposed because they are based on controlled, tonal sound exposures within the tactical sonar frequency range and because the species studied are closely related to the majority of animals expected to be located within the Proposed Action areas. The October 2005 USWTR Draft OEIS/EIS provided analysis to the 190 dB re 1 μPa^2-s criterion and threshold for behavioral effects, which the Navy had determined most accurately reflected scientifically-derived behavioral reactions from sound sources that are most similar to MFA sonars. A full discussion of the scientific data and use of those data to derive the 190 dB re 1 μPa^2-s threshold is presented in the original USWTR Draft OEIS/EIS (U.S. Environmental Protection Agency, 2005b).

The Navy's rationale for using energy flux density level (EL) for evaluation of behavioral effects included:

- **EL effect takes both the exposures SPL and duration into account.** Both SPL and duration of exposure affect behavioral responses to sound, so a behavioral effect threshold based on EL accounts for exposure duration.

- **EL takes into account the effects of multiple pings.** Effect thresholds based on SPL predict the same effect regardless of the number of received sounds. Previous actions using SPL-based criteria included implicit methods to account for multiple pings, such as the single-ping equivalent used in the SURTASS LFA (U.S. Department of the Navy, 2001c).

- **EL allows a rational ordering of behavior effects with physiological effects.** The effect thresholds for physiological effects are stated in terms of EL because experimental data described above showed the observed effects (TTS and PTS) are correlated best with the sound energy, not SPL. Using EL for behavioral effects allows the behavioral and physiological effects to be placed on a single exposure scale, with behavioral effects occurring at lower exposures than physiological effects.

As described above, behavioral observations of trained cetaceans exposed to intense underwater sound under controlled circumstances are an important data set in evaluating and developing a criterion and threshold for behavioral effects of sound. These behavioral response data are an important foundation for the scientific basis of the Navy's prior threshold of onset behavioral effects because of the (1) finer control over acoustic conditions; (2) greater quality and confidence in recorded sound exposures; and (3) the exposure stimuli closely match those of interest for the MFA sonar used as proposed in the HRC. Since no comparable controlled exposure data for wild animals exist, or are likely to be obtained in the near-term, the relationship between the behavioral results reported by Finneran and Schlundt (2004) and wild animals is not known. Although experienced, trained subjects may tolerate higher sound levels than inexperienced animals; it is also possible that prior experiences and resultant expectations may have made some trained subjects less tolerant of sound exposures.

In response to USWTR comments, potential differences between trained subjects and wild animals were considered by the Navy in conjunction with NMFS in the Navy's IHA application for RIMPAC 2006. At that time, NMFS recommended that the Navy include analysis of this threshold based on NMFS' evaluation of behavioral observations of marine mammals under controlled conditions, plus NMFS' interpretation of two additional studies on reactions to an alert stimuli (Nowacek et al., 2004) and analysis of the May 2003 USS SHOUP MFA sonar event (National Marine Fisheries Service, 2005a). Nowacek *et al.* (2004) conducted controlled exposure experiments on North Atlantic right whales using ship noise, social sounds of con-specifics, and an alerting stimulus (frequency modulated tonal signals between 500 Hz and 4.5 kHz). Animals were tagged with acoustic sensors (D-tags) simultaneously measured movement in three dimensions. Whales reacted strongly to alert signals at received levels of 133 – 148 dB SPL, mildly to conspecifics signals, and not at all to ship sounds or actual vessels. The alert stimulus caused whales to immediately cease foraging behavior and swim rapidly to the surface. Although SEL values were not directly reported, based on received exposure durations, approximate received values were on the order of 160 dB re 1μPa^2-s (SEL). National Marine Fisheries Service (2005) evaluated the acoustic exposures and coincident behavioral reactions of killer whales in the presence of SHOUP's use of MFA sonar in Haro Strait on May 5, 2003. In this case, none of the animals were directly fitted with acoustic dosimeters. However, based on a Naval Research Laboratory (NRL) analysis that took advantage of the fact that calibrated measurements of the sonar signals were made in situ and using advanced modeling to bound likely received exposures, estimates of received sonar signals by the killer whales were possible. Received SPL values ranged from 121 to 175 dB re 1 μPa. The most probable SEL values were 169.1 to 187.4 dB re 1μPa^2-s (SEL); worst-case estimates ranged from 177.7 to 195.8 dB re 1μPa^2-s (SEL). While researchers observing the animals during the course of sonar exposure subsequently reported unusual alterations in swimming, breathing, and diving behavior, Navy marine mammal scientists who reviewed the videotape of the event as part of the U.S. Pacific Fleet's investigation into the matter determined the behaviors of the killer whales as recorded on the video were within the species' normal range of behaviors and there were no immediate or general overt negative behavior reactions depicted (U.S. Department of the Navy, 2004b). Based on the duration and received levels of exposure and known behavioral reactions in other cetaceans, NMFS concluded that the killer whales "experienced exposure levels likely to induce behavioral reaction as a result of the 5 May 2003 sonar transmissions" (National Marine Fisheries Service, 2005). Accordingly, a conservative threshold for effect was derived compared to the regulatory definition of harassment, and Navy and NMFS agreed to the use of the 173 dB re 1 μPa^2-s threshold for the RIMPAC IHA request.

Subsequent to issuance of the RIMPAC IHA, additional public comments were received and considered. Based on this input, Navy continued to coordinate with NMFS to determine whether an alternate approach to energy flux density could be used to evaluate when a marine mammal may behaviorally be affected by MFA sound exposure. Coordination between the Navy and NMFS produced the adoption of risk function for evaluation of behavioral effects. The acoustic risk function approach for evaluating behavioral effects is described in the following section and fully considers the controlled, tonal sound exposure data in addition to comments received from the regulatory, scientific and public regarding concerns with the use of EL for evaluating the effects of sound on wild animals.

4.1.2.4.9 Summary of Existing Credible Scientific Evidence Relevant to Assessing Behavioral Effects

4.1.2.4.9.1 Background

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individuals, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al., 1995a; Wartzok et al., 2003; Southall et al., 2007). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

It is possible that some marine mammal behavioral reactions to anthropogenic sound may result in strandings. Several "mass stranding" events—strandings that involve two or more individuals of the same species (excluding a single cow–calf pair)—that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Sonar exposure has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Advisory Committee Report on Acoustic Impacts on Marine Mammals, 2006).

In these circumstances, exposure to acoustic energy has been considered an indirect cause of the death of marine mammals (Cox et al., 2006). Based on studies of lesions in beaked whales that have stranded in the Canary Islands and Bahamas associated with exposure to naval exercises that involved sonar, several investigators have hypothesized that there are two potential physiological mechanisms that might explain why marine mammals stranded: tissue damage resulting from resonance effects (Ketten, 2005) and tissue damage resulting from "gas and fat embolic syndrome" (Fernandez et al., 2005; Jepson et al., 2003; 2005). It is also likely that stranding is a behavioral response to a sound under certain contextual conditions and that the subsequently observed physiological effects of the strandings (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding versus exposure to sonar (Cox et al., 2006).

4.1.2.4.9.2 Development of the Risk Function

In Section 4.1.2.4.9 of the Draft EIS/OEIS, the Navy presented a dose methodology to assess the probability of Level B behavioral harassment from the effects of MFA and HFA sonar on marine mammals. Following publication of the Draft EIS/OEIS the Navy continued working with NMFS to refine the mathematically representative curve previously used, along with applicable input parameters with the purpose of increasing the accuracy of the Navy's assessment. As the regulating and cooperating agency, NMFS presented two methodologies to six scientists (marine mammalogists and acousticians from within and outside the federal government) for an independent review (National Marine Fisheries Service, 2008). Two NMFS scientists, one from the NMFS Office of Science and Technology and one from the Office of Protected Resources, then summarized the reviews from the six scientists and developed a recommendation.

One of the methodologies was a normal curve fit to a "mean of means" calculated from the mean of: (1) the estimated mean received level produced by the reconstruction of the USS SHOUP event of May 2003 in which killer whales were exposed to MFA sonar (U.S. Department of the Navy, 2004b); (2) the mean of the five maximum received levels at which Nowacek et al. (2004) observed significantly different responses of right whales to an alert stimuli; and (3) the mean of the lowest received levels from the 3 kHz data that the SPAWAR Systems Center (SSC) classified as altered behavior from Finneran and Schlundt (2004).

The second methodology was a derivation of a mathematical function used for assessing the percentage of a marine mammal population experiencing the risk of harassment under the MMPA associated with the Navy's use of the SURTASS LFA sonar (U.S. Department of the Navy, 2001c). This function is appropriate for application to instances with limited data (Feller, 1968). This methodology is subsequently identified as "the risk function" in this document.

The NMFS Office of Protected Resources made the decision to use the risk function and applicable input parameters to estimate the risk of behavioral harassment associated with exposure to MFA sonar. This determination was based on the recommendation of the two NMFS scientists; consideration of the independent reviews from six scientists; and NMFS MMPA regulations affecting the Navy's use of SURTASS LFA sonar (U.S. Department of the Navy, 2002b; National Oceanic and Atmospheric Administration, 2007b).

4.1.2.4.9.3 Methodology for Applying Risk Function

To assess the potential effects on marine mammals associated with active sonar used during training activities, the Navy together with NMFS, as a first step, investigated a series of mathematical models and methodologies that estimate the number of times individuals of the different species of marine mammals might be exposed to MFA sonar at different received levels. The Navy effects analyses assumed that the potential consequences of exposure to MFA sonar on individual animals would be a function of the received sound pressure level (dB re 1 µPa). These analyses assume that MFA sonar poses no risk, that is, does not constitute harassment to marine mammals if they are exposed to sound pressure levels from the MFA sonar below a certain basement value.

The second step of the assessment procedure requires the Navy and NMFS to identify how marine mammals are likely to respond when they are exposed to active sonar. Marine mammals can experience a variety of responses to sound including sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral responses, social responses that might result in reducing the fitness of individual marine mammals, and social responses that would not result in reducing the fitness of individual marine mammals.

As noted in the prior section, the Navy and NMFS have previously used acoustic thresholds to identify the number of marine mammals that might experience hearing losses (temporary or permanent) or behavioral harassment upon being exposed to MFA sonar (see Figure 4.1.2.4.9.3-1 left panel). These acoustic thresholds have been represented by either sound exposure level (related to sound energy, abbreviated as SEL), sound pressure level (abbreviated as SPL), or other metrics such as peak pressure level and acoustic impulse. The general approach has been to apply these threshold functions so that a marine mammal is counted as behaviorally harassed or experiencing hearing loss when exposed to received sound levels above a certain threshold and not counted as behaviorally harassed or experiencing hearing loss when exposed to received levels below that threshold. For example, previous Navy EISs, environmental assessments, MMPA take authorization requests, and the MMPA incidental harassment authorization (IHA) for the Navy's 2006 RIMPAC Major Exercise (National Oceanic and Atmospheric Administration, 2006i) used 173 decibel re 1 micropascal squared-second (dB re 1 μPa^2-s) as the energy threshold level (i.e., SEL) for Level B behavioral harassment for cetaceans. If the transmitted sonar accumulated energy received by a whale was above 173 dB re 1 μPa^2-s, then the animal was considered to have been behaviorally harassed. If the received accumulated energy level was below 173 dB re 1 μPa^2-s, then the animal was not treated as having been behaviorally harassed.

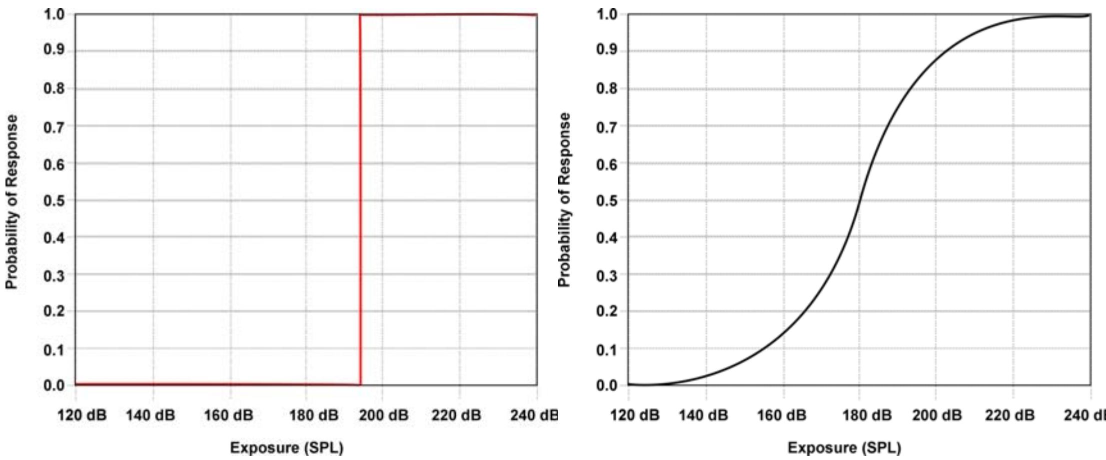


Figure 4.1.2.4.9.3-1. Step Function Versus Risk Continuum Function

Note: The left panel illustrates a typical step function with the probability of a response on the y-axis and received exposure on the x-axis. The right panel illustrates a typical risk continuum-function using the same axes. SPL is "Sound Pressure Level" in decibels referenced to 1 micropascal root mean square (1 μPa rms).

The left panel in Figure 4.1.2.4.9.3-1 illustrates a typical step-function or threshold that might also relate a sonar exposure to the probability of a response. As this figure illustrates, past Navy/NMFS acoustic thresholds assumed that every marine mammal above a particular received level (for example, to the right of the red vertical line in the figure) would exhibit identical responses to a sonar exposure. This assumed that the responses of marine mammals would not be affected by differences in acoustic conditions; differences between species and populations; differences in gender, age, reproductive status, or social behavior; or the prior experience of the individuals.

Both the Navy and NMFS agree that the studies of marine mammals in the wild and in experimental settings do not support these assumptions—different species of marine mammals and different individuals of the same species respond differently to sonar exposure. Additionally, there are specific geographic/bathymetric conditions that dictate the response of marine mammals to sonar that suggest that different populations may respond differently to sonar exposure. Further, studies of animal physiology suggest that gender, age, reproductive status, and social behavior, among other variables, probably affect how marine mammals respond to sonar exposures. (Wartzok et al., 2003; Southall et al., 2007)

Over the past several years, the Navy and NMFS have worked on developing an MFA sonar acoustic risk function to replace the acoustic thresholds used in the past to estimate the probability of marine mammals being behaviorally harassed by received levels of MFA sonar. The Navy and NMFS will continue to use acoustic thresholds to estimate temporary or permanent threshold shifts using SEL as the appropriate metric. Unlike acoustic thresholds, acoustic risk continuum functions (which are also called “exposure-response functions,” “dose-response functions,” or “stress-response functions” in other risk assessment contexts) assume that the probability of a response depends first on the “dose” (in this case, the received level of sound) and that the probability of a response increases as the “dose” increases. It is important to note that the probabilities associated with acoustic risk functions do not represent an individual’s probability of responding. Rather, the probabilities identify the proportion of an exposed population that is likely to respond to an exposure.

The right panel in Figure 4.1.2.4.9.3-1 illustrates a typical acoustic risk function that might relate an exposure, as received sound pressure level in decibels referenced to 1 μPa, to the probability of a response. As the exposure receive level increases in this figure, the probability of a response increases as well but the relationship between an exposure and a response is “linear” only in the center of the curve (that is, unit increases in exposure would produce unit increases in the probability of a response only in the center of a risk function curve). In the “tails” of an acoustic risk function curve, unit increases in exposure produce smaller increases in the probability of a response. Based on observations of various animals, including humans, the relationship represented by an acoustic risk function is a more robust predictor of the probable behavioral responses of marine mammals to sonar and other acoustic sources.

The Navy and NMFS have previously used the acoustic risk function to estimate the probable responses of marine mammals to acoustic exposures for other training and research programs. Examples of previous application include the Navy FEISs on the SURTASS LFA sonar (U.S. Department of the Navy, 2001c); the North Pacific Acoustic Laboratory experiments conducted off the Island of Kauai (Office of Naval Research, 2001), and the Supplemental EIS for SURTASS LFA sonar (U.S. Department of the Navy, 2007d).

The Navy and NMFS used two metrics to estimate the number of marine mammals that could be subject to Level B harassment (behavioral harassment and temporary threshold shift [TTS]) as defined by the MMPA, during training exercises. The agencies used acoustic risk functions with the metric of received sound pressure level (dB re 1 μPa) to estimate the number of marine mammals that might be at risk for MMPA Level B behavioral harassment as a result of being exposed to MFA sonar. The agencies will continue to use acoustic thresholds (“step-functions”) with the metric of sound exposure level (dB re 1 μPa^2-s) to estimate the number of marine mammals that might be “taken” through sensory impairment (i.e., Level A – permanent threshold shift [PTS] and Level B – TTS) as a result of being exposed to MFA sonar.

Although the Navy has not used acoustic risk functions in previous MFA sonar assessments of the potential effects of MFA sonar on marine mammals, risk functions are not new concepts for risk assessments. Common elements are contained in the process used for developing criteria for air, water, radiation, and ambient noise and for assessing the effects of sources of air, water, and noise pollution. The Environmental Protection Agency uses dose-functions to develop water quality criteria and to regulate pesticide applications (U.S. Environmental Protection Agency, 1998); the Nuclear Regulatory Commission uses dose-functions to estimate the consequences of radiation exposures (see Nuclear Regulatory Commission, 1997 and 10 Code of Federal Regulations 20.1201); the Centers for Disease Control and Prevention and the Food and Drug Administration use dose-functions as part of their assessment methods (for example, see Centers for Disease Control and Prevention, 2003, U.S. Food and Drug Administration and others, 2001); and the Occupational Safety and Health Administration uses dose-functions to assess the potential effects of noise and chemicals in occupational environments on the health of people working in those environments (for examples, see Occupational Safety and Health Administration, 1996b; Occupational Safety and Health Administration, 2006).

Risk Function Adapted from Feller (1968)

The particular acoustic risk function developed by the Navy and NMFS estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) for the probability as defined in the SURTASS LFA Sonar Final OEIS/EIS (U.S. Department of the Navy, 2001c), and relied on in the Supplemental SURTASS LFA Sonar EIS (U.S. Department of the Navy, 2007d) for the probability of MFA sonar risk for MMPA Level B behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes, odontocetes, and pinnipeds.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in U.S. Department of the Navy (2001c), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L-B}{K}\right)^{-A}}{1 - \left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);
L = Received Level (RL) in dB;
B = basement RL in dB; (120 dB);
K = the RL increment above basement in dB at which there is 50 percent risk;
A = risk transition sharpness parameter (10) .

In order to use this function, the values of the three parameters (B, K, and A) need to be established. The values used in the development of the parameters are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran, et al. (2001, 2003, and 2005; Finneran and Schlundt, 2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in Department of Commerce (National Marine Fisheries Service, 2005a); U.S. Department of the Navy (2004b); and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

4.1.2.4.9.4 Data Sources Used for Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments (Cox et al., 2006; Southall et al., 2007). The Navy is contributing to an ongoing behavioral response study in the Bahamas that is anticipated to provide some initial information on beaked whales, the species identified as the most sensitive to MFA sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures.

Until additional data is available, NMFS and the Navy have determined that the following three data sets are most applicable for the direct use in developing risk function parameters for MFA/HFA sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources. Until applicable data sets are evaluated to better qualify harassment from HFA sources, the risk function derived for MFA sources will apply to HFA.

Data from SSC's Controlled Experiments

Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al., 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al., 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests. (Schlundt et al., 2000, Finneran et al., 2002a) Bottlenose dolphins exposed to 1-second (sec) intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa root mean square (rms), and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al., 2002a). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al., 1997; Schlundt et al., 2000).

1. Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, 2005) experiments featuring 1-sec tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1μPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

    a. Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000) reported eight individual TTS experiments.

Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000) reported that "behavioral alterations," or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

b. Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 μPa^2/hertz [Hz]), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB SPL were randomly presented.

Data from Studies of Baleen (Mysticetes) Whale Responses

The only mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to a range of frequency sound sources from 120 Hz to 4500 Hz.(Nowacek et al., 2004). An alert stimulus, with a mid-frequency component, was the only portion of the study used to support the risk function input parameters.

2. Nowacek et al. (2004; 2007) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales' estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1μPa/√Hz.

Observations of Killer Whales in Haro Strait in the Wild

In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while USS SHOUP was engaged in MFA sonar operations in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field associated with the sonar operations had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, non-captive animal upon exposure to the AN/SQS-53 MFA sonar.

3. U.S. Department of Commerce (National Marine Fisheries, 2005a); U.S. Department of the Navy (2004b); Fromm (2004a, 2004b) documented reconstruction of sound fields produced by USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate closest approach time which was correlated to a reconstructed estimate of received level at an approximate whale location (which ranged from 150 to 180 dB), with a mean value of 169.3 dB SPL.

4.1.2.4.9.5 Limitations of the Risk Function Data Sources

There are significant limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.

The risk function presented here is based on three data sets that NMFS and Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data is the most rigorous and applicable for the following reasons:

- The data represents the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long-term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the MFA sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild, and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to MFA sonar.
- The behavioral responses of marine mammals that were observed in the wild are based solely on an estimated received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
  - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or

– Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

SSC San Diego Trained Bottlenose Dolphins and Beluga Data Set:

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan, 1998).
- The tests were designed to measure TTS, not behavior.
- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.
- The tones used in the tests were 1-second pure tones similar to MFA sonar.

North Atlantic Right Whales in the Wild Data Set:

- The observations of behavioral response were from exposure to alert stimuli that contained mid-frequency components but was not similar to an MFA sonar ping. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-minute alert stimuli is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set:

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the observed response as opposed to baseline conditions.

4.1.2.4.9.6 Input Parameters for the Feller-Adapted Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined in Section 4.2.1.9.3 previously. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment (U.S. Department of the Navy, 2001c, Appendix A). In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

4.1.2.4.9.6.1 Basement Value for Risk—The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the

MFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the scientists, and has been used in other publications. The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero.

4.1.2.4.9.6.2 The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the 5 maximum received levels at which Nowacek et al. (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

4.1.2.4.9.6.3 Risk Transition—The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing receive level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. NMFS has recommended that Navy use A=10 as the value for odontocetes, and pinnipeds, and A=8 for mysticetes, (Figures 4.1.2.4.9.6.3-1 and 4.1.2.4.9.6.3-2) (National Marine Fisheries Service, 2008).

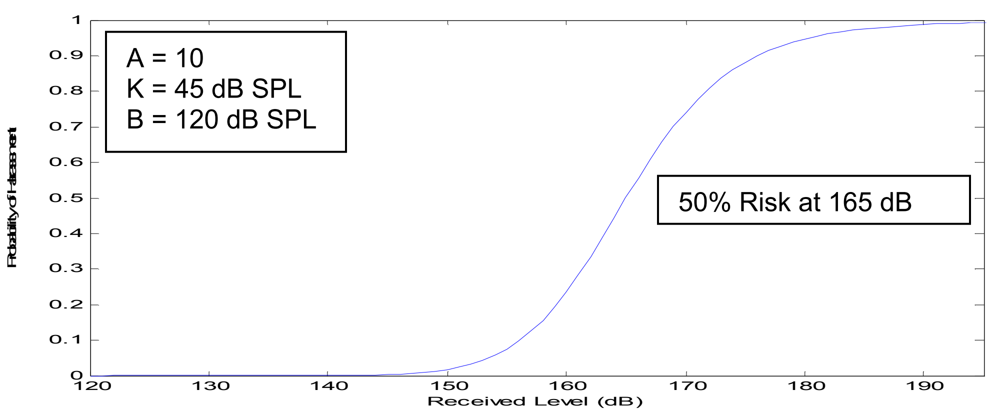


Figure 4.1.2.4.9.6.3-1. Risk Function Curve for Odontocetes (Toothed Whales) and Pinnipeds

The NMFS independent review process, described previously, provided the impetus for the selection of the parameters for the risk function curves. One scientist recommended staying close to the risk continuum concept as used in the SURTASS LFA sonar EIS. This scientist opined that both the basement and slope values; B=120 dB and A=10 respectively, from the SURTASS LFA sonar risk continuum concept are logical solutions in the absence of compelling data to select alternate values supporting the Feller-adapted risk function for MFA sonar. Another scientist indicated a steepness parameter needed to be selected, but did not recommend a value. Four scientists did not specifically address selection of a slope value. After reviewing the six scientists' recommendations, the two NMFS scientists recommended selection of A=10. Direction was provided by NMFS to use the A=10 curve for odontocetes based on the scientific review of potential risk functions explained in Section 4.1.2.4.9.2.

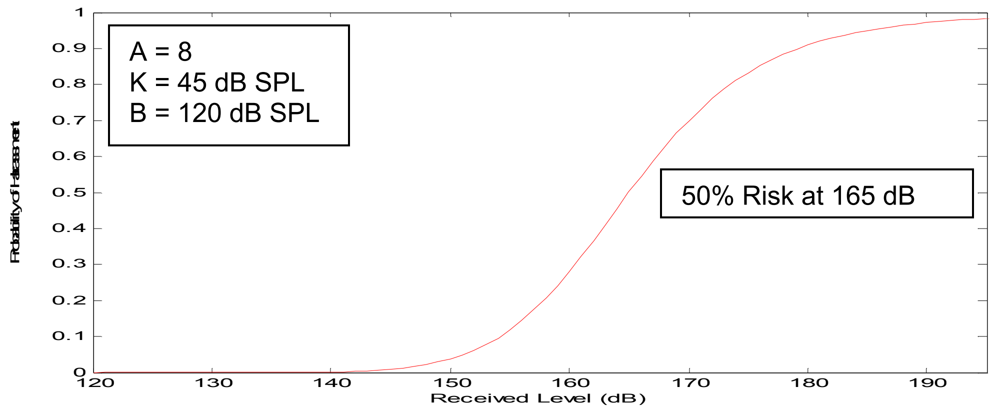


Figure 4.1.2.4.9.6.3-2. Risk Function Curve for Mysticetes (Baleen Whales)

Justification for the Steepness Parameter of A=10 for the Odontocete Curve

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA FEIS (U.S. Department of the Navy, 2001c). The analysis was performed to support the A=10 parameter for mysticete whales responding to a low-frequency sound source, a frequency range to which the mysticete whales are believed to be most sensitive to. The sensitivity analysis results confirmed the increased risk estimate for animals exposed to sound levels below 165 dB. Results from the Low Frequency Sound Scientific Research Program (LFS SRP) phase II research showed that whales (specifically gray whales in their case) did scale their responses with received level as supported by the A=10 parameter (Buck and Tyack, 2000). In the second phase of the LFS SRP research, migrating gray whales showed responses similar to those observed in earlier research (Malme et al., 1983, 1984) when the LF source was moored in the migration corridor (2 km [1.1 nm] from shore). The study extended those results with confirmation that a louder SL elicited a larger scale avoidance response. However, when the source was placed offshore (4 km [2.2 nm] from shore) of the migration corridor, the avoidance response was not evident. This implies that the inshore avoidance model – in which 50 percent of the whales avoid exposure to levels of 141 ± 3 dB – may not be valid for whales in proximity to an offshore source (U.S. Department of Navy, 2001c). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (U.S. Department of the Navy, 2001c), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al., 1984; Buck and Tyack, 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D, and National Marine Fisheries Service, 2008).

Justification for the steepness parameter of A=8 for the Mysticete Curve

The Nowacek et al. (2004) study provides the only available data source for a mysticete species behaviorally responding to a sound source (*i.e.*, alert stimuli) with frequencies in the range of tactical mid-frequency sonar (1-10 kHz), including empirical measurements of received levels

(RLs). While there are fundamental differences in the stimulus used by Nowacek et al. (2004) and tactical mid-frequency sonar (*e.g.*, source level, waveform, duration, directionality, likely range from source to receiver), they are generally similar in frequency band and the presence of modulation patterns. Thus, while they must be considered with caution in interpreting behavioral responses of mysticetes to mid-frequency sonar, they seemingly cannot be excluded from this consideration given the overwhelming lack of other information. The Nowacek et al. (2004) data indicate that five out the six North Atlantic right whales exposed to an alert stimuli "significantly altered their regular behavior and did so in identical fashion" (*i.e*., ceasing feeding and swimming to just under the surface). For these five whales, maximum RLs associated with this response ranged from root- mean-square sound (rms) pressure levels of 133-148 dB (re: 1 µPa).

When six scientists (one of them being Nowacek) were asked to independently evaluate available data for constructing a dose response curve based on a solution adapted from Feller (1968), the majority of them (4 out of 6; one being Nowacek) indicated that the Nowacek et al. (2004) data were not only appropriate but also necessary to consider in the analysis. While other parameters associated with the solution adapted from Feller (1968) were provided by many of the scientists (*i.e.*, basement parameter [B], increment above basement where there is 50 percent risk [K]), only one scientist provided a suggestion for the risk transition parameter, A.

A single curve may provide the simplest quantitative solution to estimating behavioral harassment. However, the policy decision, by NMFS-OPR, to adjust the risk transition parameter from A=10 to A=8 for mysticetes and create a separate curve was based on the fact the use of this shallower slope better reflected the increased risk of behavioral response at relatively low RLs suggested by the Nowacek et al. (2004) data. In other words, by reducing the risk transition parameter from 10 to 8, the slope of the curve for mysticetes is reduced. This results in an increase the proportion of the population being classified as behaviorally harassed at lower RLs. It also slightly reduces the estimate of behavioral response probability at quite high RLs, though this is expected to have quite little practical result owing to the very limited probability of exposures well above the mid-point of the function. This adjustment allows for a slightly more conservative approach in estimating behavioral harassment at relatively low RLs for mysticetes compared to the odontocete curve and is supported by the only dataset currently available. It should be noted that the current approach (with A=8) still yields an extremely low probability for behavioral responses at RLs between 133-148 dB, where the Nowacek data indicated significant responses in a majority of whales studied. (Note: Creating an entire curve based strictly on the Nowacek et al. [2004] data alone for mysticetes was advocated by several of the reviewers and considered inappropriate, by NMFS-OPR, since the sound source used in this study was not identical to tactical mid-frequency sonar, and there were only 5 data points available). The policy adjustment made by NMFS-OPR was also intended to capture some of the additional recommendations and considerations provided by the scientific panel (*i.e.*, the curve should be more data driven and that a greater probability of risk at lower RLs be associated with direct application of the Nowacek et al. 2004 data).

4.1.2.4.9.7 Basic Application of the Risk Function and Relation to the Current Regulatory Scheme

The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing and training with MFA sonar) at a given received level of sound. For example, at 165 dB SPL (dB re: 1µPa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al., 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available.

NMFS and Navy made the decision to apply the MFA risk function curve to HFA sources due to lack of available and complete information regarding HFA sources. As more specific and applicable data become available for MFA/HFA sources, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic. Ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions. As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al., 2003). In the HRC example, animals exposed to received levels between 120 and 130 dB may be more than 65 nautical miles (131,651 yards) from a sound source (Table 4.1.2.4.9.7-1); those distances would influence whether those animals might perceive the sound source as a potential threat, and their behavioral responses to that threat. Though there are data showing marine mammal responses to sound sources at that received level, NMFS does not currently have any data that describe the response of marine mammals to sounds at that distance (or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances. However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, the Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates.

Last, pursuant to the MMPA, an applicant is required to estimate the number of animals that will be "taken" by their activities. This estimate informs the analysis that NMFS must perform to determine whether the activity will have a "negligible impact" on the species or stock. Level B (behavioral) harassment occurs at the level of the individual(s) and does not assume any resulting population-level consequences, though there are known avenues through which behavioral disturbance of individuals can result in population-level effects. Alternately, a negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes, alone, is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS must consider other factors, such as the nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), or any of the other variables mentioned in the first paragraph (if known), as well as the number and nature of estimated Level A takes, the number of estimated mortalities, and effects on habitat. Generally speaking, the Navy and NMFS anticipate more severe effects from takes resulting from exposure to higher received levels (though this is in no way a strictly linear relationship throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels (Figure 4.1.2.4.9.7-1).

Table 4.1.2.4.9.7-1. Harassments at Each Received Level Band

Received Level	Distance at which Levels Occur in HRC	Percent of Harassments Occurring at Given Levels
Below 140 dB SPL	36 km–125 km	<1%
140>Level>150 dB SPL	15 km–36 km	2%
150>Level>160 dB SPL	5 km–15 km	20%
160>Level>170 dB SPL	2 km–5 km	40%
170>Level>180 dB SPL	0.6–2 km	24%
180>Level>190 dB SPL	180–560 meters	9%
Above 190 dB SPL	0–180 meters	2%
TTS (195 dB EFDL)	0–110 meters	2%
PTS (215 dB EFDL)	0–10 meters	<1%

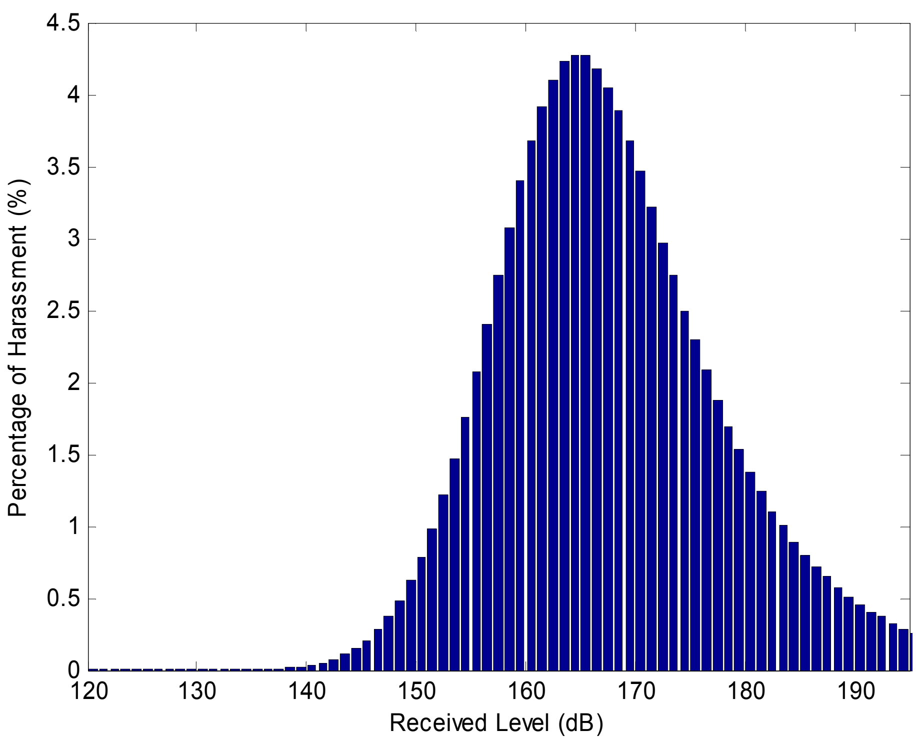


Figure 4.1.2.4.9.7-1. The Percentage of Behavioral Harassments Resulting from the Risk Function for Every 5 dB of Received Level

4.1.2.4.9.8 Navy Post Acoustic Modeling Analysis

The quantification of the acoustic modeling results includes additional analysis to increase the accuracy of the number of marine mammals affected. Table 4.1.2.4.9.8-1 provides a summary of the modeling protocols used in this analysis. Post modeling analysis includes reducing acoustic footprints where they encounter land masses, accounting for acoustic footprints for sonar sources that overlap to accurately sum the total area when multiple ships are operating together, and to better account for the maximum number of individuals of a species that could potentially be exposed to sonar within the course of one day or a discreet continuous sonar event.

Table 4.1.2.4.9.8-1. Navy Protocols Providing for Accurate Modeling Quantification of Marine Mammal Exposures

Historical Data	Sonar Positional Reporting System (SPORTS)	Annual active sonar usage data is obtained from the SPORTS database to determine the number of active sonar hours and the geographic location of those hours for modeling purposes.
Acoustic Parameters	AN/SQS-53 and AN/SQS-56	The AN/SQS-53 and the AN/SQS-56 active sonar sources separately to account for the differences in source level, frequency, and exposure effects.
	Submarine Sonar	Submarine active sonar use is included in effects analysis calculations using the SPORTS database.
Post Modeling Analysis	Land Shadow	For sound sources within the acoustic footprint of land, (approximately 65 nautical miles [nm] for the Hawaii Range Complex [HRC]) subtract the land area from the marine mammal exposure calculation.
	Multiple Ships	Correction factors are used to address the maximum potential of exposures to marine mammals resulting from multiple counting based on the acoustic footprint when there are occasions for more than one ship operating within approximately 130 nm of one another.
	Multiple Exposures	Accurate accounting for HRC training events within the course of one day or a discreet continuous sonar event: • Other HRC ASW training – 13.5 hours • RIMPAC – 12 hours • USWEX – 16 hours • Multi-strike group – 12 hours.

Pinniped

Information on the hearing abilities of the Hawaiian monk seal is limited. The range of underwater hearing in monk seals is 12 to 70 kHz, with best hearing from 12 to 28 kHz and 60 to 70 kHz (Thomas et al., 1990). This audiogram was from only one animal, and the high upper frequency range, which is high for a phocid (this taxonomic group), may not be indicative of the species. There is no information on underwater sounds, and in-air sounds are low-frequency sounds (below 1,000 Hz) such as "soft liquid bubble," short duration guttural expiration, a roar and belching/coughing sound (Miller and Job, 1992). A pup produces a higher frequency call (1.4 kHz) that presumably is used to call its mother. The audiogram of the Hawaiian monk seal suggests they hear above MFA sonar, although the in-air sounds they produce are below MFA sonar.

For there to be an exposure to MFA/HFA sonar during ASW events in the HRC, a monk seal would have to be underwater and in the vicinity of the event to exceed the exposure thresholds discussed previously. The NMFS Recovery Plan for the Hawaiian Monk Seal notes; “Monk seals spend approximately two-thirds of their time in the water” (National Marine Fisheries Service, 2007e). The acoustic modeling’s resulting in-water exposures to monk seals has, therefore, been reduced in this analysis by one-third to account for the time monk seals are not expected to be in the water.

Modeling undertaken for monk seals does not take into consideration the effect of mitigation measures or foraging habitat preferences. Monk seals generally forage at depths of less than 100 m, but occasionally dive to depths of over 500 m. The majority of ASW training in the HRC, however, takes place in waters 4 to 8 times deeper than even this reported (500 m) maximum. It is also very rare for ASW training using MFA sonar to take place in waters as shallow as 100 m in depth. The Navy’s mitigation measures require continuous visual observation during training with active sonar. It would, therefore, be rare for a Hawaiian monk seal to be present in the vicinity of an ASW event and the potential for detection by aircraft and lookouts aboard ship should further preclude the possibility that monk seals would be in the vicinity of ASW training events. Additionally, unlike the concern over beaked whales given a limited number of strandings coincident with the use of MFA sonar use, there have been no indications that any pinniped has ever been affected by exposure to MFA sonar.

4.1.2.4.10 Cetacean Stranding Events

The Navy is very concerned about and thoroughly investigates each stranding potentially associated with sonar use to better understand these interactions. Strandings can be a single animal, but several to hundreds may be involved. An event where animals are found out of their normal habitat is considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 Hanalei Mass Stranding Event; see Southall et al., 2006). Several hypotheses have been given for the mass strandings, which include the impact of shallow beach slopes on odontocete echolocation, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and from human actions. Generally inshore species do not strand in large numbers but usually as a single animal. This may be due to their familiarity with the coastal area, whereas some pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings, 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors, including bathymetry (i.e., steep drop offs), narrow channels (less than 35 nm), environmental conditions (e.g., surface ducting), and multiple sonar ships (see section on Stranding Events Associated with Navy Sonar) were compared between the different stranding events.

In a review of 70 reports of world-wide mass stranding events between 1960 and 2006, 48 (68 percent) involved beaked whales, 3 (4 percent) involved dolphins, and 14 (20 percent) involved whale species (International Whaling Commission, 2005). Cuvier’s beaked whales were involved in the greatest number of these events (48 or 68 percent), followed by sperm whales (7 or 10 percent), and Blainville’s and Gervais’ beaked whales (4 each or 6 percent). Naval training that might have involved tactical sonars are reported to have coincided with 9 (13 percent) or 10 (14 percent) of those stranding events. Between the mid-1980s and 2003 (the period reported by the International Whaling Commission, 2007), the Navy identified reports of

44 mass cetacean stranding events, of which at least 5 have been correlated with naval training that were using MFA sonar.

RIMPAC Exercises have occurred every second year since 1968, and ASW training has occurred in each of the 19 exercises that have occurred thus far. If the MFA sonar employed during those exercises killed or injured whales whenever the whales encountered the sonar, it seems likely that some mass strandings would have occurred at least once or twice over the 38-year period since 1968. With one exception, there is little evidence of a pattern in the record of strandings reported for the main Hawaiian Islands.

What is a Stranded Marine Mammal?

When a live or dead marine mammal swims or floats onto shore and becomes “beached” or incapable of returning to sea, the event is termed a “stranding” (Geraci et al., 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; National Marine Fisheries Service, 2007p). The legal definition for a stranding within the United States is that “a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance.” (16 U.S.C. 1421h).

The majority of animals that strand are dead or moribund (National Marine Fisheries Service, 2007p). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival. An event where animals are found out of their normal habitat is may be considered a stranding depending on circumstances even though animals do not necessarily end up beaching (Southhall, 2006).

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (National Marine Fisheries Service, 2007p).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell, 1987, Walsh et al., 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al., 1999). All of these normally pelagic off-shore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier’s dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier’s beaked whales, California sea lions, and harbor seals (Mazzuca et al., 1999, Norman et al., 2004, Geraci and Lounsbury, 2005).

Unusual Mortality Events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2002; Gulland, 2006; National Marine Fisheries Service, 2007p). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include (National Marine Fisheries Service, 2006c):

- A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.
- A temporal change in morbidity, mortality, or strandings is occurring.
- A spatial change in morbidity, mortality, or strandings is occurring.
- The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
- Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).
- Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.
- Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

United States Stranding Response Organization

Stranding events provide scientists and resource managers information not available from limited at-sea surveys, and may be the only way to learn key biological information about certain species such as distribution, seasonal occurrence, and health (Rankin, 1953; Moore et al., 2004; Geraci and Lounsbury, 2005). Necropsies are useful in attempting to determine a reason for the stranding, and are performed on stranded animals when the situation and resources allow.

In 1992, Congress amended the MMPA to establish the Marine Mammal Health and Stranding Response Program (MMHSRP) under authority of the Department of Commerce, NMFS. The MMHSRP was created out of concern started in the 1980s for marine mammal mortalities, to formalize the response process, and to focus efforts being initiated by numerous local stranding organizations and as a result of public concern.

Major elements of the MMHSRP include:

- National Marine Mammal Stranding Network
- Marine Mammal UME Program

- National Marine Mammal Tissue Bank (NMMTB) and Quality Assurance Program
- Marine Mammal Health Biomonitoring, Research, and Development
- Marine Mammal Disentanglement Network
- John H. Prescott Marine Mammal Rescue Assistance Grant Program (a.k.a. the Prescott Grant Program)
- Information Management and Dissemination. (National Marine Fisheries Service, 2007p)

The United States has a well-organized network in coastal states to respond to marine mammal strandings. Overseen by the NMFS, the National Marine Mammal Stranding Network is comprised of smaller organizations manned by professionals and volunteers from nonprofit organizations, aquaria, universities, and state and local governments trained in stranding response, animal health, and diseased investigation. Currently, 141 organizations are authorized by NMFS to respond to marine mammal strandings (National Marine Fisheries Service, 2007p). Through a National Coordinator and six regional coordinators, NMFS authorizes and oversees stranding response activities and provides specialized training for the network.

Stranding reporting and response efforts over time have been inconsistent, although effort and data quality within the United States have been improving within the last 20 years (National Marine Fisheries Service, 2007p). Given the historical inconsistency in response and reporting, however, interpretation of long-term trends in marine mammal stranding is difficult (National Marine Fisheries Service, 2007p). During the past decade (1995 – 2004), approximately 40,000 stranded marine mammals (about 12,400 are cetaceans) have been reported by the regional stranding networks, averaging 3,600 strandings reported per year (National Marine Fisheries Service, 2007p). The highest number of strandings were reported between the years 1998 and 2003 (National Marine Fisheries Service, 2007p). Detailed regional stranding information including most commonly stranded species can be found in Zimmerman (1991), Geraci and Lounsbury (2005), and National Marine Fisheries Service (2007p).

Stranding Data

Stranding events, though unfortunate, can be useful to scientists and resource managers because they can provide information that is not accessible at sea or through any other means. Necropsies are useful in attempting to assess a reason for the stranding, and are performed on stranded animals when the situation allows. Stranded animals have provided us with the opportunity to gain insight into the lives of marine mammals such as their natural history, seasonal distribution, population health, reproductive biology, environmental contaminant levels, types of interactions with humans, and the prevalence of disease and parasites. The only existing information on some cetacean species has been discovered from stranding events (National Marine Fisheries Service, 2007c).

Currently the government agency that is responsible for responding to strandings is the Marine Mammal Health and Stranding Response Program (MMHSRP) within NMFS. The National Marine Mammal Stranding Network, which is one part of the more comprehensive MMHSRP, is made up of smaller organizations partnered with NMFS to investigate marine mammal strandings. These stranding networks are established in all coastal states and consist of professionals and volunteers from nonprofit organizations, aquaria, universities, and state and local governments who are trained in stranding response. NMFS authorizes, coordinates, and participates in response activities and personnel training (National Marine Fisheries Service, 2007c). NMFS oversees stranding response via a National Coordinator and a regional coordinator in each of the NMFS regions. Stranding reporting and response efforts over time have been inconsistent and have been increasing over the past three decades, making any trends hard to interpret (National Marine Fisheries Service, 2007d). Over the past decade (1990–2000), approximately 40,000 stranded marine mammals have been reported by the regional stranding networks, averaging 3,600 strandings reported per year (National Marine Fisheries Service, 2007f). The highest number of strandings was reported between the years 1992–1993 and 1997–1998, with a peak in the number of reported strandings in 1998 totaling 5,708 (National Marine Fisheries Service, 2007f; National Marine Fisheries Service, 2007d). These have since been determined to have been El Niño years, which for a variety of reasons can have a drastic effect on marine mammals (see below). Reporting effort has been more consistent since 1994. Between 1994 and 1998 a total of 19,130 strandings were reported, with an average of 3,826 per year (National Marine Fisheries Service, 2007d). The composition of animals involved in strandings varied by region.

Peak years for cetacean strandings were in 1994 and 1999, and can be attributed to two UMEs. In 1994, 220 bottlenose dolphins stranded off Texas, which represented almost double the annual average (National Marine Fisheries Service, 2007f). It has been determined that the probable cause for these strandings was a morbillivirus outbreak. Then in 1999, 223 harbor porpoises stranded from Maine to North Carolina, representing a four-fold increase over the annual average (National Marine Fisheries Service, 2007f). The most likely cause for these strandings is interspecific aggression due to sea surface temperatures and a shift in prey species in the Mid-Atlantic (National Marine Fisheries Service, 2007f).

Table 4.1.2.4.10-1 describes numbers and composition of reported strandings during the more recent 5-year period between 2001-2005 (National Marine Fisheries Service, 2007d).

Table 4.1.2.4.10-1. Summary of the Number of Cetacean and Pinniped Strandings by Region from 2001-2005

Region	Number of Cetaceans	Number of Pinnipeds
Pacific	152	119
Southeast	3,549	55
Northeast	2,144	4,744
Southwest	49	230
Northwest	321	1,984
Alaska	152	119
Five-Year Totals	**6,636**	**7,489**

Source: National Marine Fisheries Service, 2007d; 2008

4.1.2.4.10.1 Causes of Strandings

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al., 1999; Carretta et al., 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Hoelzel, 2003; Geraci and Lounsbury, 2005; National Research Council, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding.

Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes listed below and described in the following sections:

Natural Stranding Causes:

- Disease
- Naturally occurring marine neurotoxins
- Weather and climatic influences
- Navigation errors
- Social cohesion
- Predation

Human Influenced (Anthropogenic) Stranding Causes:

- Fisheries interaction
- Vessel strike
- Pollution and ingestion
- Noise
- Gunshots

Natural Stranding Causes

Significant natural causes of mortality, die-offs, and stranding presented in Table 4.1.2.4.10.1-1 include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Other natural mortality not discussed in detail includes predation by other species such as sharks (Cockcroft et al., 1989; Heithaus, 2001), killer whales (Constantine et al., 1998; Guinet et al., 2000; Pitman et al., 2001), and some species of pinniped (Hiruki et al., 1999; Robinson et al., 1999). Table 4.1.2.4.10.1.1 lists unusual mortality events for marine mammals that have been attributed to or suspected from natural causes from 1978 to 2005.

Table 4.1.2.4.10.1-1. Marine Mammal Unusual Mortality Events Attributed to or Suspected from Natural Causes 1978-2005

Year	Species and number	Location	Cause
1978	Hawaiian monk seals (50)	NW Hawaiian Islands	Ciguatoxin and maitotoxin
1979-80	Harbor seals (400)	Massachusetts	Influenza A
1982	Harbor seals	Massachusetts	Influenza A
1983	Multiple pinniped species	West coast of U.S., Galapagos	El Nino
1984	California sea lions (226)	California	Leptospirosis
1987	Sea otters (34)	Alaska	Saxitoxin
1987	Humpback whales (14)	Massachusetts	Saxitoxin
1987-88	Bottlenose dolphins (645)	Eastern seaboard (New Jersey to Florida)	Morbillivirus; Brevetoxin
1987-88	Baikal seals (80-100,000)	Lake Baikal, Russia	Canine distemper virus
1988	Harbor seals (approx 18,000)	Northern Europe	Phocine distemper virus
1990	Stripped dolphins (550)	Mediterranean Sea	Dolphin morbillivirus
1990	Bottlenose dolphins (146)	Gulf Coast, U.S.	Unknown; unusual skin lesions observed
1994	Bottlenose dolphins (72)	Texas	Morbillivirus
1995	California sea lions (222)	California	Leptospirosis
1996	Florida manatees (149)	West Coast Florida	Brevetoxin
1996	Bottlenose dolphins (30)	Mississippi	Unknown; Coincident with algal bloom
1997	Mediterranean monk seals (150)	Western Sahara, Africa	Harmful algal bloom; Morbillivirus
1997-98	California sea lions (100s)	California	El Nino
1998	California sea lions (70)	California	Domoic acid
1998	Hooker's sea lions (60% of pups)	New Zealand	Unknown, bacteria likely
1999	Harbor porpoises	Maine to North Carolina	Oceanographic factors suggested
2000	Caspian seals (10,000)	Caspian Sea	Canine distemper virus
1999-2000	Bottlenose dolphins (115)	Panhandle of Florida	Brevetoxin
1999-2001	Gray whales (651)	Canada, U.S. West Coast, Mexico	Unknown; starvation involved
2000	California sea lions (178)	California	Leptospirosis
2000	California sea lions (184)	California	Domoic acid
2000	Harbor seals (26)	California	Unknown; Viral pneumonia suspected
2001	Bottlenose dolphins (35)	Florida	Unknown
2001	Harp seals (453)	Maine to Massachusetts	Unknown
2001	Hawaiian monk seals (11)	NW Hawaiian Islands	Malnutrition
2002	Harbor seals (approx. 25,000)	Northern Europe	Phocine distemper virus

Table 4.1.2.4.10.1-1. Marine Mammal Unusual Mortality Events Attributed to or Suspected from Natural Causes 1978-2005 (Continued)

Year	Species and number	Location	Cause
2002	Multispecies (common dolphins, California sea lions, sea otters) (approx. 500)	California	Domoic acid
2002	Hooker's sea lions	New Zealand	Pneumonia
2002	Florida manatee	West Coast of Florida	Brevetoxin
2003	Multispecies (common dolphins, California sea lions, sea otters) (approx. 500)	California	Domoic acid
2003	Beluga whales (20)	Alaska	Ecological factors
2003	Sea otters	California	Ecological factors
2003	Large whales (16 humpback, 1 fine, 1 minke, 1 pilot, 2 unknown)	Maine	Unknown; Saxitoxin and domoic acid detected in 2 of 3 humpbacks
2003-2004	Harbor seals, minke whales	Gulf of Maine	Unknown
2003	Florida manatees (96)	West Coast of Florida	Brevetoxin
2004	Bottlenose dolphins (107)	Florida Panhandle	Brevetoxin
2004	Small cetaceans (67)	Virginia	Unknown
2004	Small cetaceans	North Carolina	Unknown
2004	California sea lions (405)	Canada, U.S. West Coast	Leptospirosis
2005	Florida manatees, bottlenose dolphins (ongoing Dec 2005)	West Coast of Florida	Brevetoxin
2005	Harbor porpoises	North Carolina	Unknown
2005	California sea lions; Northern fur seals	California	Domoic acid
2005	Large whales	Eastern North Atlantic	Domoic acid suspected
2005-2006	Bottlenose dolphins	Florida	Brevetoxin suspected

Source: Data from Gulland and Hall (2007); citations for each event contained in Gulland and Hall (2007)

Disease

Marine mammals frequently suffer from a variety of diseases resulting from viral, bacterial, or parasites (National Oceanic and Atmospheric Administration, 2006e). Gulland and Hall (2005, 2007) provide a more-detailed summary of individual and population effects of marine mammal diseases.

Microparasites such as bacteria, viruses, and other microorganisms are commonly found in marine mammal habitats and usually pose little threat to a healthy animal (Geraci et al., 1999). For example, long-finned pilot whales that inhabit the waters off of the northeastern coast of the U.S. are carriers of the morbillivirus, yet have grown resistant to its usually lethal effects (Geraci et al., 1999). Since the 1980s, however, virus infections have been strongly associated with marine mammal die-offs (Domingo et al., 1992; Geraci and Lounsbury, 2005). Morbillivirus is the most significant marine mammal virus and suppresses a host's immune system, increasing risk of secondary infection (Harwood, 2002). A bottlenose dolphin UME in 1993 and 1994 was caused by infectious disease. Die-offs ranged from northwestern Florida to Texas, with an increased number of deaths as it spread (National Marine Fisheries Service, 2007d). A 2004 UME in Florida was also associated with dolphin morbillivirus (National Marine Fisheries Service, 2004a). Influenza A was responsible for the first reported mass mortality in the United States, occurring along the coast of New England in 1979-1980 (Geraci et al., 1999; Harwood, 2002). Canine distemper virus (a type of morbillivirus) has been responsible for large scale pinniped mortalities and die-offs (Grachev et al., 1989; Kennedy et al., 2000; Gulland and Hall, 2005), while a bacteria, *Leptospira pomona*, is responsible for periodic die-offs in California sea lions about every 4 years (Gulland et al., 1996; Gulland and Hall, 2005). It is difficult to determine whether microparasites commonly act as a primary pathogen, or whether they show up as a secondary infection in an already weakened animal (Geraci et al., 1999). Most marine mammal die-offs from infectious disease in the last 25 years, however, have had viruses associated with them (Simmonds and Mayer, 1997; Geraci et al., 1999; Harwood, 2002).

Macroparasites are usually large parasitic organisms and include lungworms, trematodes (parasitic flatworms), and protozoans (Geraci and St. Aubin, 1987; Geraci et al., 1999). Marine mammals can carry many different types, and have shown a robust tolerance for sizeable infestation unless compromised by illness, injury, or starvation (Morimitsu et al., 1987; Dailey et al., 1991; Geraci et al., 1999). Nasitrema, a usually benign trematode found in the head sinuses of cetaceans (Geraci et al., 1999), can cause brain damage if it migrates (Ridgway and Dailey, 1972). As a result, this worm is one of the few directly linked to stranding in the cetaceans (Dailey and Walker, 1978; Geraci et al., 1999).

Non-infectious disease, such as congenital bone pathology of the vertebral column (osteomyelitis, spondylosis deformans, and ankylosing spondylitis), has been described in several species of cetacean (Paterson, 1984; Alexander et al., 1989; Kompanje, 1995; Sweeny et al., 2005). In humans, bone pathology such as ankylosing spondylitis can impair mobility and increase vulnerability to further spinal trauma (Resnick and Niwayama, 2002). Bone pathology has been found in cases of single strandings (Paterson, 1984; Kompanje, 1995), and also in cetaceans prone to mass stranding (Sweeny et al., 2005), possibly acting as a contributing or causal influence in both types of events.

Naturally Occurring Marine Neurotoxins

Some single cell marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can accumulate (termed bioaccumulation) in the flesh and organs of fish and invertebrate (Geraci et al., 1999; Harwood, 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins although exposure can also occur through inhalation and skin contact (Van Dolah, 2005).

In the Gulf of Mexico and mid- to southern Atlantic states, “red tides,” a form of harmful algal bloom, are created by a dinoflagellate (*Karenia brevis*). *K. brevis* is found throughout the Gulf of Mexico and sometimes along the Atlantic coast (Van Dolah, 2005; National Marine Fisheries Service, 2007p). It produces a neurotoxin known as brevetoxin. Brevetoxin has been associated with several marine mammal UMEs within this area (Geraci, 1989; Van Dolah et al., 2003; National Marine Fisheries Service, 2004a; Flewelling et al., 2005; Van Dolah, 2005).

On the U.S. west coast and in the northeast Atlantic, several species of diatoms (microscopic marine plants) produce a toxin called domoic acid which has also been linked to marine mammal strandings (Geraci et al., 1999; Van Dolah et al., 2003; Greig et al., 2005; Van Dolah, 2005; Brodie et al., 2006; National Marine Fisheries Service, 2007p). These diatoms are widespread and can be found on the east and west coasts of the United States as well as in the Gulf of Mexico (National Marine Fisheries Service, 2007n). Domoic acid has also been known to have serious effects on public health and a variety of marine species (National Marine Fisheries Service, 2007n). Since 1998, domoic acid has been identified as the cause of mass mortalities of seabirds and marine mammals off the coast of California, and whale deaths off Georges Bank and it was suspected in mass mortalities as early as 1992 otherwise listed as "unknown neurologic disorder" (National Marine Fisheries Service, 2007n). Other algal toxins associated with marine mammal strandings include saxitoxins and ciguatoxins and are summarized by Van Dolah (2005); Ciguatoxins are common in Hawaiian reef fish.

In 2004, between March 10 and April 13, 107 bottlenose dolphins were found dead and stranded on the Florida Panhandle, along with hundreds of dead fish and marine invertebrates (National Marine Fisheries Service, 2007o). This event was declared a UME. Analyses of the dolphins found brevetoxins at high levels within the dolphin stomach contents, and at variable levels within their tissues (National Marine Fisheries Service, 2007o). Low levels of domoic acid were also detected in some of the dolphins, and a diatom that produces domoic acid (*Pseudo-nitzschia delicatissima*) was present in low to moderate levels in water samples (National Marine Fisheries Service, 2007o). In the Gulf of Mexico, two other UMEs associated with red tide involving bottlenose dolphins occurred previously in 1996, and between 1999 and 2000 (National Marine Fisheries Service, 2005h).

Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect cetaceans (Marine Mammal Commission, 2003). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (Reijnders and Aguilar, 2002). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering whales susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Specific information regarding the potential effects of environmental contamination on marine species in the Hawaiian Islands is not available, and therefore cumulative effects cannot be determined.

Weather and Climatic Influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to localized marine mammal strandings (Geraci et al., 1999; Walsh et al., 2001). Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al., 2000; Norman and Mead, 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter, 1991). Ice movement along southern Newfoundland has forced groups of blue whales and white-beaked dolphins ashore (Sergeant, 1982). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker et al., 2005).

The effect of large scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings is difficult to quantify given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore, 2005; Learmonth et al., 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al., 2006), potential starvation if not successful, and corresponding stranding due directly to starvation or succumbing to disease or predation while in a more weakened, stressed state (Selzer and Payne, 1988; Geraci et al., 1999; Moore, 2005; Learmonth et al., 2006; Weise et al., 2006).

Two recent papers examined potential influences of climate fluctuation on stranding events in southern Australia, including Tasmania, an area with a history of more than 20 mass stranding since the 1920s (Evans et al., 2005; Bradshaw et al., 2005). These authors note that patterns in animal migration, survival, fecundity, population size, and strandings will revolve around the availability and distribution of food resources. In southern Australia, movement of nutrient-rich waters pushed closer to shore by periodic meridinal winds (occurring about every 12 to 14 years) may be responsible for bringing marine mammals closer to land, thus increasing the probability of stranding (Bradshaw et al., 2006). The papers conclude, however, that while an overarching model can be helpful for providing insight into the prediction of strandings, the particular reasons for each one are likely to be quite varied.

Navigational Errors

Geomagnetism

It has been hypothesized that, like some land animals, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and that areas of local magnetic anomalies may influence strandings (Bauer et al., 1985; Klinowska, 1985; Kirschvink et al., 1986; Klinowska, 1986; Walker et al., 1992; Wartzok and Ketten, 1999). In a plot of live stranding positions in Great Britain with magnetic field maps, Klinowska (1985, 1986) observed an association between live stranding positions and magnetic field levels. In all cases, live strandings occurred at locations where magnetic minima, or lows in the magnetic fields, intersect the coastline. Kirschvink et al. (1986) plotted stranding locations on a map of magnetic data for the east coast of the United States, and were able to develop associations between stranding sites and locations where magnetic minima intersected the coast. The authors concluded that there were highly significant tendencies for cetaceans to beach themselves near these magnetic minima and coastal intersections. The results supported the hypothesis that cetaceans may have a magnetic sensory system similar to other migratory animals, and that marine magnetic topography and patterns may influence long-distance movements (Kirschvink et al., 1986). Walker et al. (1992) examined fin whale swim patterns off the northeastern U.S. continental shelf, and reported that migrating animals aligned with lows in the geometric gradient or intensity. While a similar pattern between magnetic features and marine mammal strandings at New Zealand stranding sites was not seen (Brabyn and Frew, 1994), mass strandings in Hawaii typically were found to occur within a narrow range of magnetic anomalies (Mazzuca et al., 1999).

Echolocation Disruption in Shallow Water

Some researchers believe stranding may result from reductions in the effectiveness of echolocation within shallow water, especially with the pelagic species of odontocetes who may be less familiar with coastline (Dudok van Heel, 1966; Chambers and James, 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since it is common for live strandings to occur along beaches with shallow, sandy gradients (Brabyn and

McLean, 1992; Mazzuca et al., 1999; Maldini et al., 2005; Walker et al., 2005). A contributing factor to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter, etc.) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy within echolocation signals and reduce the perceptibility of returning echoes of interest.

Social Cohesion

Many pelagic species such as sperm whales, pilot whales, melon-head whales, and false killer whales, and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al., 1999; Conner, 2000; Perrin and Geraci, 2002; National Marine Fisheries Service, 2007p).

Predation

Many species of marine mammal serve as prey to other animals and forms of marine life, including sharks and even other marine mammals. Predation from sharks is considered to be a contributing factor in the decline of the Hawaiian monk seal (Geraci et al., 1999). A stranded marine mammal will sometimes show signs of interactions with predators such as bites, teeth marks, and other injuries, which occasionally are severe enough to have been the primary cause of injury, death, and stranding.

Human Influenced (Anthropogenic) Causes

Over the past few decades there has been an increase in marine mammal mortalities believed to be caused by a variety of human activities (Geraci et al., 1999; National Marine Fisheries Service, 2007p), such as gunshots, ship strikes (National Oceanic and Atmospheric Administration, 2006e; Nelson et al., 2007), and other trauma and mutilations.

- Gunshot injuries are the most common man-made cause of strandings in sea lions and seals on the U.S. West Coast (National Marine Fisheries Service, 2007d).
- Every year a few northern right whales are killed within shipping lanes along the U.S. Atlantic coast, which may be enough to jeopardize stock recovery (Geraci et al., 1999).
- In 1998, two bottlenose dolphins and a calf were killed by vessel strikes in the Gulf of Mexico (National Marine Fisheries Service, 2005h).
- In 1999 there was one report of a stranded false killer whale on the Alabama coast that was classified as likely caused by fishery interactions or other human interaction due to limb mutilation (the fins and flukes of the animal had been amputated) (National Marine Fisheries Service, 2005e).
- 1,377 bottlenose dolphins were found stranded in the Gulf of Mexico from 1999 through 2003; 73 animals (11 percent) showed evidence of human interactions as the cause of death (e.g., gear entanglement, mutilations, gunshot wounds) (National Marine Fisheries Service, 2005h).

Data from strandings in which there was evidence of human interaction is available for the years 1999–2000. Table 4.1.2.4.10.1-2 provides the number of stranded marine mammals (cetaceans and pinnipeds) during this period that displayed evidence of human interactions (taken from National Marine Fisheries Service, 2007f). (Stranding data for the California region for the year 1999 is unavailable; therefore numbers are for stranded animals in 2000 only. Similarly, data is unavailable for the year 2000 in the Alaska region; numbers provided represent strandings for 1999 only.)

Table 4.1.2.4.10.1-2. Summary of Marine Mammal Strandings by Cause for Each Region from 1999-2000

Interaction	Southeast	Northeast	Northwest	California	Alaska
Fisheries	89	75	10	30	16
Vessel Strike	9	6	1	8	2
Gun Shot	6	6	12	41	4
Blunt Trauma	-	1	-	-	-
Mutilation	4	17	-	-	-
Plastic Ingestion	1	3	-	-	-
Power Plant Entrapment	1	11	-	23	-
Harassment	-	9	-	-	-
Arrow Wound	-	-	1	-	-
Harpoon Wound	-	-	2	-	-
Hit by Car	-	-	1	1	-
Hit by Train	-	-	1	-	-
Marine Debris Entanglement	-	-	1	3	-
Total	**110**	**128**	**27**	**106**	**22**

Source: National Marine Fisheries Service, 2007f

Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to many populations of marine mammals (Geraci et al., 1999; Baird, 2002; Culik, 2002; Carretta et al., 2004; Geraci and Lounsbury, 2005; National Marine Fisheries Service, 2007p). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al., 1999; Nieri et al., 1999; Geraci and Lounsbury, 2005; Read et al., 2006; Zeeberg et al., 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al., 1999; Campagna et al., 2007).

Bycatch

Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (National Research Council, 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Data on marine mammal bycatch within the United States was obtained from fisheries observer programs, reports of entangled stranded animals, and fishery logbooks, and was then extrapolated to estimate global bycatch by using the ratio of U.S. fishing vessels to the total number of vessels within the world's fleet (Read et al., 2006). Within U.S. fisheries, between 1990 and 1999 the mean annual bycatch of marine mammals was 6,215 animals, with a standard error of +/- 448 (Read et al., 2006). Eighty-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al., 2006). Over the decade there was a 40 percent decline in marine mammal bycatch, which was significantly lower from 1995-1999 than it was from 1990-1994 (Read et al., 2006). Read et al. (2006) suggests that this is primarily due to effective conservation measures that were implemented during this time period.

Read et al. (2006) then extrapolated this data for the same time period and calculated an annual estimate of 653,365 of marine mammals globally, with most of the world's bycatch occurring in gill-net fisheries. With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries will be the single greatest threat to many marine mammal populations around the world (Read et al., 2006).

Entanglement

Entanglement in fishing gear is a major cause of death or severe injury among the endangered whales. In the 2006-2007 whale season in Hawaii, the stranding network received reports of 26 entanglements (National Oceanic and Atmospheric Administration, 2006e). Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, or manage to be set free either of their own accord or by fishermen. Many large whales carry off gear after becoming entangled (Read et al., 2006). Many times when a marine mammal swims off with gear attached, the end result can be fatal. The gear may be become too cumbersome for the animal, or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies, and the cause of death for many stranded marine mammals is often attributed to such interactions (Baird and Gorgone, 2005). Marine mammals that die or are injured in fisheries activities may not wash ashore, therefore stranding data may underestimate fishery-related mortalities and serious injuries (National Marine Fisheries Service, 2005b).

From 1993 through 2003, 927 harbor porpoises were reported stranded from Maine to North Carolina, many of which had cuts and body damage suggestive of net entanglement. In 1999 it was possible to determine that the cause of death for 38 of the stranded porpoises was from fishery interactions, with one additional animal having been mutilated (right flipper and fluke cut off). In 2000, one stranded porpoise was found with monofilament line wrapped around its body and in 2003, nine stranded harbor porpoises were attributed to fishery interactions, with an additional three mutilated animals (National Marine Fisheries Service, 2005g). An estimated 78 baleen whales were killed annually in the offshore southern California/Oregon drift gillnet fishery during the 1980s (Heyning and Lewis, 1990). From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 19 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the mainland west coast of the United States (California Marine Mammal Stranding Network Database, 2006).

Ship Strike

Ship strikes to marine mammals are another cause of mortality and stranding (Laist et al., 2001; Geraci and Lounsbury, 2005; De Stephanis and Urquiola, 2006). An animal at the surface could be struck directly by a ship, a surfacing animal could hit the bottom of a ship, or an animal just below the surface could be cut by a ship's propeller. The severity of injuries typically depends on the size and speed of the ship (Knowlton and Kraus, 2001; Laist et al., 2001; Vanderlaan and Taggart 2007).

In the 2006-2007 whale season in Hawaii, the stranding network saw an increase in the number of vessel collisions with whales (none involving military vessels) having recorded eight ship strikes (National Oceanic and Atmospheric Administration, 2006e). Three of these collisions with marine mammals were known to have caused injury to the animal.

An examination of all known ship strikes from all shipping sources (civilian and military) indicates ship speed is a principal factor in whether a ship strike results in death (Knowlton and Kraus 2001; Laist et al. 2001, Jensen and Silber 2003; Vanderlaan and Taggart 2007). In assessing records in which ship speed was known, Laist et al. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the ship involved in the collision. While the authors concluded that most deaths occurred when a ship was traveling in excess of 13 knots, the study did not, however, take into account the historical increase in ship speed and the increase in the number of ships since records have been collected. In essence, very few modern ships transit at less than 13 knots.

Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, ship speed at the time of collision was reported for 58 cases. Of these cases, 39 (or 67 percent) resulted in serious injury or death (19 or 33 percent resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy, and 20 or 35 percent resulted in death). Operating speeds of ships that struck various species of large whales ranged from 2 to 51 knots. The majority (79 percent) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing ship speed. Specifically, the predicted probability of serious injury or death increased from 45 percent to 75 percent as ship speed increased from 10 to 14 knots, and exceeded 90 percent at 17 knots. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the ship. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the ship hull increase with increasing speed (Clyne, 1999; Knowlton et al., 1995).

The growth in civilian commercial ports and associated commercial ship traffic is a result in the globalization of trade. The Final Report of the NOAA International Symposium on “Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology” stated that the worldwide commercial fleet has grown from approximately 30,000 ships in 1950 to over 85,000 ships in 1998 (National Research Council, 2003; Southall, 2005). Between 1950 and 1998, the U.S. flagged fleet declined from approximately 25,000 to less than 15,000 and currently represents only a small portion of the world fleet. From 1985 to 1999, world seaborne trade doubled to 5 billion tons and currently includes 90 percent of the total world trade, with container shipping movements representing the largest volume of seaborne trade. It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and ship design are as, or more, significant than the total number of ships. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Ship propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005).

While there are reports and statistics of whales struck by ships in U.S. waters, the magnitude of the risks of commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on ship strike interactions between ships and marine mammals outside of U.S. waters (De Stephanis and Urquiola, 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regional based small populations where the significance of low numbers of collisions would be greater given smaller populations or populations segments.

Navy ship traffic is a small fraction of the overall U.S. commercial and fishing ship traffic. While Navy ship movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the Navy, probability of ship strikes is greatly reduced. Furthermore, actions to avoid close interaction of Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles, or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard and can be harmful to wildlife. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (National Marine Fisheries Service, 2007h). There are certain species of cetaceans, along with Florida manatees, that are more likely to eat trash, especially plastics, which is usually fatal for the animal (Geraci et al., 1999).

Between 1990 through October 1998, 215 pygmy sperm whales stranded along the U.S. Atlantic coast from New York through the Florida Keys (National Marine Fisheries Service, 2005b). Remains of plastic bags and other debris were found in the stomachs of 13 of these animals (National Marine Fisheries Service, 2005b). During the same time period, 46 dwarf sperm whale strandings occurred along the U.S. Atlantic coastline between Massachusetts and the Florida Keys (National Marine Fisheries Service, 2005e). In 1987 a pair of latex examination gloves was retrieved from the stomach of a stranded dwarf sperm whale (National Marine Fisheries Service, 2005f). From 1999–2003, 125 pygmy sperm whales were reported stranded between Maine and Puerto Rico; in one pygmy sperm whale found stranded in 2002, red plastic debris was found in the stomach along with squid beaks (National Marine Fisheries Service, 2005c).

Sperm whales and beaked whales have been known to ingest plastic debris, such as plastic bags (e.g., Evans et al., 2003; Whitehead, 2003). While this has led to mortality, the scale to which this is affecting sperm whale and beaked whale populations is unknown, Whitehead (2003) argued that it was not substantial at that time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal biomonitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains and marine ecosystem health. Using strandings and bycatch animals the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting and additional response during disease investigations (National Marine Fisheries Service 2007e).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants such as organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in planktivorous mysticetes have been reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borell, 1993; O'Shea and Brownell, 1994; O'Hara and Rice, 1996; O'Hara et al., 1999).

The man-made chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (National Marine Fisheries Service, 2007d). Despite having been banned for decades in the United States, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (National Marine Fisheries Service, 2007d). Both compounds are long lasting, reside in marine mammal fat tissues (especially in blubber), and can be toxic, causing effects such as reproductive impairment and immunosuppression (National Marine Fisheries Service, 2007d).

Both long-finned and short-finned pilot whales have a tendency to mass strand throughout their range. Short-finned pilot whales have been reported as stranded as far north as Rhode Island, and long-finned pilot whales as far south as South Carolina (National Marine Fisheries Service, 2005c). (For U.S. east coast stranding records, both species are lumped together and there is rarely a distinction between the two because of uncertainty in species identification [National Marine Fisheries Service, 2005c]). Since 1980 within the Northeast region alone, between 2 and 120 pilot whales have stranded annually either individually or in groups (National Marine Fisheries Service, 2005c). Between 1999 and 2003 from Maine to Florida, 126 pilot whales were reported to be stranded, including a mass stranding of 11 animals in 2000 and another mass stranding of 57 animals in 2002, both along the Massachusetts coast (National Marine Fisheries Service, 2005c).

It is unclear how much of a role human activities play in these pilot whale strandings, and toxic poisoning may be a potential human-caused source of mortality for pilot whales (National Marine Fisheries Service, 2005d). Moderate levels of PCBs and chlorinated pesticides (such as DDT, DDE, and dieldrin) have been found in pilot whale blubber (National Marine Fisheries Service, 2005d). Bioaccumulation levels have been found to be more similar in whales from the same stranding event than from animals of the same age or sex (National Marine Fisheries Service, 2005d). Numerous studies have measured high levels of toxic metals (mercury, lead, cadmium), selenium, and PCBs in pilot whales in the Faroe Islands (National Marine Fisheries

Service, 2005d). Population effects resulting from such high contamination levels are currently unknown (National Marine Fisheries Service, 2005d).

Habitat contamination and degradation may also play a role in marine mammal mortality and strandings. Some events caused by man have direct and obvious effects on marine mammals, such as oil spills (Geraci et al., 1999). But in most cases, effects of contamination will more than likely be indirect in nature, such as effects on prey species availability, or by increasing disease susceptibility (Geraci et al., 1999).

Navy ship operation between ports and exercise locations has the potential for release of small amounts of pollutant discharges into the water column. Navy ships are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any ship discharges such as bilgewater and deck runoff associated with the ships would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality.

Ambient Sound in the Ocean

Ambient noise is environmental background noise. Marine mammals are regularly exposed to several sources of natural and anthropogenic sounds. As one of the potential stressors to marine mammal populations, noise and acoustic influences may disrupt marine mammal communication, navigational ability, and social patterns, and may or may not influence stranding. Many marine mammals use sound to communicate, navigate, locate prey, and sense their environment. Both anthropogenic and natural sounds may cause interference with these functions, although comprehension of the type and magnitude of any behavioral or physiological responses resulting from man-made sound, and how these responses may contribute to strandings, is rudimentary at best (National Marine Fisheries Service, 2007p). Marine mammals may respond both behaviorally and physiologically to sound exposure (e.g., Richardson et al., 1995a; Finneran et al., 2000; Finneran et al., 2003; Finneran et al., 2005, National Research Council, 2005; Southall et al., 2007); however, the range and magnitude of the behavioral response of marine mammals to various sound sources is highly variable and appears to depend on the species involved, the experience of the animal with the sound source, the motivation of the animal (e.g., feeding, mating), and the context of the exposure (Richardson et al., 1995a; National Research Council, 2005; Southall et al., 2007).

Natural Sound in the Ocean

There is a large and variable natural component to the ambient noise level in the ocean as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp and the vocalizations of marine mammals. For example, lightning hits the ocean with a resulting 260 dB SPL source level and research indicates humpback whale songs vary between 171-189 dB SPL (National Research Council 2003; Au et al, 2001). In addition, Au et al., (2000) have demonstrated an increase in ambient sound levels to 120 dB SPL coinciding with the arrival of “chorusing” humpback whales in Hawaii and peaking during the mid-February to mid-March winter season.

Anthropogenic Sound in the Ocean

Anthropogenic noise that could affect ambient noise arises from the following general types of activities in and near the sea, any combination of which, can contribute to the total noise at any one place and time. These noises include: transportation; dredging; construction; oil, gas, and mineral exploration in offshore areas; geophysical seismic and/or mapping surveys; commercial and military sonar; explosions; and ocean research activities (Richardson et al., 1995a).

Mechanical noise from commercial fishing vessels, cruise ships, cargo transports, recreational boats, and aircraft, all contribute sound into the ocean (National Research Council, 2003; 2006). Mechanical noise from Navy ships, especially those engaged in ASW, is very quiet in comparison to civilian vessels of similar or larger size. This general feature is also enhanced by the use of additional quieting technologies as a means of limiting passive detection by opposing submarines.

Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (National Research Council 1994, 2000, 2003, 2005; Richardson et al., 1995a; Jasny et al., 2005; McDonald et al., 2006). Much of this increase is due to increased shipping due to ships becoming more numerous and of larger tonnage (National Research Council, 2003; McDonald et al., 2006). Andrew et al. (2002) compared ocean ambient sound from the 1960s with the 1990s for a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 dB in the frequency range of 20 to 80 Hz and 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period.

Urick (1983) provided a discussion of the ambient noise spectrum expected in the deep ocean. Shipping, seismic activity, and weather are the primary causes of deep-water ambient noise. The ambient noise frequency spectrum can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force, or sea state) (Urick, 1983). For example, for frequencies between 100 and 500 Hz, Urick (1983) estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas. In contrast to deep water, ambient noise levels in shallow waters (i.e., coastal areas, bays, harbors, etc.) are subject to wide variations in level and frequency depending on time and location. The primary sources of noise include distant shipping and industrial activities, wind and waves, marine animals (Urick, 1983). At any given time and place, the ambient noise is a mixture of all of these noise variables. In addition, sound propagation is also affected by the variable shallow water conditions, including the depth, bottom slope, and type of bottom. Where the bottom is reflective, the sounds levels tend to be higher than when the bottom is absorptive.

Most observations of behavioral responses of marine mammals to the sounds produced have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions. Carretta et al. (2001) and Jasny et al. (2005) identified increasing levels of anthropogenic noise as a habitat concern for whales and other marine mammals because of its potential to affect their ability to communicate. Acoustic devices have also been used in fisheries nets to prevent marine mammal entanglement and to deter seals from salmon cages (Johnson and Woodley 1998), little is known about their effects on non-target species.

Noise from Aircraft and Vessel Movement

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans and may contribute to over 75 percent of all human sound in the sea (Simmonds and Hutchinson 1996, International Council for the Exploration of the Sea, 2005c). The Navy estimated that the 60,000 vessels of the world's merchant fleet, annually emit low-frequency sound into the world's oceans for the equivalent of 21.9 million days, assuming that 80 percent of the merchant ships are at sea at any one time (U.S. Department of the Navy, 2001b). Ross (1976) has estimated that between 1950 and 1975, shipping had caused a rise in ambient noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century. The National Research Council (1997) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships. Michel et al. (2001) suggested an association between long-term exposure to low-frequency sounds from shipping and an increased incidence of marine mammal mortalities caused by collisions with ships.

As discussed in Appendix G, airborne sound from low-flying helicopters or airplanes may be heard by marine mammals and turtles while at the surface or underwater. Responses by mammals and turtles could include hasty dives or turns, or decreased foraging (Soto et al., 2006). Whales may also slap the water with flukes or flippers, or swim away from low flying aircraft. Due to the transient nature of sounds from aircraft involved in at-sea training and their generally high altitude, such sounds would not likely cause physical effects.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995a; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions contribute to a large vessels' noise emission into the marine environment. Prop-driven vessels also generate noise through cavitation, which accounts for much of the noise emitted by a large vessel depending on its travel speed. Noise emitted by large vessels can be characterized as low-frequency, continuous, and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity and length (Richardson et al., 1995a; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169–200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds. As noted previously, Navy ships in general and in particular those engaged in ASW, are designed to be very quiet as a means of limiting passive detection by opposing submarines.

Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away from a vessel. Unfortunately, it is not always possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a vessel's transit through an area.

Vessel noise primarily raises concerns for masking of environmental and conspecific cues. However, exposure to vessel noise of sufficient intensity and/or duration can also result in temporary or permanent loss of sensitivity at a given frequency range, referred to as temporary or permanent threshold shifts (TTS or PTS). Threshold shifts are assumed to be possible in marine mammal species as a result of prolonged exposure to large vessel traffic noise due to its intensity, broad geographic range of effectiveness, and constancy.

Collectively, significant cumulative exposure to individuals, groups, or populations can occur if they exhibit site fidelity to a particular area; for example, whales that seasonally travel to a regular area to forage or breed may be more vulnerable to noise from large vessels compared to transiting whales. Any permanent threshold shift in a marine animal's hearing capability, especially at particular frequencies for which it can normally hear best, can impair its ability to perceive threats, including ships.

Most observations of behavioral responses of marine mammals to human generated sounds have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions. Nowacek et al. (2007) provide a detailed summary of cetacean response to underwater noise.

Given the sound propagation of low-frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross, 1976 in Polefka, 2004). Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signature (as compared to a similarly-sized vessel) in order to reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005). Therefore, the potential for TTS or PTS from Navy vessel and aircraft movement is extremely low given that the exercises and training events are transitory in time, with vessels moving over large area of the ocean. A marine mammal or sea turtle is unlikely to be exposed long enough at high levels for TTS or PTS to occur. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a Navy vessel transiting through an area. If behavioral disruptions result from the presence of aircraft or vessels, it is expected to be temporary. Animals are expected to resume their migration, feeding, or other behaviors without any threat to their survival or reproduction. However, if an animal is aware of a vessel and dives or swims away, it may successfully avoid being struck.

Commercial and Research Sonar

Almost all vessels at sea are equipped with active sonar for use in measuring the depth of the water: a fathometer. In addition, many vessels engaged in commercial or recreational fishing also use active sonar commonly referred to as "fish-finders." Both types of sonar tend to be higher in frequency and lower in power as compared to the hull mounted MFA sonar used during Navy training; however, there are many more of these sonars, and they are in use much more often and in more locations than Navy sonars.

Although seismic oil and gas research taking place elsewhere is not conducted in the Hawaiian Islands, undersea research using active sound sources does occur. Sound sources employed include powerful multibeam and sidescan sonars that are generally used for mapping the ocean floor and include both mid-frequency and high-frequency systems. During mapping surveys, these sonars are run continuously, sweeping the large areas of ocean to accurately chart the complex bathymetry present on the ocean floor.

Navy Sonar

Naval sonars are designed for three primary functions: submarine hunting, mine hunting, and shipping surveillance. The Navy employs two classes of sonars: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (International Council for the Exploration of the Sea, 2005c).

The effects of MFA/HFA naval sonar on marine wildlife have not been studied as extensively as the effects of air-guns used in seismic surveys (Madsen et al., 2006; Stone and Tasker, 2006; Wilson et al., 2006; Palka and Johnson, 2007; Parente et al., 2007). Maybaum (1989, 1993) observed changes in behavior of humpbacks during playback tapes of the M-1002 system (using 203 dB re 1 µPa-m for study); specifically, a decrease in respiration, submergence, and aerial behavior rates; and an increase in speed of travel and track linearity. Direct comparison of Maybaum's results, however, with Navy MFA sonar are difficult to make. Maybaum's signal source, the commercial M-1002, is not similar to how naval mid-frequency sonar operates. In addition, behavioral responses were observed during playbacks of a control tape, (i.e., a tape with no sound signal) so interpretation of Maybaum's results are inconclusive.

In the Caribbean, sperm whales were observed to interrupt their activities by stopping echolocation and leaving the area in the presence of underwater sounds surmised (since they did not observe any vessels) to have originated from submarines using sonar (Watkins and Schevill, 1975; Watkins et al., 1985). The authors did not report receive levels from these exposures, and also got a similar reaction from artificial noise they generated by banging on their boat hull. It was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general.

Research by Nowacek, et al. (2004) on North Atlantic right whales using a 18 minute signal designed to alert whales to a vessel's presence suggests that received sound levels of only 133 to 148 pressure level (decibel [dB] re 1 micropascals per meter [µPa-m]) for the duration of the sound exposure may disrupt feeding behavior. The authors did note, however, that within minutes of cessation of the source, a return to normal behavior would be expected. Direct comparison of the Nowacek et al. (2004) sound source to MFA sonar, however, is not possible given the radically different nature of the two sources. Nowacek et al.'s source was a series of non-sonar like sounds designed to purposely alert the whale, lasting several minutes, and covering a broad frequency band. Direct differences between Nowacek et al. (2004) and MFA sonar is summarized below from Nowacek et al. (2004) and Nowacek et al. (2007):

(1) Signal duration: Time difference between the two signals is significant, 18-minute signal used by Nowacek et al. verses < 1-sec for MFA sonar.
(2) Frequency modulation: Nowacek et al. contained three distinct signals containing frequency modulated sounds:
   - Alternating 1-sec pure tone at 500 and 850 Hz
   - 2-sec logarithmic down-sweep from 4500 to 500 Hz
   - Pair of low-high (1500 and 2000 Hz) sine wave tones amplitude modulated at 120 Hz.
(3) Signal to noise ratio: Nowacek et al.'s signal maximized signal to noise ratio so that it would be distinct from ambient noise and resist masking.

(4) Signal acoustic characteristics: Nowacek et al.'s signal comprised of disharmonic signals spanning northern right whales' estimated hearing range.

Given these differences, therefore, the exact cause of apparent right whale behavior noted by the authors cannot be attributed to any one component since the source was such a mix of signal types.

Beaked Whales

Recent beaked whale strandings have prompted inquiry into the relationship between high-amplitude continuous-type sound and the cause of those strandings. For example, in the stranding in the Bahamas in 2000, the Navy MFA sonar was identified as the only contributory cause that could have lead to the stranding. The Bahamas exercise entailed multiple ships using MFA sonar during transit of a long constricted channel. The Navy participated in an extensive investigation of the stranding with the NMFS. The "Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000" concluded that the variables to be considered in managing future risk from tactical mid-range sonar were "sound propagation characteristics (in this case a surface duct), unusual underwater bathymetry, intensive use of multiple sonar units, a constricted channel with limited egress avenues, and the presence of beaked whales that appear to be sensitive to the frequencies produced by these sonars." (U.S. Department of Commerce and U.S. Department of the Navy, 2001).

The Navy analyzed the known range of operational, biological, and environmental factors involved in the Bahamas stranding and focused on the interplay of these factors to reduce risks to beaked whales from ASW training. Mitigation measures based on the Bahamas investigation are presented in Chapter 6.0. The confluence of these factors do not occur in the Hawaiian Islands although surface ducts may be present, there are rapid changes in bathymetry over relatively short distances, and beaked whales are present where MFA sonar is used. For example, beaked whales are present at PMRF and there are a few individual beaked whales that appear to be resident in the area off of the island of Hawaii and the Alenuihaha Channel between the island of Hawaii and Maui where ASW sonar operations occur regularly (Baird et al., 2006a; McSweeney et al., 2007). Although beaked whales are visually and acoustically detected in areas where sonar use routinely takes place, there has not been a stranding of beaked whales in the Hawaiian Islands associated with the 30-year use history of the present sonar systems.

This history would suggest that the simple exposure of beaked whales to sonar is not enough to cause beaked whales to strand. Brownell et al. (2004) have suggested that the high number of beaked whale strandings in Japan between 1980 and 2004 may be related to Navy sonar use in those waters given the presence of U.S. Naval Bases and exercises off Japan. The Center for Naval Analysis compiled the history of naval exercises taking place off Japan and found there to be no correlation in time for any of the stranding events presented in Brownell et al. (2004). Like the situation in Hawaii, there are clearly beaked whales present in the waters off Japan (as evidenced by the strandings); however, there is no correlation in time to strandings and sonar use. Sonar did not cause the strandings identified by Brownell et al. (2004), and more importantly, this suggests sonar use in the presence of beaked whales over two decades has not resulted in strandings related to sonar use.

In Hawaii, there have been no detected beaked whales strandings associated with the use of MFA sonar. While the absence of evidence does not prove there have been no affects on beaked whales, 30 years of history with no evidence of any impacts or strandings would seem to indicate that problems encountered in locations far from Hawaii involving beaked whales are location and context specific and do not apply in Hawaiian waters.

It has been suggested that there is an absence of strandings and floating dead marine mammals in Hawaii related to sonar use because (it is argued) dead marine mammals will not float, are eaten by sharks, are carried out to sea, or end up on remote shorelines in Hawaii and are never discovered. In Hawaii, floating dead marine mammals have been documented as persisting for a number of days even while being consumed by sharks, and strandings occur on a regular basis on most of the islands. Typically, dead marine mammals will initially sink, then refloat, and finally sink again after substantial deterioration (Spitz, 1993). The timeline of this process will vary depending primarily upon water temperature and water depth, as well as other factors such as gut content, amount of body fat, etc., that affect bacterial and other decomposition processes. Generally, refloating occurs within a few days while final sinking may require, for a large whale, several weeks. Considering the intense use and observation of the shorelines and waters around Hawaii given prevalent fishing and tourism, the claim that a significant number of whale carcasses have been consistently missed is unreasonable, and is contrary to the Pacific Island Region Marine Mammal Response Stranding Network's regular observations of strandings and dead floating marine mammals documented in Hawaii.

Stranding Analysis

Over the past two decades, several mass stranding events involving beaked whales have been documented. While beaked whale strandings have been reported since recordkeeping began in the 1800s (Geraci and Lounsbury, 1993; Cox et al., 2006; Podesta et al., 2006), several mass strandings since have been associated with naval training that may have included MFA sonar (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Jepson et al., 2003; Cox et al., 2006). As Cox et al. (2006) concludes, the state of science can not yet determine if a sound source such as MFA sonar alone causes beaked whale strandings, or if other factors (acoustic, biological, or environmental) must co-occur in conjunction with a sound source.

A review of historical data (mostly anecdotal) maintained by the Marine Mammal Program in the National Museum of Natural History, Smithsonian Institution reports 49 beaked whale mass stranding events between 1838 and 1999. The largest beaked whale mass stranding occurred in the 1870s in New Zealand when 28 Gray's beaked whales (*Mesoplodon grayi*) stranded. Blainville's beaked whale (*Mesoplodon densirostris*) strandings are rare, and records show that they were involved in one mass stranding in 1989 in the Canary Islands. Cuvier's beaked whales (*Ziphius cavirostris*) are the most frequently reported beaked whale to strand, with at least 19 stranding events from 1804 through 2000 (U.S. Department of the Navy and Department of Commerce, 2001). By the nature of the data, much of the historic information on strandings over the years is anecdotal, which has been condensed in various reports, and some of the data have been misquoted.

The discussion below centers on those worldwide stranding events that may have some association with naval training, and global strandings that the Navy feels are either inconclusive or can not be associated with naval training.

Naval Association

In the following sections, specific stranding events that have been putatively linked to potential sonar operations are discussed. Of note, these events represent a small overall number of animals over an 11-year period (40 animals), and not all worldwide beaked whale strandings can be linked to naval activity (International Council for the Exploration of the Sea, 2005b; 2005c; Podesta et al., 2006). Four of the five events occurred during North Atlantic Treaty Organization (NATO) exercises or events where Navy presence was limited (Greece, Portugal, Spain). One of the five events involved only Navy ships (Bahamas).

Beaked whale stranding events associated with potential naval training:

- 1996 May Greece (NATO/United States)
- 2000 March Bahamas (United States)
- 2000 May Portugal, Madeira Islands (NATO/United States)
- 2002 September Spain, Canary Islands (NATO/United States)
- 2006 January Spain, Mediterranean Sea coast (NATO/United States)

The following sections provide details and analysis concerning the five events noted above in addition to other events where MFA sonar use has been alleged to be potentially causal and/or a factor contributing to the stranding event.

4.1.2.4.10.2 Stranding Events Associated with Navy Sonar

Greece Stranding Event, May 12–13, 1996

Description

Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along a 38.2-kilometer strand of the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and rms SPL of 228 and 226 dB re: 1μPa, respectively (D'Amico and Verboom, 1998; D'Spain et al., 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998).

Findings

Necropsies of eight of the animals were performed, but were limited to basic external examination and sampling of stomach contents, blood, and skin. No ears or organs were collected, and no histological samples were preserved because of problems related to permits, lack of trained specialists, and lack of facilities and means (International Council for the Exploration of the Sea, 2005a).

- At least 12 of the 14 animals stranded alive in an atypical way (International Council for the Exploration of the Sea, 2005a). The spread of strandings were also atypical in location and time, as mass-strandings usually occur at the same place and at the same time (Frantzis, 1998).
- No apparent abnormalities or wounds were found (Frantzis, 2004).

- Examination of photos of the animals revealed that the eyes of at least four of the individuals were bleeding. Photos were taken soon after their death (Frantzis, 2004).
- Stomach contents contained the flesh of cephalopods, indicating that feeding had recently taken place (Frantzis, 1998).
- No unusual environmental events occurred before or during the stranding (Frantzis, 2004).

Conclusions

All available information regarding the conditions associated with this stranding were compiled, and many potential causes were examined including major pollution events, important tectonic activity, unusual physical or meteorological events, magnetic anomalies, epizootics, and conventional military activities (International Council for the Exploration of the Sea, 2005a). However, none of these potential causes coincided in time with the mass stranding, or could explain its characteristics (International Council for the Exploration of the Sea, 2005a). The robust condition of the animals, plus the recent stomach contents, is not consistent with pathogenic causes (Frantzis, 2004). In addition, environmental causes can be ruled out as there were no unusual environmental circumstances or events before or during this time period (Frantzis, 2004).

It was determined that because of the rarity of this mass stranding of Cuvier's beaked whales in the Kyparissiakos Gulf (first one in history), the probability for the two events (the military exercises and the strandings) to coincide in time and location, while being independent of each other, was extremely low (Frantzis, 1998).

Because full necropsies had not been conducted, and no abnormalities were noted, the cause of the strandings cannot be precisely determined (Cox et al., 2006). The analysis of this stranding event provided support for, but no clear evidence for, the cause-and-effect relationship of sonar operations and beaked whale strandings (Cox et al., 2006).

Bahamas Marine Mammal Stranding Event, March 15-16, 2000

Description

On March 15-16, 2000, seventeen marine mammals comprised of four different species (Cuvier's beaked whales, Blainville's beaked whales, Minke whales, and one spotted dolphin) stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands (National Marine Fisheries Service, 2001b; U.S. Department of the Navy and Department of Commerce, 2001). The strandings occurred over a 36-hour period and coincided with Navy use of MFA sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively.

Because of the unusual nature and situation surrounding these strandings, a comprehensive investigation into every possible cause was quickly launched (U.S. Department of the Navy and Department of Commerce, 2001).

Strandings were first reported at the southern end of the channels, and proceeded northwest throughout March 15, 2000. It is probable that all of the strandings occurred on March 15, even though some of the animals were not found or reported until March 16. Seven of the animals died, while ten animals were returned to the water alive; however, it is unknown if these animals survived or died at sea at a later time. (U.S. Department of the Navy and Department of Commerce, 2001)

The animals that are known to have died include five Cuvier's beaked whales, one Blainville's beaked whale, and the single spotted dolphin (U.S. Department of the Navy and Department of Commerce, 2001). Six necropsies were performed, but only three out of the six (one Cuvier's beaked whale, one Blainville's beaked whale, and the spotted dolphin) were fresh enough to permit identification of pathologies by computerized tomography. Tissues from the remaining three animals were in a state of advanced decomposition at the time of inspection. Results from the spotted dolphin necropsy revealed that the animal died with systemic debilitation disease, and is considered unrelated to the rest of the mass stranding (U.S. Department of the Navy and Department of Commerce, 2001).

Findings

Based on necropsies performed on the other five beaked whales, it was preliminarily determined that they had experienced some sort of acoustic or impulse trauma which led to their stranding and ultimate demise (U.S. Department of the Navy and Department of Commerce, 2001). Detailed microscopic tissue studies followed in order to determine the source of the acoustic trauma and the mechanism by which trauma was caused.

- All five necropsied beaked whales were in good body condition, showing no signs of infection, disease, ship strike, blunt trauma, or fishery related injuries, and three still had food remains in their stomachs. (U.S. Department of the Navy and Department of Commerce, 2001).
- Auditory structural damage was discovered in four of the whales, specifically bloody effusions or hemorrhaging around the ears (U.S. Department of the Navy and Department of Commerce, 2001).
- Bilateral intracochlear and unilateral temporal region subarachnoid hemorrhage with blood clots in the lateral ventricles were found in two of the whales (U.S. Department of the Navy and Department of Commerce, 2001).
- Three of the whales had small hemorrhages in their acoustic fats (located along the jaw and in the melon) (U.S. Department of the Navy and Department of Commerce, 2001).
- Passive acoustic monitor recordings within the area during the time of the stranding showed no signs of an explosion or other geological event such as an earthquake (U.S. Department of the Navy and Department of Commerce, 2001).
- The beaked whales showed signs of overheating, physiological shock, and cardiovascular collapse, all of which commonly result in death following a stranding (U.S. Department of the Navy and Department of Commerce, 2001).

Conclusions

The post-mortem analyses of stranded beaked whales lead to the conclusion that the immediate cause of death resulted from overheating, cardiovascular collapse, and stresses associated with being stranded on land. However, the presence of subarachnoid and intracochlear hemorrhages were believed to have occurred prior to stranding and were hypothesized as being related to an acoustic event. Passive acoustic monitoring records demonstrated that no large-scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined. The spotted dolphin was in overall poor condition for examination, but showed indications of long-term disease. No analysis of baleen whales (minke whale) was conducted. Baleen whale stranding events have not been associated with either low-frequency or mid-frequency sonar use (International Council for the Exploration of the Sea, 2005b, 2005c).

May 10–14, 2000 Stranding Event, Madeira Island, Portugal

Description

From May 10–14, 2000, three Cuvier's beaked whales were found stranded on two islands in the Madeira archipelago, Portugal (Cox et al., 2006)—two on Porto Santo Island, and one on the northeast coast of Madeira Island (Freitas, 2004). A fourth animal was reported floating in the Madeiran waters by fisherman, but did not come ashore (Woods Hole Oceanographic Institution, 2005).

Joint NATO amphibious training peacekeeping exercises involving participants from 17 countries took place in Portugal during May 2–15, 2000. The NATO exercises were conducted across an area that stretched from the Island of Madeira to the Gulf of Gascony, and was named "Linked Seas 2000." It involved Greek, British, Spanish, Portuguese, French, Romanian, and U.S. forces, and included 80 warships and several thousand men landing on the beaches (U.S. Army Corps of Engineers, 2001). The NATO exercises occurred concurrently with this atypical mass stranding of beaked whales (Freitas, 2004).

Findings

The bodies of the three stranded whales were examined post mortem (Woods Hole Oceanographic Institution, 2005). Two heads were taken to be examined, one intact and the other partially seared from a fire started by locals during an attempt to dispose of the corpse (Woods Hole Oceanographic Institution, 2005). Only one of the stranded whales was fresh enough (24 hours after stranding) to be necropsied (Cox et al., 2006).

- Results from the necropsy revealed evidence of hemorrhage and congestion in the right lung and both kidneys (Cox et al., 2006).
- There was also evidence of intercochlear and intracranial hemorrhage similar to that which was observed in the whales that stranded in the Bahamas event (Cox et al., 2006).
- There were no signs of blunt trauma, and no major fractures (Woods Hole Oceanographic Institution, 2005).

- The cranial sinuses and airways were found to be quite clear with little or no fluid deposition, which may indicate good preservation of tissues (Woods Hole Oceanographic Institution, 2005).

Conclusions

Several observations on the Madeira stranded beaked whales, such as the pattern of injury to the auditory system, are the same as those observed in the Bahamas strandings. Blood in and around the eyes, kidney lesions, pleural hemorrhages, and congestion in the lungs are particularly consistent with the pathologies from the whales stranded in the Bahamas, and are consistent with stress and pressure related trauma. The similarities in pathology and stranding patterns between these two events suggest that a similar pressure event may have precipitated or contributed to the strandings at both sites. (Woods Hole Oceanographic Institution, 2005)

Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004).

- Exercises were conducted in areas of at least 547 fathoms depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 fathoms occurring a cross a relatively short horizontal distance (Freitas, 2004).
- Multiple ships were operating around Madeira. It is not known if MFA sonar was used, and the specifics of the sound sources used the Linked Seas 2000 exercises, and their propagation characteristics, are unknown (Cox et al., 2006, Freitas, 2004).
- Exercises took place in an area surrounded by landmasses separated by less than 35 nm and at least 10 nm in length, or in an embayment. Exercises involving multiple ships employing MFA near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004).

September 24, 2002 Canary Islands Stranding Event

Description

The southeastern area within the Canary Islands is well known for aggregations of beaked whales due to its ocean depths of greater than 547 fathoms within a few hundred meters of the coastline (Fernandez et al., 2005). On September 24, 2002, 14 beaked whales were found stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (International Council For Exploration of the Sea, 2005a). Seven whales died, while the remaining seven live whales were returned to deeper waters (Fernandez et al., 2005). Four beaked whales were found stranded dead over the next 3 days either on the coast or floating offshore.

These strandings occurred within near proximity of an international naval exercise named Neo-Tapon 2002 that involved numerous surface warships and several submarines. Spanish naval sources indicated that tactical mid-range frequency sonar was utilized during the exercises, but no explosions occurred (Fernandez et al., 2005). Strandings began about 4 hours after the onset of MFA sonar activity (International Council For Exploration of the Sea, 2005a; Fernandez et al., 2005).

Findings

Eight Cuvier's beaked whales, one Blainville's beaked whale, and one Gervais' beaked whale were necropsied, six of them within 12 hours of stranding (Fernández et al., 2005).

- No pathogenic bacteria were isolated from the carcasses (Jepson et al., 2003)
- The animals displayed severe vascular congestion and hemorrhage especially around the tissues in the jaw, ears, brain, and kidneys, displaying marked disseminated microvascular hemorrhages associated with widespread fat emboli (Jepson et al., 2003; International Council For Exploration of the Sea, 2005a).
- Several organs contained intravascular bubbles, although definitive evidence of gas embolism *in vivo* is difficult to determine after death (Jepson et al., 2003).
- The livers of the necropsied animals were the most consistently affected organ, which contained macroscopic gas-filled cavities and had variable degrees of fibrotic encapsulation. In some animals, cavitary lesions had extensively replaced the normal tissue (Jepson et al., 2003).
- Stomachs contained a large amount of fresh and undigested contents, which suggests a rapid onset of disease and death (Fernandez et al., 2005).
- Head and neck lymph nodes were enlarged and congested, and parasites were found in the kidneys of all animals (Fernandez et al., 2005).

Conclusions

The association of NATO MFA sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages, and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson et al., 2003; Fernández et al., 2005). Whereas gas emboli would develop from the nitrogen gas, fat emboli would enter the blood stream from ruptured fat cells (presumably where nitrogen bubble formation occurs) or through the coalescence of lipid bodies within the blood stream.

The possibility that the gas and fat emboli found by Fernández et al. (2005) was due to nitrogen bubble formation has been hypothesized to be related to either direct activation of the bubble by sonar signals or to a behavioral response in which the beaked whales flee to the surface following sonar exposure. The first hypothesis is related to rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals, such as those conducted by beaked whales, are theoretically predicted to induce greater levels of supersaturation (Houser et al., 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size. The second hypothesis speculates that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003; Fernández et al., 2005). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Tyack et al. (2006) showed that beaked whales often make rapid ascents from deep dives suggesting that it is unlikely that beaked whales would suffer from decompression sickness. Zimmer and Tyack (2007) speculated that if repetitive shallow dives that are used by beaked whales to avoid a predator or a sound source, they could accumulate high levels of nitrogen because they would be above the depth of lung collapse (above about 210 ft) and could lead to decompression sickness. There is no evidence that beaked whales dive in this manner in response to predators or sound sources and other marine mammals such as Antarctic and Galapagos fur seals, and pantropical spotted dolphins make repetitive shallow dives with no apparent decompression sickness (Kooyman and Trillmich, 1984; Kooyman et al., 1984; Baird et al., 2001). Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004). Sound exposure levels predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated and are suspected as needing to be very high (Evans, 2002; Crum et al., 2005). Moore and Early (2004) reported that in analysis of sperm whale bones spanning 111 years, gas embolism symptoms were observed indicating that sperm whales may be susceptible to decompression sickness due to natural diving behavior. Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003), there is no conclusive evidence supporting this hypothesis, and there is concern that at least some of the pathological findings (e.g., bubble emboli) are artifacts of the necropsy. Currently, stranding networks in the United States have agreed to adopt a set of necropsy guidelines to determine, in part, the possibility and frequency with which bubble emboli can be introduced into marine mammals during necropsy procedures (Arruda et al., 2007).

January 26, 2006, Spain

Description

The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26, 2006, on the southeast coast of Spain, near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered during the day on January 27, but had already died. A following report stated that the first three animals were located near the town of Mojacar and were examined by a team from the University of Las Palmas de Gran Canarias, with the help of the stranding network of Ecologistas en Acción Almería-PROMAR and others from the Spanish Cetacean Society. The fourth animal was found dead on the afternoon of May 27, a few kilometers north of the first three animals.

From January 25-26, 2006, Standing North Atlantic Treaty Organization (NATO) Response Force Maritime Group Two (five of seven ships including one U.S. ship under NATO Operational Control) had conducted active sonar training against a Spanish submarine within 50 nm of the stranding site.

Findings

Veterinary pathologists necropsied the two male and two female beaked whales (*Ziphius cavirostris*, family *Ziphiidae*).

Conclusions

According to the pathologists, the most likely primary cause of this type of beaked whale mass stranding event is anthropogenic acoustic activities, most probably anti-submarine MFA sonar used during the military naval exercises. However, no positive acoustic link was established as a direct cause of the stranding.

Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004).

- Exercises were conducted in areas of at least 547 fathoms depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 fathoms occurring across a relatively short horizontal distance (Freitas, 2004).
- Multiple ships (in this instance, five) were operating (in this case, MFA sonar) in the same area over extended periods of time (in this case, 20 hours) in close proximity.
- Exercises took place in an area surrounded by landmasses, or in an embayment. Exercises involving multiple ships employing MFA sonar near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004).

4.1.2.4.10.3 Other Global Stranding Discussions

In the following sections, stranding events that have been linked to Navy activity in popular press are presented. As detailed in the individual case study conclusions, the Navy believes that there is enough to evidence available to refute allegations of impacts from MFA sonar, or at least indicate that a substantial degree of uncertainty in time and space that preclude a meaningful scientific conclusion.

May 5, 2003 USS SHOUP Washington State

On May 5, 2003 at 0855, USS SHOUP got underway from the pier at Naval Station Everett, Washington. USS SHOUP then transited from Everett through Admiralty Inlet to the west side of Whidbey Island, where at 1030 it began a training exercise. Use of USS SHOUP's MFA tactical sonar began at 1040. At 1420, USS SHOUP entered the Haro Strait at a speed of 18 knots. USS SHOUP terminated active sonar use at 1438.

Between May 2 and June 2, 2003, approximately 16 strandings involving 15 harbor porpoise and one Dall's porpoise were reported to the Northwest Marine Mammal Stranding Network. A comprehensive review of all strandings and the events involving USS SHOUP on 5 May 2003 were presented in U.S. Department of Navy (2004b). Given that the USS SHOUP was known to have operated sonar in the strait on May 5, and that supposed behavioral reactions of killer whales had been putatively linked to these sonar operations (National Marine Fisheries Service, 2005a), the NMFS undertook an analysis of whether sonar caused the strandings of the harbor porpoises.

As a result of the allegations regarding USS SHOUP, NMFS initiated a necropsy study involving 11 of the stranded animals discovered between May 2 and June 2, 2003. Gross examination, histopathology, age determination, blubber analysis, and various other analyses were conducted on each of the carcasses (Norman et al., 2004). The necropsies took place at the National Marine Mammal Laboratory in Seattle.

Findings

All of the carcasses suffered from some degree of freeze-thaw artifact that hampered gross and histological evaluations. At the time of necropsy, three of the porpoises were moderately fresh, whereas the remainder of the carcasses was considered to have moderate to advanced decomposition.

- None of the 11 necropsied harbor porpoise showed signs of acoustic trauma (National Marine Fisheries Service, 2003).
- One of the animals had fibrinous peritonitis, one had salmonellosis, and another had profound necrotizing pneumonia (Norman et al., 2004).
- Two of the five had perimortem blunt trauma injury with associated broken bones in their heads (National Marine Fisheries Service, 2003)
- No cause of death could be determined for the remaining six animals, which is consistent with the expected percentage in most marine mammal necropsies from the region (National Marine Fisheries Service, 2003). It is important to note, however, that these determinations were based only on the evidence from the necropsy so as not to be biased with regard to determinations of the potential presence or absence of acoustic trauma. The result was that other potential causal factors, such as one animal (Specimen 33NWR05005) found tangled in a fishing net, was unknown to the investigators in their determination regarding the likely cause of death.

Conclusions

The NMFS concluded from a retrospective analysis of stranding events that the number of harbor porpoise stranding events in the approximate month surrounding the USS SHOUP use of sonar was higher than expected based on annual strandings of harbor porpoises (Norman et al., 2004). In this regard, it is important to note that the number of strandings in the May-June timeframe in 2003 was also higher for the outer coast indicating a much wider phenomena than use of sonar by USS SHOUP in Puget Sound for one day in May. The conclusion by NMFS that the number of strandings in 2003 was higher is also different from that of The Whale Museum, which has documented and responded to harbor porpoise strandings since 1980 (Osborne, 2003a). According to The Whale Museum, the number of strandings as of May 15, 2003, was consistent with what was expected based on historical stranding records and was less than that occurring in certain years. For example, since 1992 the San Juan Stranding Network has documented an average of 5.8 porpoise strandings per year. In 1997 there were 12 strandings in the San Juan Islands with 23 strandings throughout the general Puget Sound area. Disregarding the discrepancy in the historical rate of porpoise strandings and its relation to the USS SHOUP, NMFS acknowledged that the intense level of media attention focused on the strandings likely resulted in an increased reporting effort by the public over that which is normally observed (Norman et al., 2004). NMFS also noted in its report that the “sample size is too small and biased to infer a specific relationship with respect to sonar usage and subsequent strandings.”

Seven of the porpoises collected and analyzed died prior to USS SHOUP departing to sea on May 5, 2003. Of these seven, one, discovered on May 5, 2003, was in a state of moderate decomposition, indicating it died before May 5; the cause of death was determined to be due, most likely, to salmonella septicemia. Another porpoise, discovered at Port Angeles on May 6, 2003, was in a state of moderate decomposition, indicating that this porpoise also died prior to May 5. One stranded harbor porpoise discovered fresh on May 6 is the only animal that could potentially be linked in time to USS SHOUP’s May 5 active sonar use. Necropsy results for this porpoise found no evidence of acoustic trauma. The remaining eight strandings were discovered 1 to 3 weeks after USS SHOUP’s May 5 transit of the Haro Strait, making it difficult to causally link the sonar activities of USS SHOUP to the timing of the strandings. Two of the eight porpoises died from blunt trauma injury and a third suffered from parasitic infestation, which possibly contributed to its death (Norman et al., 2004). For the remaining five porpoises, NMFS was unable to identify the causes of death.

The speculative association of the harbor porpoise strandings to the use of sonar by the USS SHOUP is inconsistent with prior stranding events linked to the use of MFA sonar. Specifically, in prior events, the stranding of whales occurred over a short period of time (less than 36 hours), stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Although MFA sonar was used by USS SHOUP, the distribution of harbor porpoise strandings by location and with respect to time surrounding the event do not support the suggestion that MFA sonar was a cause of harbor porpoise strandings. Rather, a complete lack of evidence of any acoustic trauma within the harbor porpoises, and the identification of probable causes of stranding or death in several animals, further supports the conclusion that harbor porpoise strandings were unrelated to the sonar activities of the USS SHOUP.

Additional allegations regarding USS SHOUP use of sonar having caused behavioral effects on Dall’s porpoise, orca, and a minke whale also arose in association with this event (see U.S. Department of Navy 2004 for a complete discussion).

<u>Dall’s Porpoise</u>. Information regarding the observation of Dall’s porpoise on May 5, 2003 came from the operator of a whale watch boat at an unspecified location. This operator reported the Dall’s porpoise were seen “going north” when the SHOUP was estimated by him to be 10 miles away. Potential reasons for the Dall’s movement include the pursuit of prey, the presence of harassing resident orca or predatory transient orca, vessel disturbance from one of many whale watch vessels, or multiple other unknowable reasons including the use of sonar by USS SHOUP. In short, there was nothing unusual in the observed behavior of the Dall’s porpoise on 5 May 2003 and no way to assess if the otherwise normal behavior was in reaction to the use of sonar by USS SHOUP, any other potential causal factor, or a combination of factors.

Orca. Observer opinions regarding orca J-Pod behaviors on May 5, 2003 were inconsistent, ranging from the orca being "at ease with the sound" or "resting" to their being "annoyed." One witness reported observing "low rates of surface active behavior" on behalf of the orca J-Pod, which is in conflict with that of another observer who reported variable surface activity, tail slapping and spyhopping. Witnesses also expressed the opinion that the behaviors displayed by the orca on May 5, 2003 were "extremely unusual," although those same behaviors are observed and reported regularly on the Orca Network Website, and are behaviors listed in general references as being part of the normal repertoire of orca behaviors. Given the contradictory nature of the reports on the observed behavior of the J-Pod orca, it is impossible to determine if any unusual behaviors were present. In short, there is no way to assess if any unusual behaviors were present or if present they were in reaction to vessel disturbance from one of many nearby whale watch vessels, use of sonar by USS SHOUP, any other potential causal factor, or a combination of factors.

Minke Whale. A minke whale was reported porpoising in Haro Strait on May 5, 2003, which is a rarely observed behavior. The cause of this behavior is indeterminate given multiple potential causal factors including but not limited to the presence of predatory Transient orca, possible interaction with whale watch boats, other vessels, or USS SHOUP's use of sonar. The behavior of the minke whale was the only unusual behavior clearly present on May 5, 2003, however, no way to given the existing information if the unusual behavior observed was in reaction to the use of sonar by USS SHOUP, any other potential causal factor, or a combination of factors.

July 3, 2004, Hanalei Bay, Kauai Stranding Event

The majority of the following information is taken from the NMFS report on the stranding event (Southall et al., 2006) but is inclusive of additional and new information not presented in the NMFS report. On the morning of July 3, 2004, between 150-200 melon-headed whales (*Peponocephala electra*) entered Hanalei Bay, Kauai. Individuals attending a canoe blessing ceremony observed the animals entering the bay at approximately 7:00 a.m. The whales were reported entering the bay in a "wave as if they were chasing fish" (Braun, 2005). The whales were moving fast, but not at maximum speed.

At 6:45 a.m. on July 3, 2004, approximately 25 nm from Hanalei Bay, active sonar was tested briefly prior to the start of an ASW event; this was about 15 minutes before the whales were observed in Hanalei Bay. At the nominal swim speed for melon-headed whales (5 to 6 knots), the whales had to be minimally within 1.5 to 2 nm of Hanalei Bay before the sonar at PMRF was activated. The whales were not in their open ocean habitat but had to be close to shore at 6:45 a.m. when the sonar was activated, to have been observed inside Hanalei Bay from the beach by 7:00 a.m. (Hanalei Bay is very large area.)

The whales stopped in the southwest portion of the bay grouping tightly with lots of spy hopping and tail slapping. As people went in the water among the whales, spy hopping increased and the pod separated into two groups with individual animals moving between the two clusters (Braun, 2005). This continued through most of the day, with the animals slowly moving south and then southeast within the bay (Braun, 2005). By about 3:00 p.m. police arrived and kept people from interacting with the animals. The Navy believes that the abnormal behavior by the whales during this time is likely the result of people and boats in the water with the whales rather than the result of sonar activities taking place 25 or more miles off the coast.

At 4:45 p.m. on July 3, 2004, the RIMPAC Battle Watch Captain received a call from an NMFS representative in Honolulu, Hawaii, reporting the sighting of as many as 200 melon-headed whales in Hanalei Bay. At 4:47 p.m., out of caution, the Battle Watch Captain directed all ships in the area to cease all active sonar transmissions.

An NMFS representative arrived at Hanalei Bay at 7:20 p.m. on July 3, 2004, and observed a tight single pod 75 yards from the southeast side of the bay (Braun, 2005). The pod was circling in a tight group and there was frequent tail slapping and minimal spy hopping. No predators were observed in the bay and no animals were reported as having fresh injuries. Occasionally one or two sub-adult sized animals broke from the tight pod and came nearer the shore to apparently chase fish and be in the shore break (Braun, 2005). The pod stayed in the bay through the night of July 3, 2004.

On July 4, 2004, a 700–800-foot rope was constructed by weaving together beach morning glory vines. This vine rope was tied between two canoes and with the assistance of 30 to 40 kayaks, by about 11:30 a.m. on July 4, 2004, the pod was coaxed out of the bay (Braun, 2005).

A single neonate melon-headed whale was observed in the bay on the afternoon of July 4, after the whale pod had left the bay. The following morning on July 5, 2004, the neonate was found stranded on Lumahai Beach. It was pushed back into the water but was found stranded dead between 9 and 10 a.m. near the Hanalei pier. NMFS collected the carcass and had it shipped to California for necropsy, tissue collection, and diagnostic imaging. Preliminary findings indicated the cause of death was starvation (Farris, 2004) and this was later confirmed upon completion of the NMFS stranding report (Southall et al., 2006).

Following the stranding event, NMFS undertook an investigation of possible causative factors of the stranding. This analysis included available information on environmental factors, biological factors, and an analysis of the potential for sonar involvement. The latter analysis included vessels that utilized MFA sonar on the afternoon and evening of July 2. These vessels were to the southeast of Kauai, on the opposite side of the island from Hanalei Bay.

Findings

NMFS concluded from the acoustic analysis that the melon-headed whales would have had to have been on the southeast side of Kauai on July 2 to have been exposed to sonar from naval vessels on that day (Southall et al., 2006). There was no indication whether the animals were in that region or whether they were elsewhere on July 2. NMFS concluded that to reach Hanalei Bay, the animals would have had to swim around the island of Kauai at a speed of 1.4-4.0 m/s for between 6.5 to 17.5 hours after having possibly heard sonar off the west coast of Oahu and/or the channel between Kauai and Oahu on July 2, to reach Hanalei Bay by 7:00 a.m. on July 3. Sonar transmissions began on July 3, 25 nm to the north of Hanalei Bay as part of an ASW event that started at 6:45 a.m. and lasted until 4:47 p.m. Propagation analysis conducted by the 3rd Fleet estimated that the level of sound from these transmissions at the mouth of Hanalei Bay could have ranged from 138-149 dB re: 1 µPa for intervals during the day when the vessels were generally pointed toward Kauai.

NMFS was unable to determine any environmental factors (e.g., harmful algal blooms, weather conditions) that may have contributed to the stranding. However, additional analysis by Navy investigators found that a full moon occurred the evening before the stranding and was coupled with a squid run (Mobley et al., 2007). One of the first observations of the whales entering the bay reported the pod came into the bay in a line "as if chasing fish" (Braun, 2005). In addition, a group of 500-700 melon-headed whales were observed to come close to shore and interact with humans in Sasanhaya Bay, Rota, on the same morning as the whales entered Hanalei Bay (Jefferson et al., 2006). Previous records further indicated that, though the entrance of melon-headed whales into the shallows is rare, it is not unprecedented. A pod of melon-headed whales entered Hilo Bay in the 1870s in a manner similar to that which occurred at Hanalei Bay in 2004.

The necropsy of the melon-headed whale calf suggested that the animal died from a lack of nutrition, possibly following separation from its mother. The calf was estimated to be approximately one week old. Although the calf appeared not to have eaten for some time, it was not possible to determine whether the calf had ever nursed after it was born. The calf showed no signs of blunt trauma or viral disease and had no indications of acoustic injury.

Conclusions

Although it is not impossible, it is unlikely that the sound level from the sonar caused the melon-headed whales to enter Hanalei Bay. This conclusion by the Navy is based on a number of factors:

1. The speculation that the whales may have been exposed to sonar the day before and then fled to Hanalei Bay is not supported by reasonable expectation of animal behavior and swim speeds. The flight response of the animals would have had to persist for many hours following the cessation of sonar transmissions. The swim speeds, though feasible for the species, are highly unlikely to be maintained for the durations proposed, particularly since the pod was a mixed group containing both adults and neonates. Whereas adults may maintain a swim speed of 4.0 m/s for some time, it is improbable that a neonate could achieve the same for a period of many hours.

2. The area between the islands of Oahu and Kauai and the PMRF training range have been used in RIMPAC exercises for more than 20 years, and are used year-round for ASW training using MFA sonar. Melon-headed whales inhabiting the waters around Kauai are likely not naive to the sound of sonar and there has never been another stranding event associated in time with ASW training at Kauai or in the Hawaiian Islands. Similarly, the waters surrounding Hawaii contain an abundance of marine mammals, many of which would have been exposed to the same sonar operations that were speculated to have affected the melon-headed whales. No other strandings were reported coincident with the RIMPAC exercises. This leaves it uncertain as to why melon-headed whales, and no other species of marine mammal, would respond to the sonar exposure by stranding.

3. At the nominal swim speed for melon-headed whales, the whales had to be within 1.5 to 2 nm of Hanalei Bay before sonar was activated on July 3. The whales were not in their open ocean habitat but had to be close to shore at 6:45 a.m. when the sonar was activated to have been observed inside Hanalei Bay from the beach by 7:00 a.m. (Hanalei Bay is very large area). This observation suggests that other potential factors could be causative of the stranding event (see below).

4. The simultaneous movement of 500-700 melon-headed whales and Risso's dolphins into Sasanhaya Bay, Rota, in the Northern Marianas Islands on the same morning as the 2004

Hanalei stranding (Jefferson et al., 2006) suggests that there may be a common factor which prompted the melon-headed whales to approach the shoreline. A full moon occurred the evening before the stranding and a run of squid was reported concomitant with the lunar activity (Mobley, et al., 2007). Thus, it is possible that the melon-headed whales were capitalizing on a lunar event that provided an opportunity for relatively easy prey capture.

Both the Rota and Hanalei Bay incidents occurred on the same day, which followed a full moon (the date was different given the international date line). Analysis of 18 live and near strandings involving melon-headed whales for which specific dates were provided (Brownell et al. 2006), plus three additional live strandings not listed in that report, revealed a non-random pattern with respect to lunar phase. The majority of stranding events tended to occur during the full and third quarter phases, with fewer during the new moon and one during the first quarter. Squid and other species of the deep scattering layer show vertical migrations responsive to lunar cycles. Lunar influences have been shown with other squid-eating species, including the foraging behavior of Galapagos fur seals and stranding patterns of north Atlantic sperm whales. (Mobley, et al., 2007) In addition, a report of a pod entering Hilo Bay in the 1870s indicates that on at least one other occasion, melon-headed whales entered a bay in a manner similar to the occurrence at Hanalei Bay in July 2004. Thus, although melon-headed whales entering shallow embayments may be an infrequent event, and every such event might be considered anomalous, there is precedent for the occurrence.

5. The received noise sound levels at the bay were estimated to range from roughly 95 – 149 dB re: 1 μPa. Received levels as a function of time of day have not been reported, so it is not possible to determine when the presumed highest levels would have occurred and for how long. Received levels, however, in the upper range would have been audible by human participants in the bay. The statement by one interviewee that he heard “pings” that lasted an hour and that they were loud enough to hurt his ears is unreliable. Received levels necessary to cause pain over the duration stated would have been observed by most individuals in the water with the animals. No other such reports were obtained from people interacting with the animals in the water.

Although NMFS concluded that sonar use was a “plausible, if not likely, contributing factor in what may have been a confluence of events” (Southall et al., 2006), this conclusion was based primarily on the basis that there was an absence of any other compelling explanation. The authors of the NMFS report on the incident were unaware, at the time of publication, of the simultaneous event in Rota. In light of the simultaneous Rota event, the Navy believes the Hanalei stranding does not appear as anomalous as initially indicated in the NMFS report, and the speculation that sonar was a likely contributing factor is weakened. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.). In addition, the inability to conclusively link or exclude the impact of other environmental factors makes a causal link between sonar and the melon-headed whale strandings highly speculative at best.

1980–2004 Beaked Whale Strandings in Japan (Brownell et al. 2004)

Description

Brownell et al. (2004) compare the historical occurrence of beaked whale strandings in Japan (where there are U.S. Naval bases), with strandings in New Zealand (which lacks a U.S. Naval base) and concluded the higher number of strandings in Japan may be related to the presence of the Navy vessels using MFA sonar. While the dates for the strandings were well documented, the authors of the study did not attempt to correlate the dates of any navy activities or exercises with the dates of the strandings.

To fully investigate the allegation made by Brownell et al. (2004), the Center for Naval Analysis (CNA) looked at the past U.S. Naval exercise schedules from 1980 to 2004 for the water around Japan in comparison to the dates for the strandings provided by Brownell et al. (2004). None of the strandings occurred during or soon (within weeks) after any U.S. Navy exercises. While the CNA analysis began by investigating the probabilistic nature of any co-occurrences, the results were a 100 percent probability the strandings and sonar use were not correlated by time. Given there was no instance of co-occurrence in over 20 years of stranding data, it can be reasonably postulated that sonar use in Japan waters by U.S. Navy vessels did not lead to any of the strandings documented by Brownell et al. (2004).

2004 Alaska Beaked Whale Strandings (June 7-16, 2004)

Description

In the timeframe between June 17 and July 19, 2004, five beaked whales were discovered at various locations along 1,600 miles of the Alaskan coastline and one was found floating (dead) at sea. Because the Navy exercise Alaska Shield/Northern Edge 2004 occurred within the approximate timeframe of these strandings, it has been alleged that sonar may have been the probable cause of these strandings.

The Alaska Shield/Northern Edge 2004 exercise consisted of a vessel tracking event followed by a vessel boarding search and seizure event. There was no ASW component to the exercise, no use of MFA sonar, and no use of explosives in the water. There were no events in the Alaska Shield/Northern Edge exercise that could have caused in any of the strandings over this 33-day period covering 1,600 mi of coastline.

North Carolina Marine Mammal Mass Stranding Event, January 15-16, 2005

Description

On January 15 and 16, 2005, 36 marine mammals comprised of 3 separate species (33 short-finned pilot whales, 1 minke whale, and 2 dwarf sperm whales) stranded alive on the beaches of North Carolina (National Marine Fisheries Service, 2007i; Hohn et al., 2006) distributed over a 69-mi area between the northern part of the state down to Cape Hatteras (National Marine Fisheries Service, 2007j). Thirty-one different species of marine mammals have been known to strand along the North Carolina coast since 1992; all three of the species involved in this stranding occasionally strand in this area (National Marine Fisheries Service, 2007j). This stranding event was determined to be a UME because live strandings of three different species in one weekend in North Carolina are extremely rare; in fact, it is the only stranding of offshore species to occur within a 2- to 3-day period in the region on record (National Marine Fisheries Service, 2007i; Hohn et al., 2006).

The Navy indicated that from January 12-14 some unit-level training with MFA sonar was conducted by vessels that were 93 to 185 km from Oregon Inlet. An expeditionary strike group was also conducting exercises to the southeast, but the closest point of active sonar transmission to the inlet was 650 km away (National Marine Fisheries Service, 2007i). The unit-level operations were not unusual for the area or time of year and the vessels were not involved in ASW exercises (National Marine Fisheries Service, 2007j). Marine mammal observers located on the Navy vessels reported that they did not detect any marine mammals (National Marine Fisheries Service, 2007i). No sonar transmissions were made on January 15-16.

The National Weather Service reported that a severe weather event moved through North Carolina on January 13 and 14. The event was caused by an intense cold front that moved into an unusually warm and moist air mass that had been persisting across the eastern United States for about a week. The weather caused flooding in the western part of the state, considerable wind damage in central regions of the state, and at least three tornadoes that were reported in the north central part of the state. Severe, sustained (1 to 4 days) winter storms are common for this region.

Findings

On January 16 and 17, 2005, 2 dwarf sperm whales, 27 pilot whales, and the single minke whale were necropsied and sampled. Because of the uniqueness of the stranding, 9 locations of interest within 25 stranded cetacean heads were examined closely. The only common finding in all of the heads was a form of sinusitis (National Marine Fisheries Service, 2007i).

- The pilot whales and the dwarf sperm whale were not considered to be emaciated, even though none of them had recently-eaten food in their stomachs (National Marine Fisheries Service, 2007i).
- The minke whale was emaciated, and it is believed that this was a dependent calf that had become separated from its mother, and was not a part of the other strandings (National Marine Fisheries Service, 2007i).
- Most biochemistry abnormalities indicated deteriorating conditions from being on land for an extended amount of time, and are believed to be a result of the stranding itself (National Marine Fisheries Service, 2007i).
- Three pilot whales showed signs of pre-existing systemic inflammation (National Marine Fisheries Service, 2007i).
- Lesions involving all organ systems were seen, but consistent lesions were not observed across species (National Oceanic and Atmospheric Administration, 2006e; Hohn et al., 2006).
- Cardiovascular disease was present in one pilot whale and one dwarf sperm whale, while musculoskeletal disease was present in two pilot whales (National Marine Fisheries Service, 2007i).
- Parasites were found and collected from 26 pilot whales and 2 dwarf sperm whales; parasite loads were considered to be within normal limits for free-ranging cetaceans (National Marine Fisheries Service, 2007i).
- There were no harmful algal blooms present along the coastline during the months prior to the strandings (National Marine Fisheries Service, 2007i; Hohn et al., 2006).
- Sonar transmissions prior to the strandings were limited in nature and did not share the concentration identified in previous events associated with MFA sonar use (Evans and England, 2001).
- The operational/environmental conditions were also dissimilar (e.g., no constrictive channel and a limited number of ships and sonar transmissions).

- However, other severe storm conditions existed in the days surrounding the strandings and the impact of these weather conditions on at-sea conditions is unknown.
- No harmful algal blooms were noted along the coastline.
- Environmental conditions that are consistent with conditions under which other mass strandings have occurred were present (a gently sloping shore, strong winds, and changes in up-welling to down-welling conditions) (National Marine Fisheries Service, 2007i).

Conclusions

Several whales had pre-existing conditions that may have contributed to the stranding, but were not determined to be the cause of the stranding event (National Oceanic and Atmospheric Administration, 2006e; National Marine Fisheries Service, 2007j). The actual cause of death for many of the whales was determined to be a result of the stranding itself (National Marine Fisheries Service, 2007j). NMFS concluded that this mass stranding event occurred simultaneously in time and space with MFA sonar naval activities, and has several features in common with other possible sonar-related stranding events (National Marine Fisheries Service, 2007i). For this reason, along with the rarity of the event, NMFS believes that it is possible that there exists a causal rather than a coincidental association between naval sonar activity and the stranding event (National Marine Fisheries Service, 2007i). But they also acknowledge that there are differences in operational and environmental characteristics between this event and other possible sonar-related stranding events (National Marine Fisheries Service, 2007i), such as constricted channels (National Marine Fisheries Service, 2007j).

Even though the stranding occurred while active military sonar was being utilized off the North Carolina coast, the investigation team was unable to determine what role, if any, military activities played in the stranding events (Hohn et al., 2006). If MFA sonar played a part in the strandings, sound propagation models indicated that received acoustic levels would depend heavily on the position of the whales relative to the source; however, because the exact location of the cetaceans is unknown it is impossible to estimate the level of their exposure to active sonar transmissions (National Marine Fisheries Service, 2007i). Evidence to support a definitive association is lacking, and consistent lesions across species and individuals that could indicate a single cause of the stranding were not found (National Marine Fisheries Service, 2007i).

Based on the physical evidence, it cannot be definitively determined if there is a causal link between the strandings and anthropogenic sonar activity and/or environmental conditions, or a combination of both (National Marine Fisheries Service, 2007i).

Causal Associations for Stranding Events

Marine mammal strandings have been a historic and ongoing occurrence attributed to a variety of causes. Over the last 50 years, increased awareness and reporting has led to more information about species affected and raised concerns about anthropogenic sources of stranding. While there has been some marine mammal mortalities potentially associated with MFA sonar effects on a small number of species (primarily limited numbers of certain species of beaked whales), the significance and actual causative reason for any impacts is still subject to continued investigation.

By comparison and as described previously, potential impacts on all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals vice 10s of animals) (Culik, 2002; International Council for the Exploration of the Sea, 2005c; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. International Council for the Exploration of the Sea (2005b) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, or significant portion of the overall ocean noise budget.

In conclusion, a constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military MFA sonar (Bradshaw et al., 2005; International Council for the Exploration of the Sea, 2005c; Barlow and Gisiner, 2006; Cox et al. 2006).

Several stranding events have been associated with Navy sonar activities, but relatively few of the total stranding events that have been recorded occurred spatially or temporally with Navy sonar activities. While sonar may be a contributing factor under certain rare conditions, the presence of sonar is not a necessary condition for stranding events to occur.

A review of past stranding events associated with sonar suggests that the potential factors that may contribute to a stranding event are steep bathymetry changes, narrow channels with limited egress avenues, multiple sonar ships, surface ducting, and the presence of beaked whales that in some geographic locations may be more susceptible to sonar exposures. The most important factors appear to be the presence of a narrow channel (e.g. Bahamas and Madeira Island, Portugal) that may prevent animals from avoiding sonar exposure and multiple sonar ships within that channel. There are no narrow channels (less than 35 nm wide and 10 nm in length) in the HRC, and the ships would be spread out over a wider area, allowing animals to move away from sonar activities if they choose. In addition, beaked whales may not be more susceptible to sonar but may favor habitats that are more conducive to sonar effects.

The RIMPAC Exercises have been conducted every other year since 1968 in the HRC, and along with other ASW training events have only been implicated in one stranding event which may have been simply animals following prey into a bay (Braun, 2005; Southall et al., 2006). Given the large military presence and private and commercial vessel traffic in the Hawaiian waters, it is likely that a mass stranding event would be detected. Therefore, it is unlikely that the conditions that may have contributed to past stranding events involving Navy sonar would be present in the HRC.

Evidence has also been presented indicating that there are resident populations and potentially genetically distinct populations of cetacea in the Hawaiian Islands (McSweeney et al., 2007). This would suggest that these species of cetacea have co-existed with sonar use in the Hawaiian Islands with residency indicating the animals remain in the area despite sonar use and genetic distinction indicative that they have done so for generations (of marine mammals).

4.1.2.4.11 Marine Mammal Mitigation Measures Related To Acoustic and Explosive Exposures

Chapter 6.0 provides the complete sonar and explosives mitigation measures for the HRC. The following paragraphs provide summary information about these mitigation measures.

4.1.2.4.11.1 Acoustic Exposure Mitigation Measures

Effective training in the HRC dictates that ship, submarine, and aircraft participants utilize their sensors and train with their weapons to their optimum capabilities as required by the mission. The Navy recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of a training event. As part of their SOPs, the Navy has developed mitigation measures that would be implemented to protect marine mammals and Federally listed species during ASW training. These mitigation measures, which are part of the No-action Alternative, include the establishment of a safety zone and procedures to power down or shut off sonar if animals are detected within the safety zone. For detailed list of mitigation measures see Chapter 6.0. While conducting ASW training, Navy ships always have two, although usually more, personnel on watch serving as lookouts. In addition to the qualified lookouts, the bridge team present at a minimum also includes an Officer of the Deck and one Junior Officer of the Deck include observing the waters in the vicinity of the ship. At night, personnel engaged in ASW events may also use night vision goggles and infra-red detectors, as appropriate, which can aid in the detection of marine mammals. Passive acoustic detection of vocalizing marine mammals is used to alert bridge lookouts to the potential presence of marine mammals in the vicinity.

Navy lookouts undergo extensive training to qualify as watchstanders. This training includes on-the-job instruction under the supervision of an experienced watchstander, followed by completion of the Personal Qualification Standard program. The Navy includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines as required training for Navy lookouts. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species.

Operating procedures are implemented to maximize the ability of personnel to recognize instances when marine mammals are close aboard and avoid adverse effects. These procedures include measures such as decreasing the source level and then shutting down active tactical sonar operations when marine mammals are encountered in the vicinity of a training event. Although these mitigation measures are SOPs, their use is also reinforced through promulgation of an Environmental Annex to the Operational Order for a training event. Sonar operators on ships, submarines, and aircraft use both passive and active sonar detection indicators of marine mammals as a measure of estimating when marine mammals are close. When marine mammals are detected nearby, all ships, submarines, and aircraft engaged in ASW will reduce MFA sonar power levels in accordance with specific guidelines developed for each type of training event.

NMFS and the Navy will continue coordination on the "Communications and Response Protocol for Stranded Marine Mammal Events During Navy Operations in the Pacific Islands Region" that was prepared by NMFS Pacific Region Pacific Island Region Office to facilitate communication during RIMPAC 2006. The Navy will continue to coordinate with the Hawaii NMFS Stranding Coordinator for any unusual marine mammal behavior, including stranding, beached live or dead cetaceans, floating marine mammals, or out-of-habitat/milling live cetaceans that may occur during or shortly after Navy activities in the vicinity of the stranding.

Long-Term Effects

Navy training activities are conducted in the same general areas throughout the HRC, so marine mammal populations can be exposed to repeated training over time. However, as described earlier, this HRC EIS/OEIS assumes that short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long-term significant impacts. There are resident populations of spinner dolphins and beaked whales in several areas throughout the HRC (Andrews et al., 2006; Baird et al., 2006c) that have been exposed to Navy activities but continue to use those areas. Also, the population of humpback whales in Hawaiian waters is increasing (Mobley 2004). Although this suggests that Navy activities do not have a long-term effect on marine mammals, it does not unequivocally confirm this assumption. There will be long-term monitoring program of the marine mammal populations within the HRC.

Likelihood of Prolonged Exposure

The proposed ASW training in the HRC would not result in prolonged exposure because the vessels are constantly moving, and the flow of the activity in the HRC when ASW training occurs reduces the potential for prolonged exposure.

4.1.2.4.11.2 Explosive Source Mitigation Measures

As part of the official Navy clearance procedure before an underwater detonation or Live Fire Exercise, the target area must be inspected visually (from vessels and available aircraft) and determined to be clear. The use of non-explosive rounds or weapons only has the potential to impact marine species if they are targeted at the water or if they miss the intended target. In a SINKEX for example, most of the weapons are guided munitions and gunfire that are generally very accurate. The required clearance zone at the target areas, and training within controlled ranges, minimizes the risk to marine mammals. Open ocean clearance procedures are the same for live or inert ordnance. Whenever ships and aircraft use the ranges for missile and gunnery practice, the weapons are used under controlled circumstances involving clearance procedures to ensure cetaceans, pinnipeds, or sea turtles are not present in the target area. These involve, at a minimum, a detailed visual search of the target area by aircraft reconnaissance, range safety boats, and range controllers and passive acoustic monitoring.

Ordnance cannot be released until the target area is determined to be clear. Training events are immediately halted if cetaceans, pinnipeds, or sea turtles are observed within the target area. Training events are delayed until the animal clears the target area. All observers are in continuous communication in order to have the capability to immediately stop the training. Training can be modified as necessary to obtain a clear target area. If the area cannot be cleared, it is canceled. All of these factors serve to avoid the risk of harming cetaceans, pinnipeds, or sea turtles.

The weapons used in most missile and Live Fire Exercises pose little risk to marine mammals unless they happen to be near the point of impact. Machine guns (0.50 caliber), 5-inch guns, 76-mm guns, and close-in weapons systems (anti-missile systems) exclusively fire non-explosive ammunition. The same applies to larger weapons firing inert ordnance for training. The rounds pose an extremely low risk of a direct hit and potential to directly affect a marine species. Target area clearance procedures will reduce this risk. A SINKEX uses a variety of weapons. The inert rounds pose a risk only at the point of impact and the non-inert weapons (with the exception of a live torpedo) only pose a risk of they miss the target. Target area clearance procedures will reduce this risk. Modeling results of the potential exposures of marine mammals to underwater sound from a SINKEX are summarized in Section 4.1.2.5.1.

The Navy has developed a mitigation plan to maximize the probability of sighting any ships or protected species in the vicinity of training. In order to minimize the likelihood of taking any threatened or endangered species that may be in the area, the following monitoring plan will be adhered to:

- All weapons firing will be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.
- Extensive range clearance operations will be conducted in the hours prior to commencement of the training, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.
- An exclusion zone with a radius of 1.0 nm will be established around each target. This exclusion zone is based on calculations using a 990 lb H6 net explosive weight high explosive source detonated 5 ft below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182 dB re: 1 μPa^2-s threshold established for the WINSTON S. CHURCHILL (DDG 81) shock trials. An additional buffer of 0.5 nm will be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, will be surveyed. Together, the zones extend out 2 nm from the target.

A series of surveillance over-flights would be conducted within the exclusion and the safety zones, prior to and during training, when feasible. Survey protocol will be as follows:

- All visual surveillance operations will be conducted by Navy personnel trained in visual surveillance. In addition to the over flights, the exclusion zone will be monitored by passive acoustic means, when assets are available.
- If a protected species observed within the exclusion zone is diving, firing will be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes has elapsed. After 30 minutes, if the animal has not been re-sighted it will be assumed to have left the exclusion zone. This is based on a typical dive time of 30 minutes for listed species of concern. The Officer conducting the exercise will determine if the listed species is in danger of being adversely affected by commencement of the training event.

There is a long lead-time for set up and clearance of the impact area before any event using explosives takes place (may be one to several hours). There will, therefore, be a long period of area monitoring before any detonation or live fire event begins. Ordnance cannot be released until the target area is determined clear. Training is immediately halted if marine mammals are observed within the target area. Training is delayed until the animals clear the target area.

Most underwater detonations take place in shallow sandy areas that are generally not used by cetacea and are not feeding and resting areas for sea turtles. These factors, along with range clearance procedures and exercise set-up times, all serve to avoid the risk of harming cetaceans, pinnipeds, or sea turtles. Post event monitoring of underwater detonations has not produced any evidence of mortality of any protected marine species.

4.1.2.4.12 Sonar Marine Mammal Modeling

4.1.2.4.12.1 Active Acoustic Devices

Tactical military sonars are designed to search for, detect, localize, classify, and track submarines. There are two types of sonars, passive and active:

- Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment.
- Active sonars generate and emit acoustic energy specifically for the purpose of obtaining information concerning a distant object from the received and processed reflected sound energy.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit omni-directional pulses (“pings”) and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonar emits an omni-directional ping and then rapidly scans a steered receiving beam to provide directional, as well as range, information. More advanced sonars transmit multiple preformed beams, listening to echoes from several directions simultaneously and providing efficient detection of both direction and range.

The tactical military sonars to be deployed during testing and training in the HRC are designed to detect submarines in tactical operational scenarios. This task requires the use of the sonar mid-frequency range (1 kHz to 10 kHz) and the high-frequency range (above 10 kHz). The types of tactical acoustic sources that would be used in training events are discussed in the following paragraphs.

- **Surface Ship Sonars.** A variety of surface ships participate in testing and training events, including cruisers, destroyers, and frigates. Some ships (e.g., aircraft carriers) do not have any onboard active sonar systems, other than fathometers. Others, like cruisers, are equipped with active as well as passive sonars for submarine detection and tracking. For purposes of the analysis, AN/SQS-53 surface ship sonars (present on cruisers and destroyers were modeled as having the nominal source level of 235 dB re 1 µPa at 1 m and transmitting at center frequencies of 2.6 kHz and 3.3 kHz. Sonar ping transmission durations were modeled as lasting 1 second per ping every 30 seconds and omni-directional, which is a conservative assumption that will calculate the maximum potential for effects. Actual ping durations will be less than 1 second. The AN/SQS-56 sonar present on frigates were modeled as having the nominal source level of 225 dB re 1 µPa at 1 m and transmitting at a center frequency of 7.5 kHz. Effects analysis modeling used frequencies that are required in tactical deployments such as those during RIMPAC and USWEX. Details concerning the tactical use of specific frequencies and the repetition rate for the sonar pings is classified but effects were modeled based on the required tactical training setting.

- **Submarine Sonars.** Submarine sonars are used to detect and target enemy submarines and surface ships. Submarine active sonar use is very rare and in those rare instances, the duration is very brief. It is extremely unlikely that use of active sonar by submarines would have any measurable effect on marine mammals.
- **Aircraft Sonar Systems.** Aircraft sonar systems that would operate in the HRC include sonobuoys and dipping sonar. Sonobuoys may be deployed by maritime patrol aircraft or helicopters; dipping sonars are used by carrier-based helicopters. A sonobuoy is an expendable device used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Most sonobuoys are passive, but some can generate active acoustic signals, as well as listen passively. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. During ASW training, these systems active modes are only used briefly for localization of contacts and are not used in primary search capacity. Because active mode dipping sonar use is very brief, it is extremely unlikely its use would have any effect on marine mammals. However, the AN/AQS-22 dipping sonar was modeled based on estimated use during major exercises within the HRC.
- **Torpedoes.** Torpedoes are the primary ASW weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target with a high-frequency sonar (20 kHz) and using the received echoes for guidance. Potential impacts from the use of torpedoes on the PMRF range areas were analyzed in the PMRF Enhanced Capability EIS and, consistent with NOAA's June 3, 2002, ESA Section 7 letter to the Navy for RIMPAC 2002 and the RIMPAC 2006 Biological Opinion, the Navy determined that the activities are not likely to adversely affect ESA listed species under the jurisdiction of the NMFS. The MK-48 torpedo was modeled for active sonar transmissions during specified training within the HRC.
- **Acoustic Device Countermeasures (ADC).** ADCs are, in effect, submarine simulators that make sound to act as decoys to avert localization and/or torpedo attacks. Previous classified analysis has shown that, based on the operational characteristics (source output level and/or frequency) of these acoustic sources, the potential to affect marine mammals was unlikely.
- **Training Targets.** ASW training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures; (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and (3) magnetic sources to trigger magnetic detectors. Based on the operational characteristics (source output level and/or frequency) of these acoustic sources, the potential to affect marine mammals is low, and therefore they were not modeled for this analysis. Consistent with NOAA's June 3, 2002, ESA Section 7 letter to the Navy for RIMPAC 2002 and the RIMPAC 2006 Biological Opinion, the Navy determined that the activities are not likely to adversely affect ESA listed species under the jurisdiction of NMFS.

- **Range Sources.** Range pingers are active acoustic devices that allow each of the in-water platforms on the range (e.g., ships, submarines, target simulators, and exercise torpedoes) to be tracked by the range transducer nodes. In addition to passively tracking the pinger signal from each range participant, the range transducer nodes also are capable of transmitting acoustic signals for a limited set of functions. These functions include submarine warning signals, acoustic commands to submarine target simulators (acoustic command link), and occasional voice or data communications (received by participating ships and submarines on range). Based on the operational characteristics (source output level and/or frequency) of these acoustic sources, the potential to affect marine mammals is low, and therefore they were not modeled for this analysis. Consistent with NOAA's June 3, 2002, ESA Section 7 letter to the Navy for RIMPAC 2002 and the RIMPAC 2006 Biological Opinion, the Navy determined that the activities are not likely to adversely affect ESA listed or MMPA protected species under the jurisdiction of NMFS.

4.1.2.4.12.2 Sonar Modeling Methodology

Modeling of the effects of MFA/HFA sonar and underwater detonations was conducted using methods described in brief below. A detailed description of the representative modeling areas, sound sources, model assumptions, acoustic and oceanographic parameters, underwater sound propagation and transmission models, and diving behavior of species modeled are presented in Appendix J.

The approach for estimating potential acoustic effects from HRC ASW training on cetacean species makes use of the methodology that was developed in cooperation with NOAA for the Navy's USWTR Draft OEIS/EIS (U.S. Department of the Navy, 2005a), USWEX EA/OEA (U.S. Department of the Navy, 2007b), RIMPAC EA/OEA (U.S. Department of the Navy, Commander Third Fleet, 2006) and COMPTUEX/JTFEX EA/OEA (U.S. Department of the Navy, 2007c). The methodology is provided here to determine the number and species of marine mammals for which incidental take authorization is requested.

In order to estimate acoustic effects from HRC ASW training, acoustic sources to be used were examined with regard to their operational characteristics as described in the previous section. Ship systems such as fathometers, with acoustic source levels below 201 dB re 1 μPa at 1 m were considered and were not included in the analysis given that at this source level (201 dB re 1 μPa at 1 m) or below, a ping would attenuate rapidly over distance. In addition, these sources are generally in the high-frequency range, which also reduces the propagation characteristics. It is important to note that odontocetes (toothed whales) are believed to have functional hearing in the range between approximately 40 Hz up to 80 kHz to 150 kHz and that mysticetes (baleen whales like humpbacks) are believed to have functional hearing below this upper limit (Richardson et al., 1995c). Filter-bank models of the humpback whale's ear investigated by Houser et al., (2001) suggested that humpbacks are sensitive to frequencies between 700 Hz and 10 kHz, and maximum sensitivity is between 2 kHz and 6 kHz. Research involving the recording of humpback vocalizations has found harmonics in the range up to 240 kHz (Au et al. 2001; 2006). These results do not, however, indicate that humpbacks can actually hear those high-frequency harmonics and given that sound of that frequency attenuates rapidly over distance, those sounds would not serve as a means of communication over distance. Since systems with an operating frequency greater than 150 kHz were not analyzed in the detailed modeling as these signals attenuate rapidly resulting in very short propagation distances. These acoustic sources, therefore, did not require further examination in this analysis.

Based on the information above, only AN/SQS 53, AN/SQS 56 hull-mounted MFA tactical sonar, DICASS MFA sonobuoy, MK-48 torpedo HFA sonar, and AN/AQS 22 (MFA dipping sonar), and submarine MFA sonar were determined to have the potential to affect marine mammals protected under the MMPA and ESA during HRC ASW training events.

For modeling purposes, sonar parameters (source levels, ping length, the interval between pings, output frequencies, etc.) were based on records from training events, previous exercises, and preferred ASW tactical doctrine to reflect the sonar use expected to occur during events in the HRC. The actual sonar parameters such as output settings, distance between ASW surface, subsurface, and aerial units, their deployment patterns, and the coordinated ASW movement (speed and maneuvers) across the exercise area are classified, however, modeling used to calculate exposures to marine mammals employed actual and preferred parameters to which the participants are trained and have used during past, used during ASW events in the HRC.

Every active sonar operation includes the potential to expose marine animals in the neighboring waters. The number of animals exposed to the sonar in any such action is dictated by the propagation field, the manner in which the sonar is operated (i.e., source level, depth, frequency, pulse length, directivity, platform speed, repetition rate), and the density of each marine species.

The modeling for surface ship active tactical sonar occurred in five broad steps, listed below. Results were calculated based on typical ASW training planned for the HRC. Acoustic propagation and mammal population data are analyzed for both the summer and winter timeframe. Marine mammal survey data for the offshore area beyond 25 nm (Barlow, 2006) and survey data for offshore areas within 25 nm (Mobley et al., 2000) provided marine mammal species density for modeling.

> Step 1. Environmental Provinces. The Hawaii Operating Area (OPAREA) is divided into six marine modeling areas, and each has a unique combination of environmental conditions. These are addressed by defining eight fundamental environments in two seasons that span the variety of depths, bottom types, sound speed profiles, and sediment thicknesses found in the Hawaii OPAREA. Each marine modeling area can be quantitatively described as a unique combination of these environments.
>
> Step 2. Transmission Loss. Since sound propagates differently in these eight environments, separate transmission loss calculations must be made for each, in both seasons. The transmission loss is predicted using CASS-GRAB sound modeling software.
>
> Step 3. Exposure Volumes. The transmission loss, combined with the source characteristics, gives the energy field of a single ping. The energy of over 10 hours of pinging is summed, carefully accounting for overlap of several pings, so an accurate average exposure of an hour of pinging is calculated for each depth increment. Repeating this calculation for each environment in each season gives the hourly ensonified volume, by depth, for each environment and season.
>
> Step 4. Marine Mammal Densities. The marine mammal densities were given in two dimensions, but using sources such as the North Pacific Acoustic Laboratory EIS, the

depth regimes of these marine mammals are used to project the two dimensional densities into three dimensions. Marine mammal densities (as provided by NMFS, e.g., Barlow, 2006) have high coefficients of variation.

Step 5. Exposure Calculations. Each marine mammal's three dimensional density is multiplied by the calculated impact volume—to that marine mammal depth regime. This provides the number of marine mammal density exposures per hour for that particular marine mammal species in each depth regime. In this way, each marine mammal species' (possibly fractional) exposure count per hour is based on its density, depth habitat, and the ensonified volume by depth. The marine mammal density exposures in each depth regime are then summed to predict the expected number of marine mammals harassed by activities within the HRC annually.

The movement of various units during an ASW event is largely unconstrained and dependent on the developing tactical situation presented to the commander of the forces. The planned sonar hours, by ASW training type, are given in the discussion for each type of training event for each alternative. The product of the hours of sonar and the hourly exposure count from the model provides the total exposures.

4.1.2.4.13 Explosive Source Marine Mammal Modeling

Underwater detonation activities can occur at various depths depending on the activity (SINKEX, EER/IEER, and Mine Neutralization), but may also include activities which may have detonations at or just below the surface (BOMBEX, GUNEX, or MISSILEX). Criteria for analysis of explosives potential impact on marine species is presented in Section 4.1.2.3, having application to both sea turtles and marine mammals.

4.1.2.4.13.1 Explosive Source Exercises

The exercises that use explosives are described in the following paragraphs.

Sinking Exercise (SINKEX)

In a SINKEX, a specially prepared, deactivated vessel is deliberately sunk using multiple weapons systems. The exercise provides training to ship and aircraft crews in delivering live ordnance on a real target. The target is a decommissioned and empty, cleaned, and environmentally-remediated ship hulk. It is towed to sea and set adrift at the SINKEX location. The duration of a SINKEX is unpredictable since it ends when the target sinks, sometimes immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons fired one at a time in a series. Typically the exercise lasts for 4 to 8 hours. In the case of multiple SINKEX targets being used for an exercise, a SINKEX may be conducted on successive or multiple days. If at the end of the SINKEX or expenditure of all training ordnance the hulk has not been sunk, it will be sunk by detonation of explosive charges placed inside the hull. No SINKEX hulks would be left adrift overnight. SINKEXs occur only occasionally during HRC exercises. Modeling for an analysis of impacts from a SINKEX assumes all weapons are live (non-inert) and that all weapons used would impact the water. Some or all of the following weapons may be employed in a SINKEX:

- Three Harpoon surface-to-surface and air-to-surface missiles
- Two to eight air-to-surface Maverick missiles

- Two to four MK-82 General Purpose Bombs
- Two Hellfire air-to-surface missiles
- One SLAM-ER air-to-surface missile
- Two-hundred and fifty rounds for a 5-inch gun
- One MK-48 heavyweight submarine-launched torpedo

Air-to-Surface Gunnery Exercise (A-S GUNEX)

A-S GUNEX training is conducted by rotary-wing aircraft against stationary targets (Floating At-Sea Target [FAST] and smoke buoy). Rotary-wing aircraft involved in this training event would include a single SH-60 using either 7.62-mm or 0.50-caliber door-mounted machine guns. A typical GUNEX will last approximately 1 hour and involve the expenditure of approximately 400 rounds of 0.50-caliber or 7.62-mm ammunition. Due to the small size of these rounds, they are not considered to have an underwater detonation impact.

Surface-to-Surface Gunnery Exercise (S-S GUNEX)

S-S GUNEX take place in the open ocean to provide gunnery practice for Navy and Coast Guard ship crews. GUNEX training conducted in the Offshore OPAREA involves stationary targets such as a MK-42 FAST or a MK-58 marker (smoke) buoy. The gun systems employed against surface targets include the 5-inch, 76-millimeter (mm), 25-mm chain gun, 20-mm Close-in Weapon System, and 0.50-caliber machine gun. Typical ordnance expenditure for a single GUNEX is a minimum of 21 rounds of 5-inch or 76-mm ammunition, and approximately 150 rounds of 25-mm or .50-caliber ammunition. Both live and inert training rounds are used. After impacting the water, the rounds and fragments sink to the bottom of the ocean. A GUNEX lasts approximately 1 to 2 hours, depending on target services and weather conditions. The 5-inch and 76-mm rounds are considered in the underwater detonation modeling as live (non-inert), although typically not all ordnance will be live.

Naval Surface Fire Support Exercise (NSFS)

Navy surface combatants conduct NSFS at PMRF on a virtual range against “Fake Island,” located on Barking Sands Tactical Underwater Range (BARSTUR). Fake Island is unique in that it is a virtual landmass simulated in three dimensions. Ships conducting fire support exercise training against targets on the island are given the coordinates and elevation of targets. PMRF is capable of tracking fired rounds to an accuracy of 30 ft. The 5-inch and 76-mm rounds fired into ocean during this exercise are considered in the underwater detonation modeling as live (non-inert) although typically not all ordnance will be live.

Air-to-Surface Missile Exercise (A-S MISSILEX)

The A-S MISSILEX consists of the attacking platform releasing a forward-fired, guided weapon at the designated towed target. The exercise involves locating the target, then designating the target, usually with a laser.

A-S MISSILEX training that does not involve the release of a live weapon can take place if the attacking platform is carrying a captive air training missile (CATM) simulating the weapon involved in the training. The CATM MISSILEX is identical to an LFX in every aspect except that a weapon is not released. The training event requires a laser-safe range as the target is designated just as in an LFX.

From 1 to 16 aircraft, carrying live, inert, or CATMs, or flying without ordnance (dry runs) are used during the exercise. At sea, seaborne powered targets (SEPTARs), Improved Surface Towed Targets (ISTTs), and excess ship hulks are used as targets. A-S MISSILEX assets include helicopters and/or 1 to 16 fixed wing aircraft with air-to-surface missiles and anti-radiation missiles (electromagnetic radiation source seeking missiles). When a high-speed anti-radiation missile (HARM) is used, the exercise is called a HARMEX. Targets include SEPTARs, ISTTs, and excess ship hulks.

Surface-to-Surface Missile Exercise (S-S MISSILEX)

S-S MISSILEX involves the attack of surface targets at sea by use of cruise missiles or other missile systems, usually by a single ship conducting training in the detection, classification, tracking, and engagement of a surface target. Engagement is usually with Harpoon missiles or Standard missiles in the surface-to-surface mode. Targets could include virtual targets or the SEPTAR or ship deployed surface target. S-S MISSILEX training is routinely conducted on individual ships with embedded training devices.

S-S MISSILEX could include 4 to 20 surface-to-surface missiles, SEPTARs, a weapons recovery boat, and a helicopter for environmental and photo evaluation. All missiles are equipped with instrumentation packages or a warhead. Surface-to-air missiles can also be used in a surface-to-surface mode. S-S MISSILEX activities are conducted within PMRF Warning Area W-188. Each exercise typically lasts 5 hours. Future S-S MISSILEX could range from 4 to 35 hours.

Bombing Exercise (BOMBEX)

Fixed-wing aircraft conduct BOMBEX (Sea) training events against stationary targets (MK 42 FAST or MK 58 smoke buoy) at sea. An aircraft will clear the area, deploy a smoke buoy or other floating target, and then set up a racetrack pattern, dropping on the target with each pass. At PMRF, a range boat might be used to deploy the target for an aircraft to attack. BOMBEX are considered in the underwater detonation modeling as live (non-inert), although typically not all bombs will be live.

Mine Neutralization

Mine Neutralization training events involve the detection, identification, evaluation, rendering safe, and disposal of mines and unexploded ordnance that constitutes a threat to ships or personnel. Mine neutralization training can be conducted by a variety of air, surface and sub-surface assets.

Tactics for neutralization of ground or bottom mines involve the diver placing a specific amount of explosives, which when detonated underwater at a specific distance from a mine results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by Fleet ships in open-ocean areas will be detonated at the surface. In support of an expeditionary assault, divers and Navy marine mammal assets deploy in very shallow water depths (10 to 40 ft) to locate mines and obstructions. Divers are transported to the mines by boat or helicopter. Inert dummy mines are used in the exercises. The total net explosive weight used against each mine ranges from less than 1 lb to a maximum of 20 lb.

Various types of bottom surveying equipment may be used during RIMPAC. Examples include the Canadian Route Survey System that hydrographically maps the ocean floor using multi-beam side scan sonar and the Bottom Object Inspection Vehicle used for object identification. These units can help in supporting mine detection prior to Special Warfare Operations (SPECWAROPS) and amphibious exercises.

Mine Neutralization training events take place offshore in the Pu`uloa Underwater Range (called Keahi Point in earlier documents);Naval Station Pearl Harbor; Lima Landing; Barbers Point Underwater Range off-shore of Coast Guard Air Station Barbers Point/Kalaeloa Airport (formerly Naval Air Station Barbers Point); PMRF, Kauai (Majors Bay area); PMRF and Oahu Training Areas; and in Open Ocean Areas.

All demolition activities are conducted in accordance with Commander Naval Surface Forces Pacific Instruction 3120.8F, Procedures for Disposal of Explosives at Sea/Firing of Depth Charges and Other Underwater Ordnance (U.S. Department of the Navy, 1993). Before any explosive is detonated, divers are transported a safe distance away from the explosive. Standard practices require tethered mine explosive charges in Hawaiian waters require ground mine explosive charges to be suspended 10 ft below the surface of the water.

Extended Echo Ranging and Improved Extended Echo Ranging (EER/IEER) SSQ-110

The EER/IEER Systems are airborne ASW systems used in conducting searches for submarines. These systems are made up of airborne avionics ASW acoustic processing and sonobuoys. The sonobuoys are deployed in pairs. The EER/IEER System's active sonobuoy component is the AN/SSQ-110 Sonobuoy. The AN/SSQ-110 Sonobuoy is an expendable and remote controlled sonobuoy, which will generate a sonar "ping," and the passive AN/SSQ-101 ADAR Sonobuoy, which will "listen" for the return echo of the sonar ping that has been bounced off the surface of a submarine. These sonobuoys are designed to provide underwater acoustic data necessary for naval aircrews to quickly and accurately detect submerged submarines. The sonobuoy pairs are dropped from a fixed-wing aircraft into the ocean in a predetermined pattern with a few buoys covering a very large area. Upon command from the aircraft, the first payload is released to sink to a designated operating depth and detonate generating a "ping." A second command is required from the aircraft to cause the second payload to release, detonate, and generate a second and final "ping." There is only one detonation in the total deployed pattern of buoys at a time.

Mitigation measures and modeling approaches are still being coordinated between the Navy and NMFS. Primarily, however, buoys are not dropped or activated if marine species of concern are observed or marine mammals are acoustically detected.

4.1.2.4.13.2 Explosive Source Modeling Criteria

As described in Section 4.1.2.3 for sea turtles there are several criterions for mortality, injury and TTS. The criterion for mortality for marine mammals used in the Churchill FEIS (U.S. Department of the Navy, 2001c) is "onset of severe lung injury." This is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure.

- The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms." Since the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, CHURCHILL used the mass of a calf dolphin (at 27 lb), so that the threshold index is 30.5 psi-ms.

Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum rupture (TM rupture). These criteria are considered indicative of the onset of injury.

- The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-ms in the (U.S. Department of the Navy, 2001b). This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury.
- The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an EL value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten, 1998 indicates a 30 percent incidence of PTS at the same threshold).

Three criteria are considered for non-injurious harassment or TTS, which is a temporary, recoverable, loss of hearing sensitivity (National Marine Fisheries Service, 2001a; U.S. Department of the Navy, 2001b).

- The first criterion for TTS is 182 dB re 1 μPa^2-s maximum EL level in any 1/3-octave band.
- The second criterion for estimating TTS threshold, 12 pounds per square inch (psi) peak pressure was developed for 10,000-lb charges as part of the Churchill FEIS (U.S. Department of the Navy, 2001b, [National Oceanic Atmospheric Administration, 2005, 2006h]). It was introduced to provide a safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). Navy policy is to use a 23 psi criterion for explosive charges less than 2,000 lb and the 12 psi criterion for explosive charges larger than 2,000 lb. All explosives modeled for the HRC EIS/OEIS are less than 1,500 lb.
- The third criterion is used for estimation of behavioral disturbance before TTS (sub-TTS) for cases with multiple successive explosions (having less than 2 seconds separation between explosions). The threshold is 177 dB re 1 μPa^2-s (EL) to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. Since there

may be rare occasions when multiple explosions in succession (separated by less than 2 seconds) occur during BOMBEX, GUNEX, and NSFS using other than inert rounds, the Churchill approach was extended to cover multiple exposure events at the same location. For multiple exposures, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot; this is consistent with the treatment of multiple arrivals in Churchill. For positive impulse, it is consistent with Churchill to use the maximum value over all impulses received. The original research on pure tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided the pure-tone threshold of 192 dB as the lowest TTS value. This value is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1 μPa^2-s in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure tone research generally began 5 dB lower than those causing TTS. The sub-TTS threshold is therefore derived by subtracting five dB from the 182 dB re 1 μPa^2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1 μPa^2-s sub-TTS behavioral disturbance threshold for multiple successive explosives. Previous modeling undertaken for other Navy compliance documents using the sub-TTS 177 dB threshold has demonstrated that for most explosive events, the footprint of the explosives TTS criteria pressure component (23 psi) dominates and supersedes any exposures at a received level involving the 177 dB threshold. For analysis in the HRC EIS/OEIS, therefore, given that multiple successive explosions are rare, in consideration of range clearance procedures designed to preclude the presence of marine species within the target area, and because previous modeling efforts have not resulted in expected exposures at the sub-TTS threshold level, modeling for these rare live fire events (BOMBEX, GUNEX, and NSFS) was not undertaken.

Model Results Explanation

Acoustic exposures are evaluated based on their potential direct effects on marine mammals, and these effects are then assessed in the context of the species biology and ecology to determine if there is a mode of action that may result in the acoustic exposure warranting consideration as a harassment level effect.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily applicable to the development of behavioral criteria and thresholds for marine mammals. Differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (e.g., human data tend to focus on 8-hour-long exposures), and the difference between acoustics in air and in water make extrapolation of human sound exposure standards inappropriate.

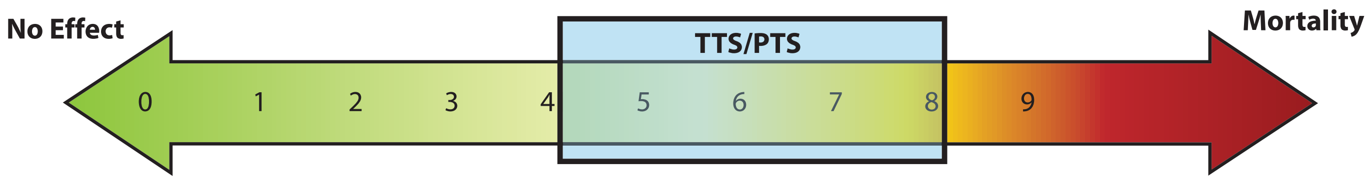
Behavioral observations of marine mammals exposed to anthropogenic sound sources exists, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars described in this EIS/OEIS (Deecke, 2006) or for multiple explosives. Controlled studies in the laboratory have been conducted to determine physical changes (TTS) in hearing of marine mammals associated with sound exposure (Finneran et al., 2001, 2003, 2005). Research on behavioral effects has been difficult because of the difficulty and complexity of implementing controlled conditions.

At the present time there is no general scientifically accepted consensus on how to account for behavioral effects on marine mammals exposed to anthropogenic sounds including military sonar and explosions (National Research Council, 2003, National Research Council, 2005). While the first elements in Figure 4.1.2.4.13.2-1 can be easily defined (source, propagation, receiver) the remaining elements (perception, behavior, and life functions) are not well understood given the difficulties in studying marine mammals at sea (National Research Council 2005). The National Research Council (2005) acknowledges "there is not one case in which data can be integrated into models to demonstrate that noise is causing adverse affects on a marine mammal population."

For purposes of predicting the number of marine mammals that will be behaviorally harassed or sustain either temporary or permanent threshold shift, the Navy uses an acoustic impact model process with numeric criteria agreed upon with the NMFS.

There are some caveats necessary to understand in order to put these exposures in context. For instance, (1) significant scientific uncertainties are implied and carried forward in any analysis using marine mammal density data as a predictor for animal occurrence within a given geographic area; (2) there are limitations to the actual model process based on information available (animal densities, animal depth distributions, animal motion data, impact thresholds, type of sound source and intensity, behavior (involved in reproduction or foraging), previous experience and supporting statistical model); and determination of what constitutes a significant behavioral effect in a marine mammal is still unresolved (National Research Council, 2005). The sources of marine mammal densities used in this EIS/OEIS are derived from NMFS surveys (Barlow, 2003, 2006; Mobley et al., 2001a). These ship board surveys cover significant distance around the Hawaiian Islands. Although survey design includes statistical placement of survey tracks, the survey itself can only cover so much ocean area. Post-survey statistics are used to calculate animal abundances and densities (Barlow and Forney, 2007). There is often significant statistical variation inherit within the calculation of the final density values depending on how many sightings were available during a survey. Occurrence of marine mammals within any geographic area including Hawaii is highly variable and strongly correlated to oceanographic conditions, bathymetry, and ecosystem level patterns (prey abundance and distribution) (Benson et al., 2002; Moore et al., 2002; Tynan, 2005; Redfern, 2006). An example of high correlation of bathymetry in Hawaii is the distribution of humpback whales (particularly mothers with calves), generally within the 100-fathom isobath. Even as the population has increased, habitat use patterns have remained fairly constant, resulting in wider distribution over the available habitat. For some species, distribution may be even more highly influenced by relative small scale biological or oceanographic features over both short and long-term time scales (Ballance et al., 2006; Etnoyer et al., 2006; Ferguson et al., 2006; Skov et al., 2007). Unfortunately, the scientific understanding of some large scale and most small scale processes thought to influence marine mammal distribution is incomplete.

Behavioral Responses



0 - No observable response
1 - Brief orientation response (investigation / visual orientation)
2 - Moderate or multiple orientation behaviors
- Brief or minor cessation/modification of vocal behavior
- Brief or minor change in respiration rates
3 - Prolonged orientation behavior
- Individual alert behavior
- Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source
- Moderate change in respiration rate
- Minor cessation or modification of vocal behavior (duration < duration of source operation), including the Lombard Effect
4 - Moderate changes in locomotion speed, direction, and/or dive profile, but no avoidance of sound source
- Brief, minor shift in group distribution
- Moderate cessation or modification of vocal behavior (approximate duration of source operation)
5 - Extensive or prolonged changes in locomotion speed, direction, and/or dive profile, but not avoidance of sound source
- Moderate shift in group distribution
- Change in inter-animal distance and/or group size (aggregation or separation)
- Prolonged cessation or modifications of vocal behavior (duration > duration of source operation)
6 - Minor or moderate individual and/or group avoidance of sound source
- Brief or minor separation of females and dependent offspring
- Aggressive behavior related to noise exposure (e.g., tail/flipper slapping, fluke display, jaw clapping/gnashing teeth, abrupt directed movement, bubble clouds)
- Extended cessation or modification of vocal behavior
- Visible startle response
- Brief cessation of reproductive behavior
7 - Excessive or prolonged aggressive behavior
- Moderate separation of females and dependent offspring
- Clear antipredator response
- Severe and/or sustained avoidance of sound source
- Moderate cessation of reproductive behavior
8 - Obvious aversion and/or progressive sensitization
- Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms
- Long-term avoidance of area (> source operation)
- Prolonged cessation of reproductive behavior
9 - Outright panic, fight, stampede, attach of conspecifics, or stranding events
- Avoidance behavior related to predator detection

Source: Southall et al., 2007

Proposed Marine Mammal Response Severity Scale Spectrum to Anthropogenic Sounds in Free Ranging Marine Mammals

Figure 4.1.2.4.13.2-1

Given the uncertainties in marine mammal density estimation and localized distributions, the Navy's acoustic impact models can not currently take into account locational data for any marine mammals within specific areas of the Hawaiian Islands with the exception of generalized information for humpback whales and Hawaiian monk seals. To resolve this issue and allow modeling to precede, animals are "artificially and uniformly distributed" within the modeling provinces described in Appendix J.

Behavioral Responses

Behavioral responses to exposure from MFA and HFA sonar and underwater detonations in Hawaii can range from no response, to avoidance and behavioral reaction (Figure 4.1.2.4.13.2-1). The intensity of the behavioral responses exhibited by marine mammals depends on a number of conditions including the age, reproductive condition, experience, behavior (foraging or reproductive), species, received sound level, type of sound (impulse or continuous) and duration (including whether exposure occurs once or multiple times) of sound (Reviews by Richardson et al., 1995a; Wartzok et al., 2003; Cox et al., 2006, Nowacek et al., 2007; Southall et al., 2007). Many behavioral responses may be short term (seconds to minutes orienting to the sound source or over several hours if they move away from the sound source) and of little immediate consequence for the animal. However, certain responses may lead to a stranding or mother-offspring separation (Baraff and Weinrich, 1994; Gabriele et al., 2001). Active sonar exposure is brief as the ship is constantly moving and the animal will likely be moving as well. Generally the louder the sound source the more intense the response although duration is also very important (Southall et al., 2007). There are no exposures exceeding the PTS threshold in the Preferred Alternative (Alternative 3).

According to the severity scale response spectrum (Figure 4.1.2.1.13.2-1) proposed by Southall et al. (2007), responses classified as from 0-3 are brief and minor, those from 4-6 have a higher potential to affect foraging, reproduction, or survival and those from 7-9 are likely to affect foraging, reproduction and survival. Sonar and explosive mitigation measures (sonar power-down or shut-down zones and explosive exclusion zones) would likely prevent animals from being exposed to the loudest sonar sounds or explosive effects that could potentially result in TTS or PTS and more intense behavioral reactions (i.e. 7-9) on the response spectrum.

There are little data on the consequences of sound exposure on vital rates of marine mammals. Several studies have shown the effects of chronic noise (either continuous or multiple pulses) on marine mammal presence in an area exposed to seismic survey airguns or ship noise (e.g., Malme et al., 1984; McCauley et al., 1998; Nowacek et al., 2004). MFA sonar use in Hawaii is not new and has occurred using the same basic sonar equipment and output for over 30 years. Given this history the Navy believes that risk to marine mammals from sonar training is low. As noted previously, it has been suggested that the absence of strandings and floating dead marine mammals in Hawaii is because (it is argued) dead marine mammals will not float, are eaten by sharks, are carried out to sea, or end up on remote shorelines in Hawaii and are never discovered. In Hawaii, floating dead marine mammals persist for a number of days even while being consumed by sharks, and strandings occur on a regular basis on most of the islands. Considering the Pacific Island Region Marine Mammal Response Stranding Network's regular observations of strandings and dead floating marine mammals and the intense use and observation of the shorelines and waters around Hawaii given prevalent fishing and tourism, it is unreasonable to assume that a significant number of whale carcasses have been consistently missed.

Even for more cryptic species such as beaked whales, the main determinant of causing a stranding appears to be exposure in a limited egress areas (a long narrow channel) with multiple ships. The result is that animals may be exposed for a prolonged period rather than several sonar pings over a several minutes and the animals having no means to avoid the exposure. Under these specific circumstances and conditions MFA sonar is believed to have contributed to the stranding and mortality of a small number of beaked whales in locations other than the HRC. There are no limited egress areas (long narrow channels) in the HRC, therefore, it is unlikely that the proposed sonar use would result in any strandings. Although the Navy has substantially changed operating procedures to avoid the aggregate of circumstances that may have contributed to previous strandings, it is important that future unusual stranding events be reviewed and investigated so that any human cause of the stranding can understood and avoided.

There have been no beaked whales strandings in Hawaii associated with the use of MFA/HFA sonar. This is a critically important contextual difference between Hawaii and areas of the world where strandings have occurred (Southall et al., 2007). While the absence of evidence does not prove there have been no impacts on beaked whales, decades of history with no evidence cannot be lightly dismissed.

Temporary Threshold Shift

A temporary threshold shift is a temporary recoverable, loss of hearing sensitivity over a small range of frequencies related to the sound source to which it was exposed. The animal may not even be aware of the TTS and does not become deaf, but requires a louder sound stimulus (relative to the amount of TTS) to detect that sound within the affected frequencies. TTS may last several minutes to several days and the duration is related to the intensity of the sound source and the duration of the sound (including multiple exposures). Sonar exposures are generally short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, TTS in marine mammals exposed to mid- or high-frequency active sonar and underwater detonations are unlikely to occur. There is currently no information to suggest that if an animal has TTS, that it will decrease the survival rate or reproductive fitness of that animal. TTS range from a MFA sonar's 235 dB source level one second ping is approximately 110 m from the bow of the ship under nominal oceanographic conditions.

Permanent Threshold Shift

A permanent threshold shift a non-recoverable and results from the destruction of tissues within the auditory system and occur over a small range of frequencies related to the sound exposure. The animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect that sound within the affected frequencies. Sonar exposures are general short in duration and intermittent (several sonar pings per minute from a moving ship), and with mitigation measures in place, PTS in marine mammals exposed to MFA or HFA sonar is unlikely to occur. There is currently no information to suggest that if an animal has PTS that it decrease the survival rate or reproductive fitness of that animal. The distance to PTS from a MFA sonar's 235 dB source level one second ping is approximately 10 m from the bow of the ship under nominal oceanographic conditions.

Population Level Effects

Some HRC training activities will be conducted in the same general areas, so marine mammal populations could be exposed to repeated activities over time. This does not mean, however, that there will be a repetition of any effects given the vast number of variables involved. The acoustic analyses assume that short-term non-injurious sound levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. However, it is unlikely that most behavioral disruptions or instances of TTS will result in long-term significant effects. The majority of the exposures modeled for the HRC would be below 170 dB SPL and are below the previously used behavioral threshold for RIMPAC, USWEX and COMPTUEX-JTFEX exercises (173 db re 1 µPa-s). Mitigation measures reduce the likelihood of exposures to sound levels that would cause significant behavioral disruption (the higher levels of 7-9 in Figure 4.1.2.4.13.2), TTS or PTS. Based on modeling the Navy has estimated that 27,570 marine mammals per year might be behaviorally harassed as a result of the Proposed Actions under the Preferred Alternative (Alternative 3). The Navy does not anticipate any mortality to result from the Proposed Actions. It is unlikely that the short term behavioral disruption would adversely affect the species or stock through effects on annual rates of recruitment or survival.

4.1.2.5 MARINE MAMMALS NO-ACTION ALTERNATIVE (BIOLOGICAL RESOURCES—OPEN OCEAN)

The discussions regarding potential impacts on fish (Section 4.1.2.2) and sea turtles (Section 4.1.2.3), as well as the discussion of non-acoustic impacts (Section 4.1.2.4.1) apply to the No-action Alternative.

4.1.2.5.1 No-action Alternative Summary of Exposures

The sonar modeling input includes a total of 1,284 hours of AN/AQS 53 and 383 hours of AN/AQS 56 tactical sonar, plus associated DICASS sonobuoy, MK-48 torpedo HFA sonar, EER/IEER, and dipping sonar modeling inputs (see of Appendix J for a detailed description of the sonar modeled). The resulting exposure numbers are generated by the model without consideration of mitigation measures that would reduce the potential for marine mammal exposures to sonar and other activities. Table 4.1.2.5.1-1 provides a summary of the total sonar exposures from all No-action Alternative ASW training that will be conducted over the course of a year. The number of exposures from each type of exercise are presented separately in Sections 4.1.2.5.5, 4.1.2.5.6, and 4.1.2.5.7.

The explosive modeling input includes Mine Neutralization, MISSILEX, BOMBEX, SINKEX, EER/IEER, GUNEX, and NSFS. The modeled explosive exposure harassment numbers by species are presented in Table 4.1.2.5.1-2. The table indicates the potential for non-injurious (Level B) harassment, as well as the onset of injury (Level A) harassment to cetaceans. Estimates for the sub-TTS behavioral threshold indicate there may be 62 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS

Table 4.1.2.5.1-1. No-action Alternative Sonar Modeling Summary—Yearly Marine Mammal Exposures from All ASW (RIMPAC, USWEX, and Other ASW Training)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	64	0	0
Fin whale[1, 2]	46	0	0
Sei whale[1, 2]	46	0	0
Humpback whale[1]	9,677	199	0
Sperm whale[1]	758	9	0
Dwarf sperm whale	2,061	35	0
Pygmy sperm whale	842	14	0
Cuvier's beaked whale	1,121	5	0
Longman's beaked whale	104	1	0
Blainville's beaked whale	347	6	0
Unidentified beaked whale	36	0	0
Bottlenose dolphin	716	17	0
False killer whale	46	0	0
Killer whale	46	0	0
Pygmy killer whale	192	4	0
Short-finned pilot whale	1,751	40	0
Risso's dolphin	486	10	0
Melon-headed whale	583	13	0
Rough-toothed dolphin	1,053	18	0
Fraser's dolphin	1,216	19	0
Pantropical spotted dolphin	2,144	49	0
Spinner dolphin	410	7	0
Striped dolphin	3,126	73	0
Monk seal[1]	104	3	0
TOTAL	26,975	522	0

Notes: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC (see Barlow 2006).
[3] 195 dB – TTS 195-215 dB re 1 µPa^2-s; for monk seals TTS is 204-224 dB re 1 µPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 µPa^2-s; for monk seals PTS is >224 dB re 1 µPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

Table 4.1.2.5.1-2. No-action Alternative Explosives Modeling Summary—Yearly Marine Mammal Exposures from All Explosive Sources

Marine Mammal Species	Sub-TTS	TTS Modeled at < 182 dB re 1 μPa^2–s or 23 psi								Total Exposures		
	Sub-TTS 177 dB	EER/IEER	Mine Neutralization	Air-to-Surface Missile Exercise	Surface-to-Surface Missile Exercise	Bombing Exercise	Sinking Exercise	Surface-to-Surface Gunnery Exercise	Naval Surface Fire Support	TTS 182 dB, 23 psi	Slight Lung/ TM Injury	Onset Mass-ive Lung Injury
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale[1, 2]	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale[1]	5	1	1	0	0	3	0	0	0	5	0	0
Sperm whale[1]	9	0	0	0	0	1	3	0	0	4	0	0
Dwarf sperm whale	13	1	0	0	0	2	4	0	0	7	0	0
Pygmy sperm whale	4	1	0	0	0	1	2	0	0	4	0	0
Cuvier's beaked whale	15	0	0	0	0	2	5	0	0	7	0	0
Longman's beaked whale	0	0	0	0	0	0	0	0	0	0	0	0
Blainville's beaked whale	2	0	0	0	0	0	1	0	0	1	0	0
Unidentified beaked whale	0	0	0	0	0	0	0	0	0	0	0	0
Bottlenose dolphin	0	0	0	0	0	0	0	0	0	0	0	0
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	2	1	0	0	0	0	1	0	0	2	0	0
Risso's dolphin	0	0	0	0	0	0	0	0	0	0	0	0
Melon-headed whale	0	0	0	0	0	0	0	0	0	0	0	0
Rough-toothed dolphin	2	1	0	0	0	1	1	0	0	3	0	0
Fraser's dolphin	6	1	0	0	0	1	2	0	0	4	0	0
Pantropical spotted dolphin	0	1	0	0	0	0	0	0	0	1	0	0
Spinner dolphin	2	0	0	0	0	0	1	0	0	1	0	0
Striped dolphin	2	1	0	0	0	1	1	0	0	3	0	0
Monk seal[1]	0	1	0	0	0	0	0	0	0	1	0	0
Total	62	9	1	0	0	12	21	0	0	43	0	0

Note:
[1] Endangered Species
2 Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
dB = decibel
μPa^2-s = squared micropascal-second
NMFS = National Marine Fisheries Service
PTS = permanent threshold shift
TM = tympanic membrane
TTS = temporary threshold shift

behavioral threshold. The modeling indicates 43 annual exposures from underwater detonations that could result in TTS. The modeling indicates no exposures from pressure from underwater detonations that could cause injury. These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation and monitoring procedures. The implementation of the mitigation and monitoring procedures presented in Chapter 6.0 will minimize the potential for marine mammal exposure and harassment through range clearance procedures.

4.1.2.5.2 Estimated Effects on ESA Listed Species—No-action Alternative

The endangered species that may be affected as a result of implementation of the HRC No-action Alternative include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), Hawaiian monk seal (*Monachus schauinslandi*) humpback whale (*Megaptera novaeangliae*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*).

For the No-action Alternative, modeling results predict that if there were no mitigation measures in place, exposures that that are temporary, non-injurious physiological effects (TTS) or behavioral effects will occur. The modeling predicts no exposures to energy in excess of 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

The following sections discuss the exposure of ESA listed species to sonar and to underwater detonations from all No-action ASW Exercises per year. The exposure numbers are given without consideration of mitigation measures. However, mitigation measures that are implemented during the ASW or underwater detonation will reduce the potential for marine mammal exposures. For each species the likelihood of detection is given based on systematic line transect surveys (Barlow, 2006) but the ability to detect marine mammals will depend on sea state conditions.

Blue Whale (*Balaenoptera musculus*)

There is no density information available for blue whales in Hawaiian waters given they have not been seen during any surveys. Given they are so few in number, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any blue whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No blue whales will be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or cause physical injury.

Mitigation measures call for continuous visual observation during training with active sonar Given the large size (up to 98 ft) of individual blue whales (Leatherwood et al., 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow, 2003), it is likely that lookouts will detect a group of blue whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound;

and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

In the unlikely event that blue whales are exposed to MFA/HFA sonar, the anatomical information available on blue whales suggests that they are not likely to hear sounds at or above mid-frequency sounds (Ketten, 1997). There are no audiograms of baleen whales. Available information on blue whale vocalizations indicate a variety of low-frequency sounds in the 10 to 300 Hz band. Blue whales tend to react to anthropogenic sound below 1 kHz (e.g., seismic air guns), suggesting that they are more sensitive to low-frequency sounds (Richardson et al., 1995a; Croll et al., 2002). Because the MFA/HFA tactical sonar proposed for HRC ASW training is outside the frequency typically used by the blue whales, they are not likely to hear or have a physiological or behavioral response to the sonar (National Oceanic and Atmospheric Administration, 2006e).

Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of blue whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury, effects on their behavior or physiology, or abandonment of areas that are regularly used by blue whales. In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect blue whales.

Fin Whale (*Balaenoptera physalus*)

There is no density information for fin whales in the Hawaiian Islands (Barlow, 2006). For purposes of acoustic effects analysis, it was assumed that the number and density of fin whales did not exceed that of false killer whales (given they have a similar reported abundance, Barlow 2006), and the modeled number of exposures for both species will therefore be the same. The risk function and Navy post-modeling analysis estimates 46 fin whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect fin whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.5.1-1).

Modeling indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales will be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 78 ft) of individual fin whales (Leatherwood et al., 1982), pronounced vertical blow, and mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow, 2003), it is likely that lookouts will detect a group of fin whales at the surface during ASW training events. Implementation of mitigation measures and probability of detecting a large fin whale reduce the likelihood of exposure and potential effects. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

In the unlikely event that fin whales are exposed to MFA/HFA sonar, the anatomical information available on fin whales suggests that they are not likely to hear mid-frequency (1 kHz to 10 kHz) sounds (Richardson et al., 1995a; Ketten, 1997). Fin whales primarily produce low-frequency calls (below 1 kHz) with source levels up to 186 dB re 1μPa at 1 m, although it is possible they produce some sounds in the range of 1.5 to 28 kHz (review by Richardson et al., 1995a; Croll et al., 2002). There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low-frequency sounds (Richardson et al., 1995a). Based on this information, if they do not hear these sounds, they are not likely to respond physiologically or behaviorally to those received levels.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane, 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and MacFarlane, 1987). Even though any undetected fin whales transiting the HRC may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects will not cause disruption of natural behavioral patterns to a point where such behavioral patterns will be abandoned or significantly altered.

Based on the model results, the nature of Navy's MFA sonar operations, behavioral patterns and acoustic abilities of fin whales, observations made during HRC training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events will likely not result in any population level effects, death or injury to fin whales. In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect fin whales.

Humpback Whale (*Megaptera novaeangliae*)

The risk function and Navy post-modeling analysis estimates 9,677 humpback whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect humpback whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.5.1-1).

Modeling indicates there would be 199 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates there would be no exposures for humpback whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s.

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral disturbance threshold. Without consideration of clearance procedures, modeling estimates five exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, and no exposures that would exceed the slight injury threshold or the massive lung injury threshold (Table 4.1.2.5.1-2). Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no humpback whales within the safety zone, and therefore potential exposure of humpback whales to sound levels from underwater detonations that exceed TTS or injury levels is highly unlikely.

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 53 ft) of individual humpback whales (Leatherwood et al., 1982), and pronounced vertical blow, it is very likely that lookouts would detect humpback whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

As noted previously, filter-bank models of the humpback whale's ear by Houser et al., (2001) suggest that humpbacks are sensitive to frequencies between 700 Hz and 10 kHz, and have a maximum sensitivity is between 2 kHz and 6 kHz. Recent reporting by Au et al., (2006) indicating high-frequency harmonics in humpback whale "song" at 24 kHz and beyond does not demonstrate that humpbacks can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental. Most social vocalizations, including female vocalizations, are below 3 kHz (Silber, 1986); therefore, are below MFA sonar range. Male songs range from 20 Hz to 24 kHz, but most of the components range from 200 Hz to 3 kHz (Au et al., 2001). A single study suggested that humpback whales responded to MFA sonar (3.1-3.6 kHz re 1 μPa^2-s) sound (Maybaum, 1989). The hand-held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e., the humpback whale responded to the low-frequency artifact rather than the MFA sonar sound).

While acoustic modeling results indicate MFA/HFA sonar may expose humpback whales to accumulated acoustic energy levels resulting in temporary behavioral effects, these exposures would have negligible impact on annual survival, recruitment, and birth rates and not likely result in population level effects. The aggregation of humpback whales in Hawaii has been increasing at up to 7 percent annually (Mobley, 2004) despite frequent encounters with tour boats. There have been no observed or reported mother calf separations as a result of Navy activities. There have been no reported or identified humpback whale strandings in Hawaii associated with the use of MFA/HFA sonar. While the absence of evidence does not prove there have been no impacts on humpback whales, decades of history with no evidence should not be dismissed. Mitigation measures presented in Chapter 6.0 would further reduce the potential acoustic exposure.

Per Navy policy, based on the quantitative analysis results that trigger a "may affect" determination, Navy has initiated Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect humpback whales.

North Pacific Right Whale (*Eubalaena japonica*)

There is no density information available for North Pacific right whales in Hawaiian waters since they have not been seen during survey. Given they are so few in number, it is unlikely that HRC training events will result in the exposure of any North Pacific right whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No right whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury.

Mitigation measures call for continuous visual observation during training with active sonar. Given their large size (up to 56 ft) of individual North Pacific right whales (Leatherwood et al., 1982), surface behavior (e.g., breaching), pronounced blow, and mean group size of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would detect a group of North Pacific right whales at the surface during ASW training events. Implementation of mitigation measures and probability of detecting a large North Pacific right whale reduce the likelihood of exposure and potential effects. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of North Pacific right whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would likely not result in any population level effects, death or injury to North Pacific right whales, and will not affect their behavior, physiology or cause abandonment of areas that are regularly used by North Pacific right whales. In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect North Pacific right whales.

Sei Whale (*Balaenoptera borealis*)

For purposes of the acoustic effects analysis, the same assumptions made previously regarding fin whales are also made for sei whales. It was therefore assumed that the number and density of sei whales did not exceed that of false killer whales (given they have a similar reported abundance, Barlow 2006), and the modeled number of exposures for both species would therefore be the same.

The risk function and Navy post-modeling analysis estimates 46 sei whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect sei whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.5.1-1).

Modeling indicates there would be no exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates no exposures for sei whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. No sei whales would be exposed to impulsive sound or pressures from underwater detonations that would cause TTS or physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 53 ft) of individual sei whales (Leatherwood et al., 1982), pronounced vertical blow, and aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow, 2003), it is likely that lookouts will detect a group of sei whales at the surface during ASW training events. Implementation of mitigation measures and probability of detecting a large sei whale reduce the likelihood of exposure and potential effects. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There is little information on the acoustic abilities of sei whales or their response to human activities. The only recorded sounds of sei whales are frequency modulated sweeps in the range of 1.5 to 3.5 kHz (Thompson et al., 1979; Knowlton et al., 1991), but it is likely that they also vocalized at frequencies below 1 kHz as do fin whales. There are no audiograms of baleen whales, but they tend to react to anthropogenic sound below 1 kHz, suggesting that they are more sensitive to low-frequency sounds (Richardson et al., 1995a). Sei whales were more difficult to approach than were fin whales and moved away from boats but were less responsive when feeding (Gunther, 1949).

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of sei whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not likely result in any population level effects, death or injury to sei whales. The proposed ASW Exercises may affect sei whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sei whales. In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect sei whales.

Sperm Whales (*Physeter macrocephalus*)

The risk function and Navy post-modeling analysis estimates 758 sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect sperm whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.5.1-1).

Modeling also indicates there would be nine exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates no exposures for sperm whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s.

Estimates for the sub-TTS behavioral threshold indicate there may be nine exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS threshold. Without consideration of clearance procedures, there would be four exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold (Table 4.1.2.5.1-2). Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no sperm whales within the safety zone, and therefore potential exposure of sperm whales to sound levels that exceed TTS is highly unlikely.

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 56 ft) of individual sperm whales (Leatherwood et al., 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow, 2003; 2006), it is very likely that lookouts would detect a group of sperm whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

In the unlikely event that sperm whales are exposed to MFA/HFA sonar, the information available on sperm whales exposed to received levels of MFA sonar suggests that the response to mid-frequency (1 kHz to 10 kHz) sounds is variable (Richardson et al., 1995a). In the Caribbean, Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area. The pulses were surmised to have originated from submarine sonar signals given that no vessels were observed. The authors did not report receive levels from these exposures, and also got a similar reaction from artificial noise they generated by banging on their boat hull. It was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general.

Other studies involving sperm whales indicate that, after an initial disturbance, the animals return to their previous activity. During playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, then ignored the signal completely (André et al., 1997).

Based on the model results, the nature of the Navy's MFA sonar training, behavioral patterns and acoustic abilities of sperm whales, observations made during past training events, and the planned implementation of procedure mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to sperm whales. The proposed ASW Exercises may affect sperm whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sperm whales. In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect sperm whales.

Hawaiian Monk Seal (*Monachus schauinslandi*)

The risk function and Navy post-modeling analysis estimates 104 Hawaiian monk seals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect Hawaiian monk seals; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.5.1-1).

Modeling also indicates there would be three exposures to accumulated acoustic energy between 204 dB and 224 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates there would be no exposures for monk seals to accumulated acoustic energy above 224 dB re 1 μPa^2-s.

As noted previously, modeling undertaken for monk seals does not take into consideration the effect of mitigation measures or foraging habitat preferences. Monk seals generally forage at depths of less than 100 m, but occasionally dive to depths of over 500 m (National Marine Fisheries Service, 2007d). The majority of ASW training in the HRC, however, takes place in waters 4 to 8 times deeper than even this known (500 m) maximum and it is very rare for ASW training to take place in waters as shallow as 100 m in depth. Additionally, mitigation measures call for continuous visual observation during training with active sonar. It would, therefore, be rare for a Hawaiian monk seal to be present in the vicinity of an ASW event and the potential for detection by aircraft and lookouts aboard ship would further preclude the possibility that monk seals would be in the vicinity of ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS threshold. There would be one exposure from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and no exposures that would exceed the injury threshold (Table 4.1.2.5.1-2). In the rare event that a monk seal was present, target area clearance procedures described in Section 4.1.2.5.1 would be used to detect monk seals within the safety zone, and therefore potential exposure of monk seals to exposures that exceed TTS is highly unlikely.

Critical habitat was designated 1986 as the area extending out to the 10-fathom depth (60 ft) for the Northwestern Hawaiian Islands (National Marine Fisheries Service, 1986). Critical habitat was extended out to the 20-fathom depth in 1988 (National Marine Fisheries Service, 1988). ASW events should not occur inside the 20-fathom isobath and given mitigation measures and range clearance procedures, activities in the HRC will not have an effect on Monk Seal Critical Habitat.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of monk seals, observations made during past training events, and the planned implementation of procedure mitigation measures, the Navy finds that the training events would not likely result in any death or injury to Hawaiian monk seals. In accordance with ESA requirements, the Navy has undertaken Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect monk seals.

4.1.2.5.3 Estimated Exposures for Non-ESA Species—No-action Alternative

Bryde's Whale (*Balaenoptera edeni*)

The risk function and Navy post-modeling analysis estimates 64 Bryde's whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1 1).

Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 46 ft) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of Bryde's whales at the surface during ASW events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 64 exposures of Bryde's whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Bryde's whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Bryde's whales.

Minke Whale (*Balaenoptera acutorostrata*)

Despite several reports of seasonal acoustic detections of minke whales in Hawaiian waters (e.g. Rankin and Barlow, 2005), there is no density information available for minke whales in Hawaiian waters given they have rarely been visually sighted during surveys. Taken conservatively, the acoustic detections suggest that minke whales may be more common than the survey data indicates. Therefore, although acoustic effects modeling cannot be undertaken without density estimates, the Navy will assume 65 minke whales may exhibit behavioral responses that NMFS would classify as harassment under the MMPA. This exposure number is based on the modeled exposures for the Bryde's whale, another seasonal baleen whale, that has a reported abundance of 469 whales in the HRC (Barlow 2006). Based upon the Navy's protective measures, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any minke whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No minke whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or cause physical injury.

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 27 ft) of individual minke whales (Barlow, 2003), it is possible that lookouts may detect minke whales at the surface during ASW training events although a systematic survey in the Hawaiian Islands failed to visually detect minke whales but were able to detect them acoustically (Barlow, 2006). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of minke whales, observations made during past training events, and the planned implementation mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to minke whales.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

The risk function and Navy post-modeling analysis estimates 347 Blainville's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates six exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Blainville's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s.

Modeling indicates there would be one exposure to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause physical injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting Blainville's beaked whales at the surface, any exposures should be precluded from occurring.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS threshold. Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting Blainville's beaked whales at the surface, these two exposures should be precluded from occurring. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 356 exposures of Blainville's beaked whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Blainville's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Blainville's beaked whales.

Bottlenose Dolphin (*Tursiops truncatus*)

The risk function and Navy post-modeling analysis estimates 716 bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 17 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no bottlenose dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. No bottlenose dolphins would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or would cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the frequent surfacing, aggregation of approximately nine animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would detect a group of bottlenose dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 733 exposures of bottlenose dolphins to potential Level B harassment annually. Based on the model results, the nature of the Navy's MFA sonar, behavioral patterns and acoustic abilities of bottlenose dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to bottlenose dolphins.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The risk function and Navy post-modeling analysis estimates 1,121 Cuvier's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates five exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Cuvier's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. Estimates for the sub-TTS behavioral threshold indicate there may be 15 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS threshold. Modeling indicates there would seven exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting Cuvier's beaked whales at the surface, these seven exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given the medium size (up to 23 ft) of individual Cuvier's beaked whales (Barlow, 2006), it is possible that lookouts may detect Cuvier's beaked whales at the surface during ASW training events although beaked whales make long duration dives that may last for 45 min (Baird et al., 2006b). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be four exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations.

There may be up to 1,148 exposures of Cuvier's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Cuvier's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Cuvier's beaked whales.

Dwarf Sperm Whale (*Kogia sima*)

The risk function and Navy post-modeling analysis estimates 2,061 dwarf sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 35 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates that seven dwarf sperm whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, and 13 exposures to noise from underwater detonations that could exceed the sub-TTS behavioral threshold (Table 4.1.2.5.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, behavioral patterns, acoustic abilities of dwarf sperm whales, results of past training, and the implementation of procedure mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to dwarf sperm whale. There may be up to 2,116 exposures of dwarf sperm whales to potential Level B harassment annually.

False Killer Whale (*Pseudorca crassidens*)

The risk function and Navy post-modeling analysis estimates 46 false killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates no exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no false killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. No false killer whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or cause physical injury (Table 4.1.2.5.1-2).

Given their size (up to 19.7 ft) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of false killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, false killer whales that are present in the vicinity of ASW training events would be detected by visual observers. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 46 exposures of false killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of dwarf sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to dwarf sperm whales.

Fraser's Dolphin (*Lagenodelphis hosei*)

The risk function and Navy post-modeling analysis estimates 1,216 Fraser's dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 19 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling also indicates that no Fraser's dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. Estimates for the sub-TTS behavioral threshold indicate there may be six exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates there would be four exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting Fraser's dolphins at the surface, these four exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 19.7 ft) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of false killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,245 exposures of Fraser's dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of false killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to false killer whales.

Killer Whale (*Orcinus orca*)

The risk function and Navy post-modeling analysis estimates 46 killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates that there would be no exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates that no killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. No killer whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS threshold or cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 23 ft), conspicuous coloring, pronounced dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90; Barlow, 2003), is very likely that lookouts would detect a group of killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 46 exposures of killer whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death, or injury to killer whales.

Longman's Beaked Whale (*Indopacetus pacificus*)

The risk function and Navy post-modeling analysis estimates 104 Longman's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates one exposure to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates that no Longman's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. No Longman's beaked whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS threshold or cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar; Given the medium size (up to 24 ft) of individual Longman's beaked whale, aggregation of approximately 17.8 animals (Barlow, 2006), it is likely that lookouts would detect a group of

Longman's beaked whale at the surface during ASW training events although beaked whales dive for long periods. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 105 exposures of Longman's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Longman's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Longman's beaked whales.

Melon-headed Whale (*Peponocephala electra*)

The risk function and Navy post-modeling analysis estimates 583 melon-headed whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 13 exposures to accumulated acoustic energy. Modeling for indicates that no melon-headed whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. No melon-headed whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS threshold or cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar; Given their size (up to 8.2 ft) and large group size (mean of 89.2 whales) or more animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would very likely detect a group of melon-headed whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 596 exposures of melon-headed whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of melon-headed whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to melon-headed whales.

Pantropical Spotted Dolphin (*Stenella attenuata*)

The risk function and Navy post-modeling analysis estimates 2,144 pantropical spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates 49 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling also indicates one exposure to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting pantropical spotted dolphins at the surface, this exposure should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and large group size hundreds of animals (Leatherwood et al., 1982), mean group size of 60.0 animals in Hawaii and probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow, 2006), it is very likely that lookouts would detect a group of pantropical spotted dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 2,194 exposures of pantropical spotted dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pantropical spotted dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pantropical spotted dolphins.

Pygmy Killer Whale (*Feresa attenuata*)

The risk function and Navy post-modeling analysis estimates 192 pygmy killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates four exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for indicates that no pygmy killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s. No pygmy killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.5 ft) and mean group size of 14.4 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would detect a group of pygmy killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 196 exposures of pygmy killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pygmy killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pygmy killer whales.

Pygmy Sperm Whale (*Kogia breviceps*)

The risk function and Navy post-modeling analysis estimates 842 pygmy sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 14 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no pygmy sperm whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s.

Estimates for the sub-TTS behavioral threshold indicate there may be four exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates four exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.4.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting pygmy sperm whales at the surface, these four exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their size (up to 10 ft) and behavior of resting at the surface (Leatherwood et al., 1982), it is very possible that lookouts would detect a pygmy sperm whale at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 864 exposures of pygmy sperm whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pygmy sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pygmy sperm whales.

Risso's Dolphin (*Grampus griseus*)

The risk function and Navy post-modeling analysis estimates 486 Risso's dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 10 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates that no Risso's dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s. No Risso's dolphins would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.5.1-2).

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing, light coloration, and large group size of up to several hundred animals (Leatherwood et al., 1982), mean group size of 15.4 dolphins in Hawaii and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow, 2006), it is very likely that lookouts would detect a group of Risso's dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 496 exposures of Risso's dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Risso's dolphin, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Risso's dolphins.

Rough-Toothed Dolphin (*Steno bredanensis*)

The risk function and Navy post-modeling analysis estimates 1,053 rough-toothed dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 18 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for indicates that no rough-toothed dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates there would three exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting rough-toothed dolphins at the surface, these three exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 14.8 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of rough-toothed dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,076 exposures of rough-toothed dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of rough-toothed dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to rough-toothed dolphins.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The risk function and Navy post-modeling analysis estimates 1,751 short-finned pilot whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 40 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no short-finned pilot whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates there would two exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting short-finned pilot whales at the surface, these two exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 20 ft), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006), it is very likely that lookouts would detect a group of short-finned pilot whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,795 exposures of short-finned pilot whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of short-finned pilot whales, observations made during past training events, and the planned implementation of mitigation measures, the

Navy finds that the HRC training events would not result in any population level effects, death or injury to short-finned pilot whales.

Spinner Dolphin (*Stenella longirostris*)

The risk function and Navy post-modeling analysis estimates 410 spinner dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates seven exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for indicates that no spinner dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates there would one exposure to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury massive lung injury (Table 4.1.2.5.1-2). Taking into consideration range clearance procedures for underwater detonation with the high probability of detecting spinner dolphins at the surface, this one exposure should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their frequent surfacing, aerobatics, and large mean group size of 31.7 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of spinner dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 420 exposures of spinner dolphins to potential Level B harassment annually Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of spinner dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to spinner dolphins.

Striped Dolphin (*Stenella coeruleoalba*)

The risk function and Navy post-modeling analysis estimates 3,126 striped dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates 73 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for indicates no exposures to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Modeling indicates three exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.5.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting striped dolphins at the surface, these three exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of striped dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 3,204 exposures of striped dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of striped dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to striped dolphins.

Unidentified Beaked Whales

The risk function and Navy post-modeling analysis estimates 36 unidentified beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.5.1-1).

Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No unidentified beaked whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.5.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 36 exposures of unidentified beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of unidentified beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to unidentified beaked whales.

4.1.2.5.4 Summary of Compliance with MMPA and ESA—No-action Alternative

Endangered Species Act

Based on analytical risk function modeling results, NMFS conclusions in the Biological Opinions issued regarding RIMPAC 2006 and USWEX 2007, and in accordance with the ESA, the Navy finds these estimates of harassment resulting from the proposed use of MFA/HFA sonar may affect endangered blue whales, North Pacific right whales, fin whales, Hawaiian monk seals, humpback whales, sei whales, and sperm whales. Modeling results indicate no PTS exposures. Implementation of mitigation measures would further reduce the potential for TTS exposures. Based on the analysis presented in the previous section, the Navy concludes that proposed and ongoing activities in the HRC may affect but not adversely affect blue whales, North Pacific right whales, fin whales, humpback whales, sei whales, sperm whales and Hawaiian monk seals.

Mitigation measures would be implemented to minimize exposure of marine mammals to impulsive sound or sound pressures from underwater detonations that would cause injury.

Five species of sea turtles could potentially occur within the HRC. All are protected under the ESA. All available acoustic information suggests that sea turtles are likely not capable of hearing mid-frequency or high-frequency sounds in the range produced by the active sonar systems considered in this analysis. Mitigation measures would be implemented to minimize exposure of sea turtles to impulsive sound or sound pressures from underwater detonations that would cause injury.

In accordance with ESA requirements, the Navy has initiated Section 7 consultation with NMFS on the potential that HRC training may affect blue whales, North Pacific right whales, fin whales, Hawaiian monk seals, humpback whales, sei whales, and sperm whales.

Marine Mammal Protection Act

Level A Harassment of Cetaceans

Modeling results for the sum of exposures for all ASW training for a year indicate no exposures that exceeds the Level A harassment threshold. In addition, the following considerations further reduce the potential for injury from tactical sonar and underwater explosions:

- Level A zone of influence radii for tactical sonar are so small that on-board observers would readily observe an approaching marine mammal.
- Many species are large and/or travel in large pods and are easily visible from an elevated platform; a marine mammal would readily be seen from a ship or aircraft in time to implement mitigation measures.

Level B Harassment of Cetaceans

As shown in Table 4.1.2.5.1-1 for sonar, the risk function (including post-modeling analysis) plus an estimate of 64 minke whale exposures results in the estimate that 27,039 marine mammals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. Modeling for the No-action Alternative for sonar indicates 522 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling also indicates no exposures to accumulated acoustic energy above 215 dB re 1 μPa^2-s. Should the Navy decide to implement the No-action Alternative, the effects on marine mammals will need to be considered by NMFS for purposes of MMPA authorization and ESA consultation.

Therefore, it is estimated that in total, 27,666 marine mammals will exhibit behavioral responses NMFS will classify as Level B harassment. This includes 522 TTS and 27,039 risk function exposures (26,975 plus an estimated 64 minke whales) as a result of MFA/HFA sonar use (27,561 exposures) in addition to 105 exposures (62 sub-TTS exposures and 43 TTS exposures) as a result of underwater detonations (for explosives see Table 4.1.2.5.1-2).

Mitigation measures will be in place to further minimize the potential for temporary harassment, although there is currently no data to quantify the mitigation efforts to successfully reduce the number of marine mammal exposures. The Navy has begun development of a comprehensive Monitoring Plan to determine the effectiveness of these measures. Many species of small cetaceans travel in very large pods, and therefore would be easily observed from an elevated platform. In addition, large baleen whales travel slowly and are easily observed on the surface. In the years of conducting Major Exercises in the HRC, there have been no documented incidences of harassments or beach strandings of marine mammals associated with active sonar or underwater detonations. In the one event associated with RIMPAC 2004, NMFS found sonar use was a plausible if not likely contributing factor (Southall et al., 2006) although it was later discovered that a similar event occurred on the same day in a bay at Rota Island, Northern Marianas Islands with no associated sonar (Jefferson et al., 2006). The Navy believes the 2004 event may be related to oceanographic changes that influenced prey distribution (see Southall, 2006; Ketten, 2006; Mobley et al., 2007). The HRC open ocean waters continue to support diverse populations of cetaceans.

4.1.2.5.5 HRC Training—No-action Alternative

The HRC training involving sonar includes ASW training activities as described in Table 2.2.2.3-1 and Appendix D. The No-action Alternative modeling for these activities includes analysis of surface ship and submarine MFA sonar, associated sonobuoys, MK-48 torpedo HFA sonar, and dipping sonars for activities other than occurring during Major Exercises on an annual basis. The modeled exposures for marine mammals during this ASW training, without consideration of mitigation measures are presented in 4.1.2.5.5-1 for the No-action Alternative. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.5.2 for ESA listed species and 4.1.2.5.3 for non-ESA listed species.

Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS are presented in the summary numbers in Table 4.1.2.5.1-2.

Table 4.1.2.5.5-1. No-action Alternative Sonar Modeling Summary—Yearly Marine Mammal Exposures from Other HRC ASW Training

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	14	0	0
Fin whale[1, 2]	10	0	0
Sei whale[1, 2]	10	0	0
Humpback whale[1]	1,561	57	0
Sperm whale[1]	166	2	0
Dwarf sperm whale	451	10	0
Pygmy sperm whale	185	4	0
Cuvier's beaked whale	266	1	0
Longman's beaked whale	22	0	0
Blainville's beaked whale	76	2	0
Unidentified beaked whale	9	0	0
Bottlenose dolphin	152	5	0
False killer whale	10	0	0
Killer whale	10	0	0
Pygmy killer whale	41	1	0
Short-finned pilot whale	376	12	0
Risso's dolphin	104	3	0
Melon-headed whale	125	4	0
Rough-toothed dolphin	230	5	0
Fraser's dolphin	264	5	0
Pantropical spotted dolphin	459	14	0
Spinner dolphin	89	2	0
Striped dolphin	669	21	0
Monk seal[1]	29	1	0
TOTAL	5,328	149	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 µPa^2-s; for monk seals TTS is 204-224 dB re 1 µPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 µPa^2-s; for monk seals PTS is >224 dB re 1 µPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

4.1.2.5.6 HRC RDT&E Activities—No-action Alternative

Other sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean are beyond the frequency range or intensity level to affect marine animals. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and short durations (<1.5 hours). These activities would have minimal effects on fish, sea turtles, and marine mammals.

4.1.2.5.7 Major Exercises—No-action Alternative

RIMPAC

The training events and impacts on marine mammals from RIMPAC Exercises were summarized in the RIMPAC 2006 Supplement to the 2002 RIMPAC EA (U.S. Department of the Navy Commander Third Fleet, 2006). The No-action Alternative modeling included 399 hours of AN/SQS 53 and 133 hours of AN/SQS 56 surface ship sonar plus dipping sonar, sonobuoys, and MK-48 torpedo high-frequency sonar per RIMPAC (conducted every other year). The modeled exposures for marine mammals during RIMPAC, without consideration of mitigation measures are presented in Table 4.1.2.5.7-1. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.5.2 for ESA listed species and 4.1.2.5.3 for non-ESA listed species. Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS are included in the summary numbers in Table 4.1.2.5.1-2. Sections 4.1.2.2 and 4.1.2.3 discuss the potential effects on fish and sea turtles respectively.

USWEX

The training events and impacts on marine mammals from USWEX have been summarized in the USWEX Programmatic EA/OEA (U.S. Department of the Navy, 2007b). The No-action Alternative modeling assumes there would be five USWEXs annually, including 525 hours of AN/SQS 53 and 175 hours of AN/SQS 56 surface ship sonar plus the associated dipping sonar and sonobuoys per year. The exposures for marine mammals during up to five USWEXs per year, are quantified without consideration of mitigation measures, and are presented in Table 4.1.2.5.7-2. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.5.2 for ESA listed species and 4.1.2.5.3 for non-ESA listed species. Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS) are included in the summary numbers in Table 4.1.2.5.7-2. Sections 4.1.2.2 and 4.1.2.3 discuss the potential effects on fish and sea turtles respectively.

Table 4.1.2.5.7-1. No-action Alternative Sonar Modeling Summary—Yearly Marine Mammal Exposures for RIMPAC (Conducted Every Other Year)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	19	0	0
Fin whale[1, 2]	14	0	0
Sei whale[1, 2]	14	0	0
Humpback whale[1]	0	0	-
Sperm whale[1]	245	3	0
Dwarf sperm whale	608	11	0
Pygmy sperm whale	248	4	0
Cuvier's beaked whale	347	2	0
Longman's beaked whale	32	0	0
Blainville's beaked whale	102	2	0
Unidentified beaked whale	11	0	0
Bottlenose dolphin	225	5	0
False killer whale	14	0	0
Killer whale	14	0	0
Pygmy killer whale	58	1	0
Short-finned pilot whale	547	12	0
Risso's dolphin	152	3	0
Melon-headed whale	182	4	0
Rough-toothed dolphin	311	6	0
Fraser's dolphin	361	6	0
Pantropical spotted dolphin	682	15	0
Spinner dolphin	122	2	0
Striped dolphin	994	23	0
Monk seal[1]	35	1	0
TOTAL	5,337	100	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 μPa^2-s; for monk seals TTS is 204-224 dB re 1 μPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 μPa^2-s; for monk seals PTS is >224 dB re 1 μPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

Table 4.1.2.5.7-2. No-action Alternative Sonar Modeling Summary - Yearly Marine Mammal Exposures from USWEX (5 per year)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	31	0	0
Fin whale[1, 2]	22	0	0
Sei whale[1, 2]	22	0	0
Humpback whale[1]	8,116	142	0
Sperm whale[1]	347	4	0
Dwarf sperm whale	1,002	14	0
Pygmy sperm whale	409	6	0
Cuvier's beaked whale	508	2	0
Longman's beaked whale	50	1	0
Blainville's beaked whale	169	2	0
Unidentified beaked whale	16	0	0
Bottlenose dolphin	339	7	0
False killer whale	22	0	0
Killer whale	22	0	0
Pygmy killer whale	93	2	0
Short-finned pilot whale	828	16	0
Risso's dolphin	230	4	0
Melon-headed whale	276	5	0
Rough-toothed dolphin	512	7	0
Fraser's dolphin	591	8	0
Pantropical spotted dolphin	1,003	20	0
Spinner dolphin	199	3	0
Striped dolphin	1,463	29	0
Monk seal[1]	40	1	0
TOTAL	16,310	273	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 µPa^2-s; for monk seals TTS is 204-224 dB re 1 µPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 µPa^2-s; for monk seals PTS is >224 dB re 1 µPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

4.1.2.6 MARINE MAMMALS ALTERNATIVE 1 (BIOLOGICAL RESOURCES—OPEN OCEAN)

The discussion under the No-action Alternative regarding potential non-acoustic impacts (Section 4.1.2.5.1) and potential ASW Impacts (Section 4.1.2.5.2) also apply for Alternative 1.

4.1.2.6.1 Alternative 1 Summary of Exposures

The increased training and RDT&E activities under Alternative 1 result in an increase in the number of hours of ASW training. The modeling input includes a total of 1,788 hours of AN/SQS 53 and 551 hours of AN/SQS 56 MFA tactical sonar plus the associated DICASS sonobuoy, MK-48 torpedo HFA sonar, and dipping sonar modeling inputs (see Appendix J for a detailed description of the sonar modeled). These exposure numbers are generated by the model without consideration of mitigation measures that would reduce the potential for marine mammal exposures to sonar. Table 4.1.2.6.1-1 provides a summary of the total sonar exposures from all Alternative 1 ASW Exercises that would be conducted over the course of a year. The number of exposures from each type of exercise are presented separately in Sections 4.1.2.6.5, 4.1.2.6.6, 4.1.2.6.7, and 4.1.2.6.8.

The explosive modeling input includes Mine Neutralization, MISSILEX, BOMBEX, SINKEX, EER/IEER, GUNEX, and NSFS. Estimates for the sub-TTS behavioral threshold indicate there may be 62 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. The modeled explosive exposure harassment numbers by species are presented in Table 4.1.2.6.1-2. The table indicates the potential for non-injurious (Level B) harassment, as well as the onset of injury (Level A) harassment to cetaceans. The modeling indicates 73 annual exposures to pressure from underwater detonations that could result in TTS. The modeling indicates three exposures (an annual total) from pressure or acoustics from underwater detonations that could cause slight injury. These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation and monitoring procedures. The implementation of the mitigation and monitoring procedures presented in Chapter 6.0 will minimize the potential for marine mammal exposure and harassment through range clearance procedures.

Table 4.1.2.6.1-1. Alternative 1 Sonar Modeling Summary—Yearly Marine Mammal Exposures from All ASW (RIMPAC, USWEX, and Other ASW Training)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	89	0	0
Fin whale[1, 2]	66	2	0
Sei whale[1, 2]	66	2	0
Humpback whale[1]	9,685	199	0
Sperm whale[1]	1,067	12	0
Dwarf sperm whale	2,827	48	0
Pygmy sperm whale	1,155	20	0
Cuvier's beaked whale	1,559	7	0
Longman's beaked whale	145	2	0
Blainville's beaked whale	478	9	0
Unidentified beaked whale	50	0	0
Bottlenose dolphin	994	24	0
False killer whale	66	2	0
Killer whale	66	2	0
Pygmy killer whale	266	6	0
Short-finned pilot whale	2,430	56	0
Risso's dolphin	675	15	0
Melon-headed whale	811	18	0
Rough-toothed dolphin	1,445	25	0
Fraser's dolphin	1,674	28	0
Pantropical spotted dolphin	2,988	69	0
Spinner dolphin	561	9	0
Striped dolphin	4,361	101	0
Monk seal[1]	147	4	0
TOTAL	33,671	660	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 µPa^2-s; for monk seals TTS is 204-224 dB re 1 µPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 µPa^2-s; for monk seals PTS is >224 dB re 1 µPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

Table 4.1.2.6.1-2. Alternative 1 Explosives Modeling Summary—Yearly Marine Mammal Exposures from All Explosive Sources

Marine Mammal Species	Sub-TTS	TTS Modeled at < 182 dB re 1 μPa²–s or 23 psi								Total Exposures		
	Sub-TTS 177 dB	EER/IEER	Mine Neutralization	Air to Surface Missile Exercise	Surface to Surface Missile Exercise	Bombing Exercise	Sinking Exercise	Surface to surface Gunnery Exercise	Naval Surface Fire Support	TTS 182 dB, 23 psi	Slight Lung/ TM Injury	Onset Massive Lung Injury
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale[1, 2]	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale[1]	5	5	1	0	0	3	0	0	0	9	1	0
Sperm whale[1]	9	1	0	0	0	1	3	0	0	5	0	0
Dwarf sperm whale	13	5	0	0	0	2	4	1	1	13	0	0
Pygmy sperm whale	4	2	0	0	0	1	2	0	0	5	0	0
Cuvier's beaked whale	15	1	0	0	0	2	5	0	0	8	0	0
Longman's beaked whale	0	0	0	0	0	0	0	0	0	0	0	0
Blainville's beaked whale	2	1	0	0	0	0	1	0	0	2	0	0
Unidentified beaked whale	0	0	0	0	0	0	0	0	0	0	0	0
Bottlenose dolphin	0	1	0	0	0	0	0	0	0	1	0	0
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	2	2	0	0	0	0	1	0	0	3	0	0
Risso's dolphin	0	1	0	0	0	0	0	0	0	1	0	0
Melon-headed whale	0	1	0	0	0	0	0	0	0	1	0	0
Rough-toothed dolphin	2	2	0	0	0	1	1	0	0	4	0	0
Fraser's dolphin	6	3	0	0	0	1	2	0	0	6	0	0
Pantropical spotted dolphin	0	3	0	0	0	0	0	0	0	3	1	0
Spinner dolphin	2	1	0	0	0	0	1	0	0	2	0	0
Striped dolphin	2	4	0	0	0	1	1	1	1	8	1	0
Monk seal[1]	0	2	0	0	0	0	0	0	0	2	0	0
Total	62	35	1	0	0	12	21	2	2	73	3	0

Note:
[1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
dB = decibel
μPa²-s = squared micropascal-second
TM = tympanic membrane
TTS = temporary threshold shift

4.1.2.6.2 Estimated Effects on ESA Listed Species—Alternative 1

The endangered species that may be affected as a result of implementation of Alternative 1 include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), Hawaiian monk seal (*Monachus schauinslandi*), humpback whale (*Megaptera novaeangliae*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*).

For Alternative 1, modeling results predict that if there were no mitigation measures in place, exposures that that are temporary, non-injurious physiological effects (TTS) or behavioral effects would occur. The modeling predicts one humpback whale exposure to energy in excess of the criteria for slight lung injury. The criteria for lung injury are extremely conservative with regard to humpback whales given that the established threshold, which corresponds to body mass in a complex manner, was based on a calf dolphin (at 26.9 lb) as compared to the approximate 4,000 lb mass of a newborn humpback whale. Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 53 ft) of individual humpback whales (Leatherwood et al., 1982), and pronounced vertical blow, it is very likely that lookouts would detect humpback whales at the surface during training events and preclude this exposure from occurring.

The following sections discuss the exposure of ESA listed species to sonar and underwater detonations from all Alternative 1 exercises per year. The exposure numbers are given without consideration of mitigation measures. However, mitigation measures that are implemented during the ASW and underwater detonation Exercises would reduce the potential for marine mammal exposures.

Blue Whale (*Balaenoptera musculus*)

There is no density information available for blue whales in Hawaiian waters given they have not been seen during survey. Given they are so few in number, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any blue whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No blue whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of blue whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury, effects on their behavior or physiology, or abandonment of areas that are regularly used by blue whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 1 that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect blue whales.

Fin Whale (*Balaenoptera physalus*)

There is no density information for fin whales in the Hawaiian Islands (Barlow, 2006). For purposes of acoustic effects analysis, it was assumed that the number and density of fin whales did not exceed that of false killer whales and the modeled number of exposures for both species will therefore be the same. The risk function and Navy post-modeling analysis estimates 66 fin whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect, but is not likely to adversely affect, fin whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.6.1-1).

Modeling also indicates that there would be two exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates no exposures for fin whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s. No fin whales would be exposed to impulsive sound or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or cause physical injury (Table 4.1.2.6.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of Navy's MFA sonar operations, behavioral patterns and acoustic abilities of fin whales, observations made during HRC training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events will likely not result in any population level effects, death or injury to fin whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 1, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect fin whales.

Humpback Whale (*Megaptera novaeangliae*)

The acoustic effects analysis for Alternative 1 based the risk function and Navy post-modeling analysis estimates 9,685 humpback whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect humpback whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.6.1-1).

Modeling also indicates there would be 199 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates no exposures for humpback whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be five exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of clearance procedures, modeling indicates there would be nine exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, one exposure that would exceed the injury threshold, and no exposures that would exceed the massive injury threshold (Table 4.1.2.6.1-2). Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no humpback whales within the safety zone, and therefore potential exposure of humpback whales to sound levels from underwater detonations that exceed TTS or injury levels is highly unlikely. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

As noted previously, filter-bank models of the humpback whale's ear by Houser et al., (2001) suggest that humpbacks are sensitive to frequencies between 700 Hz and 10 kHz, and have a maximum sensitivity is between 2 kHz and 6 kHz. Recent reporting by Au et al., (2006) indicating high-frequency harmonics in humpback whale "song" at 24 kHz and beyond does not demonstrate that humpbacks can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental. Most social vocalizations, including female vocalizations, are below 3 kHz (Silber, 1986); therefore, are below MFA sonar range. Male songs range from 20 Hz to 24 kHz, but most of the components range from 200 Hz to 3 kHz (Au et al., 2001). A single study suggested that humpback whales responded to MFA sonar (3.1-3.6 kHz re 1 μPa^2-s) sound (Maybaum, 1989). The hand-held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e., the humpback whale responded to the low-frequency artifact rather than the MFA sonar sound).

While acoustic modeling results indicate MFA/HFA sonar may expose humpback whales to accumulated acoustic energy levels resulting in temporary behavioral effects, these exposures would have negligible impact on annual survival, recruitment, and birth rates and not likely result in population level effects. The aggregation of humpback whales in Hawaii has been increasing at up to 7 percent annually (Mobley, 2004) despite frequent encounters with tour boats. There have been no observed or reported mother calf separations as a result of Navy activities. There have been no reported or identified humpback whale strandings in Hawaii associated with the use of MFA/HFA sonar. While the absence of evidence does not prove there have been no impacts on humpback whales, decades of history with no evidence should not be dismissed. Mitigation measures presented in Chapter 6.0 would further reduce the potential acoustic exposure.

Per Navy policy, based on the quantitative analysis results that trigger a "may affect" determination, Navy has initiated Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect humpback whales.

North Pacific Right Whale (*Eubalaena japonica*)

There is no density information available for North Pacific right whales in Hawaiian waters given they have not been seen during survey. Given they are so few in number, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any right whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No right whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of North Pacific right whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would likely not result in any population level effects, death or injury to North Pacific right whales, and will not affect their behavior, physiology or cause abandonment of areas that are regularly used by North Pacific right whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 1, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect North Pacific right whales.

Sei Whale (*Balaenoptera borealis*)

For purposes of the acoustic effects analysis, the same assumptions made previously regarding fin whales are also made for sei whales. It was therefore assumed that the number and density of sei whales did not exceed that of false killer whales, and the modeled number of exposures for both species would therefore be the same. The risk function and Navy post-modeling analysis estimates 66 sei whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect, but is not likely to adversely affect, sei whales; therefore, the Navy has initiated Section 7 consultation with NMFS (Table 4.1.2.6.1-1).

Modeling also predicts two exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling predicts no exposures for sei whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s. No sei whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury (Table 4.1.2.6.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of sei whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not likely result in any population level effects, death or injury to sei whales. The proposed ASW Exercises may affect sei whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sei whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 1, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect sei whales.

Sperm Whales (*Physeter macrocephalus*)

The risk function and Navy post-modeling analysis estimates 1,067 sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect, but is not likely to adversely affect, sperm whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.6.1-1).

Modeling also predicts 12 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling predicts no exposures for sperm whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be nine exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of clearance procedures, modeling indicates there would be five exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold (Table 4.1.2.6.1-2). Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no sperm whales within the safety zone, and therefore potential exposure of sperm whales to sound levels that exceed TTS is highly unlikely. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar training, behavioral patterns and acoustic abilities of sperm whales, observations made during past training events, and the planned implementation of procedure mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to sperm whales. The proposed ASW Exercises may affect sperm whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sperm whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 1, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect sperm whales.

Hawaiian Monk Seal (*Monachus schauinslandi*)

The risk function and Navy post-modeling analysis estimates 147 Hawaiian monk seals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect, but is not likely to adversely affect, Hawaiian monk seals; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.6.1-1).

Modeling also predicts four exposures to accumulated acoustic energy between 204 dB and 224 dB re 1 μPa^2-s (the Hawaiian monk seal thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling predicts there would be no exposures for monk seals to accumulated acoustic energy above 224 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS for Hawaiian monk seals.

Modeling undertaken for monk seals does not take into consideration the effect of mitigation measures or foraging habitat preferences. Monk seals generally forage at depths of less than 100 m, but occasionally dive to depths of over 500 m. The majority of ASW training in the HRC, however, takes place in waters 4 to 8 times deeper than even this known (500 m) maximum and it is very rare for ASW training to take place in waters as shallow as 100 m in depth. Additionally, mitigation measures call for continuous visual observation during training with active sonar. It would, therefore, be rare for a Hawaiian monk seal to be present in the vicinity of an ASW event and the potential for detection by aircraft and lookouts aboard ship would further preclude the possibility that monk seals would be in the vicinity of ASW training events.

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of clearance procedures, modeling indicates there would be two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and no exposures that would exceed the injury threshold (Table 4.1.2.6.1-2). In the rare event that a monk seal was present, target area clearance procedures described in Section 4.1.2.5.1 would be used to detect monk seals within the safety zone, and therefore potential exposure of monk seals to exposures that exceed TTS is highly unlikely. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Critical habitat was designated 1986 as the area extending out to the 10-fathom depth (60 ft) for the Northwestern Hawaiian Islands (National Marine Fisheries Service, 1986). Critical habitat was extended out to the 20-fathom depth in 1988 (National Marine Fisheries Service, 1988). ASW events should not occur inside the 20-fathom isobath and given mitigation measures and range clearance procedures, activities in the HRC will not have an effect on Monk Seal Critical Habitat.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of monk seals, observations made during past training events, and the planned implementation of procedure mitigation measures, the Navy finds that the training events would not likely result in any death or injury to Hawaiian monk seals. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 1, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect Hawaiian monk seals.

4.1.2.6.3 Estimated Exposures for Non-ESA Species—Alternative 1

Bryde's Whale (*Balaenoptera edeni*)

The risk function and Navy post-modeling analysis estimates 89 Bryde's whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1). Modeling indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Modeling for all alternatives indicates that no Bryde's whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No Bryde's whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.6.1-2).

Given the large size (up to 46 ft) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow, 2003; 2006), it is very likely that lookouts would detect a group of Bryde's whales at the surface. Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, Bryde's whales that are present in the vicinity of ASW training events may be detected by visual observers. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 89 exposures of Bryde's whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Bryde's whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Bryde's whales.

Minke Whale (*Balaenoptera acutorostrata*)

Despite several reports of seasonal acoustic detections of minke whales in Hawaiian waters (e.g. Rankin and Barlow, 2005), there is no density information available for minke whales in Hawaiian waters given they have rarely been visually sighted during surveys. Taken conservatively, the acoustic detections suggest that minke whales may be more common than the survey data indicates. Therefore, although acoustic effects modeling cannot be undertaken without density estimates, the Navy will assume 89 minke whales may exhibit behavioral responses that NMFS would classify as harassment under the MMPA. This exposure number is based on the modeled exposures for the Bryde's whale, another seasonal baleen whale, that has a reported abundance of 469 whales in the HRC (Barlow 2006). Based upon the Navy's protective measures, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any minke whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No minke whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or cause physical injury. No minke whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury.

Given the large size (up to 27 ft) of individual minke whales (Barlow, 2003), it is possible that lookouts may detect a minke whales at the surface although a systematic survey in the Hawaiian Islands failed to visually detect minke whales but were able to detect using acoustic methods (Barlow, 2006). Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, minke whales that are present in the vicinity of ASW training events would be detected by visual observers. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, behavioral patterns, acoustic abilities of minke whales, results of past training, and the implementation of procedure mitigation measures, the Navy finds that the

HRC training events would not result in any population level effects, death or injury to minke whales.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

The risk function and Navy post-modeling analysis estimates 478 Blainville's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates nine exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Blainville's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be two exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause physical injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting Blainville's beaked whales at the surface, these two exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given the size (up to 15.5 ft) of individual Blainville's beaked whales, it is possible that lookouts may detect Blainville's beaked whales at the surface although beaked whales dive for long periods. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 491 exposures of Blainville's beaked whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Blainville's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Blainville's beaked whales.

Bottlenose Dolphin (*Tursiops truncatus*)

The risk function and Navy post-modeling analysis estimates 994 bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 24 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no bottlenose dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. Modeling indicates that one bottlenose dolphin would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold and no exposures to impulsive noise or pressures from underwater detonations that would cause physical injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the frequent surfacing, aggregation of approximately nine animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would detect a group of bottlenose dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,019 exposures of bottlenose dolphins to potential Level B harassment annually. Based on the model results, the nature of the Navy's MFA sonar, behavioral patterns and acoustic abilities of bottlenose dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to bottlenose dolphins.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The risk function and Navy post-modeling analysis estimates 1,559 Cuvier's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates seven exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Cuvier's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be 15 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would eight exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting Cuvier's beaked whales at the surface, these exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given the medium size (up to 23 ft) of individual Cuvier's beaked whales (Barlow, 2006), it is possible that lookouts may detect Cuvier's beaked whales at the surface during ASW training events although beaked whales dive for long periods (Baird et al., 2006b). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,,589 exposures of Cuvier's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Cuvier's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Cuvier's beaked whales.

Dwarf Sperm Whale (*Kogia sima*)

The risk function and Navy post-modeling analysis estimates 2,827 dwarf sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 48 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no dwarf sperm whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be 13 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates 13 exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting pygmy sperm whales at the surface, these 13 exposures should be precluded from occurring. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 2,901 exposures of dwarf sperm whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of dwarf sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the

HRC training events would not result in any population level effects, death or injury to dwarf sperm whales.

False Killer Whale (*Pseudorca crassidens*)

The risk function and Navy post-modeling analysis estimates 66 false killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates two exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no false killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No false killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 19.7 ft) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of false killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 68 exposures of false killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of false killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to false killer whales.

Fraser's Dolphin (*Lagenodelphis hosei*)

The risk function and Navy post-modeling analysis estimates 1,674 Fraser's dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 28 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Fraser's dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be six exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be six exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting Fraiser's dolphins at the surface, these six exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their large aggregations, mean group size of 286.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is very likely that lookouts would detect a group of Fraser's dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,714 exposures of Fraser's dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Fraser's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Fraser's dolphins.

Killer Whale (*Orcinus orca*)

The risk function and Navy post-modeling analysis estimates 66 killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates two exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s, which is the threshold indicative of onset PTS. No killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 23 ft), conspicuous coloring, pronounced dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90; Barlow, 2003), is very likely that lookouts would detect a group of killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 68 exposures of killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to killer whales.

Longman's Beaked Whale (*Indopacetus pacificus*)

The risk function and Navy post-modeling analysis estimates 145 Longman's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates two exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Longman's beaked whale would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No Longman's beaked whale would be exposed to impulsive noise or pressures from underwater detonations will exceed the sub-TTS behavioral disturbance threshold or that would cause physical injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar; Given the medium size (up to 24 ft) of individual Longman's beaked whale, aggregation of approximately 17.8 animals (Barlow, 2006), it is likely that lookouts would detect a group of Longman's beaked whale at the surface during ASW training events although beaked whales dive for long periods. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 147 exposures of Longman's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Longman's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Longman's beaked whales.

Melon-headed Whale (*Peponocephala electra*)

The risk function and Navy post-modeling analysis estimates 811 melon-headed whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 18 exposures to accumulated acoustic energy. Modeling for Alternative 1 indicates that no melon-headed whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No melon-headed whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold. One melon-headed whale may be exposed to impulsive noise or pressures from underwater detonations that would cause TTS (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar; Given their size (up to 8.2 ft) and large group size (mean of 89.2 whales) or more animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would very likely detect a group of melon-headed whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 830 exposures of melon-headed whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of melon-headed whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to melon-headed whales.

Pantropical Spotted Dolphin (*Stenella attenuata*)

The risk function and Navy post-modeling analysis estimates 2,988 pantropical spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 69 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no pantropical spotted dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s, which is the threshold indicative of onset PTS.

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates three exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, one exposure to impulsive noise or pressures from underwater detonations that would cause slight physical injury, and none that would cause massive lung injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting pantropical spotted dolphins at the surface, these three exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations Given their frequent surfacing and large group size hundreds of animals (Leatherwood et al., 1982), mean group size of 60.0 animals in Hawaii and probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow, 2006), it is very likely that lookouts would detect a group of pantropical spotted dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 3,060 exposures of pantropical spotted dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pantropical spotted dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pantropical spotted dolphins.

Pygmy Killer Whale (*Feresa attenuata*)

The risk function and Navy post-modeling analysis estimates 266 pygmy killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates six exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no pygmy killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s, which is the threshold indicative of onset PTS. No pygmy killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.5 ft) and mean group size of 14.4 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2003), it is likely that lookouts would detect a group of pygmy killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 272 exposures of pygmy killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pygmy killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pygmy killer whales.

Pygmy Sperm Whale (*Kogia breviceps*)

The risk function and Navy post-modeling analysis estimates 1,155 pygmy sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 20 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no pygmy sperm whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 µPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be four exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates five exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the possibility of detecting pygmy sperm whales at the surface, these exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their size (up to 10 ft) and behavior of resting at the surface (Leatherwood et al., 1982), it is very possible that lookouts would detect a pygmy sperm whale at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,184 exposures of pygmy sperm whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy’s MFA sonar operations, behavioral patterns and acoustic abilities of pygmy sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pygmy sperm whales.

Risso’s Dolphin (*Grampus griseus*)

The risk function and Navy post-modeling analysis estimates 675 Risso’s dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 15 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no Risso’s dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. One Risso’s dolphin would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold and none would be exposed to levels that would cause physical injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing, light coloration, and large group size of up to several hundred animals (Leatherwood et al., 1982), mean group size of 15.4 dolphins in Hawaii and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow, 2006), it is very likely that lookouts would detect a group of Risso’s dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 691 exposures of Risso's dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Risso's dolphin, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Risso's dolphins.

Rough-Toothed Dolphin (*Steno bredanensis*)

The risk function and Navy post-modeling analysis estimates 1,445 rough-toothed dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 25 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no rough-toothed dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be four exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.6.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting rough-toothed dolphins at the surface, these four exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 14.8 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of rough-toothed dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,476 exposures of rough-toothed dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of rough-toothed dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to rough-toothed dolphins.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The risk function and Navy post-modeling analysis estimates 2,430 short-finned pilot whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 56 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no short-finned pilot whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be three exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 20 ft), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006). It is very likely that lookouts would detect a group of short-finned pilot whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 2,491 exposures of short-finned pilot whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of short-finned pilot whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to short-finned pilot whales.

Spinner Dolphin (*Stenella longirostris*)

The risk function and Navy post-modeling analysis estimates 561 spinner dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates nine exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates that no spinner dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be two exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury massive lung injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their frequent surfacing, aerobatics, and large mean group size of 31.7 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of spinner dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 574 exposures of spinner dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of spinner dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to spinner dolphins.

Striped Dolphin (*Stenella coeruleoalba*)

The risk function and Navy post-modeling analysis estimates 4,361 striped dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates 101 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 1 indicates no exposures to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates eight exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, one exposure to impulsive noise or pressures from underwater detonations that would cause slight physical injury, and none that would cause massive lung injury (Table 4.1.2.6.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of striped dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 4,472 exposures of striped dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of striped dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to striped dolphins.

Unidentified Beaked Whales

The risk function and Navy post-modeling analysis estimates 50 unidentified beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.6.1-1).

Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No unidentified beaked whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.6.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 50 exposures of unidentified beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of unidentified beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to unidentified beaked whales.

4.1.2.6.4 Summary of Compliance with MMPA and ESA—Alternative 1

Endangered Species Act

Based on analytical modeling results, five endangered marine mammal species occurring within the Hawaii OPAREA may be exposed to acoustic energy that could result in TTS or behavioral modification, including the fin whale, humpback whale, sei whale, sperm whale, and Hawaiian monk seal. Modeling indicates no PTS exposures. Based on the analysis presented in the previous section and in accordance with ESA requirements, the Navy would undertake Section

7 consultation with NMFS based on the determination for Alternative 1, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect blue whales, fin whale, humpback whales, North Pacific right whales, sei whales, sperm whales, and Hawaiian monk seals.

Mitigation measures would be implemented to prevent exposure of marine mammals to impulsive sound or sound pressures from underwater detonations that would cause injury.

Five species of sea turtles could potentially occur within the HRC. All are protected under the ESA. All available acoustic information suggests that sea turtles are likely not capable of hearing mid-frequency or high-frequency sounds in the range produced by the sound sources analyzed. Mitigation measures would be implemented to prevent exposure of sea turtles to impulsive sound or sound pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause injury.

Marine Mammal Protection Act

Level A Harassment of Cetaceans

Modeling results for the sum of exposures for all ASW Exercises for a year indicate no exposures that exceeds the Level A harassment threshold. Modeling for explosives indicates three potential exposures that may result in slight injury, however, the following considerations reduce the potential for injury from tactical sonar and underwater explosions:

- Level A zone of influence radii are small that observers would readily observe an approaching marine mammal.
- Many species are large and/or travel in large pods and are easily visible from an elevated platform; a ship or aircraft would readily see a marine mammal in time to implement mitigation measures.

Level B Harassment of Cetaceans

As shown in Table 4.1.2.6.1-1, quantitative modeling results indicate potential for exposures at thresholds that equate to Level B harassment of cetaceans (TTS and behavioral). Based on an estimate for minke whales and the risk function including post-modeling analysis, the Navy estimates 33,760 marine mammals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. Modeling for Alternative 1 indicates 660 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Estimates for the sub-TTS behavioral threshold indicate there may be 62 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Estimates for underwater detonations indicate there may be 73 TTS exposures. Modeling indicates no exposures to accumulated acoustic energy above 215 dB re 1 μPa^2-s.

Therefore, it is estimated that in total, 34,555 marine mammals will exhibit behavioral responses NMFS will classify as Level B harassment. This includes 660 TTS and 33,760 risk function exposures (33,671 plus an estimated 89 minke whales) as a result of MFA/HFA sonar use

(34,420 exposures) in addition to 135 exposures (62 sub-TTS exposures and 73 TTS exposures) as a result of underwater detonations (for explosives see Table 4.1.2.6.1-2). Should the Navy decide to implement Alternative 1, the effects on marine mammals will need to be considered by NMFS for purposes of MMPA authorization and ESA consultation.

Mitigation measures will be in place to further minimize the potential for temporary harassment, although there is currently no data to quantify the mitigation efforts to successfully reduce the number of marine mammal exposures. The Navy has begun development of a comprehensive Monitoring Plan to determine the effectiveness of these measures. Many species of small cetaceans travel in very large pods, and therefore would be easily observed from an elevated platform. In addition, large baleen whales travel slowly and are easily observed on the surface. In the years of conducting Major Exercises in the HRC, there have been no documented incidences of harassments or beach strandings of marine mammals associated with active sonar or underwater explosives. In the one event associated with RIMPAC 2004, sonar was suggested to be a plausible contributing factor (Southall et al., 2006) although a similar event occurred on the same day in a bay at Rota Island, Northern Marianas Islands with no associated sonar (Jefferson et al., 2006) and may be related to oceanographic changes that influenced prey distribution (Southall 2006; Ketten, 2006). The HRC Open Ocean waters continue to support diverse and stable populations of cetaceans.

4.1.2.6.5 Increased Tempo and Frequency of Training—Alternative 1

The HRC training for Alternative 1 involving sonar includes ASW training activities as described in Table 2.2.2.3-1 and Appendix D. The number of hours of sonar modeled for Alternative 1 included 360 hours of AN/SQS-53 and 75 hours of AN/SQS-56 surface ship sonar, plus the associated sonobuoys, MK-48 HFA sonar, and submarine sonar use on an annual basis. Modeled exposures for marine mammals during other HRC ASW training, without consideration of mitigation measures are presented in Table 4.1.2.6.5-1. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.6.2 for ESA listed species and 4.1.2.6.3 for non-ESA listed species. Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS) are included in the summary numbers in Table 4.1.2.6.1-2.

4.1.2.6.6 Enhanced and Future RDT&E Activities—Alternative 1

There are no new or future RDT&E activities that would affect marine animals. Sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean are generally transmitting above the frequency range or below the intensity level to affect marine animals. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and are generally of short durations (<1.5 hours). These activities would have minimal effects on fish, sea turtles, and marine mammals.

4.1.2.6.7 HRC Enhancements—Alternative 1

There are no new HRC enhancements that would affect marine animals. Other sources such as the Portable Undersea Tracking Range, underwater communications, and electronic warfare systems that may be deployed in the ocean are beyond the frequency range or intensity level to affect marine animals. The Navy would develop appropriate habitat data and any necessary Best Management Practices and mitigations in coordination with NMFS and USFWS. The Navy will continue to work with regulatory agencies throughout the planning and development process to minimize the potential for impacts on marine mammals.

Table 4.1.2.6.5-1. Alternative 1 Sonar Modeling Summary—Yearly Marine Mammal Exposures from Other HRC ASW Training

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	14	0	0
Fin whale[1, 2]	10	0	0
Sei whale[1, 2]	10	0	0
Humpback whale[1]	1,569	57	-
Sperm whale[1]	167	2	0
Dwarf sperm whale	454	10	0
Pygmy sperm whale	186	4	0
Cuvier's beaked whale	267	1	0
Longman's beaked whale	23	0	0
Blainville's beaked whale	77	2	0
Unidentified beaked whale	9	0	0
Bottlenose dolphin	153	5	0
False killer whale	10	0	0
Killer whale	10	0	0
Pygmy killer whale	41	1	0
Short-finned pilot whale	377	12	0
Risso's dolphin	105	3	0
Melon-headed whale	126	4	0
Rough-toothed dolphin	232	5	0
Fraser's dolphin	266	5	0
Pantropical spotted dolphin	461	14	0
Spinner dolphin	90	2	0
Striped dolphin	672	21	0
Monk seal[1]	30	1	0
TOTAL	5,359	149	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 μPa^2-s; for monk seals TTS is 204-224 dB re 1 μPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 μPa^2-s; for monk seals PTS is >224 dB re 1 μPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

4.1.2.6.8 Major Exercises—Alternative 1

RIMPAC

The training events and impacts on marine mammals from RIMPAC Exercises have been summarized in the RIMPAC 2006 Supplement to the 2002 RIMPAC EA (U.S. Department of the Navy, Commander Third Fleet, 2006). The Alternative 1 RIMPAC differs from the assessment in the EA by assuming there could be two Carrier Strike Groups (CSG) instead of a single CSG. An Alternative 1 RIMPAC, therefore, would include 1,064 hours of 53C surface ship sonar plus associated dipping sonar, sonobuoys, and MK-48 torpedoes per RIMPAC (conducted every other year). The modeled exposures for marine mammals during RIMPAC, without consideration of mitigation measures are presented in Table 4.1.2.6.8-1. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.6.2 for ESA listed species and 4.1.2.6.3 for non-ESA listed species. Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS are included in the summary numbers in Table 4.1.2.6.1-2. Sections 4.1.2.2 and 4.1.2.3 discuss the potential effects on fish and sea turtles, respectively.

USWEX

The training events and impacts on marine mammals from USWEX have been summarized in the USWEX Programmatic EA/OEA (U.S. Department of the Navy, 2007b). The number of hours of sonar modeled for Alternative 1 for USWEX is calculated based on there being six USWEXs annually; an increase of one USWEX from the No-action Alternative. Six USWEX would total 630 hours of AN/SQS 53 and 210 hours of AN/SQS 56 surface ship sonar, plus the associated sonobuoys, dipping sonar, MK-48 HFA sonar, and submarine sonar use on an annual basis. The modeled exposures for marine mammals during up to six USWEXs per year, without consideration of mitigation measures are presented in Table 4.1.2.6.8-2. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.6.2 for ESA listed species and 4.1.2.6.3 for non-ESA listed species. Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS are included in the summary numbers in Table 4.1.2.6.1-2. Sections 4.1.2.2 and 4.1.2.3 discuss the potential effects on fish and sea turtles respectively.

Table 4.1.2.6.8-1. Alternative 1 Sonar Modeling Summary—Yearly Marine Mammal Exposures for RIMPAC with 2 Strike Groups (Conducted Every Other Year)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	39	0	0
Fin whale[1, 2]	29	1	0
Sei whale[1, 2]	29	1	0
Humpback whale[1]	0	0	-
Sperm whale[1]	486	6	0
Dwarf sperm whale	1,208	21	0
Pygmy sperm whale	493	9	0
Cuvier's beaked whale	690	3	0
Longman's beaked whale	63	1	0
Blainville's beaked whale	204	4	0
Unidentified beaked whale	22	0	0
Bottlenose dolphin	442	11	0
False killer whale	29	1	0
Killer whale	29	1	0
Pygmy killer whale	116	3	0
Short-finned pilot whale	1,079	25	0
Risso's dolphin	300	7	0
Melon-headed whale	360	8	0
Rough-toothed dolphin	618	11	0
Fraser's dolphin	719	13	0
Pantropical spotted dolphin	1,341	31	0
Spinner dolphin	240	4	0
Striped dolphin	1,957	45	0
Monk seal[1]	70	2	0
TOTAL	10,563	208	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 μPa^2-s; for monk seals TTS is 204-224 dB re 1 μPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 μPa^2-s; for monk seals PTS is >224 dB re 1 μPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

Table 4.1.2.6.8-2. Alternative 1 Sonar Modeling Summary—Yearly Marine Mammal Exposures from USWEX (6 per year)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	36	0	0
Fin whale[1, 2]	27	1	0
Sei whale[1, 2]	27	1	0
Humpback whale[1]	8,116	142	0
Sperm whale[1]	414	4	0
Dwarf sperm whale	1,165	17	0
Pygmy sperm whale	476	7	0
Cuvier's beaked whale	602	3	0
Longman's beaked whale	59	1	0
Blainville's beaked whale	197	3	0
Unidentified beaked whale	19	0	0
Bottlenose dolphin	399	8	0
False killer whale	27	1	0
Killer whale	27	1	0
Pygmy killer whale	109	2	0
Short-finned pilot whale	974	19	0
Risso's dolphin	270	5	0
Melon-headed whale	325	6	0
Rough-toothed dolphin	595	9	0
Fraser's dolphin	689	10	0
Pantropical spotted dolphin	1,186	24	0
Spinner dolphin	231	3	0
Striped dolphin	1,732	35	0
Monk seal[1]	47	1	0
TOTAL	17,749	303	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 μPa^2-s; for monk seals TTS is 204-224 dB re 1 μPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 μPa^2-s; for monk seals PTS is >224 dB re 1 μPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

4.1.2.7 MARINE MAMMALS ALTERNATIVE 2 (BIOLOGICAL RESOURCES—OPEN OCEAN)

The discussion under the No-action Alternative regarding potential non-acoustic impacts (Section 4.1.2.5.1) and potential ASW Impacts (Section 4.1.2.5.2) also apply for Alternative 2.

4.1.2.7.1 Alternative 2 Summary of Exposures

The increased training under Alternative 2 results in an increase in the number of hours of ASW training. The modeling input includes a total of 2,496 hours of AN/SQS 53 and 787 hours of AN/SQS 56 surface ship sonar plus associated sonobuoys, dipping sonar, MK-48 HFA sonar, and submarine sonar use as modeling inputs (see Appendix J for a detailed description of the sonar modeled). These exposure numbers are generated by the model without consideration of mitigation measures that would reduce the potential for marine mammal exposures to sonar. Table 4.1.2.7.1-1 provides a summary of the total sonar exposures from all Alternative 2 ASW Exercises that would be conducted over the course of a year. The number of exposures from each type of exercise are presented separately in Sections 4.1.2.7.5, 4.1.2.7.6, 4.1.2.7.7, and 4.1.2.7.8.

The explosive modeling input includes Mine Neutralization, MISSILEX, BOMBEX, SINKEX, EER/IEER, GUNEX, and NSFS. The modeled explosive exposure harassment numbers by species are presented in Table 4.1.2.7.1-2. Estimates for the sub-TTS behavioral threshold indicate there may be 63 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, the table indicates the potential for non-injurious (Level B) harassment, as well as the onset of injury (Level A) harassment to cetaceans. The modeling indicates 80 annual exposures to pressure or acoustics from underwater detonations that could result in TTS. Modeling indicates three exposures from underwater detonations that could cause slight injury. To reiterate, these exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation and monitoring procedures. Implementation of the mitigation and monitoring procedures presented in Chapter 6.0 will minimize the potential for marine mammal exposure and harassment through range clearance procedures.

Table 4.1.2.7.1-1. Alternative 2 Sonar Modeling Summary - Yearly Marine Mammal Exposures from All ASW (RIMPAC, USWEX, Multiple Strike Group, and Other ASW Training)

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	135	0	0
Fin whale[1, 2]	99	3	0
Sei whale[1, 2]	99	3	0
Humpback whale[1]	12,583	329	0
Sperm whale[1]	1,535	16	0
Dwarf sperm whale	4,288	66	0
Pygmy sperm whale	1,751	27	0
Cuvier's beaked whale	2,273	10	0
Longman's beaked whale	217	3	0
Blainville's beaked whale	725	12	0
Unidentified beaked whale	73	0	0
Bottlenose dolphin	1,460	33	0
False killer whale	99	3	0
Killer whale	99	3	0
Pygmy killer whale	399	9	0
Short-finned pilot whale	3,580	77	0
Risso's dolphin	994	21	0
Melon-headed whale	1,194	25	0
Rough-toothed dolphin	2,194	34	0
Fraser's dolphin	2,536	40	0
Pantropical spotted dolphin	4,344	95	0
Spinner dolphin	853	13	0
Striped dolphin	6,341	139	0
Monk seal[1]	206	6	0
TOTAL	48,077	967	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 μPa^2-s; for monk seals TTS is 204-224 dB re 1 μPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 μPa^2-s; for monk seals PTS is >224 dB re 1 μPa^2-s (Kastak et al., 1999b; 2005)
Assumes 3 Strike Group Exercise in winter
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

Table 4.1.2.7.1-2. Alternative 2 Explosives Modeling Summary - Yearly Marine Mammal Exposures from All Explosive Sources

Marine Mammal Species	Sub-TTS	TTS Modeled at < 182 dB re 1 µPa²–s or 23 psi								Total Exposures		
	Sub-TTS 177 dB	EER/IEER	Mine Neutralization	Air to Surface Missile Exercise	Surface to Surface Missile Exercise	Bombing Exercise	Sink Exercise	Surface to surface Gunnery Exercise	Naval Surface Fire Support	TTS 182 dB, 23 psi	Slight Lung/TM Injury	Onset Massive Lung Injury
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale[1, 2]	0	0	0	0	0	0	0	0	0	0	0	0
Sei whale	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale[1]	5	5	1	0	0	4	0	0	2	12	1	0
Sperm whale[1]	9	1	0	0	0	1	3	0	0	5	0	0
Dwarf sperm whale	13	5	0	0	0	2	4	1	1	13	0	0
Pygmy sperm whale	4	2	0	0	0	1	2	0	0	5	0	0
Cuvier's beaked whale	16	1	0	0	0	2	5	0	0	8	0	0
Longman's beaked whale	0	0	0	0	0	0	0	0	0	0	0	0
Blainville's beaked whale	2	1	0	0	0	0	1	0	0	2	0	0
Unidentified beaked whale	0	0	0	0	0	0	0	0	0	0	0	0
Bottlenose dolphin	0	1	0	0	0	0	0	0	0	1	0	0
False killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Pygmy killer whale	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	2	2	0	0	0	0	1	1	1	5	0	0
Risso's dolphin	0	1	0	0	0	0	0	0	0	1	0	0
Melon-headed whale	0	1	0	0	0	0	0	0	0	1	0	0
Rough-toothed dolphin	2	2	0	0	0	1	1	0	0	4	0	0
Fraser's dolphin	6	3	0	0	0	1	2	0	0	6	0	0
Pantropical spotted dolphin	0	3	0	0	0	0	0	1	1	5	1	0
Spinner dolphin	2	1	0	0	0	0	1	0	0	2	0	0
Striped dolphin	2	4	0	0	0	1	1	1	1	7	1	0
Monk seal[1]	0	2	0	0	0	0	0	0	1	3	0	0
Total	63	35	1	0	0	13	21	4	7	80	3	0

Note:
[1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
dB = decibel
µPa²-s = squared micropascal-second
TM = tympanic membrane
TTS = temporary threshold shift

4.1.2.7.2 Estimated Effects on ESA Listed Species—Alternative 2

The endangered species that may be affected as a result of implementation of Alternative 2 include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), Hawaiian monk seal (*Monachus schauinslandi*) humpback whale (*Megaptera novaeangliae*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*).

For Alternative 2, modeling results presented in Table 4.1.2.7.1-1 predict that if there were no mitigation measures in place, exposures would result in temporary, non-injurious physiological effects (TTS) and behavioral harassment. The modeling predicts that as a result of summing all annual expected values resulting from the acoustic impact modeling, those fractional exposures mathematically round to one exposure of a humpback whale at slight injury threshold. Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no humpback whales within the safety zone. Potential exposure of humpback whales to levels that exceed thresholds for TTS or injury levels from underwater detonations is, therefore, highly unlikely. In addition, the established positive impulse criteria for lung injury are extremely conservative with regard to large whales in that the established lung injury threshold, which corresponds to body mass in a complex manner, was based on a calf dolphin (at 26.9 lb) as compared to the approximate 4,000 lb mass of a newborn humpback whale.

The HRC training involving sonar includes ASW training activities as described in Table 2.2.2.3-1 and Appendix D. The No-action Alternative modeling for these activities includes analysis of surface ship and submarine MFA sonar, associated sonobuoys, MK-48 torpedo HFA sonar, and dipping sonars for activities other than occurring during Major Exercises on an annual basis. The modeled exposures for marine mammals during this ASW training, without consideration of mitigation measures are presented in 4.1.2.5.5-1 for the No-action Alternative. Effects on marine mammals from these exposures are included in the discussion in Sections 4.1.2.7.2 for ESA listed species and 4.1.2.7.3 for non-ESA listed species.

Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS) are presented in the summary numbers in Table 4.1.2.7.1-2.

The following sections present details concerning the exposure of ESA listed species to sonar from all Alternative 2 ASW Exercises per year. The exposure numbers are given without consideration of mitigation measures. However, mitigation measures that are implemented during the ASW Exercises would reduce the potential for marine mammal exposures to sonar.

Blue Whale (*Balaenoptera musculus*)

There is no density information available for blue whales in Hawaiian waters given they have not been seen during survey. Given they are so few in number, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any blue whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No blue whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of blue whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury, effects on their behavior or physiology, or abandonment of areas that are regularly used by blue whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect blue whales.

Fin Whale (*Balaenoptera physalus*)

There is no density information for fin whales in the Hawaiian Islands (Barlow, 2006). As described previously, for purposes of acoustic effects analysis estimates, it was assumed that the number and density of fin whales did not exceed that of false killer whales (given similar abundance estimates), and the modeled number of exposures for both species would therefore be the same.

The risk function and Navy post-modeling analysis estimates 99 fin whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect fin whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.7.1-1).

Modeling also indicates there would be three exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates no exposures for fin whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No fin whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury (Table 4.1.2.7.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of Navy's MFA sonar operations, behavioral patterns and acoustic abilities of fin whales, observations made during HRC training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events will likely not result in any population level effects, death or injury to fin whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect fin whales.

Humpback Whale (*Megaptera novaeangliae*)

The risk function and Navy post-modeling analysis estimates 12,583 humpback whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table

4.1.2.7.1-1). The Navy believes this may affect but is not likely to adversely affect humpback whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS

Modeling also indicates there would be 329 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling indicates no exposures for humpback whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be five exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral disturbance threshold. Without consideration of clearance procedures during events involving underwater detonations, modeling estimates there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, one exposure that would exceed the slight injury threshold, and no exposures that exceed the massive injury threshold (Table 4.1.2.7.1-2). Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no humpback whales within the safety zone. Potential exposure of humpback whales to levels that exceed thresholds for TTS or injury levels from underwater detonations is, therefore, highly unlikely. In addition, the established positive impulse criteria for lung injury are extremely conservative with regard to large whales in that the established threshold, which corresponds to body mass in a complex manner, was based on a calf dolphin (at 26.9 lb) as compared to the approximate 4,000 lb mass of a newborn humpback whale. Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 53 ft) of individual humpback whales (Leatherwood et al., 1982), and pronounced vertical blow, it is very likely that lookouts would detect humpback whales at the surface during training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

As noted previously, filter-bank models of the humpback whale's ear by Houser et al., (2001) suggest that humpbacks are sensitive to frequencies between 700 Hz and 10 kHz, and have a maximum sensitivity is between 2 kHz and 6 kHz. Recent reporting by Au et al., (2006) indicating high-frequency harmonics in humpback whale "song" at 24 kHz and beyond does not demonstrate that humpbacks can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental. Most social vocalizations, including female vocalizations, are below 3 kHz (Silber, 1986); therefore, are below MFA sonar range. Male songs range from 20 Hz to 24 kHz, but most of the components range from 200 Hz to 3 kHz (Au et al., 2001). A single study suggested that humpback whales responded to MFA sonar (3.1-3.6 kHz re 1 μPa^2-s) sound (Maybaum, 1989). The hand-held sonar system had a sound artifact below 1,000 Hz which caused a response to the control playback (a blank tape) and may have affected the response to sonar (i.e., the humpback whale responded to the low-frequency artifact rather than the MFA sonar sound).

While acoustic modeling results indicate MFA/HFA sonar may expose humpback whales to accumulated acoustic energy levels resulting in temporary behavioral effects, these exposures would have negligible impact on annual survival, recruitment, and birth rates and not likely result in population level effects. The aggregation of humpback whales in Hawaii has been increasing at up to 7 percent annually (Mobley, 2004) despite frequent encounters with tour boats. There have been no observed or reported mother calf separations as a result of Navy activities. There have been no reported or identified humpback whale strandings in Hawaii associated with the use of MFA/HFA sonar. While the absence of evidence does not prove there have been no impacts on humpback whales, decades of history with no evidence should not be dismissed. Mitigation measures presented in Chapter 6.0 would further reduce the potential acoustic exposure.

Per Navy policy, based on the quantitative analysis results that trigger a “may affect” determination, Navy has initiated Section 7 consultation with NMFS based on the determination that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect humpback whales.

North Pacific Right Whale (*Eubalaena japonica*)

There is no density information available for North Pacific right whales in Hawaiian waters given they have not been seen during survey. Given they are so few in number, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any right whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral reaction. No right whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy’s MFA sonar operations, behavioral patterns and acoustic abilities of North Pacific right whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would likely not result in any population level effects, death or injury to North Pacific right whales, and will not affect their behavior, physiology or cause abandonment of areas that are regularly used by North Pacific right whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect North Pacific right whales.

Sei Whale (*Balaenoptera borealis*)

There is no density information for sei whales in the Hawaiian Islands (Barlow, 2006). As described previously, for purposes of acoustic effects analysis estimates, it was assumed that the number and density of sei whales did not exceed that of false killer whales (given similar abundance estimates), and the modeled number of exposures for both species would therefore be the same.

The risk function and Navy post-modeling analysis estimates 99 sei whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect sei whales; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.7.1-1).

Modeling also predicts three exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling predicts no exposures for sei whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No sei whales would be exposed to impulsive sound or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury (Table 4.1.2.7.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of sei whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not likely result in any population level effects, death or injury to sei whales. The proposed ASW Exercises may affect sei whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sei whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect sei whales.

Sperm Whales (*Physeter macrocephalus*)

The risk function and Navy post-modeling analysis estimates 1,535 sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also predicts 16 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling predicts there would be no exposures for sperm whales to accumulated acoustic energy above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be nine exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of clearance procedures, there would be five exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold (Table 4.1.2.7.1-2). Target area clearance procedures described in Section 4.1.2.5.1 would make sure there are no sperm whales within the safety zone, and therefore potential exposure of sperm whales to sound levels from underwater detonations that exceed TTS is highly unlikely. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar training, behavioral patterns and acoustic abilities of sperm whales, observations made during past training events, and the planned implementation of procedure mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to sperm whales. The proposed ASW Exercises may affect sperm whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sperm whales. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect sperm whales.

Hawaiian Monk Seal (*Monachus schauinslandi*)

The risk function and Navy post-modeling analysis estimates 206 Hawaiian monk seals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. The Navy believes this may affect but is not likely to adversely affect Hawaiian monk seals; therefore, the Navy has initiated ESA Section 7 consultation with NMFS (Table 4.1.2.7.1-1).

Modeling also predicts six exposures to accumulated acoustic energy between 204 dB and 224 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively for monk seals). Modeling predicts there would be no exposures for monk seals to accumulated acoustic energy above 224 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS for monk seals.

Modeling undertaken for monk seals does not take into consideration the effect of mitigation measures or foraging habitat preferences. Monk seals generally forage at depths of less than 100 m, but occasionally dive to depths of over 500 m. The majority of ASW training in the HRC, however, takes place in waters 4 to 8 times deeper than even this known (500 m) maximum and it is very rare for ASW training to take place in waters as shallow as 100 m in depth. Additionally, mitigation measures call for continuous visual observation during training with active sonar. It would, therefore, be rare for a Hawaiian monk seal to be present in the vicinity of an ASW event and the potential for detection by aircraft and lookouts aboard ship would further preclude the possibility that monk seals would be in the vicinity of ASW training events.

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of clearance procedures, modeling estimates there would be three exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and no exposures that would exceed the injury threshold (Table 4.1.2.7.1-2). In the rare event that a monk seal was present, target area clearance procedures described in Section 4.1.2.5.1 would be used to detect monk seals within the safety zone, and therefore potential exposure of monk seals to underwater detonations that exceed the TTS threshold is highly unlikely. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Critical habitat for Hawaiian monk seals was designated 1986 as the area extending out to the 10-fathom depth (60 ft) for the Northwestern Hawaiian Islands (National Marine Fisheries Service, 1986). Critical habitat was extended out to the 20-fathom depth in 1988 (National Marine Fisheries Service, 1988). ASW events should not occur inside the 20-fathom isobath and given mitigation measures and range clearance procedures, activities in the HRC will not have an effect on Monk Seal Critical Habitat.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of monk seals, observations made during past training events, and the planned implementation of procedure mitigation measures, the Navy finds that the training events would not likely result in any death or injury to Hawaiian monk seals. In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect Hawaiian monk seals.

4.1.2.7.3 Estimated Exposures for Non-ESA Species—Alternative 2

Bryde's Whale (*Balaenoptera edeni*)

The risk function and Navy post-modeling analysis estimates 135 Bryde's whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1). Modeling indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Modeling for all alternatives indicates that no Bryde's whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No Bryde's whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.7.1-2).

Given the large size (up to 46 ft) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is very likely that lookouts would detect a group of Bryde's whales at the surface. Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, Bryde's whales that are present in the vicinity of ASW training events may be detected by visual observers. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 135 exposures of Bryde's whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Bryde's whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Bryde's whales.

Minke Whale (*Balaenoptera acutorostrata*)

Despite several reports of seasonal acoustic detections of minke whales in Hawaiian waters (e.g. Rankin and Barlow, 2005), there is no density information available for minke whales in Hawaiian waters given they have rarely been visually sighted during surveys. Taken conservatively, the acoustic detections suggest that minke whales may be more common than the survey data indicates. Therefore, although acoustic effects modeling cannot be undertaken without density estimates, the Navy will assume 135 minke whales may exhibit behavioral responses that NMFS would classify as harassment under the MMPA. This exposure number is based on the modeled exposures for the Bryde's whale, another seasonal baleen whale, that has a reported abundance of 469 whales in the HRC (Barlow 2006). Based upon the Navy's protective measures, it is unlikely that HRC MFA/HFA sonar training events will result in the exposure of any minke whales to accumulated acoustic energy in excess of any energy flux threshold or an SPL that would result in a behavioral response. No minke whales would be exposed to impulsive noise or pressures from underwater detonations that would exceed the sub-TTS behavioral threshold or cause physical injury.. No minke whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause TTS or physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the large size (up to 27 ft) of individual minke whales (Barlow, 2003), it is possible that lookouts may detect minke whales at the surface during ASW training events, although a systematic survey in the Hawaiian Islands failed to visually detect minke whales but was able to detect them acoustically (Barlow, 2006). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of minke whales, observations made during past training events, and the planned implementation mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to minke whales.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

The risk function and Navy post-modeling analysis estimates 725 Blainville's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 12 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no Blainville's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be two exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause physical injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation, most if not all exposures as a result of that event should be precluded.

Mitigation measures call for continuous visual observation during training with active sonar. Given the size (up to 15.5 ft) of individual Blainville's beaked whales and aggregation of 2.3 animals, it is possible that lookouts may detect Blainville's beaked whales at the surface although beaked whales dive for long periods. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 741 exposures of Blainville's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Blainville's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Blainville's beaked whales.

Bottlenose Dolphin (*Tursiops truncatus*)

The risk function and Navy post-modeling analysis estimates 1,460 bottlenose dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 33 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no bottlenose dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No bottlenose dolphin would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold. Modeling indicates there would be one exposure to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given the frequent surfacing, aggregation of approximately nine animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would detect a group of bottlenose dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS. Without consideration of range clearance procedures, modeling indicates there would be one exposure to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation, most if not all exposures as a result of that event should be precluded.

There may be up to 1,494 exposures of bottlenose dolphins to potential Level B harassment annually. Based on the model results, the nature of the Navy's MFA sonar, behavioral patterns and acoustic abilities of bottlenose dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to bottlenose dolphins.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

The risk function and Navy post-modeling analysis estimates 2,273 Cuvier's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 10 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no Cuvier's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be 16 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be 8 exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation, most if not all exposures as a result of that event should be precluded.

Mitigation measures call for continuous visual observation during training with active sonar. Given the medium size (up to 23 ft) of individual Cuvier's beaked whales (Barlow, 2006), it is possible that lookouts may detect Cuvier's beaked whales at the surface during ASW training events, although beaked whales make long duration dives that may last for 45 min (Baird et al., 2006b). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 2,307 exposures of Cuvier's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Cuvier's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Cuvier's beaked whales.

Dwarf Sperm Whale (*Kogia sima*)

The risk function and Navy post-modeling analysis estimates 4,288 dwarf sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 66 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no dwarf sperm whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be 13 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates 13 exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury (Table 4.1.2.7.1-2). Range clearance procedures for underwater detonation, however, should preclude most if not all exposures as a result of that event. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 4,380 exposures of dwarf sperm whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of dwarf sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to dwarf sperm whales.

False Killer Whale (*Pseudorca crassidens*)

The risk function and Navy post-modeling analysis estimates 99 false killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates three exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no false killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No false killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 19.7 ft) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of false killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 102 exposures of false killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of false killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to false killer whales.

Fraser's Dolphin (*Lagenodelphis hosei*)

The risk function and Navy post-modeling analysis estimates 2,536 Fraser's dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 40 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no Fraser's dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be six exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be six exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their large aggregations, mean group size of 286.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is very likely that lookouts would detect a group of Fraser's dolphins at the surface during ASW training events The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 2,588 exposures of Fraser's dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Fraser's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Fraser's dolphins.

Killer Whale (*Orcinus orca*)

The risk function and Navy post-modeling analysis estimates 99 killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates three exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 23 ft), conspicuous coloring, pronounced dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90; Barlow, 2003), is very likely that lookouts would detect a group of killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 102 exposures of killer whale to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to killer whales.

Longman's Beaked Whale (*Indopacetus pacificus*)

The risk function and Navy post-modeling analysis estimates 217 Longman's beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates three exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no Longman's beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No Longman's beaked whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar; Given the medium size (up to 24 ft) of individual Longman's beaked whale, aggregation of approximately 17.8 animals (Barlow, 2006), it is likely that lookouts would detect a group of Longman's beaked whales at the surface during ASW training events although beaked whales dive for long periods. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 220 exposures of Longman's beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Longman's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Longman's beaked whales.

Melon-headed Whale (*Peponocephala electra*)

The risk function and Navy post-modeling analysis estimates 1,194 melon-headed whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 25 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no melon-headed whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. One melon-headed whale would be exposed to impulsive noise or pressures from underwater detonations that will exceed the TTS behavioral disturbance threshold, and none would be exposed to levels that would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.2 ft) and large group size (mean of 89.2 whales) or more animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2003), it is very likely that lookouts would very likely detect a group of melon-headed whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,220 exposures of melon-headed whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of melon-headed whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to melon-headed whales.

Pantropical Spotted Dolphin (*Stenella attenuata*)

The risk function and Navy post-modeling analysis estimates 4,344 pantropical spotted dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 95 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no pantropical spotted dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling estimates five exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, one exposure to impulsive noise or pressures from underwater detonations that would cause slight injury, and no exposures resulting in massive lung injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting pantropical spotted dolphins at the surface, these exposures associate with underwater detonations should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 60.0 animals in Hawaii with a probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow, 2006) it is very likely that lookouts would detect a group of pantropical spotted dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 4,444 exposures of pantropical spotted dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pantropical spotted dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pantropical spotted dolphins.

Pygmy Killer Whale (*Feresa attenuata*)

The risk function and Navy post-modeling analysis estimates 399 pygmy killer whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates nine exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no pygmy killer whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No pygmy killer whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.5 ft) and mean group size of 14.4 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is very likely that lookouts would detect a group of pygmy killer whales at the during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 408 exposures of pygmy killer whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pygmy killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pygmy killer whales.

Pygmy Sperm Whale (*Kogia breviceps*)

The risk function and Navy post-modeling analysis estimates 1,751 pygmy sperm whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 27 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no pygmy sperm whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be four exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates five exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation, these five exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their size (up to 10 ft) and behavior of resting at the surface (Leatherwood et al., 1982), it is very possible that lookouts would detect a pygmy sperm whale at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,787 exposures of pygmy sperm whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of pygmy sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to pygmy sperm whales.

Risso's Dolphin (*Grampus griseus*)

The risk function and Navy post-modeling analysis estimates 994 Risso's dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 21 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no Risso's dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. One Risso's dolphin would be exposed to impulsive noise or pressures from underwater detonations that will exceed the TTS behavioral disturbance threshold, and none would be exposed to levels that would cause physical injury (Table 4.1.2.7.1-2).

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing, light coloration, and large group size of up to several hundred animals (Leatherwood et al., 1982), mean group size of 15.4 dolphins in Hawaii and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow, 2006), it is very likely that lookouts would detect a group of Risso's dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 1,016 exposures of Risso's dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of Risso's dolphin, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to Risso's dolphins.

Rough-Toothed Dolphin (*Steno bredanensis*)

The risk function and Navy post-modeling analysis estimates 2,194 rough-toothed dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 34 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no rough-toothed dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be four exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting rough-toothed dolphins at the surface, these four exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 14.8 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of rough-toothed dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 2,234 exposures of rough-toothed dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of rough-toothed dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to rough-toothed dolphins.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The risk function and Navy post-modeling analysis estimates 3,580 short-finned whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 77 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no short-finned pilot whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates there would be five exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or massive lung injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting short-finned pilot whales at the surface, these five exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 20 ft), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006). It is very likely that lookouts would detect a group of short-finned pilot whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 3,664 exposures of short-finned pilot whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of short-finned pilot whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to short-finned pilot whales.

Spinner Dolphin (*Stenella longirostris*)

The risk function and Navy post-modeling analysis estimates 853 spinner dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 13 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no spinner dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling estimates there would be two exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, no exposure to impulsive noise or pressures from underwater detonations that would cause slight injury or massive lung injury (Table 4.1.2.7.1-2). Given range clearance procedures for underwater detonation and the high probability of detecting spinner dolphins at the surface, these exposures from underwater detonations should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their frequent surfacing, aerobatics, and large mean group size of 31.7 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of spinner dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 870 exposures of spinner dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of spinner dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to spinner dolphins.

Striped Dolphin (*Stenella coeruleoalba*)

The risk function and Navy post-modeling analysis estimates 6,341 striped dolphins will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates 139 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling for Alternative 2 indicates that no striped dolphins would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS.

Estimates for the sub-TTS behavioral threshold indicate there may be two exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Without consideration of range clearance procedures, modeling indicates seven exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, one exposure to impulsive noise or pressures from underwater detonations that would cause slight physical injury, and none that would cause massive lung injury (Table 4.1.2.7.1-2). Given that many of these events occur in relatively shallow water and taking into consideration range clearance procedures for underwater detonation with the high probability of detecting striped dolphins at the surface, these exposures should be precluded from occurring.

Mitigation measures call for continuous visual observation during training with active sonar. Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow, 2006), it is very likely that lookouts would detect a group of striped dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 6,489 exposures of striped dolphins to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of striped dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to striped dolphins.

Unidentified Beaked Whales

The risk function and Navy post-modeling analysis estimates 73 unidentified beaked whales will exhibit behavioral responses that NMFS will classify as harassment under the MMPA (Table 4.1.2.7.1-1).

Modeling also indicates no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. Modeling for all alternatives indicates that no unidentified beaked whales would be exposed to accumulated acoustic energy at or above 215 dB re 1 μPa^2-s, which is the threshold indicative of onset PTS. No unidentified beaked whales would be exposed to impulsive noise or pressures from underwater detonations that will exceed the sub-TTS behavioral disturbance threshold or would cause physical injury (Table 4.1.2.7.1-2). The implementation of mitigation measures to reduce exposure to high levels of sonar sound; and the short duration and intermittent exposure to sonar, reduces the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (foraging, reproduction, or survival), TTS or PTS.

There may be up to 73 exposures of unidentified beaked whales to potential Level B harassment annually. Based on these modeling results, the nature of the Navy's MFA sonar operations, behavioral patterns and acoustic abilities of unidentified beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the HRC training events would not result in any population level effects, death or injury to unidentified beaked whales.

4.1.2.7.4 Summary of Compliance with MMPA and ESA—Alternative 2

Endangered Species Act

Based on analytical risk function modeling results, NMFS conclusions in the Biological Opinions issued regarding RIMPAC 2006 and USWEX 2007, and in accordance with the ESA, the Navy finds the estimates of harassment resulting from the proposed use of MFA sonar may affect endangered blue whale, North Pacific right whale, fin whales, Hawaiian monk seals, humpback whales, sei whales, and sperm whales. Based on the analysis presented in the previous section the Navy concludes that HRC ASW Exercises may affect fin whale, humpback whales, sei whales, sperm whales, and Hawaiian monk seals.

Mitigation measures would be implemented to prevent exposure of marine mammals to impulsive sound or sound pressures from underwater detonations that would cause injury.

Five species of sea turtles could potentially occur within the HRC. All are protected under the ESA. All available acoustic information suggests that sea turtles are likely not capable of hearing MFA/HFA sounds in the range produced by the sources analyzed in this document. Mitigation measures would be implemented to reduce or prevent the potential exposure of sea turtles to impulsive sound or sound pressures from underwater detonations that would cause injury.

In accordance with ESA requirements, the Navy would undertake Section 7 consultation with NMFS based on the determination for Alternative 2, that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, sperm whales, and Hawaiian monk seals.

Marine Mammal Protection Act

Level A Harassment of Cetaceans

Modeling results for the sum of exposures for all ASW Exercises for a year indicate no exposures that exceed the Level A harassment threshold. However, given implementation of mitigation measures, it is unlikely that ASW training would result in injury to marine mammals. Modeling for explosives indicates three potential exposures that may result in slight injury, however, the following considerations reduce the potential for injury from tactical sonar and underwater explosions:

- Level A zone of influence radii are small that observers would readily observe an approaching marine mammal.
- Many species are large and/or travel in large pods and are easily visible from an elevated platform; a ship or aircraft would readily see a marine mammal in time to implement mitigation measures.

Level B Harassment of Cetaceans

As shown in Table 4.1.2.6.1-1 for sonar, the risk function (including post-modeling analysis) plus an estimate of 135 minke whale exposures results in the estimate that 48,212 marine mammals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. Modeling for Alternative 2 indicates 967 exposures from sonar to accumulated acoustic energy between 195 dB and 215 dB re 1 µPa^2-s (the thresholds established to be indicative of onset TTS and onset PTS respectively). Modeling also indicates no exposures to accumulated acoustic energy above 215 dB re 1 µPa^2-s for sonar.

Estimates for the sub-TTS behavioral threshold indicate there may be 63 exposures resulting in behavioral harassment from successive explosions in a single event involving underwater detonations. Given that successive multiple explosions are rare events and considering range clearance, it is extremely unlikely there would be any exposures exceeding the sub-TTS behavioral threshold. Estimates for underwater detonations indicate there may be 80 TTS exposures. Modeling indicates no exposures to accumulated acoustic energy above 215 dB re 1 µPa^2-s resulting in PTS from explosives.

Therefore, under Alternative 2, it is estimated that in total, 49,322 marine mammals will exhibit behavioral responses NMFS will classify as Level B harassment. This includes 976 TTS and 48,221 risk function exposures (48,077 plus an estimated 135 minke whales) as a result of MFA/HFA sonar use (49,188 exposures) in addition to 143 exposures (63 sub-TTS exposures and 80 TTS exposures) as a result of underwater detonations (for explosives see Table 4.1.2.7.1-2).

Mitigation measures will be in place to further minimize the potential for temporary harassment, although there is currently no data to quantify the mitigation efforts to successfully reduce the number of marine mammal exposures. The Navy is developing a comprehensive Monitoring Plan to determine the effectiveness of these measures. Many species of small cetaceans travel in very large pods, and therefore would be easily observed from an elevated platform. In addition, large baleen whales travel slowly and are easily observed on the surface. In the decades of conducting Major Exercises in the HRC, there have been no documented incidences of harassments or beach strandings of marine mammals associated with active sonar or underwater explosives. In the one event associated with RIMPAC 2004, sonar was suggested to be a plausible contributing factor (Southall et al., 2006) although a similar event occurred on the same day in a bay at Rota Island, Northern Marianas Islands with no associated sonar (Jefferson et al., 2006) and may be related to oceanographic changes that influenced prey distribution (Southall, 2006; Ketten, 2006). The HRC Open Ocean waters continue to support diverse and stable populations of cetaceans. Based on the potential for Level B harassment, the Navy will consult with NMFS and apply for a 5-year Letter of Authorization under the MMPA.

Table 4.1.2.7.5-1. Alternative 2 Sonar Modeling Summary—Yearly Marine Mammal Exposures from Other HRC ASW Training

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	15	0	0
Fin whale[1, 2]	10	0	0
Sei whale[1, 2]	10	0	0
Humpback whale[1]	1,651	61	-
Sperm whale[1]	169	2	0
Dwarf sperm whale	462	10	0
Pygmy sperm whale	189	4	0
Cuvier's beaked whale	273	1	0
Longman's beaked whale	24	0	0
Blainville's beaked whale	78	2	0
Unidentified beaked whale	9	0	0
Bottlenose dolphin	155	5	0
False killer whale	10	0	0
Killer whale	10	0	0
Pygmy killer whale	42	1	0
Short-finned pilot whale	382	12	0
Risso's dolphin	106	3	0
Melon-headed whale	127	4	0
Rough-toothed dolphin	236	5	0
Fraser's dolphin	271	6	0
Pantropical spotted dolphin	466	14	0
Spinner dolphin	92	2	0
Striped dolphin	680	21	0
Monk seal[1]	30	1	0
TOTAL	5,497	154	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 μPa^2-s; for monk seals TTS is 204-224 dB re 1 μPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 μPa^2-s; for monk seals PTS is >224 dB re 1 μPa^2-s (Kastak et al., 1999b; 2005)
TTS = temporary threshold shift
PTS = permanent threshold shift

4.1.2.7.5 Increased Tempo and Frequency of Training—Alternative 2

The HRC training for Alternative 2 involving sonar includes ASW training as described in Table 2.2.2.3-1 and Appendix D. The number of hours of sonar modeled for Alternative 2 included 2,496 hours of AN/SQS 53 and 787 hours of AN/SQS 56 surface ship sonar, plus the associated sonobuoys, dipping sonar, MK-48 HFA sonar, and submarine sonar use on an annual basis. Modeled exposures for marine mammals during other HRC ASW training, without consideration of mitigation measures are presented in Table 4.1.2.7.5-1. Effects on marine mammals from these exposures are included in the discussion in Section 4.1.2.7.2 for ESA listed species and Section 4.1.2.7.3 for non-ESA listed species. Exposures from underwater detonations (i.e., SINKEX, EER/IEER, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS) are included in the summary numbers in Table 4.1.2.7.1-2.

4.1.2.7.6 Enhanced and Future RDT&E Activities—Alternative 2

There are no new or future RDT&E activities that would affect marine animals. Noise sources such as UAVs, underwater communications, and electronic warfare systems that may be deployed in the ocean are generally transmitting above the frequency range or below the intensity level to affect marine animals. Other RDT&E activities identified as ASW do not include sonar or include very limited use of sonar and are generally of short durations (<1.5 hours). These activities would have minimal effects on fish, sea turtles, and marine mammals.

4.1.2.7.7 HRC Enhancements—Alternative 2

There are no new HRC enhancements that would affect marine animals. Other sources such as underwater communications and electronic warfare systems that may be deployed in the ocean are beyond the frequency range or intensity level to affect marine animals.

4.1.2.7.8 Major Exercises—RIMPAC, USWEX, and Multiple Strike Group Training—Alternative 2

RIMPAC

The number of hours of sonar modeled for Alternative 2 for RIMPAC is the same as detailed in the discussion for Alternative 1. An Alternative 2 RIMPAC, includes 798 hours of AN/SQS 53 and 266 hours of AN/SQS 56 surface ship sonar, plus the associated sonobuoys, dipping sonar, MK-48 HFA sonar, and submarine sonar use per RIMPAC (conducted every other year). The modeled exposures for marine mammals during RIMPAC for Alternative 2, without consideration of mitigation measures, are the same as presented in Table 4.1.2.6.8-1 for Alternative 1. Effects on marine mammals from these exposures under Alternative 2 are included in the discussion in Section 4.1.2.7.2 for ESA listed species and Section 4.1.2.7.3 for non-ESA listed species.

USWEX

The number of hours of sonar modeled for Alternative 2 for USWEX is the same as detailed in the discussion for Alternative 1. The training events and impacts on marine mammals from USWEX have been summarized in the USWEX Programmatic EA/OEA (U.S. Department of the Navy, 2007b). The number of hours of sonar modeled for Alternative 2 for USWEX is calculated based on there being six USWEXs annually. Six USWEX would total 630 hours of AN/SQS 53 and 210 hours of AN/SQS 56 surface ship sonar, plus associated sonobuoys, dipping sonar, MK-48 HFA sonar, and submarine sonar use on an annual basis. The exposures for marine mammals during up to six USWEXs per year are modeled without consideration of mitigation measures, and are the same presented in Table 4.1.2.6.8-2 for Alternative 1. Effects on marine mammals from these exposures under Alternative 2 are included in the discussion in Sections 4.1.2.7.2 for ESA listed species and 4.1.2.7.3 for non-ESA listed species.

Multiple Strike Group Training Exercise

Up to three Strike Groups would conduct training simultaneously in the HRC in a Multiple Strike Group Training Exercise. The Strike Groups would not be homeported in Hawaii, but would stop in Hawaii en route to a final destination. The Strike Groups would be in Hawaii for up to 10 days per exercise. Training would be provided to submarine, ship, and aircraft crews in tactics, techniques, and procedures for ASW, Defensive Counter Air, Maritime Interdiction, and operational level C2 of maritime forces. The three Strike Group marine mammal exposure modeling included 708 hours of AN/SQS 53 and 236 hours of AN/SQS 56 surface ship sonar plus the associated dipping sonar, sonobuoys, and MK-48 torpedoes using HFA. The modeled exposures for marine mammals during the Multiple Strike Group training exercise, without consideration of mitigation measures are presented in Table 4.1.2.7.8-1. Modeling assumed the exercise is conducted during the winter to account for potential humpback whale exposures. Effects on marine mammals from these exposures under Alternative 2 are included in the discussion in Sections 4.1.2.7.2 for ESA listed species and 4.1.2.7.3 for non-ESA listed species.

4.1.2.8 MARINE MAMMALS ALTERNATIVE 3 (BIOLOGICAL RESOURCES—OPEN OCEAN)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Sonar usage for Alternative 3 and the impacts associated with ASW training, therefore, would be identical to the sonar usage and analysis presented for the No-action Alternative (Tables 4.1.2.5.1-1, 4.1.2.5.5-1, 4.1.2.5.7-1, and 4.1.2.5.7-2). Impacts associated with explosives would be as described in Section 4.1.2.7 and shown in Table 4.1.2.7.1-2.

4.1.2.8.1 Summary of Compliance with ESA and MMPA—Alternative 3

Potential impacts on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are the same as those analyzed for the No-action Alternative. Potential impacts on marine biological resources from non-ASW (sonar usage) training activities and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2. Conclusions regarding the potential for impact are based on analytical modeling results, the history of ongoing activities in the HRC, NMFS conclusions in the Biological Opinions issued regarding RIMPAC 2006 and USWEX 2007 and after-action reports from those exercises. Modeling and estimates for explosives indicates three potential exposures that may result in slight injury, however, given the standard mitigation measures and range clearance procedures, these exposures are unlikely. Navy finds that the HRC training events analyzed for

Alternative 3 would not result in any injury or death to any sea turtles or marine mammal species and would have negligible impact on annual survival, recruitment, and birth rates.

Table 4.1.2.7.8-1. Alternative 2 Sonar Modeling Summary—Yearly Marine Mammal Exposures for Multiple Strike Group Training Exercise

Marine Mammals	Risk Function	TTS[3]	PTS[4]
Bryde's whale	45	0	0
Fin whale[1, 2]	33	1	0
Sei whale[1, 2]	33	1	0
Humpback whale[1]	2,816	126	0
Sperm whale[1]	466	4	0
Dwarf sperm whale	1,453	18	0
Pygmy sperm whale	593	7	0
Cuvier's beaked whale	708	3	0
Longman's beaked whale	71	1	0
Blainville's beaked whale	246	3	0
Unidentified beaked whale	23	0	0
Bottlenose dolphin	464	9	0
False killer whale	33	1	0
Killer whale	33	1	0
Pygmy killer whale	132	3	0
Short-finned pilot whale	1,145	21	0
Risso's dolphin	318	6	0
Melon-headed whale	382	7	0
Rough-toothed dolphin	745	9	0
Fraser's dolphin	857	11	0
Pantropical spotted dolphin	1,351	26	0
Spinner dolphin	290	4	0
Striped dolphin	1,972	38	0
Monk seal[1]	59	2	0
TOTAL	14,268	302	0

Note: [1] Endangered Species
[2] Due to a lack of density data for fin and sei whales, false killer whale results were used because they have a similar size population within the HRC.
[3] 195 dB – TTS 195-215 dB re 1 µPa^2-s; for monk seals TTS is 204-224 dB re 1 µPa^2-s (Kastak et al., 1999a; 2005)
[4] 215 dB- PTS >215 dB re 1 µPa^2-s; for monk seals PTS is >224 dB re 1 µPa^2-s (Kastak et al., 1999b; 2005)
dB = decibel
TTS = temporary threshold shift
PTS = permanent threshold shift

ESA

In accordance with Section 7 of the ESA, the Navy has undertaken Section 7 consultation with NMFS for the proposed and ongoing activities in the HRC under Alternative 3 as the preferred alternative for listed species under the jurisdiction of NMFS. The Navy finds that activities under Alternative 3 are not likely to affect green, olive ridley, loggerhead, hawksbill, or leatherback sea turtles. The Navy additionally finds that the proposed and ongoing activities in the HRC may affect but are not likely to adversely affect endangered blue whale, North Pacific right whale, fin whales, Hawaiian monk seals, humpback whales, sei whales, and sperm whales.

MMPA

The Navy has initiated consultation with NMFS in accordance with the MMPA on Alternative 3. The Navy estimates 27,704 marine mammals will exhibit behavioral responses that NMFS will classify as harassment under the MMPA. From this total, modeling for Alternative 3 indicates 522 exposures to accumulated acoustic energy between 195 dB and 215 dB re 1 μPa^2-s, which are the thresholds established to be indicative of onset TTS and onset PTS respectively. Modeling indicates no exposures to accumulated acoustic energy above 215 dB re 1 μPa^2-s. Modeling and estimates for explosives indicates three potential exposures that may result in slight injury, however, given the standard mitigation measures and range clearance procedures, these exposures are unlikely.

Therefore, the Navy estimates that in total, 27,704 marine mammals will exhibit behavioral responses NMFS will classify as Level B harassment. This includes 522 TTS and 27,039 risk function exposures (26,975 plus an estimated 64 minke whales) as a result of MFA/HFA sonar use (27,561 exposures) in addition to 143 exposures (63 sub-TTS exposures and 80 TTS exposures) as a result of underwater detonations (for explosives see Table 4.1.2.7.1-2). The Navy remains in consultation with NMFS, and would request authorization from NMFS for 27,704 MMPA Level B harassment takes and no Level A harassments under Alternative 3 (the preferred alternative).

4.1.2.9 MARINE MAMMAL MORTALITY REQUEST

Under the MMPA, the Navy is requesting a Letter of Authorization (LOA) for the incidental harassment of marine mammals pursuant to Section 101 (a)(5)(A) of the MMPA for the proposed and ongoing activities analyzed under Alternative 3 as the preferred alternative. The authorization requested is for the incidental harassment of marine mammals by behavioral disruption. It is understood that an LOA is applicable for up 5 years, and is appropriate where authorization for serious injury or mortality of marine mammals is requested. In this case, per Navy policy developed in conjunction with NMFS based on assessment of prior stranding events, a subset of beaked whales that experience disruption of natural behavioral patterns could experience secondary effects leading to serious injury or mortality. The request is for exercises and training events conducted within the HRC. These include training that use MFA/HFA sonar or underwater detonations. The request is for a 5-year period beginning at the issuance of the LOA (estimated to be November 2008) or the date of expiration for the NDE II on 20 January 2009; whichever comes first.

The acoustic modeling approach taken in the HRC EIS/OEIS and the LOA request attempts to quantify potential exposures to marine mammals resulting from operation of MFA/HFA sonar and underwater detonations. Results from this conservative modeling approach are presented without consideration of mitigation measures employed per Navy SOPs. For example, securing or turning off an active sonar when an animal approaches closer than a specified distance reduces potential exposure since the sonar is no longer transmitting. Modeling results from the HRC analysis does not predict any marine mammal mortalities. Modeling results do predict that one humpback whale could be exposed to sonar in excess of PTS threshold indicative of Level A injury under Alternative 2. However, given standard mitigation measures presented in Chapter 6.0, and the high likelihood that humpback whales can be readily detected, a single Level A exposure is very unlikely.

To reiterate an important point, the history of Navy activities in the HRC and analysis in this document indicate that military readiness activities are not expected to realistically result in any sonar–induced Level A injury or mortalities to marine mammals.

There are natural and manmade sources of mortality other than sonar and underwater detonation that may contribute to stranding events as described in the Cetacean Stranding Section (Section 4.1.2.4.10). Documented marine mammal strandings are a regular occurrence within the Hawaiian Islands since early record keeping began in the 1930's (Mazzuca et al., 1999, Maldini et al., 2005). For instance, 22 cetacean and 14 Hawaiian monk seal strandings or boat strikes were reported in Hawaiian waters during 2006 (National Marine Fisheries Service, Pacific Islands Region Office, 2007a). Of these 22 strandings (involving 7 species), 17 are attributed to either vessel strikes or fisheries interaction. In a review of mass strandings within Hawaii, approximately two-thirds occurred during the summer (Mazzuca et al., 1999). The actual cause of a particular stranding may not be immediately apparent when there is little evidence of physical trauma, especially in the case of disease or age-related mortalities. These events require careful scientific investigation by a collaborative team of subject matter experts to determine actual cause of death.

In a letter from NMFS to Navy dated October 2006, NMFS indicated that Section 101(a)(5)(A) authorization is appropriate for MFA/HFA sonar activities because it allows NMFS to consider the potential for incidental mortality. NMFS' letter indicated, "Because mid-frequency sonar has been implicated in several marine mammal stranding events including some involving serious injury and mortality, and because there is no scientific consensus regarding the causal link between sonar and stranding events, NMFS cannot conclude with certainty the degree to which mitigation measures would eliminate or reduce the potential for serious injury or mortality." In addition, given the frequency of naturally occurring marine mammal strandings in Hawaii (e.g., natural mortality), it is conceivable that a stranding could co-occur with a Navy exercise even though the stranding is actually unrelated to and not caused by Navy activities. Accordingly, the Navy's LOA application will include requests for take, by mortality, of the most commonly stranded non ESA-listed species.

Evidence from five beaked whale strandings, all of which have taken place outside the HRC, and have occurred over approximately a decade, suggests that the exposure of beaked whales to MFA sonar in the presence of certain conditions (e.g., multiple units using tactical sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although these physical factors believed to contribute to the likelihood of beaked whale strandings are not present, in their aggregate, in the Hawaiian Islands, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings.

There have been no beaked whales strandings in Hawaii associated with the use of MFA/HFA sonar. This is a critically important contextual difference between Hawaii and areas of the world where strandings have occurred (rf. Southall et al., 2007). While the absence of evidence does not prove there have been no impacts on beaked whales, decades of history with no evidence cannot be lightly dismissed. Accordingly, however, to allow for scientific uncertainty regarding contributing causes of beaked whale strandings and the exact mechanisms of the physical effects, the Navy will also request authorization for take, by mortality, of the beaked whale species present in the Hawaiian Islands. Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of MFA/HFA sonar during Navy exercises within the HRC. Authorization for a very small number of mortalities for beaked whales and commonly stranded species is prudent given the potential for a single individual of these species to be found dead coincident with Navy activities given an average of two strandings per month occur in Hawaii.

Through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the unlikely event that a causal relationship were to be found between Navy activities and a future stranding. The Navy's LOA application requests the take, by serious injury or mortality, of 2 each of 10 species (bottlenose dolphin, Kogia *spp*., melon-headed whale, pantropical spotted dolphin, pygmy killer whale, short-finned pilot whale, striped dolphin, Cuvier's, Longman's, and Blainville's beaked whales), however, these numbers may be modified through the MMPA process, based on available data.

4.1.3 CULTURAL RESOURCES—OPEN OCEAN

4.1.3.1 NO-ACTION ALTERNATIVE, ALTERNATIVE 1, ALTERNATIVE 2, AND ALTERNATIVE 3 (CULTURAL RESOURCES OPEN OCEAN)

There are numerous submerged cultural resources (primarily shipwrecks) widely scattered throughout the region of influence for Open Ocean training and RDT&E activities (see Figures 3.1.3-1 through 3.1.3-3). There are no dense clusters of resources and, according to NOAA shipwreck maps, the features are situated at considerable depths. With the exception of resources within Naval Station Pearl Harbor (e.g., *USS Arizona*, *USS Utah*), there are no shipwrecks listed in the National or State Registers of Historic Places. Humpback whales and other marine mammals, which are considered culturally significant to Native Hawaiians, seasonally transit the area.

The only training event with the potential to affect submerged cultural resources in the open (deep) ocean areas is SINKEX. SINKEX involves the sinking of surface targets (typically excess vessel hulks) by air, surface, or submarine weapons systems. After the target is destroyed, the remaining expended material settles to the sea floor. Because of the significant depths and scattered distribution of shipwrecks within this 235,000 nm^2 area, the likelihood of the expended material from the target coming in contact with a shipwreck is very low. In the remote chance that target material does sink onto a shipwreck, effects on the feature would be minimal because of the size of the material involved and the cushioning effect that water has on the weight of materials at those depths. In addition, if the exact locations of shipwrecks can be determined prior to training, they will be avoided. As a result, adverse effects on cultural resources within open ocean areas from any of the alternatives are not expected.

Animals, including humpback whales and other marine mammals that may have cultural significance to Native Hawaiians, are not directly protected by the NHPA; however, they are protected under the ESA and MMPA. Any anticipated effects and associated mitigation measures on marine mammals under these acts are presented within the biological sections of this EIS/OEIS.

Although effects on underwater cultural resources are not anticipated, the potential for unanticipated discovery of underwater resources always exists. To ensure that previously unidentified submerged cultural resources are adequately protected, the Commander, Naval Region (COMNAVREG), the Advisory Council on Historic Preservation (Council), and the Hawaii SHPO entered into a Programmatic Agreement (PA) in 2003 regarding Navy undertakings in Hawaii (Appendix H). Among the stipulations of the PA is one focused on unanticipated discoveries: Stipulation XI(A). The PA stipulates; "If during the performance of an undertaking, historic properties, including submerged archaeological sites and TCPs, are discovered or unanticipated effects are found, or a previously unidentified property which may be eligible for listing on the National Register of Historic Places is discovered, COMNAVREG Hawaii will take all reasonable measures to avoid or minimize harm to the property until it concludes consultation with the State Historic Preservation Office and any Native Hawaiian organization, including OCHCC, which has made known to COMNAVREG Hawaii that it attaches religious and cultural significance to the historic property."

4.1.4 HAZARDOUS MATERIALS & WASTES—OPEN OCEAN

4.1.4.1 NO-ACTION ALTERNATIVE (HAZARDOUS MATERIALS AND WASTES—OPEN OCEAN)

4.1.4.1.1 HRC Training—No-action Alternative

Hazardous Materials

Navy training conducted under the No-action Alternative will require the use of a variety of solid and liquid hazardous materials. Hazardous materials required on the open ocean ranges can be broadly classified as shipboard materials necessary for normal operations and maintenance, such as fuel and paint, and training materials. Training materials include both live and practice munitions (considered to be hazardous materials because they contain explosives or propellants), and non-munition training materials. Table 4.1.4.1.1-1 lists training involving the use of training materials containing hazardous materials.

Under the No-action Alternative, the use of hazardous materials for shipboard operations will not increase from baseline levels. Hazardous materials will continue to be controlled in compliance with OPNAVINST 5090.1B (2002), Chapter 19. The No-action Alternative will not affect hazardous materials management practices aboard ship.

Table 4.1.4.1.1-1. HRC Training with Hazardous Materials No-action Alternative—Open Ocean Areas

Training Event	Training Materials Containing Hazardous Material		
	Item	# per training event	Total #
Air Combat Maneuver (ACM)	Chaff	6	4,428
	Flare	3	2,214
Surface-to-Air Gunnery Exercise (S-A GUNEX)	5-in projectile	3	258
	7.62-mm projectile	3	258
	JATO bottle	1	86
	20-mm projectile	1,900	163,000
Surface-to-Air Missile Exercise (S-A MISSILEX)	Missile	3	51
	JATO Bottle	1	17
Chaff Exercise (CHAFFEX)	MK-36 super rapid bloom offboard chaff	7.5	255
Naval Surface Fire Support (NSFS)	5-in or 76-mm ammunition	82	1,804
	20-mm projectile	8	176
Visit, Board, Search, and Seizure (VBSS)	0.50 caliber gun ammunition	2,000	120,000
Surface-to-Surface Gunnery Exercise (S-S GUNEX)	5-in or 76-mm ammunition	20	1,380
	Smoke canister	0.52	36
	7.62-mm or .50-cal ammunition	150	10,400
Surface-to-Surface Missile Exercise (S-S MISSILEX)	Missile	2	14
Air-to-Surface Gunnery Exercise (A-S GUNEX)	0.50-cal or 7.62-mm ammunition	400	51,200
	Smoke canister	1	128
Air-to-Surface Missile Exercise (A-S MISSILEX)	Missile	2	72
Bombing Exercise (BOMBEX) (Sea)	MK-76	9	315
	MK-82	3	105
	BDU-45	1.7	60
	CBU	1	35
	MK-83	0.5	18
	Smoke canister	1	35
Sinking Exercise (SINKEX)	5-in or 76-mm ammunition	700	4,200
	Missiles	11	66
	MK-82	4	24
	MK-83	4	24
	MK-84	4	24
Anti-Surface Warfare (ASUW) Torpedo Exercise (TORPEX) (Submarine-Surface)	MK-48 torpedo	3	105
Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX)	Sonobuoys	24-43	12,500
	Smoke canister	1-2	558
	MK-39	0-1	305
Anti-Submarine Warfare Torpedo Exercise (ASW TORPEX)	Recoverable Exercise Torpedo (REXTORP)	1	500
	MK-39	1	500
Flare Exercise	Flare	1	6

Expended Training Materials

Various types of training items will be shot, launched, dropped, or placed within the Open Ocean Area under the No-action Alternative. Some training materials, including gun ammunition, bombs and missiles, targets, sonobuoys, chaff, and flares, will be expended on the range and not recovered. Items that are expended on the water, and fragments that are not recognizable as training material (e.g., flare residue or candle mix), typically will not be recovered. Sonobuoys and flares, smoke buoys and markers, and other pyrotechnic training devices expended in the water can leak or leach small amounts of toxic substances as they degrade and decompose. Section 4.1.7, Water Resources – Open Ocean, has a more comprehensive analysis effects of expended materials on ocean water quality.

Based on the assumed expenditure rates and training tempo (see Table 4.1.4.1.1-1), about 654 tons of training materials will be expended in the 235,000 nm^2 HRC annually, or about 5.6 lb/nm^2. If an additional assumption is made that these materials will not be distributed uniformly over the range, but that >99 percent of the material will be expended over only about 20 percent of the range, then about 28 lb/nm^2 will be deposited annually. If the debris remains in the top 6 inches of bottom sediments, and the bottom sediments have about the same density, dry weight, as terrestrial soils, then the concentration of these materials in bottom sediments will increase at a rate of about 15 parts per billion (ppb) per year.

A small percentage of training items containing energetic materials will fail to function properly, and—if not recovered—will remain on the sea floor as unexploded ordnance (UXO). Based on an assumed “dud” rate of 5 percent, approximately 1,500 ordnance items per year may become UXO. Over a 20-year period of use, for example, this UXO would reach a concentration of about 1 item per 10 nm^2.

Expended training items will decompose very slowly, so the volume of decomposing training material within the training areas, and the amounts of toxic substances being released to the environment, will gradually increase over the period of military use. Concentrations of some substances in sediments surrounding the disposed items will increase over time, possibly inhibiting benthic flora and fauna.

Within the approximately 235,000 nm^2 of ocean encompassed by the HRC, however, the amount of ocean bottom habitat affected by a few tons per year of training material will be insignificant, even assuming that some portions of the training areas are used more heavily than others. Over a 20-year period, for example, based on the assumptions made above for annual expenditures, the total concentration of these materials will be about 0.3 parts per million (ppm). Sediment transport via currents can eventually disperse these contaminants outside of the training areas, where they will be present at very low concentrations and, thus, have no effect on the environment.

<u>Sonobuoys</u>

Sonobuoys are electromechanical devices used for a variety of ocean sensing and monitoring tasks. Approximately 12,500 sonobuoys, weighing a total of about 244 tons will be deployed annually for training under the No-action Alternative. Lead solder, lead weights, and copper anodes are used in the sonobuoys. Sonobuoys also may contain lithium sulfur dioxide, lithium, or thermal batteries.

A sonobuoy's seawater batteries can release copper, silver, lithium, or other metals. During operation, the sonobuoy floats in the water column, releasing these materials to the surrounding marine environment; the amounts released depend on the type of battery used. Marine organisms in its vicinity can be exposed to battery effluents for up to 8 hours. Once expended and scuttled, the sonobuoy sinks to the ocean floor. Various types of sonobuoys can be used, so the exact amounts of hazardous materials that will be expended on the ranges are not known. Table 4.1.4.1.1-2 provides estimates of potentially hazardous sonobuoy materials, based on the common types of sonobuoys now in use by the Navy.

Table 4.1.4.1.1-2: Sonobuoy Hazardous Materials, No-action Alternative (based on average amounts of constituents)

Sonobuoy Constituent	Annual Amount (pounds)
Fluorocarbons	250
Copper	4,250
Lead	11,800
Copper thiocyanate	19,900
Tin/lead-plated steel	750
TOTAL	37,000

Pyrotechnic Residues

About 757 smoke grenades and about 2,220 flares will be used annually under the No-action Alternative. Solid flare and pyrotechnic residues may contain, depending on their purpose and color, aluminum, magnesium, zinc, strontium, barium, cadmium, nickel, and perchlorates. At an average residue weight of about 0.85 lb per item, an estimated 1.3 tons per year of these residues will be deposited on the sea floor. Based on an area of 235,000 nm^2, the rate of deposition of these materials will be about 0.01 lb/nm^2 per year.

Hazardous constituents in pyrotechnic residues are typically present in small amounts or low concentrations, and are bound up in relatively insoluble compounds. As inert, incombustible solids with low concentrations of leachable metals, these materials typically do not meet the Resource Conservation and Recovery Act (RCRA) criteria for characteristic hazardous wastes. The perchlorate compounds present in the residues are highly soluble, although persistent (i.e., do not break down readily into other compounds under natural conditions) in the environment, and should disperse quickly.

Chaff

Chaff is a thin polymer with an aluminum coating used to decoy enemy radars. All of the components of the aluminum coating are present in seawater in trace amounts, except magnesium, which is present at 0.1 percent. The stearic acid coating is biodegradable and nontoxic. The chaff is shot out of launchers using a propellant charge. Under the No-action Alternative, it is estimated that 34 CHAFFEX and 738 ACMs will be held per year, releasing about 4,700 packages of chaff over the Open Ocean Area. About 4.4 tons of chaff would be released annually, or about 0.04 lb/nm^2, but these releases would be distributed over the year, such that the chaff from one exercise would disperse prior to a subsequent event.

The chaff fibers are well-dispersed upon ejection from the launcher. The fine, neutrally buoyant chaff streamers act like fine particulates upon entering the water, temporarily increasing the turbidity and reducing the clarity of the ocean's surface waters. The fibers are quickly dispersed more widely by wind, waves, and currents.

The fibers are too short and fine to pose an entanglement risk. They may be accidentally or intentionally ingested by marine life, but the fibers are non-toxic. Chemicals leached from the chaff will be diluted by the surrounding seawater, reducing the potential for concentrations of these chemicals to build up to levels that can affect sediment quality and benthic habitats. The widely spaced releases will have no discernable effect on the marine environment. (U.S. Department of the Air Force, 1997)

Hazardous Wastes

Used hazardous materials and chemical byproducts generated at sea are not considered to be hazardous wastes until offloaded in port. The accumulation of used hazardous materials aboard ship will not increase. Used and excess hazardous wastes will continue to be managed in compliance with OPNAVINST 5090.1B (2003), Chapter 12. The No-action Alternative will not affect hazardous materials management practices aboard ship. Hazardous wastes will be offloaded upon reaching port in Hawaii, and enter the Navy's shore-side waste management system, which has sufficient long-term capacity for these waste streams.

4.1.4.1.2 HRC RDT&E Activities—No-action Alternative

HRC RDT&E activities under the No-action Alternative will consist of the Naval Undersea Warfare Center (NUWC) shipboard tests on the Fleet Operational Readiness (FORACS) and Shipboard Electronic Systems Evaluation Facility (SESEF) ranges. Navy vessels engaged in these activities will use small quantities of hazardous materials and generate small quantities of used hazardous materials during routine ship operations. These materials will be managed in accordance with OPNAVINST 5090.1B. Hazardous materials inventories will be replenished and used hazardous materials will be offloaded while the vessels are in port.

4.1.4.1.3 Major Exercises—No-action Alternative

Major Exercises under the No-action Alternative, such as RIMPAC and USWEX, include combinations of unit-level training and, in some cases, RDT&E activities that have been occurring in the HRC for decades. Potential impacts from Major Exercises will be similar to those described earlier for training and RDT&E activities.

4.1.4.2 ALTERNATIVE 1 (HAZARDOUS MATERIALS AND WASTES—OPEN OCEAN)

4.1.4.2.1 Increased Tempo and Frequency of Training—Alternative 1

Hazardous Materials

Increases in shipboard hazardous materials transport, storage, and use to support increased training under Alternative 1 would be managed in compliance with OPNAVINST 5090.1B (2002), Chapter 19. No new types of hazardous materials would be required under Alternative 1, and existing hazardous materials storage and handling facilities, equipment, supplies, and procedures would continue to provide for adequate management of these materials. No releases of hazardous materials to the environment and no unplanned exposures of personnel to hazardous materials are anticipated under this alternative.

Open Ocean Area training involving hazardous materials would increase by varying degrees from current levels in support of the Fleet Response Training Plan (FRTP). Those increases are described in Table 4.1.4.2.1-1; the amounts of hazardous wastes from sonobuoys would be the same as under the No-action Alternative (see Table 4.1.4.1.1-2). Only the number of training events would increase; no new types of training would be introduced. Air-to-surface gunnery and air combat maneuvers would experience the largest percentage increases from baseline levels under Alternative 1. Amounts of expended training materials would increase in rough proportion to the overall increases in training.

Under Alternative 1, the total amount of expended training materials would increase by about 80 tons over the No-action Alternative, a 12 percent increase. Under the same assumptions as presented above for the No-action Alternative, the annual rate of deposition of expended training materials would be about 31 lb/nm^2, or an annual increase in concentration of about 17 ppb. Over 20 years, the concentration of expended training materials in bottom sediments (top 6 inches) would increase by about 0.34 ppm, compared to about 0.3 ppm under the No-action Alternative. Annual deposits of UXO would be about 1,580 items compared with about 1,500 under the No-action Alternative.

Hazardous Wastes

The amounts of hazardous wastes generated by training under Alternative 1 would be incrementally greater than those under the No-action Alternative (see Table 4.1.4.2.1-1). These incremental increases, however, would still be well within the capacity of the Navy's hazardous waste management system. All hazardous wastes would continue to be managed in compliance with OPNAVINST 5090.1B (2003). No substantial changes in hazardous waste management are anticipated for operating Navy assets under Alternative 1.

4.1.4.2.2 Enhanced RDT&E Activities—Alternative 1

RDT&E activities under Alternative 1 would consist of the NUWC shipboard tests on the FORACS and SESEF ranges. Navy vessels engaged in these activities would use minor quantities of hazardous materials and generate minor quantities of used hazardous materials during routine ship operations. These materials would be managed in accordance with OPNAVINST 5090.1B. Hazardous materials inventories would be replenished and used hazardous materials would be offloaded while the vessels are in port.

4.1.4.2.3 HRC Enhancements—Alternative 1

None of the HRC enhancements would have a substantial effect on hazardous materials use or hazardous waste generation under Alternative 1.

4.1.4.2.4 Major Exercises—Alternative 1

Major Exercises consist of training and, in some cases, RDT&E activities, both addressed above. Potential impacts would be similar to those described earlier for training and RDT&E activities.

Table 4.1.4.2.1-1. HRC Training with Hazardous Training Materials Alternative 1—Open Ocean Areas

Training Event	Training Material			
	Item	Annual Quantity (#)		
		No-action	Alt 1	Change
Air Combat Maneuver (ACM)	Chaff	4,428	4,644	216
	Flare	2,214	2,322	108
Surface-to-Air Gunnery Exercise (S-A GUNEX)	5-in projectile	258	324	66
	7.62-mm projectile	258	324	66
	JATO Bottle	86	108	22
	20-mm projectile	163,000	205,000	42,000
Surface-to-Air Missile Exercise (S-A MISSILEX)	Missile	51`	78	27
	JATO Bottle	17	26	9
Chaff Exercise (CHAFFEX)	MK-36 Super Rapid Bloom Offboard Chaff	255	255	0
Naval Surface Fire Support (NSFS)	5-in or 76-mm ammunition	1,804	2,296	492
	20-mm projectile	176	224	48
Visit, Board, Search, and Seizure (VBSS)	0.50-caliber gun ammunition	120,000	120,000	0
Surface-to-Surface Gunnery Exercise (S-S GUNEX)	5-in or 76-mm ammunition	1,380	1,820	440
	Smoke canister	36	47	11
	7.62-mm / 0.50-cal ammunition	10,400	13,700	3,300
Surface-to-Surface Missile Exercise (S-S MISSILEX)	Missile	14	24	10
Air-to-Surface Gunnery Exercise (A-S GUNEX)	7.62-mm / 0.50-cal ammunition	51,200	60,800	9,600
	Smoke canister	128	152	24
Air-to-Surface Missile Exercise (A-S MISSILEX)	Missile	72	100	28
Bombing Exercise (BOMBEX) (Sea)	MK-76	315	315	0
	MK-82	105	105	0
	BDU-45	60	60	0
	CBU	35	35	0
	MK-83	18	18	0
	Smoke canister	35	35	0
Sinking Exercise (SINKEX)	5-in or 76-mm ammunition	700	700	0
	Missiles	66	66	0
	MK-82	24	24	0
	MK-83	24	24	0
	MK-84	24	24	0
Anti-Surface Warfare Torpedo Exercise (ASUW TORPEX) (Submarine-Surface)	MK-48 torpedo	105	105	0
Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX)	Sonobuoy	12,500	12,500	0
	Smoke canister	558	558	0
	MK-39	305	305	0
Anti-Submarine Warfare Torpedo Exercise (ASW TORPEX)	Recoverable Exercise Torpedo (REXTORP)	500	500	0
	MK-39	500	500	0
Flare Exercise (FLAREX)	Flare	6	6	0

Note: Training events not listed above are assumed to have no hazardous materials associated with them.

4.1.4.3 ALTERNATIVE 2 (HAZARDOUS MATERIALS AND WASTES—OPEN OCEAN)

4.1.4.3.1 Increased Tempo and Frequency of Training—Alternative 2

Hazardous Materials

Increases in shipboard hazardous materials transport, storage, and use to support increased training under Alternative 2 would be managed in compliance with OPNAVINST 5090.1B (2002). No substantial changes in hazardous materials management practices for ordinary ship operations and maintenance are anticipated under Alternative 2.

Open-ocean training involving hazardous materials would increase by varying degrees from current levels in support of the FRTP. Only the number of training events would increase; no new types of training would be introduced. Amounts of expended training materials would increase in rough proportion to the overall increase in training (see Table 4.1.4.3.1-1). Table 4.1.4.3.1-2 shows the increase in releases of hazardous materials for sonobuoys.

Under Alternative 2, the total amount of expended training materials would increase by about 113 tons over the No-action Alternative, a 17 percent increase. Under the same assumptions as presented above for the No-action Alternative, the annual rate of deposition of expended training materials would be about 33 lb/nm^2, or an annual increase in concentration of about 18 ppb. Over 20 years, the concentration of expended training materials in bottom sediments (top 6 inches) would increase by about 0.35 ppm, compared to about 0.3 ppm under the No Action Alternative. Annual deposits of UXO would be about 1,690 items compared with about 1,500 under the No-action Alternative, or less than one per 100 nm^2.

Hazardous Wastes

The overall amount of hazardous waste generated by normal vessel and aircraft operation and maintenance during training under Alternative 2 would be more than that generated under the No-action Alternative. This increase would be due primarily to the increased number of training events anticipated under Alternative 2. All hazardous wastes would continue to be managed in compliance with OPNAVINST 5090.1B (2003), Chapter 12. No substantial changes in hazardous materials management practices are anticipated under Alternative 2.

4.1.4.3.2 Enhanced RDT&E Activities—Alternative 2

RDT&E activities under Alternative 2 would consist of the NUWC shipboard tests on the FORACS and SESEF ranges. Navy vessels engaged in these activities would use minor quantities of hazardous materials and generate minor quantities of used hazardous materials during routine ship operations. These materials would be managed in accordance with OPNAVINST 5090.1B. Hazardous materials inventories would be replenished, and used hazardous materials would be offloaded while the vessels are in port.

Table 4.1.4.3.1-1. HRC Training with Hazardous Training Materials Alternative 2—Open Ocean Areas

Training Event	Training Material			
	Item	Annual Quantity (#)		
		No-action	Alt 2	Change
Air Combat Maneuver (ACM)	Chaff	4,428	4,884	456
	Flare	2,214	2,442	228
Surface-to-Air Gunnery Exercise (S-A GUNEX)	5-in projectile	258	324	66
	7.62-mm projectile	258	324	66
	JATO Bottle	86	108	22
	20-mm projectile	163,000	205,000	42,000
Surface-to-Air Missile Exercise (S-A MISSILEX)	Missile	51	78	27
	JATO Bottle	17	26	9
Chaff Exercise (CHAFFEX)	MK-36 Super Rapid Bloom Offboard Chaff	255	278	23
Naval Surface Fire Support (NSFS)	5-in or 76 mm ammunition	1,804	2,296	492
	20-mm projectile	176	224	48
Visit, Board, Search, and Seizure (VBSS)	0.50 caliber gun ammunition	120,000	132,000	12,000
Surface-to-Surface Gunnery Exercise (S-S GUNEX)	5-in or 76-mm ammunition	1,380	1,820	440
	Smoke canister	36	47	11
	7.62-mm / 0.50-cal ammunition	10,400	13,700	3,300
Surface-to-Surface Missile Exercise (S-S MISSILEX)	Missile	14	24	10
Air-to-Surface Gunnery Exercise (A-S GUNEX)	7.62-mm / 0.50-cal ammunition	51,200	60,800	9,600
	Smoke canister	128	152	24
Air-to-Surface Missile Exercise (A-S MISSILEX)	Missile	72	100	28
Bombing Exercise (BOMBEX) (Sea)	MK-76	315	342	27
	MK-82	105	114	9
	BDU-45	60	65	5
	CBU	35	38	3
	MK-83	18	19	1
	Smoke canister	35	38	3
Sinking Exercise (SINKEX)	5-in or 76-mm ammunition	700	700	0
	Missiles	66	66	0
	MK-82	24	24	0
	MK-83	24	24	0
	MK-84	24	24	0
Anti-Surface Warfare Torpedo Exercise (ASUW TORPEX) (Submarine-Surface)	MK-48 torpedo	105	114	9
Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX)	Sonobuoy	12,500	13,900	1,400
	Smoke canister	558	621	63
	MK-39	305	339	34
Anti-Submarine Warfare Torpedo Exercise (ASW TORPEX)	Recoverable Exercise Torpedo (REXTORP)	500	650	150
	MK-39	500	650	150
Flare Exercise (FLAREX)	Flare	6	7	1

Note: Training events not listed above are assumed to have no hazardous materials associated with them.

Table 4.1.4.3.1-2. Sonobuoy Hazardous Materials, Alternative 2 (based on average amounts of constituents)

Sonobuoy Constituent	Annual Amount lb	Increase Over Baseline (percent)
Fluorocarbons	278	11
Copper	4,730	11
Lead	13,100	11
Copper thiocyanate	22,100	11
Tin/lead-plated steel	834	11
TOTAL	41,000	11

Note: values rounded to three significant digits.
Source: U.S. Department of the Navy, no date. San Clemente Island Ordnance Database

4.1.4.3.3 Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Hazardous Materials

Up to three Strike Groups would be allowed to conduct training simultaneously in the HRC. Vessels, aircraft, and other military assets employed in training would carry and use hazardous materials for routine operation and maintenance. Increased hazardous materials storage, transport, or use resulting from these additional training events would be managed in compliance with OPNAVINST 5090.1B (2002).

Hazardous Wastes

Vessels, aircraft, and other military assets employed in the Strike Group Exercises would generate hazardous wastes from routine operation and maintenance activities. Increased hazardous wastes storage, transport, and disposal resulting from these additional training events would be managed in compliance with OPNAVINST 5090.1B (2002), Chapter 19. This alternative would not affect hazardous materials management practices aboard ship.

4.1.4.4 ALTERNATIVE 3 (HAZARDOUS MATERIALS AND WASTES—OPEN OCEAN)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on hazardous materials and waste under Alternative 3 would be the same as those described for Alternative 2.

4.1.5 HEALTH AND SAFETY—OPEN OCEAN

4.1.5.1 NO-ACTION ALTERNATIVE (HEALTH AND SAFETY—OPEN OCEAN)

4.1.5.1.1 HRC Training—No-action Alternative

Public Safety

Training that occurs over the Open Ocean Area will continue to be conducted mainly in Warning Areas. Range Safety officials will ensure that projectiles, lasers, targets, and missiles are operated safely, and that Air Operations and other potentially hazardous training events are safely executed in controlled areas. The Navy's standard range safety procedures are designed to minimize risks to the public and to Navy training and its personnel. Before any potentially hazardous training is allowed to proceed, the overwater target area will be determined to be clear using inputs from ship sensors, visual surveillance of the range from aircraft and range safety boats, and radar and acoustic data.

Target areas will be cleared of personnel prior to conducting training, so the only public health and safety issue will be if a training event has a significant failure leading to debris or expended materials outside the expected area. Risks to public health and safety are minimized by clearing a hazard area that accounts for potential failures. For some vehicles, the hazard area is sufficiently contained due to physical limits of the vehicle (such as an unguided rockets) that flight termination system is not required. For other test vehicles (such as guided missiles), a flight termination system is required, which provides high reliability that no debris will exit the hazard area.

In addition, all training must comply with DoD Directive 4540.1, "Use of Airspace by U.S. Military Seas" and OPNAVINST 3770.4A, "Use of Airspace by U.S. Military Aircraft and Firing Over the High Seas" which specify procedures for conducting Aircraft Operations and for firing missiles and projectiles. Safety procedures include:

- Missile and projectile firing areas are to be selected, "so that trajectories are clear of established oceanic air routes or areas of known surface or air activity."
- During use of ordnance from aircraft or surface vessels, range procedures, and safety practices ensure that there are no vessels or aircraft in the intended path or impact area of the ordnance.
- For training events with a large hazard footprint (e.g., MISSILEXs), special sea and air surveillance measures are taken to search for, detect, and clear the area of intended events.
- Aircraft are required to make a clearing pass over the intended target area to ensure that it is clear of boats, divers, or other non-participants.
- The Navy notifies the public of hazardous activities through the use of NOTAMs and NOTMARs.
- Aircraft carrying ordnance are not allowed to over-fly surface vessels.

The remoteness of the offshore ranges provides a large degree of isolation from population centers. The Navy establishes temporary access limitations for areas with risk of injury or property damage to the public.

Demolition Operations will be conducted in accordance with Commander, Naval Surface Force, U.S. Pacific Fleet Instruction 3120.8F. Commander, Naval Surface Force, U.S. Pacific Fleet Instruction 3120.8F specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as possible shipping, recreational boating, diving, and commercial or recreational fishing.

Recreational diving within the Open Ocean Area takes place primarily at known diving sites. The locations of popular diving sites are well-documented, dive boats are typically well-marked, and diver-down flags will be visible from the ships conducting the proposed training, so possible interactions between training events within the offshore areas and scuba diving will be minimized. The Navy will also notify the public of hazardous activities through NOTAMs and NOTMARs. Recreational dives typically take place in waters less than 125 ft deep, and usually within 3 mi of shore, while most Navy training occurs in deep waters more than 3 mi from shore, so popular dive sites and Navy training activities will overlap very little.

Offshore Operations include the use of MFA/HFA sonar. The effect of sonar on humans varies with the frequency of sonar involved. Of the three types of sonar (high-, mid-, and low-frequency), mid- frequency and low-frequency are the two with the greatest potential to affect humans. Research was conducted for MFA sonar at the Naval Submarine Medical Research Laboratory and the Navy Experimental Diving Unit to determine permissible limits of exposure to MFA sonars. Based on this research, an unprotected diver could safely operate for over 1 hour at a distance of 1,000 yards from the Navy's most powerful sonar. At this distance, the sound pressure level will be approximately 190 dB. At 2,000 yards or approximately 1 nm, this same unprotected diver could operate for over 3 hours. Exposure to MFA sonar in excess of 190 dB could result in slight visual-field shifts, fogging of the faceplate, spraying of any water within the mask, and general ear discomfort associated with loud sound.

Prior public notification of Navy training, use of known training areas, avoidance of non-military vessels and personnel, and the remoteness of the Open Ocean Area reduce the potential for interaction between the public and Navy vessels. To date, these safety strategies have been effective.

Public Health

Management of hazardous materials and hazardous wastes in conjunction with Navy training on the Open Ocean Area was addressed in Section 4.1.4. Materials expended on the sea ranges during Navy training will include liquid and soluble hazardous constituents that will quickly disperse in the water column. These materials also will include solid hazardous constituents that will quickly settle to the ocean floor and soon become buried in sediment, coated by corrosion, or encrusted by benthic organisms. Due to the very small quantities of these materials relative to the extent of the sea ranges (see Section 4.1.4.1.1), the volume of the ocean, and the remoteness of the sea ranges relative to human populations, their concentrations in areas of potential human contact generally will be undetectable. The analysis in Section 4.1.4 identified no significant impacts from use of hazardous materials or generation, transportation, and disposal of hazardous wastes in the HRC.

Sources of EMR include radar, navigational aids, and Electronic Warfare (EW). These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the United States. EW systems emit EMR similar to that from cell phones, hand-held radios, commercial radio, and television stations. SOPs in place to protect Navy personnel and the public include setting the heights and angles of EMR transmission to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. To avoid excessive exposures from EMR, military aircraft are operated in accordance with standard procedures that establish minimum separations distances between EMR emitters and people, ordnance, and fuels. Based on the power levels emitted, the minimum safe separation distances established, and the additional measures identified above, no substantial adverse effects are anticipated.

4.1.5.1.2 HRC RDT&E Activities—No-action Alternative

RDT&E activities under the No-action Alternative will consist of the NUWC shipboard tests on the SESEF range and missile defense activities. Navy vessels engaged in activities on the SESEF range will pose no public health or safety risk during routine ship operations. Missile defense activities include aerial targets launched from PMRF, mobile sea-based platforms, or military cargo aircraft. During missile defense RDT&E activities, a ballistic missile target vehicle is launched from PMRF and intercepted by a ship-launched missile. Missile launches by their very nature involve some degree of risk, and it is for this reason that DoD and PMRF have specific launch and range safety policies and procedures to assure that any potential risk to the public and government assets (launch support facilities) are minimized.

Ship and Aircraft Exclusion Areas ensure that vehicles are not in areas of unacceptable risk. These areas include the places where planned debris may impact (such as dropped stages of multi-stage vehicles or debris from hit-to-kill intercept engagements) and also the regions at risk if there is a failure (such as under the planned flight path). Aircraft regions are designed in a similar fashion. The specific definition of each of these regions is determined by a probabilistic risk analysis that incorporates modeling of the vehicle response to malfunctions, mission rules (such as Destruct Limits), and the vulnerability of vehicles to debris. NOTMARs and NOTAMs are issued for the entire region that may be at risk, encompassing both exclusion areas and warning areas (areas with very remote probability of hazard). Surveillance by aircraft and satellite is used to ensure that there are no ships or aircraft in cleared areas, and also that the collective risk meets acceptable risk criteria for the mission.

Many procedures are in place to mitigate the potential hazards of an accident during the flight of one of these missiles. The PMRF Flight Safety Office prepares Range Safety Operational Procedures (RSOPs) for missions involving missiles, supersonic targets, or rockets. This RSOP addresses the safety aspects of debris from hit-to-kill intercept tests where an interceptor missile impacts a target missile. The Commanding Officer of PMRF approves each RSOP, which includes specific requirements and mission rules. The Flight Safety Office has extensive experience in analyzing the risks posed by such a mission. In spite of the developmental nature of missile activities (which leads to a significant probability of mission failure), the United States has an unblemished record of public safety during missile and rocket launches. Appendix K describes the general approach to protect the public and involved personnel from launch accident hazards.

Prior to each mission, a comprehensive analysis of the proposed mission, including flight plans, planned impact areas, vehicle response to malfunctions, and effects of flight termination action is performed. A probabilistic analysis is performed with sufficient conservative assumptions incorporated to ensure that the risks from the mission are acceptable. The guidance of the Range Commanders' Council (RCC) for acceptable risk (in RCC-321) is followed. These acceptable risk criteria are designed to ensure that the risk to the public from range operations is lower than the average background risk for other third-party activities (for example, the risk of a person on the ground being injured from an airplane crash).

4.1.5.1.3 Major Exercises—No-action Alternative

Major Exercises consist of training and, in some cases, RDT&E activities, both addressed above. Potential impacts will be similar to those described earlier for training and RDT&E activities.

4.1.5.2 ALTERNATIVE 1 (HEALTH AND SAFETY—OPEN OCEAN)

4.1.5.2.1 Increased Tempo and Frequency of Training—Alternative 1

Offshore training proposed under Alternative 1 would have all the components of the No-action Alternative, but training would increase and new weapons platforms and systems would be employed. The safety procedures implemented under this alternative are the same as those described under the No-action Alternative.

Public Safety

Several training events would experience increases from current levels in support of the FRTP. Table 2.2.2.3-1 describes those increases. Only the number of training events would increase; no new types of training would be introduced. Increases in the number of individual training events would increase the potential for conflicts with non-participants. Given the Navy's comprehensive safety procedures and its safety record for training, however, the actual potential for public safety impacts from training would remain low.

Public Health

Management of hazardous materials and hazardous wastes in conjunction with Navy training on the Open Ocean Area is addressed in Section 4.1.4. The quantities of materials expended on the sea ranges during Navy training would increase moderately under Alternative 1, as compared to the quantities expended under the No-action Alternative. Expended training materials would include liquid or soluble hazardous materials that would quickly disperse in the water column. They also would include solid hazardous constituents that would quickly settle to the ocean floor and soon become buried in sediment, coated by corrosion, or encrusted by benthic organisms. Due to the very small quantities of these materials relative to the extent of the sea ranges, the volume of the ocean, and the remoteness of the sea ranges relative to human populations, their concentrations in areas of potential human contact generally would be low to undetectable.

Sources of EMR include radar, navigational aids, and EW. These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the United States. EW systems emit EMR similar to that from cell phones, hand-held radios, commercial radio, and television stations. SOPs in place to protect Navy personnel and the public include setting the heights and angles of EMR transmission to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. To avoid excessive exposures from EMR, military aircraft are operated in accordance with standard procedures that establish minimum separations distances between EMR emitters and people, ordnance, and fuels. Based on the power levels emitted, the minimum safe separation distances established, and the additional measures identified above, no substantial adverse effects are anticipated.

4.1.5.2.2 Enhanced RDT&E Activities—Alternative 1

RDT&E activities under Alternative 1 would consist of the NUWC shipboard tests on the FORACS and SESEF ranges and missile defense activities. Navy vessels engaged in NUWC activities would pose no public health or safety risk during routine ship operations. Proposed launches associated with enhanced and future RDT&E activities would have a similar impact on health and safety as those described for the No-action Alternative.

4.1.5.2.3 HRC Enhancements and Major Exercises—Alternative 1

Major Exercises consist of training and, in some cases, RDT&E activities, both addressed earlier. Potential impacts would be similar to those described earlier for training and RDT&E activities.

4.1.5.3 ALTERNATIVE 2 (HEALTH AND SAFETY—OPEN OCEAN)

4.1.5.3.1 Increased Tempo and Frequency of Training—Alternative 2

Public Safety

Several training events would experience increases from current levels in support of the FRTP. Table 2.2.2.3.1-1 describes those increases. Only the number of training events would increase; no new types of training would be introduced. Increases of over 100 percent in the number of individual training events would increase the potential for conflicts with non-participants. Given the Navy's safety procedures and its safety record for training, however, the actual potential for public safety impacts from training would remain low.

Public Health

Management of hazardous materials and hazardous wastes in conjunction with Navy training on the Open Ocean Area is addressed in Section 4.1.4. The quantities of materials expended on the sea ranges during Navy training would increase substantially under Alternative 2, as compared to the quantities expended under the No-action Alternative. Expended training materials would include liquid and soluble hazardous constituents that would quickly disperse in the water column. They also would include solid hazardous constituents that would quickly settle to the ocean floor and soon become buried in sediment, coated by corrosion, or encrusted by benthic organisms. Due to the very small quantities of these materials relative to the extent of the sea ranges, the volume of the ocean, and the remoteness of the sea ranges relative to human populations, their concentrations in areas of potential human contact generally would be low to undetectable.

Sources of EMR include radar, navigational aids, and EW. These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the United States. EW systems emit EMR similar to that from cell phones, hand-held radios, commercial radio, and television stations. SOPs in place to protect Navy personnel and the public include setting the heights and angles of EMR transmission to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. To avoid excessive exposures from EMR, military aircraft are operated in accordance with standard procedures that establish minimum separations distances between EMR emitters and people, ordnance, and fuels. Based on the power levels emitted, the minimum safe separation distances established, and the additional measures identified above, no substantial adverse effects are anticipated.

4.1.5.3.2 Enhanced RDT&E Activities—Alternative 2

RDT&E activities under Alternative 2 would consist of the NUWC shipboard tests on the FORACS and SESEF ranges and missile defense activities. Navy vessels engaged in NUWC activities would pose no public health or safety risk during routine ship operations. Proposed launches associated with enhanced and future RDT&E activities would have a similar impact on health and safety as those described for the No-action Alternative.

4.1.5.3.3 Future RDT&E Activities—Alternative 2

Future RDT&E activities for the Open Ocean Area would include directed energy. PMRF would develop the necessary SOPs and range safety requirements necessary to provide safe training associated with future high-energy laser tests. PMRF Range Safety would require the proposed high-energy laser program to provide specific information about the proposed usage so that a safety analysis of all types of hazards could be completed and appropriate remedial procedures would be taken before initiation of potentially hazardous laser activities.

The high-energy laser program office would be responsible for providing all necessary documentation to PMRF prior to issuance of the Range Safety Approval (RSA) or RSOP. These include:

- Letter of Approval or a Letter of No Concern from the FAA for the use of the laser within Honolulu FAA airspace,
- Letter of Approval or a Letter of No Concern for the use of their laser if it will or has the potential of lasing above the horizon from United States Space Command (USSPACECOM) as well as clearance from USSPACECOM for each intended laser firing,
- Letter of Approval from the Laser Safety Review Board (LSRB) at Dahlgren for the use for their laser on Navy Ranges (this letter entails a survey and certification of the laser by the LSRB), and
- Range Safety Laser Data Package.

The Range Safety Laser Data Package is intended to provide the Range Safety Office with sufficient information to perform an evaluation of the safety of the laser and the proposed lasing activity and to approve the laser and its operation, and any risk mitigations required.

The PMRF Range Safety Office would analyze the submittal to ensure that it is in compliance with PMRF safety criteria, which is based on Range Commanders Council document RCC-316, OPNAVINST 5100.27A, and *2004 Laser Safety Survey Report for the Pacific Missile Range Facility Open Ocean Range*. PMRF would be responsible for publishing an RSA or an RSOP specifying hazard areas and safety guidelines for the operation of the laser. The RSA/RSOP process would include an onsite safety inspection of the system by a PMRF Laser Safety Specialist to ensure that it complies with the Navy guidelines for lasers. As appropriate, the Range Safety Office would review the proposed laser systems for other non-optical hazard mechanisms, such as toxic releases.

Safety assurance would include defining exclusion areas, ensuring that the NOTAM and NOTMAR requests are submitted to the responsible agencies (FAA and Coast Guard respectively), ensuring that the laser operation falls within the approved operational areas, surveillance/clearance of the operational area and scheduling of the appropriate airspace and surface space.

For general training scenarios of the proposed high-energy laser, the Range Safety Office would build on the *2004 Laser Safety Survey Report* performed by the Corona Division of the Naval Surface Warfare Center (Solis, 2004). This document defines the boundaries of the two laser target areas at PMRF: the outer W-186 Area and the outer W-188 Area are multipurpose bombing and laser target ranges used for aerial lasing. Only airborne laser designators may be used on the laser target areas. Procedures and restrictions for use of these areas are defined in this survey.

4.1.5.3.4 Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Vessels, aircraft, and other military assets employed in the Strike Group Exercises would increase the overall intensity and duration of Navy training on the sea ranges. The Strike Group training would be similar to other large-exercise training events held on the range, and similarly would consist of a number of individual training events spread over large areas among several ranges. As with those other training events, Multiple Strike Group training is not anticipated to pose a substantial risk to public safety.

4.1.5.4 ALTERNATIVE 3 (HEALTH AND SAFETY—OPEN OCEAN)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.1.6 NOISE—OPEN OCEAN

4.1.6.1 NO-ACTION ALTERNATIVE, ALTERNATIVE 1, ALTERNATIVE 2, AND ALTERNATIVE 3 (NOISE—OPEN OCEAN)

Potential airborne sound as a result of Navy training was examined to determine what effect the training and RDT&E activities would have in the overall ambient sound levels within the HRC that resulted in an effect on the traditionally analyzed sensitive human sound receptors (i.e., schools, hospitals, etc.).

The factors considered in determining the significance of sound effects on marine mammals, birds, and fish are discussed within other sections of this chapter. Potential sound effects on fish (to the extent that sound introduced into the sea can affect catch) and marine mammals are discussed in Section 4.1.2.

While HRC training does generate airborne sound, sound-generating events in the Open Ocean Area do not result in perceptible changes to the overall sound environment. In addition, training does not have an effect on sensitive sound receptors because these events are typically conducted away from populated areas and most sensitive sound receptors. For training events that involve the expenditure of munitions either from aircraft or surface vessels, the Navy uses advance notice and scheduling, and strict on-scene procedures to ensure the area is clear of civilian vessels or other non-participants. The public is notified of the location, date, and time of the hazardous activities via NOTMARs, thereby precluding any acoustical impacts on sensitive receptors. Proposed increases in training and RDT&E activities under Alternative 1, Alternative 2, and Alternative 3 would result in increases in sound events. The increases would contribute a negligible level of increased sound, however, because they would continue to occur within the open ocean where typically no sensitive sound receptors are present.

The HRC is approved for supersonic flight; however, no data are available that describe the exact location of supersonic activities. Supersonic activity in the HRC is generally restricted to altitudes greater than 30,000 ft above sea level or in areas at least 30 nm from shore. These restrictions prevent most sonic booms from reaching the ground. There would be no perceptible increase in long-term sound levels as a result of sonic booms, and populated areas are not likely to be affected since such flights would typically be conducted in areas greater than 30 nm offshore and above 30,000 ft. More-detailed information on sonic booms is provided in Appendix G.

4.1.7 WATER RESOURCES—OPEN OCEAN

4.1.7.1 NO-ACTION ALTERNATIVE (WATER RESOURCES—OPEN OCEAN)

4.1.7.1.1 HRC Training—No-action Alternative

Under the No-action Alternative, Navy training in the Open Ocean Area (see Table 4.1-1) will expend a wide variety of materials, a substantial portion of which will not be recovered. Types of unrecovered materials include the following:

- Incidental releases of fuel, hydraulic fluid, and oil;
- Expendable training materials and devices (e.g., sonobuoys, targets);
- Munitions, including bombs, projectiles, torpedoes, and missiles; and
- Chaff and flares

Incidental Releases

Potential impacts on water quality will primarily be associated with the incidental release of materials from aircraft, surface ships, submarines, or other vessels. Hazardous constituents of concern, possibly emitted from the surface ship or submarine (i.e., fuel, oil), are less dense than seawater; they will remain near the surface and, therefore, will not affect the benthic community. Sheens produced by these incidental releases will not cause any significant long-term impact on water quality because most of the toxic components (e.g., benzene, xylene) will evaporate within several hours to days or will be degraded by biogenic organisms (e.g., bacteria, phytoplankton, zooplankton).

Expended Training Materials

At-sea training and test activities involve numerous combatant ships, torpedo retrieval boats, and other support craft. These vessels are manned, and do not intentionally expend any munitions constituents into the water. Offshore training activities also expend bombs, missiles, torpedoes, sonobuoys, targets, flares, and chaff, and accessory materials such as guide wires and hoses, from ships, submarines, or aircraft. Various types of training items are shot, launched, dropped, or placed within the HRC. Training materials entering the ocean in large quantities could affect marine water quality.

Most weapons and other devices used during at-sea training exercises are removed at the conclusion of the exercises. Some training materials, including gun ammunition and naval shells, bombs and missiles, mortars and rockets, targets and sonobuoys, and chaff and flares, however, are used on the range and not recovered. Items expended on the water, and fragments not recognizable as expended training materials (e.g., flare residue or candle mix), typically are not recovered. The types of expendable training materials used in each category of at-sea training are generally discussed below. Following this discussion of expended training materials by warfare area is an evaluation of each type of expendable training material, and a summary of their constituents of concern.

The ordnance used in offshore training activities usually does not carry “live” warheads (i.e., those with explosives). Explosives and propellants in live rounds are mostly consumed during operation of the item, leaving only residues. Training items that do contain energetic materials may fail to function properly, however, and—if not recovered—remain on the range as UXO containing explosives or propellants that eventually will be released to the environment. Sonobuoys and flares, smoke grenades, and other pyrotechnic training devices expended in the water may leak or leach toxic substances as they degrade and decompose. Table 4.1.7.1.1-1 lists constituents of concern for some ordnance components.

Table 4.1.7.1.1-1. Ordnance Constituents of Concern

Training Munitions	Constituent of Concern
Pyrotechnics Tracers Spotting Charges	Barium chromate Potassium perchlorate
Oxidizers	Lead oxide
Delay Elements	Barium chromate Potassium perchlorate Lead chromate
Propellants	Ammonium perchlorate
20-mm projectiles	Depleted Uranium
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

Anti-Air Warfare

Anti-Air Warfare (AAW) training includes Air Combat Maneuvers, Air Defense Exercise, and Air-to-Air Missile Exercise. Expended training materials for this warfare area consist mostly of spent projectiles and unrecovered targets from Surface-to-Air Gunnery Exercises (S-A GUNEXs), Surface-to-Air Missile Exercises (S-A MISSILEXs), and stinger missile exercises. The expenditure of about 294,000 small arms ammunition (see Table 4.1.4.1.1-1) would deposit about 6 tons per year (TPY) of mostly non-toxic metallic materials in bottom sediments in the HRC. Of the 163,000 rounds of 20 mm projectiles fired annually in S-A GUNEX training, as many as 10 percent (16,300) could include depleted uranium (DU). The 20 mm projectiles are fired from the Phalanx Close-In Weapon System (CIWS). The CIWS is the Navy's primary point defense Anti-Air-Warfare (AAW) weapon system and is found on nearly every aircraft carrier, surface combatant, and amphibious ship in the Navy's inventory. However, the CIWS is being replaced with a missile-based system. Also, as DU rounds are no longer manufactured for use by the Navy, the Navy's inventory and subsequent level of use is expected to decrease. MISSILEXs use missiles and aerial targets. Participating aircraft use a variety of air-to-air missiles, while surface ships use surface-to-air missiles. Typically, two NATO Seasparrow missiles and four BQM-74 aerial targets are expended during a MISSILEX. These items contain propellants, fuels, engine oil, hydraulic fluid, and batteries, all of which may affect water quality. The total amounts of expended training materials for this warfare area weigh about 94 TPY. The aggregate effects on water quality of training materials expended on the range under the No-action Alternative are addressed below.

Anti-Submarine Warfare

ASW encompasses Air ASW, Surface Ship ASW, and Submarine ASW. These training activities affect water and sediment quality by expending training materials that release constituents into the water column and accumulate in ocean bottom sediments over time. Air and Ship ASW exercises drop sonobuoys and targets (MK-30 and MK-39 Expendable Mobile ASW Training Targets [EMATTs]) into the ocean. The Submarine ASWs may expend MK-30 or MK-39 (EMATT) targets, although most exercises use another submarine as a target; no sonobuoys are used. Any training torpedoes used generally are recovered following each event.

Under the No-action Alternative, Air ASW, Ship ASW, and Submarine ASW events conducted each year use about 600 torpedoes, 800 targets, and 12,500 sonobuoys. Sonobuoys sink after use. About 55 percent of the EMATTs are recovered, all of the MK-30 targets are recovered, and all of the exercise torpedoes are recovered. The main sources of water quality impacts are the batteries or fuel used to propel or operate EMATTs and sonobuoys. The control wires, ballast, and other accessories from torpedo exercises mostly affect the bottom sediments. The aggregate effects on water quality of training materials expended on the range under the No-action Alternative are addressed below.

Mine Warfare

Small Object Avoidance training does not require targets or other devices that use or contain hazardous materials. Under the No-action Alternative, 22 MINEX exercises are conducted each year. Mine training shapes are made of non-toxic materials that do not affect water quality. Most of these events consist of one aircraft dropping inert mine training shapes. MINEXs are limited to physical effects on ocean bottom sediments by inert mine training shapes. Due to their chemical composition and size, these mine training shapes do not substantially affect the ocean bottom. Discarded mine training shapes do not substantially affect ocean bottom sediments at their settlement locations.

Anti-Surface Warfare

ASUW consists mostly of MISSILEXs, Bombing Exercises (BOMBEXs), GUNEXs, and Sinking Exercises (SINKEXs). GUNEXs expend projectiles against stationary and maneuverable surface targets. The A-S MISSILEXs fire AGM-114 Hellfire missiles at high-speed targets from SH-60 helicopters. In the BOMBEXs, FA-18 aircraft use MK-82 live and BDU-45 practice bombs to attack surface targets. The No-action Alternative includes six SINKEXs; these exercises use a variety of weapons platforms (e.g., aircraft, surface vessels, submarines) expending several different types of ordnance against an environmentally clean ship hulk. The total amounts of expended training materials for this warfare area are listed in Table 4.1.4.1.1-1. The aggregate effects on water quality of training materials expended on the range under the No-action Alternative are addressed below.

Electronic Combat

Typical Electronic Combat (EC) activities include threat avoidance training, signals analysis, use of airborne and surface electronic jamming devices, and firing of simulated (Smokey) Surface-to-Air Missiles (SAMs). When practicing tactics against simulated SAMs, aircrews deploy chaff and defensive flares when over water. Under the No-action Alternative, 50 EC events are conducted. The aggregate effects on water quality of training materials expended on the range under the No-action Alternative are addressed below.

Smokey SAMs, chaff, and flares are the only EC ancillary systems that can affect water quality resources. The main source of expended training materials is practice S-A Missiles (referred to as Smokey SAMs). Constituents of Smokey SAMs that end up in the ocean after use include a 2-foot long biodegradable Styrofoam-like body, and any unburned propellant.

The major constituents of chaff and flares are aluminum and magnesium. Some flares also contain chromium and lead. The aluminum fibers that make up chaff are generally non-toxic. Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and scavenged by particulates and transported to the bottom sediments (Monterey Bay Aquarium Research Institute, 2002).

Combustion products from flares are mostly non-hazardous, consisting of magnesium oxide, sodium carbonate, carbon dioxide, and water. Small amounts of metals are used to give flares and other pyrotechic materials bright and distinctive colors. The amounts of flare residues are negligible, and the chemical constituents do not substantially affect water quality resources.

Aggregated Expended Training Materials Deposited on the HRC

This section evaluates the aggregate effects of the unrecovered training materials from all training activities on the open ocean water quality of the HRC, based on the quantitative information provided in the Hazardous Materials and Wastes section (see Section 4.1.4.1).

Gun Shells, Small Arms, and Practice Bombs

These training materials generally remain intact upon contact with the surface of the ocean, and sink quickly through the water column to the bottom. They thus do not affect water quality directly. Degradation and dispersal of explosive and propellant residues, and explosives and propellants from items that do not function (i.e., UXO), would not substantially affect bottom sediments or water quality. Corrosion of metallic materials may affect the bottom sediments immediately surrounding expended items, but would not contaminate substantial portions of the ocean bottom. Corrosion of metallic materials and the leaching of toxic substances from them also may indirectly affect water quality in their vicinity, but not to a substantial degree due to the relatively insignificant amount of material, its slow rate of release into the environment, and the action of ocean currents in dispersing the materials once they enter the water column.

20-mm Depleted Uranium Projectiles

The CIWS fires 20-mm DU rounds during training and system calibration. It is the only Navy weapon system that employs DU rounds. A Nuclear Regulatory Commission (NRC) license to fire CIWS DU rounds was required before the system could be employed aboard naval vessels. The NRC approved Navy's license application which clearly stated that CIWS DU rounds would be fired at sea and not recovered. Consultations with the NRC and Environmental Protection Agency (EPA) determined that this practice was acceptable because of the absence of environmental risk.

Unlike other DU munitions, CIWS rounds are not intended for use against hardened armored targets. They are designed to penetrate the thin skin of an incoming missile. The DU portion of a CIWS round is less than 2 inches long and weighs 2.5 ounces. The CIWS rounds produce little pyrophoric (spark producing) action and consequential aerosolization of DU when they strike a target.

Uranium occurs naturally in seawater, marine sediments, and marine organisms. Depleted uranium is 40 percent less radioactive than naturally occurring uranium. A CIWS DU round contains approximately the same small amount of radioactivity as five household smoke detectors. Once fired, these rounds fall into the ocean mostly intact and sink to the bottom. CIWS DU rounds dissolve in seawater at a very slow rate, taking many years to completely dissolve. This very small amount of depleted uranium released to the environment combined with the turbidity and the large volume of water above the rounds does not significantly contribute to the concentration of uranium naturally in the marine environment. At 1 foot, the radiation levels from a CIWS DU round are indistinguishable from normal background radiation levels.

Missiles and Aerial Targets

Missiles and aerial targets used in training contain hazardous materials as normal parts of their functional components. Missiles contain igniters, explosive bolts, batteries, warheads, and solid propellants, and aerial targets contain fuels, engine oil, hydraulic fluid, and batteries, all of which may affect water quality. Exterior surfaces may be coated with anti-corrosion compounds containing toxic metals. Most of the missiles are equipped with non-explosive warheads that contain no hazardous materials. For missiles falling in the ocean, the principal contaminant is unburned solid propellant residue and batteries. Table 4.1.7.1.1-2 lists the missiles typically fired during training and their associated hazardous materials.

Table 4.1.7.1.1-2. Missiles Typically Fired in Training Exercises

Type	Hazardous Materials
AIM-7 Sparrow	The missile is propelled by a Hercules MK-58 dual-thrust solid propellant rocket motor. The explosive charge is an 88-lb WDU-27/B blast-fragmentation warhead.
AIM-9 Sidewinder	Depending on the model, the propulsion system contains up to 44 lb of solid double-base propellant. The warhead contains approximately 10 lb of PBX-N HE.
AIM-114B Hellfire	The missile is propelled by a solid propellant rocket motor, the Thiokol TX-657 (M120E1).
AIM-120 AMRAAM	The missile is propelled by a solid propellant (ATK WPU-6B booster and sustainer) rocket motor that uses RS HTPB solid propellant fuel). The warhead is 40 lb of HE.
SM-1 and SM-2 Standard Missile	Propulsion system has 1,550 lb of aluminum and ammonia propellant in the booster and 386 lb of propellant in the sustainer. The warhead is 75 - 80 lb, depending on the version. Potassium hydroxide battery 1.9 oz.

Missile propellants typically contain ammonium perchlorate, aluminum compounds, copper, and organic lead compounds. Perchlorate is an inorganic chemical used in the manufacture of solid rocket propellants and explosives. A typical surface-to-air missile (e.g., SM-2) initially has 150 lb of solid propellant and uses 99 to 100 percent of the propellant during the exercise (i.e., <1.5 lb remaining). The remaining solid propellant fragments sink to the ocean floor and undergo physical and chemical changes in the presence of seawater. Tests show that water penetrates only 0.06 inches into the propellant during the first 24 hours of immersion, and that fragments slowly release ammonium and perchlorate ions. These ions rapidly disperse into the surrounding seawater such that local concentrations are extremely low.

Because perchlorate historically has not been considered a widespread contaminant, no Federal or State water standards exist (California Department of Public Health, 2007). The Department of Health Services has adopted a notification level for perchlorate in drinking water of 6 micrograms per liter (µg/L); however, this action level is not applicable to this analysis involving missile testing over the ocean.

Assuming that all of the propellant on the ocean floor was in the form of 4-inch cubes, only 0.42 percent of it will be wetted during the first 24 hours of immersion. If all of the ammonium perchlorate leaches out of the wetted propellant, then approximately 0.01 lb will enter the surrounding seawater. The leaching rate will decrease over time as the concentration of perchlorate in the propellant declines. The aluminum in the propellant binder will eventually be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide will not pose a threat to the marine environment.

As noted above, most of the missiles would have non-explosive warheads that do not contain hazardous materials. Some missiles, however, could contain explosives. An estimated 99.997 percent of this material would be consumed in a high-order detonation, typically leaving less than 1.0 lb of residue. Explosives residues would degrade and disperse in a manner similar to that of propellants, and similarly would not be a substantial concern. Studies have concluded that munitions residues do not impact the marine environment.

Missile batteries are another source of contaminants. The batteries used for missiles are similar in type and size to those used for sonobuoys. The evaluation of the effects of expended sonobuoys (see below) concluded that they do not have a substantial effect on marine water or sediment quality.

Aerial Targets

Aerial targets are used on the HRC for testing and training. Most aerial targets contain jet fuel, oils, hydraulic fluid, batteries, and explosive cartridges. Following a training exercise, targets are generally flown (using remote control) to predetermined recovery points. Fuel is shut off by an electronic signal, the engine stops, and the target descends. A parachute is activated and the target lands on the ocean's surface, where it is retrieved by range personnel using helicopters or range support boats. Some targets are hit by missiles, however, and fall into the ocean. Table 4.1.7.1.1-3 lists hazardous materials from airborne targets typically used in Navy training.

Table 4.1.7.1.1-3. Hazardous Materials in Aerial Targets Typically Used in Navy Training

Type	Hazardous Materials
LUU-2	Flare materials, including magnesium and explosive bolts.
Tactical Air-Launched Decoy (TALD)	The tail section may contain a flare.
BQM-74	Oils, hydraulic fluids, a nickel-cadmium battery, and 16 gallons of JP-8 fuel.

Two types of aerial targets are used during MISSILEX: BQM-74 and the Ballistic Aerial Target System (BATS). The BQM-74 is the most common target used for this exercise. It is usually recovered after an exercise, unless it is severely damaged by a direct hit. The BATS are destroyed upon impact with the water, and are not recovered.

Hazardous materials in targets (e.g., BQM-74) include fuel and batteries. The hazardous constituents of concern for fuels, engine oil, and hydraulic fluids are hydrocarbons (compounds primarily containing carbon and hydrogen). They can be present in a wide variety of substances, such as petroleum-based fuels (diesel, JP-5, JP-4, bunker fuel, and gasoline), oils, and lubricants (Johnston et al., 1989; Grovhoug, 1992; Shineldecker, 1992). The most toxic components of fuel oils are aromatic hydrocarbons such as benzene, toluene, xylene, and Polycyclic Aromatic Hydrocarbons (PAHs) such as naphthalene, acenaphthene, and fluoranthene. Some PAHs are volatile and water-soluble (Curl and O'Donnell, 1977). PAHs may be hazardous to wildlife, and they also can be hazardous to human health (Hoffman et al. 1995).

A BQM-74 initially has 107 lb of liquid fuel. This analysis conservatively assumes that 20 percent of the fuel (i.e., 21.5 lb) remains at the completion of each mission, and that 5 percent of the fuel comprises PAHs (PAHs such as acenaphthene generally make up less than 4 percent of fuel oil, and naphthalene is generally less than 1 percent [National Research Council, 1985]). This analysis also assumes a worst-case scenario in which the BQM-74 is not recovered, but is destroyed on impact with the water. (Note: most targets are recovered by using an engine cut-off switch and a parachute. The target is retrieved from the water by helicopter.)

In the case of a severe malfunction and a crash, the target hits the water surface at a speed of at least 500 knots (600 miles per hour) and can realistically affect an area up to 10 times the size of the target (taking into consideration water displacement). A typical target (BQM-74) is approximately 12.9 ft long, 2.3 ft high, with a wingspan of approximately 5.8 ft. The analysis therefore assumes that a circle with a diameter of 58 ft encompasses the affected area. Given the low density of the hazardous constituents (e.g., fuel, oil) relative to seawater, the analysis also assumes that only the top 3 ft of the water column is affected. Based on these assumptions, the affected surface area is about 10,600 ft^2 and the affected volume of seawater is 2.5×10^5 gallons. The resulting concentration of PAHs is 503 µg/L.

Once concentrations are determined, comparisons with the NAWQC are possible for a single training event. The NAWQC provides both acute and chronic concentrations. Acute values are levels producing short-term effects (i.e., lethality), while chronic values produce long-term or sub-lethal effects. The estimated total PAHs concentration of 503 µg/L is below the threshold established in the NAWQC for individual PAHs: naphthalene (acute = 2,350 µg/L) and acenaphthene (acute = 970 µg/L; chronic = 710 µg/L). Thus, a crash of a BQM-74 would have no substantial effect on water quality.

The combined concentrations from multiple exercises throughout a year cannot be compared with the NAWQC because of the assumptions upon which these criteria are based. The criteria apply to instantaneous or short-term concentrations, not to chronic or long-term effects. Even if two events were to occur simultaneously, they are not likely to affect the same volume of water. Hence, the water quality analysis considers each proposed training activity separately.

The NAWQC includes maximum permissible concentrations to protect aquatic life from water contaminants. Saltwater criteria exist for benzene, toluene, and three PAH compounds: naphthalene, acenaphthene, and fluoranthene. Benzene and toluene are both very volatile, and are unlikely to be present after a short period. Fluoranthene is generally not present, or is found at <0.1 percent) in refined petroleum (National Research Council, 1985). These constituents were therefore not considered in this analysis.

Batteries are another source of contaminants from targets. The batteries used for targets are similar in type and size to those used for sonobuoys. The evaluation of the effects of expended sonobuoys (see below) concluded that they do not have a substantial effect on marine water or sediment quality.

Surface Targets

Surface targets generally include: (1) stationary targets such as the large (10 ft on a side) cube-shaped inflatable urethane balloon (called a “Killer Tomato”); (2) towable targets such as 14-ft long three hulled trimaran having a large billboard-like target area extending vertically from the center or a low profile 18-ft long 4-ft diameter inflatable cylinder pointed at both ends (called a “banana”); (3) mobile targets such as a “roboski”, which is a remote controlled jet-ski; and (4) ship hulks. In general, these targets are constructed of non-toxic materials, and have few or no hazardous constituents. Ship hulks are cleaned of hazardous materials prior to use. Expended surface targets will sink to the bottom and eventually be buried in sediment, as with other non-hazardous expended training materials left on the range.

Subsurface Targets

Subsurface targets include the MK-30 and the MK-39. In the No-action Alternative, about 800 MK-39 targets would be used per year. The EMATT is a negatively buoyant, battery-operated device that is not recovered, and sinks to the seafloor at the conclusion of its operating life. It is powered by lithium sulfur dioxide batteries. Over time, the following chemical reactions occur as battery chemicals leach into the sea:

- Lithium bromide is an soluble salt that dissociates into bromine and lithium ions in seawater. Bromine and lithium are the seventh and 15th most abundant elements present in seawater, respectively. In addition to being found naturally in seawater, currents dilute the concentrations of these elements around the EMATT, so releases of lithium bromide would have no effect on water or sediment quality.
- The lithium metal contained in the EMATT is very reactive with water. When the lithium reacts with water it causes an exothermic (heat-liberating) reaction that generates soluble hydrogen gas and lithium hydroxide. The hydrogen gas eventually reenters the biosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized, ultimately forming water, so releases of lithium metal would have no effect on water or sediment quality.
- Sulfur dioxide, a gas that is highly soluble in water, is a major reactive component in the battery. The sulfur dioxide ionizes in the water, forming bisulfite that is easily oxidized to sulfate in the alkaline environment of the ocean. Sulfur is present as sulfate in large quantities (i.e., 885 milligrams per liter) in the ocean, so releases of sulfur dioxide would have no effect on water or sediment quality.

Because the chemical reactions of the lithium sulfur dioxide batteries are local and short-lived, the concentrations of the chemicals released by the EMATT battery are greatly diffused by the ocean currents. For this reason and in light of the reactions described above, the lithium sulfur dioxide batteries do not substantially affect marine water quality. The effects of the lead components used in the soldering of the internal wiring and trim weights and the corrosive components of the EMATTs are the same as from the sonobuoys (i.e., limited solubilities and slow release rates; discussed below), and do not substantially affect water quality.

At the conclusion of their operating life, EMATTs scuttle themselves and sink to the seafloor to be abandoned. Expended EMATTs are unlikely to result in any physical impacts on the seafloor. Expended EMATTs sink into a soft bottom or lie on a hard bottom, where they may be covered eventually by shifting sediments. Over time, the EMATTs degrade, corrode, and become incorporated into the sediments.

The MK-30 is powered by a rechargeable silver-zinc battery system. As the MK-30 degrades, the battery components leach out into the ocean. Similar to the EMATT system, chemicals leaching from the battery system are greatly diffused by ocean currents. However, MK-30 targets are recovered after their use. With few or no MK-30s expended in the ocean each year, the amount of hazardous constituents introduced into the ocean environment from this source are negligible.

Sonobuoys

Sonobuoys are expendable devices used for a variety of ocean sensing and monitoring tasks, such as to detect underwater acoustic sources and to measure water column temperatures. Three types of sonobuoys are tested: passive, active, and bathythermograph. Lead solder, lead weights, and copper anodes are used in sonobuoys. Sonobuoys also may contain lithium sulfur dioxide, lithium, or thermal batteries. Expendable Bathythermographs, do not use batteries and do not contain any hazardous materials. Analog Digital Converters have constituents similar to sonobuoys. Under the No-action Alternative, an estimated 12,500 sonobuoys will be used each year.

The three main types of batteries used in standard range sonobuoys are classified according to the type of cathode used: lead chloride, cuprous thiocyanate, or silver chloride (U.S. Department of the Navy, 1993). Each of these batteries uses a magnesium anode. These batteries are designed to have an active life ranging from one to eight hours, depending on the functional design of each particular sonobuoy. The chemical constituents of concern for water quality are lead, copper, and silver. Results by the Navy (U.S. Department of the Navy, 1993) indicate no substantial effects on marine water quality from sonobuoy batteries. Table 4.1.7.1.1-4 shows the estimated maximum concentrations of constituents of concern from sonobuoys, compared to the Federal water quality criteria.

Table 4.1.7.1.1-4. Concentration of Sonobuoy Battery Constituents and Criteria

Constituent	Concentration (micrograms / Liter)		
	Estimated Maximum, Proposed Action[1]	Federal Criteria[3]	
		1-Hour	Daily
Lead	11.0	210.0	8.1
Copper	0.015	4.8	3.1
Silver	0.0001	1.9	N/A

[1] Concentration (µg/L) of metal released into 1 cubic meter from scuttled seawater battery.
[2] Source: United States Environmental Protection Agency, 2005a.

Sonobuoys contain other metal and non-metal components, such as metal housing (nickel-plated, steel-coated with polyvinyl chloride [PVC] plastics to reduce corrosion), lithium batteries, and internal wiring that, over time, can release chemical constituents into the surrounding water. The lithium battery (used only in active sonobuoys) consists of an exterior metal jacket (nickel-plated steel) containing sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide. During battery operation, the lithium reacts with the sulfur dioxide and forms lithium dithionite. Since the reaction proceeds nearly to completion once the cell is activated, only residues are present when the battery life terminates. As a result, the lithium battery does not substantially degrade marine water quality.

Approximately 0.7 ounces (20 grams) of lead solder are used in the internal wiring (solder) of each sonobuoy, and 15 ounces (425 grams) of lead are used for the hydrophone and lead shot ballast. The lead source is in the un-ionized metallic form that is insoluble in water, so the lead shot and solder are not released into the seawater. Various lead salts (lead dichloride, lead carbonate, lead dihydroxide) likely form on the exposed metal surfaces. These metal salts have limited solubilities (9.9 grams per liter [g/L], 0.001 g/L, and 0.14 g/L, respectively) (U.S. Department of the Navy, 1993). For these reasons, lead components of the sonobuoy do not substantially degrade marine water quality.

Most of the other sonobuoy components are either coated with plastic to reduce corrosion or consist of solid metal. The slow rate at which solid metal components are corroded by seawater translates into slow release rates into the marine environment. Once the metal surfaces corrode, the rate of metal released into the environment decreases. Releases of chemical constituents from all metal and non-metal sonobuoy components are further reduced by natural encrustation of exposed surfaces. Therefore, corrosive components of the sonobuoy do not substantially degrade marine water quality.

Frequent training and testing activities involving sonobuoys result in the accumulation of scuttled sonobuoys on the ocean floor. The main source of contaminants in each sonobuoy is the seawater battery. These batteries have a maximum life of 8 hours, after which the chemical constituents in the battery have been consumed. Long-term releases of lead and other metal from the remaining sonobuoy components will be substantially slower than the release during seawater battery operation. Dispersion of released metals and other chemical constituents due to currents near the ocean floor will help minimize any long-term degradation of water quality in the project area. As a result, marine water quality will not be degraded by sonobuoy use during ASW activities.

Torpedoes

Torpedoes and torpedo targets typically contain hazardous materials, such as propellants. Other hazardous materials are used in the warheads, guidance system, and instruments. Potential effects of torpedoes on water or sediment quality are associated with propulsion systems, chemical releases, or expended accessories. The potentially hazardous or harmful materials are not normally released into the marine environment because the torpedo is sealed and, at the end of a run, the torpedoes are recovered. The OTTO Fuel II in a torpedo will not normally be released into the marine environment. In the worst-case scenario of a catastrophic failure, however, up to 59 lb of OTTO fuel can be released from a MK-46 torpedo (U.S. Department of the Navy, 1996a). In the event of such a maximum potential spill, temporary impacts on water quality may occur.

The MK-46 Recoverable Exercise Torpedo (REXTORP) and MK-50 REXTORP torpedo are non-explosive exercise torpedoes that use air charges or hydrostatic pressure to discharge ballast and float to the water's surface. They have no warheads, no propellant, and negligible amounts of hazardous materials. Table 4.1.7.1.1-5 describes torpedoes typically used in training, and Table 4.1.7.1.1-6 describes torpedo constituents.

Table 4.1.7.1.1-5. Torpedoes Typically Used in Navy Training Activities

Torpedo	Characteristics
MK-46 EXTORP	Hazardous materials include explosive bolts (less than 0.035 oz.), gas generator (130.9 lb), and a seawater battery (4 oz). The monopropellant is Otto Fuel.
MK-48 ADCAP EXTORP	The hazardous materials list is classified.
MK-54 EXTORP	This EXTORP is based on the propulsion system of the MK-46 torpedo and the search and homing capabilities of the MK-50 torpedo.

Notes: in - inch; lb - pound, oz - ounce.

Sources: Naval Institute Guide to Ships and Aircraft of the U.S. Fleet, 2001.

Table 4.1.7.1.1-6. MK-46 Torpedo Constituents

Materials	
Torpedo Hydraulic Fluid (MIL-H-5606E mineral oil base)	Practice Arming Rotor (Lead Azide)
Grease (Dow Corning 55M Grease)	Scuttle Valve (Lead Azide)
Lubricating and Motor Oils	Frangible Bolt (Lead Azide and Cyclonite)
Luminous Dye (Sodium Fluorescein)	Propellant (Ammonium Perchlorate)
Solder (QQ-S-571, SN60)	Gas Generator (Barium Chromate and Lead Azide)
Ethylene Glycol (two speed valve backfill fluid)	Release Mechanism (Barium Chromate and Lead Azide)
Ballast Lead Weight	Stabilizer (Barium Chromate and Lead Azide)
Explosive Bolts (Lead Azide and Cyclonite)	Cartridge Activated Cutter (Barium Chromate and Lead Azide)
Pressure Actuated Bolt (Potassium Perchlorate)	Propulsion Igniter
Practice Exploder (Lead Azide)	Exercise Head Battery

Source: U.S. Department of the Navy, 1996a

Propulsion Systems

OTTO Fuel II propulsion systems are used in both the MK-46 and the MK-48 torpedoes. OTTO Fuel II may be toxic to marine organisms (U.S. Department of the Navy, 1996a). There have been over 5,800 exercise test runs of the MK-46 torpedo worldwide between FY89 and FY96 (U.S. Department of the Navy, 1996a), and approximately 30,000 exercise test runs of the MK-48 torpedo over the last 25 years (U.S. Department of the Navy, 1996b). Most of these launches have been on Navy test ranges, where there have been no reports of deleterious impact on marine water quality from the effects of OTTO Fuel II or its combustion products (U.S. Department of the Navy, 1996a). Furthermore, Navy studies conducted at torpedo test ranges that have lower flushing rates than the open sea did not detect residual OTTO Fuel II in marine environment (U.S. Department of the Navy, 1996a). Thus, no adverse effects are anticipated from use of this fuel.

OTTO Fuel II would not be released into the marine environment during normal operation. During a catastrophic failure, however, up to 59 lb of fuel could be released from a MK-46 (U.S. Department of the Navy, 1996a). Even in the event of such a spill, no long-term adverse impacts on marine water quality would result, because:

- The water volume and depth would dilute the spill, and

- Common marine bacteria degrade and ultimately break down OTTO Fuel (U.S. Department of the Navy, 1996a)

Exhaust products from the combustion of OTTO Fuel II include nitrogen oxides, carbon monoxide, carbon dioxide, hydrogen, nitrogen, methane, ammonia, and hydrogen cyanide (U.S. Department of the Navy, 1996a). These combustion products are released to the sea, where they are dissolved, disassociated, or dispersed in the water column. Except for hydrogen cyanide, combustion products are not a concern (U.S. Department of the Navy, 1996a) because:

- Most OTTO Fuel II combustion products, specifically carbon dioxide, water, nitrogen, methane, and ammonia, occur naturally in seawater.
- Several of the combustion products are bioactive. Nitrogen is converted into nitrogen compounds through nitrogen fixation by certain cyanobacteria, providing nitrogen sources and essential micronutrients for marine phytoplankton. Carbon dioxide and methane are integral parts of the carbon cycle in the oceans and are taken up by many marine organisms.
- Carbon monoxide and hydrogen have low solubility in seawater, and excess gases would bubble to the surface.
- Trace amounts of nitrogen oxides may be present, but they are usually below detectable limits. Nitrogen oxides in low concentrations are not harmful to marine organisms, and are a micronutrient source of nitrogen for aquatic plant life.
- Ammonia can be toxic to marine organisms in high concentrations, but releases from OTTO fuel would be quickly diluted to negligible levels.

Hydrogen cyanide does not normally occur in seawater and, at high enough concentrations, could pose a risk to both humans and marine biota. The USEPA acute and chronic national recommendation for cyanide in marine waters is 1.0 µg/L, or approximately one ppb (U.S. Department of the Navy, 1996a). Hydrogen cyanide concentrations of 280 ppb would be discharged by MK-46 torpedoes and hydrogen cyanide concentrations ranging from 140 to 150 ppb would be discharged from MK-48 torpedoes (U.S. Department of the Navy, 1996a). These initial concentrations are well above the USEPA recommendations for cyanide. Because it is very soluble in seawater, however, hydrogen cyanide would be diluted to less than one µg/L at 17.7 ft from the center of the torpedo's path, and thus should pose no substantial threat to marine organisms. Even during the most intensive events, at most eight MK-48 exercise torpedoes would be used in a given day. These launches would occur over 24 hours, and are not likely to be conducted in the same portion of the HRC.

MK-50 Torpedoes. All the MK50s used on the range are Recoverable Exercise Torpedoes (REXTORPs). Hazardous materials may be found in components of the MK-50 torpedo. During normal exercises, no hazardous materials are released to the marine environment because the torpedo is sealed. At the end of an exercise, the torpedoes are recovered.

MK-46 Torpedoes. Several hazardous materials can be found in components of the MK-46 torpedo. During normal exercises, no hazardous materials are released to the marine environment because the torpedo is sealed. At the end of an exercise, the torpedoes are recovered (U.S. Department of the Navy, 1996a).

Hazardous materials could be released on impact with a target or the seafloor. During exercises, however, the guidance system of the torpedo is programmed for target and bottom avoidance (U.S. Department of the Navy, 1996a), minimizing accidental releases. Furthermore, the contaminants would be released instantaneously, so the area exposed to acutely toxic concentrations would be minimized.

During normal venting of excess pressure or upon failure of the torpedo's buoyancy bag, gaseous carbon dioxide, water, hydrogen, nitrogen, carbon monoxide, methane, ammonia, hydrochloric acid, hydrogen cyanide, formaldehyde, potassium chloride, ferrous oxide, potassium hydroxide, and potassium carbonate would be discharged (U.S. Department of the Navy, 1996a). Even in the event of a release, however, no long-term, adverse effects on marine water quality would result, because:

- Most of the discharges would be dissolved, disassociated, or dispersed in the water column.
- Most of the discharged compounds, specifically carbon dioxide, water, hydrogen, nitrogen, methane, and ammonia naturally occur in seawater.
- Several of the discharged compounds are bioactive. Nitrogen is converted into nitrogen compounds through nitrogen fixation by certain blue green algae, providing nitrogen sources and essential micronutrients for marine phytoplankton. Carbon dioxide and methane are integral parts of the carbon cycle in the oceans, and are taken up by many marine organisms.
- Hydrogen chloride, potassium chloride, potassium hydroxide, and dipotassium carbonate are soluble in seawater, and would disassociate into ions that naturally occur in seawater.
- Carbon monoxide and hydrogen have low solubility in seawater, and excess gases would bubble to the surface.
- Although insoluble in water, iron monoxide is nonhazardous.
- Formaldehyde normally does not occur in seawater. The total amount of formaldehyde that would be discharged from the rupture of the buoyancy bag is 3.93 µg (U.S. Department of the Navy, 1996a). This quantity would be diluted below 1 µg/l in less than 0.3 ft.

Hydrogen cyanide could pose a risk to both humans and marine biota. The USEPA acute and chronic national recommendation for cyanide in marine waters is one µg/L, or approximately one ppb (U.S. Department of the Navy, 1996a). An estimated 3.87 µg of hydrogen cyanide would be discharged into the marine environment if the Buoyancy Sub-system buoyancy bag ruptured (U.S. Department of the Navy, 1996a). This quantity of hydrogen cyanide would be diluted to below the USEPA limit in less than 0.3 ft. During normal Buoyancy Sub-system venting, fewer exhaust products would be released than during a buoyancy bag rupture and these products would be released in a greater volume of water, so, BSS venting would not affect water quality.

Torpedo Accessories

Various accessories are expended during the launch, operation, and recovery of MK-46, MK-48, MK-50, and MK-54 exercise torpedoes. An assortment of air launch accessories, all of which consist of non-hazardous materials, would be expended into the marine environment during air launching of MK-46 and MK-50 torpedoes. Depending on the type of launch craft used, MK-46 air launch accessories may comprise a nose cap, suspension bands, air stabilizer, release wire, and propeller baffle (U.S. Department of the Navy, 1996a). MK-50 air launch accessories may comprise a nose cap, suspension bands, air stabilizer, sway brace pad, arming wire, and fahnstock clip (U.S. Department of the Navy, 1996a).

All of these expendable materials would sink to the ocean bottom. The materials likely would not result in any physical impacts on the sea floor because they would sink into a soft bottom, where they would be covered eventually by shifting sediments. Over time, these materials would degrade, corrode, and become incorporated into the sediments. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment.

Upon completion of a MK-46 REXTORP or MK-50 REXTORP launch, six steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface for recovery. The 180-lb ballasts sink rapidly to the bottom and, in areas of soft bottoms, are buried into the sediments. The MK-46 Exercise Torpedoes (EXTORPs) also use ballasts, which weigh 72 lb. MK-54 and MK-48 Advanced Capabilities (ADCAP) torpedoes use buoyancy bags to lift the torpedoes to the surface after their run.

Lead and lead compounds are designated as priority toxic pollutants pursuant to Section 304(a) of the CWA of 1977. The USEPA saltwater quality standard for lead is 8.1 µg/L, continuous, and 210 µg/L maximum concentration (U.S. Environmental Protection Agency, 2000). Lead is a minor constituent of seawater, with a background concentration of 0.02 to 0.4 µg/L (U.S. Department of the Navy, 1996a). Even if all of the expended lead ballasts and hoses from torpedo exercises were concentrated into less than 1 percent of the bottom area of the HRC and a high rate of its dissolution into the water column were assumed, the lead would not be sufficient to exceed the water quality standard.

The metallic lead of the ballast weights likely would not dissolve into the sediment or water as lead ions (U.S. Department of the Navy, 1996a). The lead is jacketed in steel, so the surface of the lead would not be in direct contact with the seawater. Also, in areas of soft bottoms, the lead weight would quickly be buried due to the velocity of its impact with the bottom and its greater density. As a result, releases of dissolved lead into bottom waters are expected to be negligible.

The MK-48 EXTORP is equipped with a single-strand control wire, which is laid behind the torpedo as it moves through the water. At the end of a torpedo run, the control wire is released from the firing vessel and the torpedo to enable recovery of the torpedo. The wire sinks rapidly and settles on the ocean floor, stretched into a long single line, as opposed to being looped or in tangles. The MK-48 torpedo also uses a flex hose to protect the control wire. The flex hose is expended into the ocean after completion of the torpedo run and, because of its weight, rapidly sinks to the bottom. Two types of flex hose are used: the Strong Flex Hose and Improved Flex Hose. The Improved Flex Hose is replacing the Strong Flex Hose in accordance with a phased schedule.

Chaff and Flares

Chaff is a thin polymer with a metallic (aluminum) coating used to decoy enemy radars. The chaff is shot out of launchers using a propellant charge. The fine chaff streamers act like particulates in the water, temporarily increasing the turbidity of the ocean's surface. They quickly disperse, however, and the widely spaced exercises have no discernable effect on the marine environment. The Air Force has studied chaff, and has reported no adverse impacts from chaff and said that chaff is generally nontoxic (U.S. Air Force, Air Combat Command, 1997).

Flares are used over water during training. Flares consist of powdered or pelleted magnesium imbedded in a matrix. They are incendiary and burn at high temperatures. Two types of flares are used: those ejected from aircraft to act as a decoy for enemy missiles, and those deployed under parachutes to provide illumination in support of other activities. The combustion products from flares are not hazardous, consisting primarily of sodium carbonate, carbon dioxide, water, and magnesium oxide.

Hazardous constituents are typically present in pyrotechnic residues, but are bound up in relatively insoluble compounds. Solid flare and pyrotechnic residues may contain, depending on their purpose and color, an average weight of up to 0.85 lb of aluminum, magnesium, zinc, strontium, barium, cadmium, nickel, and perchlorates. As inert, incombustible solids with low concentrations of leachable metals, these materials typically do not meet the RCRA criteria for characteristic hazardous wastes. The perchlorate[1] compounds present in the residues are relatively soluble, albeit persistent in the environment, and probably disperse quickly.

Laboratory leaching tests of flare pellets and residual ash using synthetic seawater found barium in the pellets, while boron and chromium were found in the ash. The pH of the test water was raised in both tests. Ash from flares will be dispersed over the water surface and then settle out. Chemicals will leach from the flare particles into the water column while it is settling. Any chemicals leaching from the particles after they reach the bottom will be dispersed by currents. Therefore, local and temporary impacts on water quality may occur, but no long-term impacts are anticipated.

Mine Shapes

Mine shapes are inert (i.e., containing no energetic materials) concrete and steel objects that are dropped in the mine training ranges. These ranges are used for training of air crews in offensive mine laying by delivery of inert mine shapes from aircraft. There are no hazardous materials in mine shapes. Trace amounts of chromium, nickel, or other toxic metals could leach out of the steel gradually over time as it corrodes, but ocean chemistry would not be affected because of the very low rate of these emissions and their rapid dispersal in the ocean.

Unexploded Ordnance (UXO)

A small percentage of the explosive training items, generally less than 5 percent, may fail to function as designed. The result can be no detonation or a low-order detonation. In the first case, the item likely will settle to the ocean floor intact. In the second case, some portion of the

1 Perchlorates are water-soluble inorganic compounds that are relatively persistent in the environment; exposure to which has been found to cause adverse health effects.

original explosives or propellants may remain, and likely will be exposed to seawater. Given the wide range of training materials, varying failure rates and types of failures, and the wide range of explosives and propellants that may be involved, a quantitative estimate of these materials would be subject to numerous assumptions and caveats. However, these materials would be a small fraction of the total amount of unrecovered training materials, and a quantitative consideration of their effects would not change the overall conclusions of this water quality analysis.

Summary

Water Quality

Training and testing activities will introduce several types of water pollutants to the water column. These substances include propellant and explosives residues and battery constituents from missiles and aerial targets; battery constituents from sub-surface targets and sonobuoys; torpedo fuel, metals from rusting and corroding casings and accessory materials, and chaff and flare residues. Based on the qualitative and quantitative analyses of expended training materials presented above, however, these pollutants will be released in quantities and at rates such that they will not violate any water quality standard or criteria. The No-action Alternative will have no effect on the designated beneficial uses of marine waters.

Bottom Sediments

The environmental fates of hazardous constituents have been addressed above for each category of expended training material. The aggregate effects of expended training materials on ocean bottom sediments also can be assessed in terms of the number and weight of deposited items per unit area of bottom surface. A total of about 654 tons per year, are expended under the No-action Alternative (see Table 4.1.4.1.1-1). Assuming an ocean floor area of about 235,000 nm^2, and making a further conservative assumption that the training materials are concentrated within 20 percent of this area, this is about 5.6 lb per nm^2.

Expended training materials will settle to the ocean bottom and will be covered by sediment deposition over time. Most of the expended training material is inert, and thus harmless, but some of the expended training materials consists of toxic metals such as lead. These items decompose slowly, so the volume of decomposing training materials within the training areas, and the amounts of toxic substances being released to the environment, gradually increase over the period of military use. Concentrations of some substances in sediments surrounding the disposed items increase over time. Sediment transport via currents may eventually disperse these contaminants outside of the training areas. The density of discarded training materials in ocean bottom sediments is not high enough, however, to result in substantial sediment toxicity. Neither inert nor toxic expended training materials at this density will measurably affect sediment quality.

4.1.7.1.2 HRC RDT&E Activities—No-action Alternative

RDT&E activities under the No-action Alternative are listed in Table 4.1-1. Unrecovered materials associated with RDT&E activities will be similar to those discussed above for training, with the exception of Missile Defense activities. Therefore, the discussion presented above would apply here. Potential water quality impacts associated with Missile Defense activities include hydrocarbon chloride deposition and solid propellants released into the open ocean.

The effects of hydrogen chloride deposition were modeled from the Advanced Solid Rocket Motor (ASRM). Under nominal launch conditions, when the relative humidity is less than 100 percent, deposition of hydrogen chloride gas on the surface of the sea will not be significant. Analyses for the most conservative case, where rain will be present soon after test firing the ASRM, concluded that acid deposition on surface water will not affect larger surface water bodies in the area. This analysis was based on the buffering capacity of fresh water, which is considerably lower than the buffering capacity of sea water. It is expected, therefore, that even for the most conservative case, where all of the hydrogen chloride emissions fall over the Open Ocean Area, the pH will not be depressed by more than 0.2 standard units for more than a few minutes. (U.S. Army Space and Strategic Defense Command, 1994)

Mathematical modeling of ASRM tests indicate that the maximum deposition of aluminum oxide will be about 1.6 milligrams per square meter (mg/m^2) (0.0007 ounces per square inch ($oz./in^2$). Aluminum oxide is not toxic under natural conditions, but may contribute potentially harmful species of soluble aluminum forms under acidic conditions. The portion of aluminum oxide that reacts with hydrogen chloride to form additional toxic aluminum species is difficult to quantify. The most conservative approach assumes that all of the deposited aluminum oxide reacts with hydrogen chloride. With this extremely conservative assumption, the deposition of about 1.6 mg/m^2 (0.0007 $oz./in^2$) of aluminum oxide equals approximately 0.0054 mg per liter (mg/L) (5.4 parts per billion) of aluminum at a water depth of 0.5 ft. This analysis assumes that rain will not be falling at the time of the test event or within 2 hours after the event. Rainfall will increase the amount of deposition. (U.S. Army Space and Strategic Defense Command, 1994) Even in the most conservative scenario of an on-ship or early flight failure, where all of the propellant is ignited and all of the hydrogen chloride and aluminum oxide are deposited, any toxic concentration of these products will be buffered and diluted by seawater to non-toxic levels within minutes. Consequently, any impacts of an accidental release will be very transient.

Solid propellant is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate. The ammonium perchlorate contained within the matrix of rubber will dissolve slowly. While there is no definitive information on the solubility or toxicity of the propellant material in seawater, its toxicity is expected to be relatively low. In a most conservative case, toxic concentrations of ammonium perchlorate will be expected only within a few yards of the source. (U.S. Department of the Air Force, 2002) In the event of an ignition failure or other launch mishap, a fueled rocket motor or portions of the unburned fuel will likely fall into ocean waters. In that case, small fragments of fuel may float on the surface of the sea for a time, and some dissolution may occur. However, the fragments will become waterlogged and sink (U.S. Department of the Air Force, 2002). In terms of the potential for cumulative impacts, the effect of any hydrogen chloride deposition in the Open ocean Area will be very transient due to the buffering capacity of seawater. Similarly, deposition of aluminum compounds will be very small and dispersal by surface mixing will be rapid. Therefore, no incremental, additive impacts are anticipated.

NASA conducted a thorough evaluation of the effects of missile systems that are deposited in seawater. It concluded that the release of hazardous materials aboard missiles into seawater will not be significant. Materials will be rapidly diluted and, except in the vicinity of the debris, will not be found at concentrations identified as producing any adverse effect. The Pacific Ocean is thousands of feet deep in the vicinity of the launch area; consequently, the water quality impact from the fuel is expected to be minimal. Any area affected by the slow dissolution of the propellant will be relatively small due to the size of the rocket motor or propellant pieces relative to the quantity of seawater (U.S. Department of the Air Force, 2002).

4.1.7.1.3 Major Exercises—No-action Alternative

Major Exercises under the No-action Alternative, such as RIMPAC and USWEX, include combinations of unit-level training and, in some cases, RDT&E activities that have been occurring in the HRC for decades (see Table 4.1-1). Therefore, the potential impacts of Major Exercises will be the same as those described earlier for training and RDT&E activities.

4.1.7.2 ALTERNATIVE 1 (WATER RESOURCES—OPEN OCEAN)

4.1.7.2.1 Increased Tempo and Frequency of Training—Alternative 1

Under Alternative 1, several training events would increase from current levels. Only the number of training events would increase; no new types of training would be introduced in the Open Ocean Area. Increases in the number of individual training events would proportionately increase the amounts of water pollutants released. However, the quantities of these materials would still be very small, relative to the extent of the sea ranges, and the large volume of ocean waters into which they would disperse. Therefore, the potential for water quality effects from these constituents would not be significant.

4.1.7.2.2 Enhanced and Future RDT&E Activities—Alternative 1

Water quality effects of RDT&E activities under Alternative 1 would be the same as those described under the No-action Alternative. Future RDT&E activities (see Table 4.1-1) would not introduce any new types of expended materials or debris into the Open Ocean Area.

4.1.7.2.3 HRC Enhancement—Alternative 1

No new types of expended material or debris would be introduced into the Open Ocean Area. Therefore, proposed HRC enhancements would have no effect on open ocean water quality.

4.1.7.2.4 Major Exercises—Alternative 1

Major Exercises under Alternative 1, such as RIMPAC and USWEX, include combinations of unit-level training and, in some cases, RDT&E activities that have been occurring in the HRC for decades (see Table 4.1-1). Although training events associated with Major Exercises would increase under Alternative 1, potential impacts would still be the same as those described under the No-action Alternative.

4.1.7.3 ALTERNATIVE 2 (WATER RESOURCES—OPEN OCEAN)

4.1.7.3.1 Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, several training events would increase from current levels. Only the number of training events would increase; no new types of training would be introduced in the Open Ocean Area. Increases in the number of individual training events would proportionately increase the amounts of water pollutants released. However, the quantities of these materials would still be very small, relative to the extent of the sea ranges, and the large volume of ocean waters into which they would disperse. Therefore, the potential water quality effects of these constituents would not be significant.

4.1.7.3.2 Enhanced and Future RDT&E Activities—Alternative 2

Water quality effects of RDT&E activities under Alternative 2 would be the same as those described under the No-action Alternative. Future RDT&E activities (see Table 4.1-1) would not introduce any new types of expended materials or debris into the Open Ocean Area.

4.1.7.3.3 Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Vessels, aircraft, and other military assets employed during Multiple Strike Group training would increase the overall intensity and duration of Navy training on the sea ranges. The Strike Group training would be similar to other large-exercise training events held on the range. Although the intensity of training associated with Multiple Strike Group Training would increase under Alternative 2, potential impacts would still be the same as those described under the No-action Alternative, and no new types of expended material or debris would be introduced into the open ocean.

4.1.7.4 ALTERNATIVE 3 (WATER RESOURCES—OPEN OCEAN)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on water resources under Alternative 3 would be the same as those described for Alternative 2.

4.2 NORTHWESTERN HAWAIIAN ISLANDS

Table 4.2-1 lists ongoing research, development, test, and evaluation (RDT&E) activities for the No-action Alternative and proposed RDT&E activities for Alternatives 1, 2, and 3 near the Northwestern Hawaiian Islands. Alternative 3 is the preferred alternative.

Table 4.2-1. RDT&E Activities Near the Northwestern Hawaiian Islands

Research, Development, Test, and Evaluation (RDT&E) Activities
• Missile Defense

The Presidential Proclamation establishing the Papahānaumokuākea Marine National Monument requires that all training and RDT&E activities of the Armed Forces shall be carried out in a manner that avoids, to the extent practicable and consistent with operational requirements, adverse impacts on monument resources and qualities. Current Navy activities associated with the Monument include missile defense RDT&E.

Missile defense RDT&E activities for the No-action Alternative (see Figure 2.2.2.5.1-3) and proposed RDT&E activities for Alternatives 1, 2, and 3 (see Figure 2.2.3.5-1) have overflights and intercepts that have the potential to generate debris that falls within areas of the Northwestern Hawaiian Islands.

4.2.1 NORTHWESTERN HAWAIIAN ISLANDS OFFSHORE

A review of the 13 resources against program offshore RDT&E activities under the No-action Alternative, and proposed RDT&E activities under Alternative 1, Alternative 2 and Alternative 3, was performed for the Northwestern Hawaiian Islands. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

Any airspace issues associated with the Northwestern Hawaiian Islands offshore are addressed in Section 4.1.1 (Airspace—Ocean Ocean). There are no current or proposed Hawaii Range Complex (HRC) activities that will affect air quality, health and safety, land use, noise; or the existing land forms, geology, or associated soils development of the islands. Socioeconomic characteristics (population size, employment, income generated, and housing cost) do not apply since all the islands are uninhabited. No transportation (roadways, railways, etc) and utility systems (water, wastewater, electricity, and natural gas) exist offshore. HRC activities within the Northwestern Hawaiian Islands do not generate any hazardous waste streams that could impact local water quality.

4.2.1.1 BIOLOGICAL RESOURCES—NORTHWESTERN HAWAIIAN ISLANDS—OFFSHORE

4.2.1.1.1 Nihoa—Biological Resources—Offshore

Less than 12 of the potential 46 annual missile flight trajectories could result in a missile flying over portions of the Papahānaumokuākea Marine National Monument. Of particular concern is the potential for debris landing on Nihoa and Necker islands at the southeastern end of the Northwestern Hawaiian Islands, the closest of the Northwestern Hawaiian Islands to the Main Hawaiian Islands. At this point in their flight, the boosters normally follow a ballistic trajectory and will not impact the monument resources. For select intercept missions the potential exists for limited debris to fall into the waters offshore of Necker and Nihoa in the Papahānaumokuākea Marine National Monument. All training and RDT&E activities conducted in the HRC will be performed in a manner that avoids, to the extent practicable and consistent with training requirements, adverse impacts on monument resources and qualities. Thus, as discussed in the beginning of Section 3.2, these military readiness activities are exempt from consultation requirements or monument regulations. All activities with the potential to affect the Northwestern Hawaiian Islands will be performed in accordance with ongoing practices, such as equipment inspections, to minimize the potential for contributing to the spread of invasive species.

4.2.1.1.1.1 No-action Alternative (Biological Resources—Nihoa—Offshore)

HRC RDT&E Activities—No-action Alternative

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Nihoa.

Wildlife

A debris analysis to identify weight and toxicity of the debris that could potentially impact Nihoa was performed by the Terminal High Altitude Area Defense (THAAD) (one of the missiles with a trajectory that could potentially result in debris offshore of Nihoa) Project Office. Low-force debris (under 0.5 foot-pound) is not expected to severely harm threatened, endangered, or other marine species occurring in offshore waters. Quantities of falling debris (e.g., small amount of solid rocket propellant remaining) will be low and widely scattered so as not to present a toxicity issue.

In a successful intercept, both missiles would be destroyed by the impact. Momentum would carry debris along the respective paths of the two missiles until the debris falls to earth. The debris would consist of a few large pieces (approximately 110 pounds [lb]), of each missile, many medium pieces (approximately 11 lb), and mostly tiny particles. This debris is subject to winds on its descent to the surface. The debris would generally fall into two elliptically-shaped areas. Most debris would fall to the earth within 3 to 40 minutes after intercept, but some of the lighter particles may drift airborne, for as long as 2 to 4 hours before landing. (U.S. Department of the Navy, 1998a)

The potential exists for debris greater than 0.5 foot-pound to impact the offshore waters of Nihoa. No estimate of the actual area impacted was calculated since the likelihood of impacts on submerged coral reef habitat at Nihoa is anticipated to be low. A debris analysis to identify weight and toxicity of the debris that could potentially impact Nihoa was performed by the

THAAD (one of the missiles with a trajectory that could potentially result in debris offshore of Nihoa) Project Office. Low-force debris (under 0.5 foot-pound) is not expected to severely harm threatened, endangered, or other marine species occurring in offshore waters. Quantities of falling debris (e.g., solid rocket propellant) will be low and widely scattered so as not to present a toxicity issue. The potential exists for debris greater than 0.5 foot-pound to impact the offshore waters of Nihoa. Since most of the coral present only survive at depths less than 40 feet, coral cover is not greater than 25 percent, the debris will be widely scattered, and the velocity will be slowed following impact at the water's surface, the likelihood of impacts on submerged coral reef habitat associated with Nihoa will be low.

According to the analysis in the Point Mugu Sea Range Environmental Impact Statement (EIS), less than 0.0149 marine mammals would be exposed to missile debris per year, and the probability of this debris affecting marine mammals or other marine biological resources is less than 10^{-6} (1 in 1 million). This probability calculation was based on the size of the Pacific Ocean area studied and the marine mammal population density within that area. The Point Mugu range area (27,183 square nautical miles [nm^2]) is 0.1 percent of the Pacific Missile Range Facility (PMRF) Temporary Operating Area (2.1 million nm^2), and the density of marine mammals is larger. It is reasonable to conclude that the probability of marine mammals being struck by debris from similar missile testing at PMRF will be even more remote than at Point Mugu. (U.S. Department of the Navy, 1998c)

The various trajectories, launch sites, and intercept areas are selected with consideration to both the mission requirements and to minimize the effects on any particular location. During training, dedicated Navy lookouts who have received extensive training would be posted to scan the ocean for anything detectible in the water. For both training and RDT&E activities, spotters in aircraft would also relay information on marine species observed in the projected intercept areas. Training is halted, or a launch delayed, if marine mammals or sea turtles are detected in a target area. For a marine mammal or sea turtle to be injured, it would have to enter the target area undetected and then surface at the exact point where a projectile, spent missile, or spent target landed.

Interceptor missile element test activities associated with the Missile Defense Agency lethality program could include development and testing of Nuclear, Biological, or Chemical material simulants. These activities were analyzed in the *Programmatic Environmental Assessment, Theater Missile Defense Lethality Program* (U.S. Army Space and Strategic Defense Command, 1993b). The only proposed chemical simulant that might be included as part of the No-action Alternative in a target payload will be small quantities of tributyl phosphate (TBP), which is a non-flammable, non-explosive, colorless, odorless liquid typically used as a component of aircraft hydraulic fluid, as a plasticizer, and as a solvent in commercial industry. The release of simulant will occur at a high altitude over the open ocean during a nominal flight test. The potential ingestion of toxins, such as the small amount of propellant or simulant remaining in the spent boosters or on pieces of missile debris, by marine mammals or fish species in the offshore area will be remote because of (1) atmospheric dispersion, (2) the diluting and neutralizing effects of seawater, and (3) the relatively small area that could potentially be affected.

According to tests performed on White Sands Missile Range using TBP (U.S. Army Space and Missile Defense Command, 2004), toxicity levels for aquatic species that include algae, crustaceans, water fleas, fathead minnows, and rainbow trout range from 0.0002 ounce (oz) per gallon (gal) to 0.002 oz/gal. Assuming as a worse case that TBP would penetrate to a depth of 1 foot, approximately 0.00004 oz/gal would be deposited within 1 cubic foot of water. This amount would be less than the toxicity level for the species mentioned.

Potential effects on marine biological resources from mid-frequency active/high-frequency active (MFA/HFA) sonar usage determined for the No-action Alternative are discussed in the applicable Open Ocean No-action Alternative sections.

4.2.1.1.1.2 Alternative 1 (Biological Resources—Nihoa—Offshore)

HRC RDT&E Activities—Alternative 1

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Nihoa.

Wildlife

No increase in the number of missile defense launches (46) would occur as part of Alternative 1, and the impacts on foraging birds or marine species would be the same as those discussed in the No-action Alternative. Payloads on some future RDT&E target vehicle launches from PMRF would incorporate additional chemical simulants (Section 2.2.3.5), which could include larger quantities of TBP and various glycols. Up to approximately 120 gal of simulant could be used in target vehicles. The release of simulant would continue to occur at a high altitude over the open ocean during a nominal flight test. Assuming as a worst case that TBP would penetrate to a depth of 1 foot, approximately 0.00009 oz/gal would be deposited within 1 cubic foot of water. This amount would be less than the toxicity level for species such as algae, crustaceans, and minnows. According to a Material Safety Data Sheet prepared for propylene glycol, this material is expected to be non-hazardous to aquatic species: The lethal concentration that kills 50 percent of test animals (LC50) over a 96-hour period for salmon is 0.42 oz/gal, and the effective concentration where 50 percent of its maximal effect is observed (EC50) over a 72-hour period for marine algae is 0.15 oz/gal. Propylene glycol is not expected to bioaccumulate. (Plastic Process Equipment, 2007) When released into water, ethylene glycol is expected to readily biodegrade and is expected to have a half-life between 1 and 10 days. This material is not expected to significantly bioaccumulate. The LC50 over a 96-hour period for fish is over 0.01 oz/gal. (Mallinckrodt Baker, Inc., 2007) According to Science Lab.com, the LC50/96 hours is 0.22 oz/gal for bluegill (Science Lab.com, 2007).

The potential ingestion of toxins, such as the small amount of propellant or simulant remaining in the spent boosters or on pieces of missile debris, by marine mammals or fish species would be remote because of (1) atmospheric dispersion, (2) the diluting and neutralizing effects of seawater, and (3) the relatively small area that could potentially be affected. Also as part of Alternative 1, launches from Wake Island, the Ronald Reagan Ballistic Missile Defense Test Site (Reagan Test Site) at U.S. Army Kwajalein Atoll, and Vandenberg Air Force Base toward the vicinity of PMRF are proposed. Launches from those sites would be from existing launch facilities, and the intercept areas would be in the Open Ocean Area and Temporary Operating Area of the PMRF Range. Targets would also be launched from ships and aircraft. The effects of these missile tests would be similar to those described above for the No-action Alternative and in Section 4.2.1.1.1.1.

Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean Alternative 1 sections.

4.2.1.1.1.3 Alternative 2 (Biological Resources—Nihoa—Offshore)

HRC RDT&E Activities—Alternative 2

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Nihoa.

Wildlife

An increase in Missile Exercises from 46 per year to 50 per year could result in a slight increase in the potential for impacts on foraging birds or marine species offshore of Nihoa; however, the four additional events may not necessarily involve missiles that could impact offshore of Nihoa and the probability for widely scattered debris or simulant to affect fish, marine mammals, or sea turtles would continue to be low. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean Alternative 2 sections.

4.2.1.1.1.4 Alternative 3 (Biological Resources—Nihoa—Offshore)

HRC RDT&E Activities—Alternative 3

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Nihoa.

Wildlife

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.2.1.1.2 Necker—Biological Resources—Offshore

4.2.1.1.2.1 No-action Alternative (Biological Resources—Necker—Offshore)

HRC RDT&E Activities—No-action Alternative

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Necker.

Wildlife

While missiles could overfly Necker, it is unlikely that missile debris would impact on or near the island; any impacts would be similar to those discussed above for Nihoa Island. Potential effects on marine biological resources from MFA/HFA sonar usage determined for the No-action Alternative are discussed in the applicable Open Ocean No-action Alternative sections.

4.2.1.1.2.2 Alternative 1 (Biological Resources—Necker—Offshore)

HRC RDT&E Activities—Alternative 1

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Necker.

Wildlife

Although missiles could overfly Necker, it is unlikely that missile debris would impact in the offshore waters of the island. No increase in the number of missile defense launches (46) would occur as part of Alternative 1, and any impacts on wildlife would be the same as those discussed above in the No-action Alternative for Nihoa. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean Alternative 1 sections.

4.2.1.1.2.3 Alternative 2 (Biological Resources—Necker—Offshore)

HRC RDT&E Activities—Alternative 2

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Necker.

Wildlife

It is unlikely that missile debris would impact in the offshore waters of the island. An increase in Missile Exercises from 46 per year to 50 per year could result in a slight increase in the potential for impacts on wildlife on Necker; however, the four additional Missile Exercises may not necessarily involve missiles that could impact offshore, and the probability for widely scattered debris or simulant to affect fish, marine mammals, or sea turtles would continue to be low. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean Alternative 2 sections.

4.2.1.1.2.4 Alternative 3 (Biological Resources—Necker—Offshore)

HRC RDT&E Activities—Alternative 3

Vegetation

No threatened or endangered marine vegetation has been identified offshore of Necker.

Wildlife

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action

Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.2.2 NORTHWESTERN HAWAIIAN ISLANDS ONSHORE

A review of the 13 resources against program RDT&E activities under the No-action Alternative, and proposed RDT&E activities under Alternative 1, Alternative 2, and Alternative 3, was performed for the Northwestern Hawaiian Islands onshore. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

Any airspace issues associated with the Northwestern Hawaiian Islands are addressed under 4.1.1 (Airspace—Open Ocean). There are no current or proposed HRC activities that will affect air quality, health and safety, land use, noise; or the existing land forms, geology, or associated soils development of the islands. Socioeconomic characteristics (population size, employment, income generated, and housing cost) do not apply since all the islands are uninhabited. No transportation (roadways, railways, etc) and utility systems (water, wastewater, electricity, and natural gas) exist onshore. HRC activities within the Northwestern Hawaiian Islands do not generate any hazardous waste streams that could impact local water quality.

4.2.2.1 BIOLOGICAL RESOURCES—NORTHWESTERN HAWAIIAN ISLANDS

4.2.2.1.1 Nihoa—Biological Resources

Of particular concern is the potential for debris on Nihoa at the southeastern end of the Northwestern Hawaiian Islands. At this point in their flight, the boosters follow a ballistic trajectory and should not impact monument resources. For select intercept missions the potential exists for limited debris to fall onto the island of Nihoa in the Papahānaumokuākea Marine National Monument.

4.2.2.1.1.1 No-action Alternative (Biological Resources—Nihoa)

HRC RDT&E Activities—No-action Alternative

Vegetation

Any falling debris from missile tests with trajectories that have the potential to affect Nihoa should cool down sufficiently prior to impact so as not to present a fire hazard for vegetation such as the endangered loulu, `ohai, *Amaranthus brownii*, and *Schiedea verticillata*. PMRF conducted a thermal degradation analysis of the potential debris. The analysis showed the maximum temperature of the potential debris would be 150°C at impact. Based on PMRF's literature review and conversations with a fire specialist with the U.S. Forest Service regarding the temperature required for a non-spark ignition of dry vegetation PMRF found ignition temperatures ranging between 200°C and 380°C. The debris would have to be in excess of 200°C and remain in contact with dry vegetation for a substantial amount of time in order to ignite the vegetation. Therefore, any debris potentially landing on Nihoa will not be a fire hazard. (Missile Defense Agency, 2006)

According to correspondence from the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office, the Service's previous concurrence of no significant impact from THAAD activities remained valid (U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, 2007). If feasible, consideration will be given to alterations in the missile flight trajectory, to further minimize the potential for debris impacts on vegetation on the island.

Wildlife

A debris analysis to identify weight and toxicity of the debris that could potentially impact Nihoa was performed by the THAAD (one of the missiles with a trajectory that could potentially result in debris on Nihoa) Project Office. Preliminary results indicated that debris greater than 0.5 foot-pound is not expected to impact on Nihoa (U.S. Army Space and Missile Defense Command, 2002). Low-force debris (under 0.5 foot-pound) is not expected to severely harm threatened, endangered, migratory, or other endemic species occurring on the island. The probability for this widely scattered debris to hit birds, seals, or other wildlife will be low. Quantities of falling pieces of debris (e.g., small amount of solid rocket propellant remaining) will be low and widely scattered so as not to present a toxicity issue.

Appendix C includes a description of the Migratory Bird Treaty Act (MBTA). Section 704(a) of the MBTA prescribes regulations to exempt the Armed Forces for the incidental taking of migratory birds during military readiness activities authorized by the Secretary of Defense or the Secretary of the military department concerned. Congress determined that allowing incidental take of migratory birds as a result of military readiness activities is consistent with the MBTA and the treaties. The Armed Forces must give appropriate consideration to the protection of migratory birds when planning and executing military readiness activities, but not at the expense of diminishing the effectiveness of such activities. The low probability of debris capable of significantly impacting a population of a particular bird species should exempt the ongoing missile tests from the take prohibitions. (U.S. Fish and Wildlife Service, 2007a; U.S. Department of the Navy, 2007a)

Regular marine trash removal has been conducted within the Northwestern Hawaiian Islands since 1997 through a multi-agency effort led by the National Marine Fisheries Service, in collaboration with, among others, the Navy, Coast Guard, U.S. Fish and Wildlife Service, National Ocean Service, and State of Hawaii. This effort has resulted in the removal of more than 540 tons of fishing gear and other marine trash over the last 7 years. (National Oceanic and Atmospheric Administration, 2006c)

4.2.2.1.1.2 Alternative 1 (Biological Resources—Nihoa)

HRC RDT&E Activities—Alternative 1

Vegetation

Falling debris from enhanced and future RDT&E missile tests should cool down sufficiently before impact so as not to present a fire hazard for vegetation such as the endangered loulu, \`ohai, *Amaranthus brownii*, and *Schiedea verticillata*. If feasible, consideration would be given to alterations in the missile flight trajectory, to further minimize the potential for debris impacts on vegetation on the island.

Wildlife

The release of simulant would continue to occur at a high altitude over the open ocean during a nominal flight test. No increase in the number of missile defense launches would occur as part of Alternative 1. The potential ingestion of toxins, such as the small amount of propellant or simulant remaining in the spent boosters or on pieces of missile debris, by birds or monk seals on the island would be remote because of (1) atmospheric dispersion, (2) the diluting and neutralizing effects of seawater, and (3) the relatively small area that could potentially be affected. It is also unlikely that enough simulant capable of affecting birds or monk seals would reach the island of Nihoa due to the dispersal by area winds of the material (which would be exo-atmospheric).

4.2.2.1.1.3 Alternative 2 (Biological Resources—Nihoa)

HRC RDT&E Activities—Alternative 2

Vegetation

The increase in the number of missile launches proposed (from 46 to 50) could result in a slight increase in the potential for additional impacts on vegetation on Nihoa. However, various trajectories, launch sites, and intercept areas are used that may or may not have the potential to affect the island. Any impacts on vegetation from proposed activities would be similar to those from the No-action Alternative and Alternative 1.

Wildlife

An increase in Missile Exercises from 46 per year to 50 per year could result in a slight increase in the potential for additional impacts on wildlife on Nihoa; however, the probability for widely scattered debris to hit birds, seals, or other wildlife would continue to be low. Quantities of falling debris (e.g., solid rocket propellant) would be low and widely scattered so as not to present a toxicity issue. Various trajectories, launch sites, and intercept areas would continue to be used, which would help to minimize the effects on any particular location. Effects would be similar to those discussed above in the No-action Alternative section.

4.2.2.1.1.4 Alternative 3 (Biological Resources—Nihoa)

HRC RDT&E Activities—Alternative 3

Vegetation

Effects on vegetation under Alternative 3 would be the same as those described for Alternative 2.

Wildlife

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential impacts on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are the same as those analyzed for the No-action Alternative. Potential impacts on marine and terrestrial biological resources from non-ASW (sonar usage) training activities and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.2.2.1.2 Necker—Biological Resources

4.2.2.1.2.1 No-action Alternative (Biological Resources—Necker)

HRC RDT&E Activities—No-action Alternative

Vegetation

Although missiles could overfly Necker, it is unlikely that missile debris would impact on or near the island; any falling debris should cool down sufficiently before impact so as not to present a fire hazard for the sparse vegetation on Necker, including the endangered `ohai as described in Section 4.2.2.1.1.1. If feasible, consideration would be given to alterations in the missile flight trajectory, to further minimize the potential for debris impacts on vegetation on the island.

Wildlife

Although missiles could overfly Necker, it is unlikely that missile debris would impact on or near the island; any impacts on wildlife would be similar to those discussed above for Nihoa Island. No increase in the number of missile defense launches would occur as part of Alternative 1.

4.2.2.1.2.2 Alternative 1 (Biological Resources—Necker)

HRC RDT&E Activities

Vegetation

It is unlikely that debris from enhanced and future RDT&E missile tests would impact on or near the island.

Wildlife

Although missiles could overfly Necker, it is unlikely that missile debris would impact on or near the island; any impacts would be similar to those discussed above for Nihoa Island. No increase in the number of missile defense launches would occur as part of Alternative 1.

4.2.2.1.2.3 Alternative 2 (Biological Resources—Necker)

HRC RDT&E Activities

Vegetation

It is unlikely that debris from an increase in Missile Exercises from 46 per year to 50 per year would impact on or near the island.

Wildlife

An increase in Missile Exercises from 46 per year to 50 per year would not necessarily result in additional impacts on wildlife on Necker, since the probability for widely scattered debris to hit birds, seals, or other wildlife would continue to be low. Although missiles could overfly Necker, it is unlikely that missile debris would impact on or near the island; any impacts would be similar to those discussed above for Nihoa Island.

4.2.2.1.2.4 Alternative 3 (Biological Resources—Necker)

HRC RDT&E Activities—Alternative 3

Vegetation

Effects on vegetation under Alternative 3 would be the same as those described for Alternative 2.

Wildlife

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential impacts on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are the same as those analyzed for the No-action Alternative. Potential impacts on marine and terrestrial biological resources from non-ASW (sonar usage) training activities and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.2.2.2 CULTURAL RESOURCES—NORTHWESTERN HAWAIIAN ISLANDS

4.2.2.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Northwestern Hawaiian Islands)

Missile defense RDT&E activities, including THAAD testing, have the potential to generate debris that falls within areas of the Northwestern Hawaiian Islands, particularly the vicinity of Nihoa. Some of these islands are known to have significant cultural resources sites, and the islands of Nihoa and Necker (Mokumanamana) are listed in the National and Hawaii State Registers of Historic Places. Debris analyses of the types, quantities, weights, and sizes associated with the PMRF Missile Exercises indicate that the potential to impact land resources of any type is very low and extremely remote (U.S. Army Space and Missile Defense Command 2002). In addition, trajectories can be altered under certain circumstances to further minimize the potential for impacts. As noted in Section 4.2.2.1, future missions will include consideration of missile flight trajectory alterations, if feasible, to minimize the potential for debris within these areas. As a result, impacts on cultural resources within the Northwestern Hawaiian Islands are not expected. In accordance with Section 106 of the National Historic Preservation Act, the Hawaii State Historic Preservation Office (SHPO) was provided a copy of the Draft EIS/OEIS and afforded an opportunity to comment. The SHPO responded on September 17, 2007, indicating that no historic properties will be affected.

4.3 KAUAI

4.3.1 KAUAI OFFSHORE

4.3.1.1 PMRF OFFSHORE (BARSTUR, BSURE, SWTR, KINGFISHER)

Table 4.3.1.1-1 lists ongoing Hawaii Range Complex (HRC) training and research, development, test, and evaluation (RDT&E) activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 offshore of Pacific Missile Range Facility (PMRF). Alternative 3 is the preferred alternative.

Table 4.3.1.1-1. Training and RDT&E Activities at PMRF Offshore (BARSTUR, BSURE, SWTR, Kingfisher)

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Naval Surface Fire Support Exercise (Barking Sands Tactical Underwater Range [BARSTUR], Barking Sands Underwater Range Extension [BSURE]) • Expeditionary Assault • Flare Exercise • Anti-Submarine Warfare (ASW) Tracking Exercise (BARSTUR, BSURE, Shallow Water Training Range [SWTR]) • ASW Torpedo Exercise (BARSTUR, BSURE, SWTR) • Major Integrated ASW Training Exercise (BARSTUR, BSURE, SWTR) • Electronic Combat Operations • Mine Countermeasures Exercise (MCM) • Mine Neutralization • Mine Laying • Swimmer Insertion/Extraction • Special Warfare Operations (SPECWAROPS)	• Anti-Air Warfare RDT&E • Electronic Combat/Electronic Warfare (EC/EW) • High-Frequency Radio Signals • Missile Defense • Additional Chemical Simulant (Alternative 1) • Launched SM-6 from Sea-Based Platform (AEGIS) (Alternative 1) • Test Unmanned Surface Vehicles (Alternative 1) • Test Unmanned Aerial Vehicles (UAVs) (Alternative 1) • Test Hypersonic Vehicles (Alternative 1) • Portable Undersea Tracking Range (Alternative 1) • Expanded Training Capability for Transient Air Wings (Alternative 1) • Kingfisher Underwater Training Area • Directed Energy (Alternative 2/3) • Advanced Hypersonic Weapon (Alternative 2/3)

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for PMRF/Main Base Offshore training and RDT&E activities. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous material and hazardous waste, health and safety, land use, noise, and utilities.

There are no reports of emissions from Navy training and RDT&E activities affecting the air quality offshore of PMRF/Main Base. Use of the area offshore of PMRF could require control of the airspace; however, any issues associated with this airspace are included within the PMRF/Main Base discussion (Section 4.3.2.1.2). Because no ground disturbance or building modifications would occur offshore, there would be no impact on geology and soils. Training and RDT&E activities in the area offshore of PMRF would require small amounts of hazardous materials for maintenance and would generate small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with PMRF's hazardous materials management plans as described in Appendix C. No noise-sensitive land receptors are affected by existing noise levels at the site. All training and RDT&E activities offshore of PMRF/Main Base are conducted in accordance with health and safety guidance, as described in Appendix C. There is no public health and safety issue. There would be no impact on utilities and land use because the training population is transient and training sites remain the same for each alternative. Land use does not conflict with recreational activities occurring in or adjacent to PMRF. There are no utility issues associated with offshore training and RDT&E activities for PMRF/Main Base.

4.3.1.1.1 Biological Resources—PMRF Offshore (BARSTUR, BSURE, SWTR, Kingfisher)

Potential impacts of RDT&E activities, including missile launches on marine biological resources within the PMRF region of influence, have been addressed in detail in the Strategic Target System Environmental Impact Statement (EIS), the Restrictive Easement EIS, the PMRF Enhanced Capability EIS, and the Theater High Altitude Area Defense Pacific Flight Tests Environmental Assessment (EA), (U.S. Army Strategic Defense Command, 1992; U.S. Army Space and Strategic Defense Command 1993a; U.S. Department of the Navy, 1998a; U.S. Army Space and Missile Defense Command, 2002). Based on these prior analyses and the effects of current and past missile launch activities, the potential impacts of activities related to continuing RDT&E on offshore biological resources are expected to be minimal.

The analytical approach for biological resources involved evaluating the degree to which the proposed launch activities can impact vegetation, wildlife, threatened or endangered species, and sensitive habitat within the affected area. Offshore refers to ocean areas from 0 to 12 nautical miles (nm) offshore of PMRF/Main Base. Criteria for assessing potential impacts on biological resources are based on the following: the number or amount of the resource that will be impacted relative to its occurrence at the project site, the sensitivity of the resource to proposed training and RDT&E activities, and the duration of the impact. Impacts are considered substantial if they have the potential to result in reduction of the population size of Federally listed threatened or endangered species, degradation of biologically important unique habitats, substantial long-term loss of vegetation, or reduction in capacity of a habitat to support wildlife.

4.3.1.1.1.1 No-action Alternative (Biological Resources—PMRF Offshore ([BARSTUR, BSURE, SWTR, Kingfisher])

HRC Training and Major Exercises—No-action Alternative

Vegetation

No threatened or endangered vegetation is located in the offshore area.

Wildlife

Effects of the applicable training events on open ocean marine species more than 12 nm offshore will be the same or less than those described for the offshore region. Effects on marine species from underwater sound levels produced by the use of mid-frequency active/high-frequency active (MFA/HFA) sonar and from underwater explosions are addressed in Section

4.1.2. At PMRF, portions of the Bombing Exercise (BOMBEX), Mine Exercise (MINEX), gunnery/special weapons tests, and Sinking Exercise (SINKEX) can also occur within offshore waters. Effects on marine species are similar to those presented in Section 4.1.2 and are further discussed below.

The weapons used in most BOMBEX and Gunnery Exercises (GUNEX) pose little risk to foraging birds, whales, Hawaiian monk seals (*Monachus schauinslandi)*, or sea turtles within the offshore area unless they were to be near the surface at the point of impact. Both 0.50-caliber machine guns and the close-in weapons systems exclusively fire non-explosive ammunition. The same applies to larger weapons firing inert ordnance for training events. These rounds pose a risk only at the point of impact. To avoid harming animals, target areas are determined to be clear of marine mammals and sea turtles before training begins.

Expeditionary Assault or Special Warfare Operations (SPECWAROPS) amphibious landing training events on PMRF occur at Majors Bay, which has coral coverage of less than 2 percent. The training takes place in specific routes in order to minimize to the extent practicable impacts on coral and other sensitive marine life. Amphibious vehicles are washed down after completion of training to minimize the potential for introducing alien or invasive species. Potential impacts of past amphibious landings during Expeditionary Assault training have been monitored. The area of Majors Bay used for landing training is located in an area typically not used by sea turtles or monk seals. Within 1 hour prior to initiation of Expeditionary Assault landing training events, landing routes and beach areas are surveyed for the presence of sensitive wildlife. If any marine mammals or sea turtles are found to be present on the beach, the training is delayed until the animals leave the area.

Flares are used over water during training. They are composed of a magnesium pellet that burns quickly at a very high temperature leaving ash, end caps, and pistons. Ash from flares will be dispersed over the water surface and then settle out. Chemical leaching will occur throughout the settling period through the water column, and any leaching after the particles reach the bottom will be dispersed by currents. Therefore, localized and temporary impacts on benthic resources may occur, but no long-term impact is anticipated.

Impacts on sea turtles and marine mammals in the offshore area from Anti-Submarine Warfare (ASW) Exercises, mainly from sonar and underwater explosions, will be similar to those discussed in Section 4.1.2. Detection of another vessel is the goal of ASW. During ASW training there is a heightened awareness of the need to detect and identify everything within the water column since it may be the opponent. The Navy has conducted submarine training in and around the Hawaiian Islands for years. Before any explosive training, the range is carefully screened visually to ensure that no marine mammals or other intruders are present. When the divers enter the water, they also have an opportunity to detect marine mammals and humpback whales visually or audibly (if the whales are vocalizing). The training does not proceed if marine mammals are in the vicinity. The delay between initiating the fuse and the detonation of the explosives is only 30 minutes, minimizing the opportunity for marine mammals to enter the area. Given the relatively small size of the charge, the area within which marine mammals would be at risk from the explosive is quite limited. Most ASW training involving the launch of an exercise torpedo occur on the BARSTUR range under range control of PMRF, outside the 100-fathom isobath and well clear of the Hawaiian Islands Humpback Whale National Marine Sanctuary boundaries. (U.S. Department of the Navy, 1998a)

Electronic Combat Operations consist of air-, land-, and sea-based emitters simulating enemy systems electronic signals, designed to simulate threat radars. Ship and aircraft crews train to respond to these signals as appropriate with little potential for impacts on marine species. Appropriately configured aircraft fly threat profiles against the ships so that crews can be trained to detect electronic signatures of various threat aircraft, or so that ship crews can be trained to detect counter jamming of their own electronic equipment by the simulated threat.

In Mine Countermeasures Exercises, aircraft, ships, and submarines train to detect, then avoid or disable in-water mines and placing mines in the water respectively. Tactics for neutralizing ground or bottom mines involve a diver placing a specific amount of explosives which, when detonated underwater at a specific distance from a mine, results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Mine laying involves aircraft and submarines deploying mines into the water. As discussed in Section 4.1.2.3.1, there is a long period of area monitoring before any detonation or live fire event begins. Ordnance cannot be released until the target area is determined clear. Species are large or travel in large pods and are easily visible from an elevated platform; a ship or aircraft would readily see a marine mammal in time to implement mitigation measures. Activities are immediately halted if sea turtles or marine mammals are observed within the target area. Activities are delayed until the animal clears the target area. Most underwater detonations take place in sandy areas that are generally not used by sea turtles and are free of coral. All of these factors serve to avoid the risk of harming cetaceans, pinnipeds, or sea turtles. Post event monitoring of underwater detonations has not observed any mortality.

Swimmer Insertion/Extraction involves underwater training with a Sea, Air, and Land (SEAL) Delivery Vehicle (SDV) that transports SEALs between a submerged submarine and shore. Impacts will be minor and similar to those of Expeditionary Assault training events discussed above. Special training involving swimmers and small boats within the 100-fathom isobath pose a very low risk of potentially harmful direct or indirect effects on marine mammals. Similar training has been conducted in Hawaiian waters for many years without any indication that such training has had any effect on marine mammal populations. Small boat coxswains and special operations forces are aware of the environment around them and avoid both unidentified objects and marine mammals, which pose a more severe hazard to them than they pose to the mammals. Although most training is at night, special operations forces are specially trained for night training and the use of night vision devices. (U.S. Department of the Navy, 1998a)

SPECWAROPS are performed by Navy SEALs and U.S. Marines and include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. These activities occur within regularly used range areas with little potential for long-term impacts on marine species.

High-frequency test and evaluation include the use of High-Frequency Radio Signals and the evaluation of their effectiveness. High frequency in the radio spectrum refers to frequencies between 3 megahertz (MHz) and 30 MHz. This frequency range is commonly used for maritime and amateur short-wave radio transmissions. These test and evaluation activities can take place both at PMRF shore sites and within W-188. No impacts on offshore marine species are anticipated.

In an Air-to-Air Missile Exercise (A-A MISSILEX), missiles are fired from aircraft against unmanned aerial target drones such as the subsonic BQM. The fired missiles and targets during MISSILEXs are not recovered, with the exception of BQMs, which have parachutes. Launches of target missiles and drones from PMRF as part of Missile Defense Activities occur from existing ground-based target launch sites at the PMRF launch complex and Kauai Test Facility (KTF). Their potential effects are discussed below.

Noise

The effects of noise on wildlife vary from serious to no effect in different species and situations. Behavioral responses to noise also vary from startling to retreat from favorable habitat. Animals can also be very sensitive to sounds in some situations and very insensitive to the same sounds in other situations. (Larkin, 1996) Noise from launches may startle nearby wildlife and cause flushing behavior in birds, but this startle reaction would be of short duration. The increased presence of personnel, vehicles, helicopters, and landing craft immediately before a launch would tend to cause birds and other mobile species of wildlife to temporarily leave the area that would be subject to the highest level of launch noise. However, training is usually short in duration and occurs within regularly used range areas. Major Exercises incorporate procedures to avoid wildlife that are foraging, resting, or hauled out, such as threatened green turtles (*Chelonia mydas*) or endangered Hawaiian monk seals.

Air Emissions

Within offshore waters, the potential ingestion of contaminants by fish and other marine species will be remote because of atmospheric dispersion of the emission cloud, the diluting effects of the ocean water, and the relatively small area of the Essential Fish Habitat (EFH) that will be affected. Further discussions on the effects of MISSILEX and other training and RDT&E activities on fish and EFH are presented in the Open Ocean Section (4.1.2) and in the Navy's *Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex EIS/OEIS* (U.S. Department of the Navy, 2007a).

In the unlikely event of a launch mishap involving a liquid-propellant missile, if the fuel and/or oxidizer do not explode or burn, they will likely be deposited on the ground or water surface. Materials will be rapidly diluted in the seawater and, except for the immediate vicinity of the debris, will not be found at concentrations identified as producing adverse effects (U.S. Department of the Navy, 1998a). For Terminal High Altitude Area Defense (THAAD) missiles, a maximum of 0.5 gallon (gal) of hypergolic bi-propellants will be released from the Divert and Attitude Control System. For a Lance missile, up to several hundred pounds of inhibited red fuming nitric acid (IRFNA) and hydrazine can be released. The Liquid Fuel Target System has the potential to release up to several hundred gallons of IRFNA and coal tar distillate.

Bi-propellants are two liquid missile propellants, such as THAAD's monomethyl hydrazine and nitrogen tetroxide, stored in separate tanks and fed into the missile system separately as fuel and oxidizer. The nitric acid produced from the bi-propellant release will initially cause spattering, a localized increase in water temperature, and local lowering of the hydrogen ion concentration (pH) value. However the low levels of emission combined with the natural buffering capacity of seawater will neutralize the reaction in a relatively short period of time. The potential ingestion of toxins by fish species, which may be used for food sources, will be remote due to this buffering capacity, although some fish may be injured or killed if present at the bi-propellants' initial point of contact. (U.S. Army Space and Missile Defense Command, 2002)

When released, the IRFNA will volatize into the atmosphere. Residual nitric acid will cause a localized short-term pH change in the water; however, the acid will mix with the water and eventually be neutralized and diluted. The IRFNA (hypergolic oxidizer) will also form nitric and nitrous acid on contact with water, and will be quickly diluted and buffered by seawater. With regard to the initiator or hydrazine fuels, these highly reactive species quickly oxidize, forming amines and amino acids, which are beneficial nutrients to simple marine organisms. Prior to oxidation, there is some potential for exposure of marine life to toxic levels, but for a very limited area and time (National Aeronautic and Space Administration, 2002). Coal tar distillate fuel would not mix with the water, but would form a slick on the surface. Because of (1) the diluting and neutralizing effects of seawater, (2) the relatively small area that will be affected, and (3) the existing spill prevention, containment, and control measures in place at PMRF, minimal impacts on marine species are expected.

Debris

According to analysis contained in the PMRF Enhanced Capability EIS, debris from shore-based missile launch programs is not expected to produce any measurable impacts on offshore benthic (sea floor) resources.

The probability for a launch mishap is very low. However, an early flight termination or mishap will cause missile debris to impact along the flight corridor, potentially in offshore waters. Debris will be removed from shallow water if possible. In most cases, the errant missile will be moving at such a high velocity that resulting missile debris will strike the water further downrange. If humpback whales, monk seals, or sea turtles were observed in the offshore launch safety zone, the launch will be delayed (U.S. Department of the Navy, 1998a).

The potential impact on EFH from nominal launch activities would mainly be from spent boosters and missile debris to waters off the coast within the Temporary Operating Area (TOA). By the time the spent rocket motors impact in the ocean, generally all of the propellants in them will have been consumed. Any residual aluminum oxide, burnt hydrocarbons, or propellant materials are not expected to present toxicity concerns. In a successful intercept, both missiles will be destroyed by the impact over the ocean. Momentum will carry the debris along the respective paths of the two missiles until the debris falls to earth. The debris will consist of a few large pieces (10 to 100 pounds [lb]), many medium pieces (10 lb or less), but mostly tiny particles. Such missile components will immediately sink to the ocean bottom out of reach of most marine life. Some fish near the surface could be injured or killed by larger pieces of debris. It is unlikely that the smaller pieces of sinking debris will have sufficient velocity to harm individual marine mammals or fish.

According to the analysis in the Point Mugu Sea Range EIS, less than 0.0149 marine mammals in its affected area would be exposed to missile debris per year, and the probability of this debris affecting marine mammals or other marine biological resources is less than 10^{-6} (1 in 1 million). This probability calculation was based on the size of the Pacific Ocean area studied and the marine mammal population density within that area. The Point Mugu range area (27,183 square nautical miles [nm^2]) is 0.1 percent of the PMRF TOA (2.1 million nm^2), and the density of marine mammals is larger. It is reasonable to conclude that the probability of marine mammals being struck by debris from missile testing at PMRF would be even more remote than at Point Mugu. (U.S. Department of the Navy, 1998c)

In the unlikely event of a launch mishap, scattered pieces of burning propellant could enter coastal water and potentially affect EFH closer to shore. Concentrations of toxic materials would be highest in this shallow water and have a greater chance of being ingested by feeding animals. However, the potential for a launch mishap is relatively slight, and in most cases the errant missile would be moving at a rapid rate such that pieces of propellant and other toxic debris would strike the water further downrange. The debris would also be small and widely scattered, which would reduce the possibility of ingestion.

Interceptor missile element test activities associated with the Missile Defense Agency lethality program could include development and testing of nuclear, biological, or chemical material simulants. These activities were analyzed in the *Programmatic Environmental Assessment, Theater Missile Defense Lethality Program* (U.S. Army Space and Strategic Defense Command, 1993b). The use and effects of simulants have been analyzed in other PMRF-related documents (U.S. Department of the Navy, 1998a; U.S. Army Space and Missile Defense Command, 2002; U.S. Army Space and Missile Defense Command, 2003). The only proposed chemical simulant that might be included as part of the No-action Alternative in a target payload would be small quantities of tributyl phosphate (TBP), which is a non-flammable, non-explosive, colorless, odorless liquid typically used as a component of aircraft hydraulic fluid, as a plasticizer, and as a solvent in commercial industry. The release of simulant will occur at a high altitude over the open ocean during a nominal flight test. The potential ingestion of toxins, such as the small amount of propellant or simulant remaining in the spent boosters or on pieces of missile debris, by marine mammals or fish species in the offshore area will be remote because of (1) atmospheric dispersion, (2) the diluting and neutralizing effects of seawater, and (3) the relatively small area that could potentially be affected. Effects of TBP are further discussed in Section 4.2.1.1.1.1.

<u>Electromagnetic Radiation (EMR)</u>

Specific siting and orientation of the radar results in a cone shaped EMR zone being projected skyward yet within site boundaries. In terms of the potential for EMR impacts on wildlife, the main beam of the THAAD radar or other ground-based radar system during missile flight tests will not be directed toward the ground and will have a lower limit of 4 to 5 degrees above horizontal, which would preclude EMR impacts on green turtles or monk seals on the beach.

Marine mammals and sea turtles are normally found below the surface of the water. Radiofrequency radiation does not penetrate the surface of water to any great degree. The power density level just below the surface of the ocean will not exceed the permissible human exposure level for uncontrolled environments. (U.S. Department of the Navy, 2002a) No adverse impacts should occur to whales, other marine mammals, or sea turtles at least 0.5 inch below the surface. It is also highly unlikely that an individual whale or turtle would be on or substantially above the surface of the water for a significant amount of time within the main beam or side lobe areas during the particular time that the radar would be operating (U.S. Department of the Navy, 2002a). (U.S. Army Space and Missile Defense Command, 2003)

The potential for main-beam (airborne) exposure thermal effects on birds exists. The potential for impacts on birds and other wildlife was addressed in the Ground-Based Radar Family of Radars EA (U.S. Army Space and Strategic Defense Command, 1993c). The analysis was based on the conservative assumption that the energy absorption rate of a bird’s body was equal to its resting metabolic rate, and that this could pose a potential for adverse effects. Birds in general typically expend energy at up to 20 times their resting metabolic rates during flight.

Mitigating these concerns is the fact that radar beams are relatively narrow. To remain in the beam for any period requires that the bird flies directly along the beam axis, or that a hovering bird such as a raptor does so for a significant time. There is presently insufficient information to make a quantitative estimate of the joint probability of such an occurrence (beam stationary/bird flying directly on-axis or hovering for several minutes), but it is estimated to be insubstantial. Since birds are not likely to remain continuously within the radar beam, the likelihood of harmful exposure is not great. The use of existing sensors is part of routine activities on PMRF as analyzed in the PMRF Enhanced Capability EIS. (U.S. Department of the Navy, 1998a)

Earlier analysis of ground-based radar's potential impacts on birds indicated that power densities of 243 to 390 milliwatts per square inch would be necessary to affect birds weighing up to 7.7 lbs. The power density of radars such as THAAD is not expected to exceed 32 milliwatts per square inch. (U.S. Army Space and Strategic Defense Command, 1993c)

HRC RDT&E Activities—No-action Alternative

PMRF's additional mission is supporting RDT&E projects. The at sea activities are analyzed in the Open Ocean Section (4.1.2). Land sensor and missile defense effects will be the same or similar to those discussed above. Other activities on PMRF include one-of-a-kind or short duration RDT&E activities conducted for both government and commercial customers. Examples include humpback whale detection, Maritime Synthetic Range, and numerous System Integration Checkout activities. Generally these types of activities have no or minimal effect on biological resources.

Major Exercises—No-action Alternative

In addition to routine training events at PMRF, Command and Control (C2), Aircraft Support Operations, Missile Launches, and SPECWAROPS are conducted during biennial and annual Major Exercises. C2 is achieved through a network of communication devices strategically located at selected Department of Defense (DoD) installations around the islands with no impacts on biological resources. The Major Exercises are combined forces performing different activities throughout the HRC. Potential impacts on biological resources offshore of PMRF/Main Base from a Major Exercise are similar to those described above for training and RDT&E activities.

A number of general mitigation measures help ensure that the risk of a harmful effect on marine mammals and humpback whales is extremely low. Since 1990, the Shipboard Environmental Coordinator's Guide to Environmental Compliance informs ships of the National Marine Fisheries Service (NMFS) restrictions on approaching humpback whales. Also, all Navy ships calling on Hawaiian ports are advised of important natural resource issues, including precautions regarding whales, in the reply to their request for a berth. Because this anticipates the actual date of arrival by approximately 2 days, the ships are advised of humpback precautions and other possible issues well before they approach Hawaii. This ensures that protection of the humpback whale is officially considered during the planning and conducting of training events, including Amphibious Warfare Operations. In addition, there is an annual ship, submarine, and aircraft notice in mid-November announcing the arrival of the whales, and reminding recipients of the existing restrictions. (U.S. Department of the Navy, 1998a)

4.3.1.1.1.2 Alternative 1 (Biological Resources—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Increased Tempo and Frequency of Training, New Training, and Major Exercises—Alternative 1

Alternative 1 would include up to six Undersea Warfare Exercises (USWEXs) per year, the biennial Rim of the Pacific (RIMPAC) Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). This would amount to an average increase of approximately 9 percent for offshore training and RDT&E activities.

Vegetation

No threatened or endangered vegetation is located in the offshore area.

Wildlife

With the exception of impacts associated with MFA/HFA sonar use (Section 4.1.2), impacts to wildlife would be similar to those described previously for the No-action Alternative since the additional training and RDT&E activities would be performed throughout the HRC and not confined to one particular area. It is unlikely that an individual listed species or other wildlife offshore of PMRF would be repeatedly exposed to noise, debris, EMR, or emissions as a result of increased training and RDT&E activities.. The additional training would continue to comply with relevant Navy policies and procedures, such as existing clearance procedures, which would minimize the potential for effects on wildlife.

Transiting battle groups also conduct ASW training along their track, which typically lies at least 25 miles (mi) north of Kauai. Major Exercises are typically conducted over 50 mi from any island, but include portions close to land to simulate passage through straits or amphibious operations. ASW training during these phases must include shallow water operations, and is conducted off PMRF and in the channel between Kaula and Niihau. Effects would be the same as those discussed above in the No-action Alternative.

<u>New Training</u>

An additional proposed training event associated with Major Exercises is Field Carrier Landing Practice (FCLP). This event involves pilots from an aircraft carrier air wing using carrier planes to practice at a land runway. As discussed in Chapter 2.0, the runway at PMRF could be used for FCLP. For each pilot, the FCLP would include 8 to 10 touch-and-go landings at the PMRF runway during both daytime and at night. Sound levels from these training events would be similar to sound levels currently occurring at the PMRF runway. Other than startle effects, no substantial impacts on wildlife, including threatened and endangered species, are anticipated.

<u>Hawaii Range Complex Enhancements</u>

Sources such as the proposed Portable Undersea Tracking Range, underwater communications, and electronic warfare systems that may be deployed in the ocean are beyond the frequency range or intensity level to affect marine animals. Flat areas with no known coral concentration would be selected for the Portable Undersea Tracking Range when possible. In areas that have not been mapped for coral presence, the Navy would develop appropriate habitat data and any necessary Best Management Practices and mitigations in coordination with NMFS and USFWS. The Navy will continue to work with regulatory agencies throughout the planning and development process to minimize the potential for impacts on coral, fish, and marine mammals.

Enhanced and Future RDT&E Activities—Alternative 1

Payloads on some target vehicle launches from PMRF would incorporate additional chemical simulants, which include larger quantities of TBP and various glycols. Up to approximately 120 gal of simulant could be used in target vehicles. The families of chemicals were selected based on the criteria to minimize potential toxicity and maximize the potential to simulate the more dangerous chemical warfare agents. Potential effects from the use of these simulants are further discussed in Sections 4.2.1.1.1.1 and 4.2.1.1.1.2.

The release of simulant would continue to occur at a high altitude over the open ocean during a nominal flight test. The potential ingestion of toxins, such as the small amount of propellant or simulant remaining in the spent boosters or on pieces of missile debris, by marine mammals or fish species would be remote because of (1) atmospheric dispersion, (2) the diluting and neutralizing effects of seawater, and (3) the relatively small area that could potentially be affected.

As part of Alternative 1, PMRF would develop the capability to launch the Extended Range Active Missile, tentatively designated Standard Missile-6 (SM-6), from a sea-based platform. Standard Missiles are the Navy's primary surface-to-air fleet defense weapon. SM-1 entered production in 1967. The SM-6 is an upgrade in software and power to the existing SMs. It is vertically launched from a canister and compatible with existing Aegis cruisers and destroyers. It will have a Solid Rocket Booster and Dual Thrust Solid Rocket Motor on the proven SM-2 Block IV airframe (Raytheon, 2007). Impacts should be similar to those for other solid propellant missile launches previously discussed.

Also as part of Alternative 1, launches from Wake Island, the Reagan Test Site at U.S. Army Kwajalein Atoll (USAKA), and Vandenberg Air Force Base (AFB) toward the vicinity of PMRF are proposed. Launches from those sites would be from existing launch facilities and the intercept areas would be in the Open Ocean Area and TOA of the PMRF Range. Targets would also be launched from sea-based and air-based platforms. The effects of these missile tests would be similar to those described above for the No-action Alternative and in Section 4.1.2.

4.3.1.1.1.3 Alternative 2 (Biological Resources—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Increased Tempo and Frequency of Training Activities—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. With the exception of impacts associated with MFA/HFA sonar use (Section 4.1.2), impacts on wildlife would be similar to those described previously for the No-action Alternative since the additional training would be performed throughout the HRC and would not be confined to one particular area. This dispersion of activity with identical mitigations should minimize any increase in potential effects. It is unlikely that a listed species or other wildlife offshore of PMRF would be injured or killed as a result of increased training. Likewise, increases in the number of training events would continue to comply with relevant Navy policies and procedures, such as existing clearance procedures, which would minimize the potential for increased likelihood of effects on wildlife.

Enhanced and Future RDT&E Activities—Alternative 2

PMRF would also add the capability to test non-eye-safe lasers. These types of lasers are associated with the Hellfire system and the GQM-163 Coyote. If Airborne Laser system testing were conducted at PMRF, separate environmental documentation would be required to analyze the specific test requirements.

Advanced Hypersonic Weapon

Launches of the Advanced Hypersonic Weapon for testing would be similar to launches of the Strategic Target System previously analyzed in the Strategic Target System EIS and the PMRF Enhanced Capability EIS (U.S. Army Strategic Defense Command, 1992; U.S. Department of the Navy, 1998a). No new facilities would be required. The launch azimuth and flight termination system would be the same as that of the existing Strategic Target System. Existing radars and hazard areas would also be the same. As a result, impacts on biological resources would be minimal.

Effects from reentry vehicles and missiles impacting Illeginni have been assessed in several documents including the 1977 EA Missile Impacts, Illeginni Island and the 2004 EA for Minuteman III Modification, which includes the Summary of the 1992 EA for Department of Energy (DOE) Reentry Vehicles, Flight Test Program, U.S. Army Kwajalein Atoll, Republic of the Marshall Islands (Ballistic Missile Defense System Command, 1977; U.S. Department of the Air Force, 2004). Reentry vehicles impacts on Illeginni most often occur in cleared or maintained areas in the center of the island. Mitigation measures include the use of best management practices developed by USAKA to prevent any unnecessary additional disturbance of bird nesting sites and the least possible disruption of vegetation and habitat in the post-test cleanup process.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during current Major Exercises, in various areas of the HRC, with impacts on biological resources being similar to those described above.

4.3.1.1.1.4 Alternative 3 (Biological Resources—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.3.1.1.2 Cultural Resources—PMRF Offshore (BARSTUR, BSURE, SWTR, Kingfisher)

4.3.1.1.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Training with the potential to affect cultural resources at PMRF Offshore include Swimmer Insertion/Extraction, Expeditionary Assault, Mine Countermeasures (MCM), and Humanitarian Assistance Operation and Non-Combatant Evacuation Operation (HAO/NEO). All three of these training events exhibit similar training that involves personnel and equipment (e.g., Amphibious Assault Vehicle (AAVs), SDVs, supply trucks) crossing beach areas or following existing roads from the shoreline and dispersing into designated areas for from 1 to 18 days of training.

According to the National Oceanic and Atmospheric Administration's shipwreck maps, there are also two known wrecks and two Native Hawaiian fishponds in the vicinity of PMRF. Both of the wrecks and one fishpond are near the northern extreme of the facility's shoreline (approximately 5.3 mi north of Majors Bay); the second fishpond is in central PMRF (Site 05-0721–Kawaiele Ditch) (approximately 2.6 mi north of Majors Bay) and is significant as a traditional cultural property associated with the Menehune (International Archaeological Resources Institute, Inc., 2005). Given the distance of these underwater resources from the Major's Bay training and RDT&E activities, no adverse effects on underwater cultural resources are expected.

Increases in the number of training events proposed for Alternative 1, Alternative 2, and Alternative 3 would have no effect on cultural resources at PMRF Offshore. Baseline training and RDT&E activities (i.e., the No-action Alternative) analyzed above will have no adverse effect on known cultural resources at PMRF, and established guidance (e.g., the PMRF Integrated Cultural Resources Management Plan [ICRMP] and a Memorandum of Agreement) is in place for protection. Increased tempo and frequency of training under Alternative 1 would not be anticipated to produce adverse effects. (International Archaeological Resources Institute, Inc., 2005)

If unanticipated cultural resources are encountered (particularly human remains) for any activity, training and RDT&E activities plans direct that all activities will cease in the immediate vicinity of the find and procedures outlined in the PMRF ICRMP, Standard Operating Procedure (SOP) II.3.3, followed (International Archaeological Resources Institute, Inc., 2005).

4.3.1.1.3 Socioeconomics—PMRF Offshore (BARSTUR, BSURE, SWTR, Kingfisher)

4.3.1.1.3.1 No-action Alternative (Socioeconomics—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

There will be no change in the nature, scope, or intensity of training and RDT&E activities within the HRC. Offshore PMRF training and RDT&E activities that have the potential to affect socioeconomics include: Expeditionary Assault, Swimmer Insertion/Extraction and SPECWAROPS, Anti-Air Warfare RDT&E, Electronic Combat/Electronic Warfare (EC/EW), High-Frequency Radio Signals, and Missile Defense. These training and RDT&E activities have the potential to temporarily disrupt commercial fishing, and tourism offshore of PMRF (there is no commercial shipping to PMRF). Due to the Navy's procedures for issuing Notices to Mariners (NOTMARs), such disruptions are limited. NOTMARs provide notice to commercial ship operators, commercial fisherman, recreational boaters, and other area users that the military will be operating in a specific area, allowing them to plan their activities accordingly. These temporary clearance procedures for safety purposes have been employed regularly over time without significant socioeconomic impacts on commercial shipping, commercial fishing, or tourist-related activities. Under the No-action Alternative, the local economy of Kauai will continue to benefit from PMRF/Main Base.

4.3.1.1.3.2 Alternative 1 (Socioeconomics—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Increased Tempo and Frequency HRC Training—Alternative 1

Under Alternative 1, the Navy proposes to increase the tempo and frequency of training in the HRC (see Table 2.2.2.3-1). Under Alternative 1, there are no increases in offshore HRC training associated with PMRF/Main Base and FCLPs are not a part of offshore training. Under Alternative 1, the socioeconomic impact on the economy of Kauai would be the same as discussed under the No-action Alternative and Kauai would continue to benefit from PMRF.

Enhanced RDT&E Activities—Alternative 1

The Navy proposes to enhance RDT&E activities from current levels as necessary as shown in Table 2.2.3.3-1. Under Alternative 1, PMRF/Main Base would increase RDT&E activities offshore. Under Alternative 1, Anti-Air Warfare RDT&E would increase by 14 percent. EC/EW and High-Frequency Radio Signals would increase by 11 percent. PMRF/Main Base would also develop the capability to launch the SM-6 missile from a sea based platform. Unmanned Aerial Vehicle (UAV) testing would be conducted a few nautical miles off the PMRF/Main Base coast. The Navy would continue to issue NOTMARs for scheduled RDT&E activity times and locations, and precautions would be taken to ensure that no interactions between military RDT&E activities and civilian vessels occurred during RDT&E activities. No additional impacts on socioeconomics are anticipated.

Major Exercises—Alternative 1

The Navy proposes to continue RIMPAC and USWEX. Activities associated with Major Exercises would be chosen from the appropriate matrix of training events in Appendix D. There are no proposed increases in offshore Major Exercises supported by PMRF/Main Base. The socioeconomic impact on the economy of Kauai from these training would be the same as discussed under the No-action Alternative, and Kauai would continue to benefit from PMRF.

4.3.1.1.3.3 Alternative 2 (Socioeconomics—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Increased Tempo and Frequency HRC Training—Alternative 2

Under Alternative 2, the Navy proposes to increase the tempo and frequency of training in the HRC. For example, instead of a training event lasting 5 days, the same training would be completed in 3 days. Under Alternative 2, Expeditionary Assault activities would increase by 9 percent and Swimmer Insertion/Extraction would increase by approximately 10 percent. Training would have the potential for occasional, temporary disruptions of commercial fishing and tourism within the HRC; however, such training would be infrequent and of very limited duration. Offshore training would not result in significant restrictions on commercial fishing or tourism-related activities due to the Navy's procedures for issuing NOTMARs and the ability of commercial vessels to plan accordingly when NOTMARs are issued. Additionally, the Navy would continue precautions to ensure that no interactions between military training and civilian vessels occur during training events. No additional impacts on socioeconomics are anticipated.

Enhanced and Future HRC RDT&E Activities—Alternative 2

Under Alternative 2, PMRF/Main Base would continue the increased RDT&E activities as well as Directed Energy and the Advanced Hypersonic Weapon for future RDT&E activities. Anti-Air Warfare RDT&E would increase by approximately 26 percent, EC/EW would increase by 23 percent, missile defense would increase by approximately 9 percent and High-Frequency Radio Signals would increase by 22 percent. Use of additional chemical simulants, launching the SM-6 from a Sea-based Platform (AEGIS), testing UAVs and Advanced Hypersonic Vehicles as discussed under Alternative 1 would continue. The Navy proposes to establish a long-term Maritime Directed Energy Center at PMRF. Up to four air targets would be used for testing. The Advanced Hypersonic Weapon would eventually involve launches of long range missiles from KTF, which is located on PMRF, and launches would average one per year. The Navy would continue to issue NOTMARs for scheduled RDT&E activity times and locations, and precautions would be taken to ensure that no interactions between military activities and civilian vessels occurred during training. Beneficial impacts on Kauai economics would continue as a result of the additional personnel and services that may be required.

Additional Major Exercises—Alternative 2

Up to three Strike Groups would conduct training simultaneously in the HRC. Proposed Major Exercises would be similar to current training for the RIMPAC and USWEX Exercises. The Strike Groups would not be homeported in Hawaii, but would stop in Hawaii en route to a final destination. Commercial shipping (route), commercial fishing, sport fishing, and tourist-related activities occur regularly within the HRC area. Proposed increases in training under Alternative 2 would result in increases in training offshore of PMRF/Main Base. However, the Navy would continue to issue NOTMARs for scheduled Major Exercise times and locations, and precautions would be taken to ensure that no interactions between military activities and civilian vessels occurred during training. Beneficial impacts on Kauai economics would continue as a result of the additional personnel and services that may be required.

4.3.1.1.3.4 Alternative 3 (Socioeconomics—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on socioeconomics under Alternative 3 would be the same as those described for Alternative 2.

4.3.1.1.4 Transportation—PMRF Offshore (BARSTUR, BSURE, SWTR, Kingfisher)

4.3.1.1.4.1 No-action Alternative (Transportation—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

The No-action Alternative stands as no change from current levels of training, and the Navy will continue its current activities at the HRC. Offshore PMRF is used by tourist boats and by barges delivering ordnance and fuel to PMRF/Main Base. A primary commercial shipping route exists approximately 50 mi north of Kauai; there is no commercial shipping to PMRF.

Barges carrying explosives are met at Nawiliwili Bay by trained ordnance personnel and special vehicles for transit to and delivery at PMRF. All ordnance is transported in accordance with U.S. Department of Transportation regulations. PMRF has established guidelines (PMRF Instruction [PMRFINST] 8023.G) that covers the handling and transportation of ammunition, explosives, and hazardous materials on the facility.

Liquid fuels are transported to KTF. These fuels are shipped to the site by truck, aircraft, or barge, which do not affect transportation routes offshore of the island of Kauai. Transportation of these materials is conducted in accordance with U.S. Department of Transportation regulations and specific safety procedures developed for the location.

The Navy has developed extensive protocols and procedures for the safe operation of its vessels and the safe execution of its training (e.g. NOTMARs). Any disruption of tour boats due to the Navy use of the waterway offshore of PMRF/Main Base is occasional and temporary.

4.3.1.1.4.2 Alternative 1 (Transportation—PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Increase Tempo and Frequency HRC Training—Alternative 1

Under Alternative 1, there are no increases in offshore HRC training associated with PMRF/Main Base. Offshore training events would remain as discussed under the No-action Alternative.

Enhanced RDT&E Activities—Alternative 1

Under Alternative 1, PMRF/Main Base would increase RDT&E activities offshore. Under Alternative 1, Anti-Air Warfare RDT&E would increase by 14 percent. EC/EW and High-Frequency Radio Signals would increase by 11 percent. PMRF/Main Base would also develop the capability to launch the SM-6 missile from a sea based platform. UAV testing would be conducted a few nautical miles off the PMRF/Main Base coast. Offshore waterway systems at PMRF/Main Base would be impacted occasionally and temporarily by increases and upgrades of RDT&E activities. The Navy would continue to issue NOTMARs for scheduled activity times and locations, and precautions would be taken to ensure that no interactions between military activities and civilian vessels occurred during offshore RDT&E activities.

Major Exercises—Alternative 1

Under Alternative 1, there are no increases in offshore Major Exercises supported by PMRF/Main Base and FCLPs are a part of offshore training at PMRF/Main Base. Under

Alternative 1, offshore Major Exercises would remain as discussed under the No-action Alternative.

4.3.1.1.4.3 Alternative 2 (Transportation —PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

Increase Tempo and Frequency HRC Training—Alternative 2

Under Alternative 2, the Navy proposes to compress training and increase the frequency of training in the HRC. Under Alternative 2, Expeditionary Assault would increase by 9 percent, C2 would increase by 100 percent, and Swimmer Insertion/Extraction would increase by approximately 10 percent. Offshore waterway systems at PMRF/Main Base would be impacted occasionally and temporarily by increases in training.

Enhanced and Future RDT&E—Alternative 2

Under Alternative 2, PMRF/Main Base would continue the increased RDT&E activities and Directed Energy and Advanced Hypersonic Weapon for future RDT&E activities. Anti-Air Warfare RDT&E would increase by approximately 26 percent. EC/EW would increase by 23 percent, missile defense would increase by approximately 9 percent, and High-Frequency Radio Signals test and evaluation would increase by 22 percent. The upgrades in Additional chemical simulant, launches of SM-6 missiles from Sea-based Platform (AEGIS), and testing UAVs and Hypersonic Vehicles as discussed under Alternative 1 would continue. The Navy would continue to issue NOTMARs for scheduled activity times and locations, and precautions would be taken to ensure that no interactions between military activities and civilian vessels occurred during training activities.

Additional Major Exercises—Alternative 2

Up to three Strike Groups would conduct training simultaneously in the HRC. Proposed Major Exercises would be similar to current training events for the RIMPAC and USWEX Exercises. The Strike Groups would not be homeported in Hawaii, but would stop in Hawaii en route to a final destination. The Navy would continue to issue NOTMARs for scheduled activity times and locations, and precautions would be taken to ensure that no interactions between military activities and civilian vessels occurred during training. No additional impacts on waterways offshore of PMRF/Main Base are anticipated.

4.3.1.1.4.4 Alternative 3 (Transportation —PMRF Offshore [BARSTUR, BSURE, SWTR, Kingfisher])

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on transportation under Alternative 3 would be the same as those described for Alternative 2.

4.3.1.2 NIIHAU OFFSHORE

Table 4.3.1.2-1 lists ongoing training events and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 offshore at Niihau. Alternative 3 is the preferred alternative.

Table 4.3.1.2-1. Training and RDT&E Activities at Niihau Offshore

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Electronic Combat Operations • Special Warfare Operations (SPECWAROPS) • Mine Countermeasures Exercise • Flare Exercise	• Kingfisher Underwater Training Area (Alternative 1)

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 was performed for Niihau. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, hazardous material and hazardous waste, health and safety land use, noise, socioeconomics, transportation, utilities, and water resources.

Air emissions from HRC training and RDT&E activities would not change the regional air quality surrounding Niihau. Use of the area offshore of Niihau could require control of the airspace; however, any issues associated with this airspace are included within the PMRF/Main Base discussion (Section 4.3.2.1.2). There are no HRC training and RDT&E activities that affect any offshore cultural resources, land-forms, land use, or geology. Training and RDT&E activities associated with this site would adhere to policies and regulations governing hazardous materials and hazardous waste, health and safety, and noise, as discussed in Appendix C. There would be no impact on Kauai's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. The transportation infrastructure on Niihau is not used during HRC training and RDT&E activities. There is no central utility system on the island. Training and RDT&E activities at the site would not generate any hazardous waste streams that could impact local water quality.

4.3.1.2.1 Biological Resources—Niihau Offshore

4.3.1.2.1.1 No-action Alternative (Biological Resources—Niihau Offshore)

HRC Training and Major Exercises—No-action Alternative

PMRF remotely operates a radar unit at Paniau (northeast corner of the island) and the Niihau Perch site electronic warfare system. In addition, PMRF flies AEGIS drone targets along the east coast of the island away from inhabited areas. These training events will continue intermittently under the No-action Alternative with the following minimal impacts on marine species. Effects on marine species from underwater sound levels produced by the use of MFA/HFA sonar are addressed in Section 4.1.2.

Vegetation

No threatened or endangered vegetation is located in the offshore area. SPECWAROPS training on Niihau will use existing openings, which will minimize the potential for impacts on the common plants found in Niihau's rocky and sandy beach intertidal habitats.

Wildlife

As described in Section 4.3.1.1.1.1, marine mammals and sea turtles are normally found below the surface of the water. Radiofrequency radiation does not penetrate the surface of water to any great degree. The power density level just below the surface of the ocean will not exceed the permissible human exposure level for uncontrolled environments. (U.S. Department of the Navy, 2002a) No adverse impacts should occur to whales, other marine mammals, or sea turtles at least 0.5 inch below the surface. It is also unlikely that an individual will be on or substantially above the surface of the water in the location of the main beam for a significant amount of time during the radar's operation. (U.S. Army Space and Missile Defense Command, 2003)

The microwave on Niihau is focused on PMRF only. A small signal (about 5 watts, similar to a cell phone) is transmitted from the Electro-magnetic Environmental System Simulator (EMESS) 1 site. Nesting seabirds on Lehua would not be affected.

Reefs offshore of Niihau are poorly developed, and SPECWAROPS on Niihau use existing openings, which will minimize the potential for impacts from Major Exercises. The black coral (*Antipathes sp.*) that occurs at 90 ft and deeper off the northern end of the island should not be affected by current training and Major Exercises. Noise and movement of personnel, vehicles, helicopters, and landing craft during training can temporarily displace sensitive species in the offshore area, such as the green turtle and Hawaiian monk seals that haul out on the island. However, all ocean vessel landing areas are first checked to ensure the sites are clear of monk seals. Training will avoid areas where green turtles are basking. Training activities will also avoid any beach area with sea turtle nests, as they occasionally nest on Niihau beaches.

4.3.1.2.1.2 Alternative 1 (Biological Resources—Niihau Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). This would amount to an average increase of approximately 76 percent for Electronic Combat Operations. The number of SPECWAROPS would remain the same.

Vegetation

No threatened or endangered vegetation is located in the offshore area. SPECWAROPS training on Niihau would continue to use existing openings, which would minimize the potential for impacts on the common plants found in Niihau's rocky and sandy beach intertidal habitats.

Wildlife

With the exception of impacts associated with MFA/HFA sonar use (Section 4.1.2), impacts on wildlife would be similar to those described previously for the No-action Alternative. It is unlikely that a listed marine species or other wildlife would be injured or killed as a result of increased training offshore of Niihau. The additional training would comply with relevant Navy policies and procedures, which would minimize the potential for effects on wildlife. This would include the briefing of all participants on current guidelines to avoid undue impacts on wildlife. No EMR impacts on wildlife on the ocean surface are anticipated, as described in Section 4.3.1.1.1.1. It is also very unlikely that a seabird would remain within the radar beam for any considerable length of time. (U.S. Army Space and Missile Defense Command, 2004)

HRC Enhancements—Alternative 1

Kingfisher Underwater Training Area

PMRF would establish a simulated underwater minefield used to exercise the Kingfisher mine detection system closer to Niihau (Figure 2.2.3.6.4-2). This underwater training area would be approximately 2 mi off the southeast coast of Niihau at a depth of between 300 and 1,200 ft in flat areas free of high-relief features such as cliffs where coral could be established. Reefs offshore of Niihau are poorly developed. The known black coral beds are located off the northern coast of the island and not in the area proposed for the training area.

Buoys deployed at Kingfisher Underwater Training Area could act as Fish Aggregating Devices which could attract pelagic species such as tuna, mahimahi, wahoo, and numerous shark species and thus also attract fishermen. This has not been an issue for the Kingfisher training area offshore of PMRF. The clump of chain anchoring each buoy to the ocean floor may eventually become buried, depending on currents and the softness of the ocean floor. There would be no electronics and no emitters on the buoys. Limited ocean floor disturbance would occur from buoy installation

Mobile marine species could leave the area temporarily to avoid the installation activities. They are expected to return once installation is complete. Some sessile organisms such as sponges, and anemones, may be lost due to anchoring the chain, but these species would be avoided to the maximum extent practicable.

4.3.1.2.1.3 Alternative 2 (Biological Resources—Niihau Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. With the exception of impacts associated with MFA sonar use (Section 4.1.2), impacts on wildlife would be similar to those described previously for the No-action Alternative since the additional training would be performed throughout the HRC and would not be confined to one particular area. This dispersion of training with identical mitigations should buffer any potential increase in likelihood or intensity of effect. It is unlikely that a listed species or other wildlife offshore of Niihau would be injured or killed as a result of increased training. Likewise, increases in the number of training events would continue to comply with relevant Navy policies and procedures, such as existing clearance procedures, which would minimize the potential for increased likelihood of effects on wildlife.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during current

Major Exercises, in various areas of the HRC, with impacts on biological resources being similar to those described above.

4.3.1.2.1.4 Alternative 3 (Biological Resources—Niihau Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.3.1.3 KAULA OFFSHORE

Table 4.3.1.3-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Kaula. Alternative 3 is the preferred alternative.

Table 4.3.1.3-1. Training at Kaula Offshore

Training
• Air-to-Ground Gunnery Exercise (A-G GUNEX)

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Kaula. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and waste, health and safety, noise, socioeconomics, transportation, utilities, and water resources.

Air emissions from HRC training would not change the regional air quality surrounding Kaula. Use of the island does require control of the airspace above this land area; however, any issues associated with airspace are included within the onshore discussion for Kaula (Section 4.3.2.10.1). Training associated with this site would adhere to policies and regulations governing hazardous materials and waste, and health and safety, as discussed in Appendix C. Because access to the island is restricted, no noise impacts on civilian or military personnel would occur. Potential noise impacts on wildlife are addressed under the biological resources section. There would be no impact on Kauai's socioeconomics, transportation, or utilities because access to the island is restricted. There are no facilities, transportation, or utility systems on the island. Training at the site would not generate any hazardous waste streams that could impact local water quality.

4.3.1.3.1 Biological Resources—Kaula Offshore

4.3.1.3.1.1 No-action Alternative (Biological Resources—Kaula Offshore)

The Navy uses the southeastern tip of Kaula for Air-to-Surface Gunnery Exercises (A-S GUNEX). Potential effects on biological resources are discussed below. Effects on marine species from underwater sound levels produced by the use of MFA/HFA sonar are addressed in Section 4.1.2.

Vegetation

No threatened or endangered vegetation is located in the offshore area.

Wildlife

Under the No-action Alternative, current GUNEX training will continue. Kaula is covered by a sparse grass landscape and earthen/rock outcrops, reportedly underlain by a relatively thin soil layer with highly weathered limestone bedrock. Soil erosion that could impact coral offshore is thus not an issue for the island.

Pursuant to a previous Section 7 Consultation and Biological Opinion (National Oceanic and Atmospheric Administration, 1979), the Navy agreed to mitigations that reduce or eliminate any potential impacts on humpback whales. No live fire is used. Mitigations agreed to include seasonal use during periods when humpback whales are not present, surveying the waters off Kaula to ensure that no whales are present, and limiting the impact area to the southern tip of the island. These mitigation measures are also used for other marine species including Hawaiian monk seals and sea turtles. Impacts on marine mammals are also discussed in the Open Ocean Section (4.1.2).During GUNEX at Kaula, the target is visually cleared by aircraft flying over Kaula and determining whether it is safe to complete the mission. Only if the target is clear does the mission continue. The potential for any harm to marine mammals from gunnery practice rounds is very remote. A gunnery practice round does not carry any explosives but does carry the equivalent of a shotgun shell which generates a puff of smoke upon impact for scoring. Aircrews are aware that they are not to harm or harass any marine mammals. As part of the required clearance before a GUNEX, participants must determine that the area to be gunned is clear, visually and with their sensors, whether at Kaula or far out to sea. The lack of an explosive charge, the required clearance, and conducting the majority of gunnery runs at either Kaula or the controlled ranges at PMRF keep the risk to marine mammals very remote.

Small numbers of Hawaiian monk seals now haul-out on a small limestone bench on Kaula. Major Exercises may cause monk seals to temporarily leave this haul-out site and enter the water temporarily. Based on the Navy's level of use of Kaula and the number of Hawaiian monk seals continually sighted at Kaula, it is likely that monk seals will return once the disturbance from the training had ended. Major Exercises affecting Kaula thus will have only an occasional, short-term effect on monk seals at this site. RIMPAC Exercises occur biennially and USWEX activities will occur only up to six times per year, for a maximum of 4 days per Major Exercise. Since these Major Exercises will affect less than 10 percent of the island over less than 10 percent of the year, its effects on marine species will be reduced to the extent practicable.

4.3.1.3.1.2 Alternative 1 (Biological Resources—Kaula Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). This would amount to an average increase of approximately 76 percent for Electronic Combat Operations. The number of SPECWAROPS would remain the same. Two additional GUNEXs per year could occur under Alternative 1. Only small caliber weapons are used. Practices described above would continue to minimize impacts on marine species.

While training events would increase in number, the likelihood of a similar increase in impacts on biological resources on or adjacent to Kaula would be minimal due to implementation of guidelines established for training as described above. As stated in Section 4.3.1.3.1.1, the intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. Effects on marine biological resources from underwater sound levels produced by the use of MFA/HFA sonar are addressed in Section 4.1.2.

4.3.1.3.1.3 Alternative 2 (Biological Resources—Kaula Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. Two additional GUNEXs per year could occur under Alternative 2. Only small caliber weapons are used. With the exception of impacts associated with MFA sonar use (Section 4.1.2), impacts on wildlife would be similar to those described previously for the No-action Alternative since the additional training would be performed throughout the HRC and would not be confined to one particular area. This dispersion of training with identical mitigations should buffer any potential increase in likelihood or intensity of effect. It is unlikely that a listed species or other wildlife offshore of Kaula would be injured or killed as a result of increased training. Likewise, increases in the number of training events would continue to comply with relevant Navy policies and procedures, such as existing clearance procedures, which would minimize the potential for increased likelihood of effects on wildlife.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during current Major Exercises, in various areas of the HRC, with impacts on biological resources being similar to those described above.

4.3.1.3.1.4 Alternative 3 (Biological Resources—Kaula Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.3.1.3.2 Cultural Resources—Kaula Offshore

4.3.1.3.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Kaula Offshore)

The underwater cultural resources region of influence for Kaula includes areas offshore of the southwestern tip of the island where there is an existing, heavily disturbed ordnance impact area. Kaula has previously been used for BOMBEX and GUNEX, and no impacts on cultural resources have been identified. There are no recorded underwater cultural resources surrounding Kaula (see Figures 3.1.3-1 and 3.3.1.1.2-1). No impacts on cultural resources would occur from either the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2 KAUAI ONSHORE

4.3.2.1 PACIFIC MISSILE RANGE FACILITY/MAIN BASE

Table 4.3.2.1-1 lists ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 at PMRF/Main Base. Alternative 3 is the preferred alternative. Sections 4.3.2.1.1 to 4.3.2.1.13 address impacts on specific resources of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 at PMRF/Main Base.

Table 4.3.2.1-1. Training and RDT&E Activities at PMRF/Main Base

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Expeditionary Assault • Swimmer Insertion/Extraction • Special Warfare Operations (SPECWAROPS) • Air Operations • Humanitarian Assistance/Non-Combatant Evacuation Operations (HAO/NEO) • Command and Control (C2) • Aircraft Support Operations • Personnel Support Operations • Field Carrier Landing Practice (Alternative 1)	• Anti-Air Warfare RDT&E • Electronic Combat/Electronic Warfare (EC/EW) • High-Frequency Radio Signals • Missile Defense (including THAAD radars) • Joint Task Force Wide Area Relay Network • Additional Chemical Simulant (Alternative 1) • Test Unmanned Aerial Vehicles (Alternative 1) • Test Hypersonic Vehicles (Alternative 1) • Large Area Tracking Range (LATR) Upgrade (Alternative 1) • Expanded Training Capability for Transient Air Wings (Alternative 1) • Enhanced Auto ID System and Force Protection Capability (Alternative 1) • Construct Range Operations Control Building (Alternative 1) • Improve Fiber Optics Infrastructure (Alternative 1) • Directed Energy (Alternative 2/3) • Advanced Hypersonic Weapon (Alternative 2/3)

4.3.2.1.1 Air Quality—PMRF/Main Base

4.3.2.1.1.1 No-action Alternative (Air Quality—PMRF/Main Base)

Air quality conditions under the No-action Alternative will not differ from the existing conditions as described in Chapter 3.0. Navy training and RDT&E activities with potential to affect air quality include emergency generators, Air Operations, missile launches, and personnel support (such as government vehicle miles traveled and private vehicle commuting).

Air emissions will occur from the use of facility electrical generators used for emergency back-up power at PMRF. The existing power generators will continue to be operated in accordance with limits set forth in the PMRF Title V Permit, and therefore will not have a significant impact on the air quality in the basin. Table 4.3.2.1.1.1-1 lists the predicted emissions from the five existing generators, based on the limits in the Title V Permit for PMRF/Main Base. The Title V permit controls the emissions generated by restricting the hours for use for each generator.

Table 4.3.2.1.1.1-1. Air Emissions from Emergency Generators, PMRF/Main Base

Pollutant	Averaging Time	Predicted Emissions (μg/m^3)	Hawaii Ambient Air Quality Standard (μg/m^3)	Percent of Standard
Sulfur Dioxide	3-hour	561	1,300	43
	24-hour	141	365	39
	Annual (2)	13	80	16
Nitrogen Dioxide	Annual (2,3)	65	70	93
Carbon Monoxide	1-Hour	1,364	10,000	14
	8-hour	683	5,000	14
PM-10	24-hour	64	150	43
	Annual (2)	7	50	14
Lead (1)	Calendar Quarter	-	1.5	0
Hydrogen Sulfide (1)	1-hour	-	35	0

(1) Lead and hydrogen sulfide are not expected at PMRF
(2) The annual concentrations are based on fuel limitations in Title V Permit of 208,000 gal/year for the combined usage of the 320-kilowatt (kW) generators and 217,800 gal/year for the combined usage of the 600-kW generators
(3) Nitrogen Dioxide concentrations were calculated using the ozone limiting method with a background ozone concentration of 34.6 μg/m^3
PM-10 = Particulate matter with a mean aerodynamic diameter greater than or equal to 10 microns

Additional personnel (whether active duty or training, both military and civilian) have the potential to impact air quality. The increase in personnel is proportional to the impact on air quality, to a large degree. Sources of air emissions to consider include: vehicle miles traveled (VMT) by on-base government-owned vehicles, VMT of new employees not living on base and commuting, and new construction and operation of office/residential pace for added employees working/living on base. The continuation of HRC training and RDT&E activities at PMRF is not expected to require additional employees or involve additional trainees.

HRC Training—No-action Alternative

PMRF/Main Base will continue to conduct current HRC training under the No-action Alternative. Onshore training that has potential to affect air quality includes Expeditionary Assault, Swimmer Insertion/Extraction, SPECWAROPS, Aircraft Support Operations, Air Operations, and

HAO/NEO. This training will produce mobile emissions from helicopters, fixed-wing Air Operations, and operations of diesel engines of landing craft and tracked vehicles.

Existing aircraft exercises and support will continue from the PMRF airfield under the No-action Alternative. Approximately 69 percent of Navy aircraft using the airfield are C-26 "Metroliner" aircraft and the UH-3H "S-61" helicopter. The estimated annual mobile source emission levels, including aerospace ground support activities and engine testing, are:

- 12.9 tons per year (TPY) for carbon monoxide
- 3.6 TPY for volatile organic compounds (VOC)
- 13.8 TPY for nitrogen dioxides
- 1.3 TPY for sulfur dioxide
- 0.8 TPY for particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM-10)

These emissions are calculated using an air emissions screening computer program developed by the Air Force to calculate air emissions for realignment of aircraft, personnel, and for facility construction (U.S. Air Force, 2005). Aircraft operating data are derived from 2004 operations at the airfield (U.S. Department of the Navy, Engineering Field Activity Chesapeake, 2006). Appendix C includes details of the applicability screening and supporting analysis. These emissions are not further evaluated because they are not restricted by the current Title V permit held by PMRF, and because the General Conformity Rule applicability analysis, though a useful tool, is not required for Navy actions in Hawaii.

Anti-Air Warfare training and other training that requires missile launches from PMRF/Main Base will continue to occur at current levels described in Chapter 2.0 (Table 2.2.2.3-1). Each launch is a discrete event, and the total number of launches for the No-action Alternative will not exceed that currently being performed annually at PMRF. Missile and rocket launches are characterized by intense combustive reactions over a short period, which result in exhaust streams of varying sizes, depending on the size of the launch vehicle. The tempo of launch events will be managed by range activities to stay within the limits of current guidelines established by governmental agencies or professional organizations.

Analysis of launch-related impacts is covered in the 1998 PMRF Enhanced Capability Final EIS. Analysis of typical launch vehicles at PMRF determined that exhaust emissions will not produce short-term exceedances of either the National Ambient Air Quality Standards (NAAQS) or health-based guidance levels in areas to which the general public would have access. The ground hazard area used to support the Strategic Target System launch program—10,000 ft—was used as a worst case. This area is evacuated of all personnel before any launch. Also, personnel remaining outdoors within the launch hazard area will wear appropriate safety equipment, such as respirator masks. Therefore, no air quality impacts in the lower troposphere (Earth's surface to 6.2 mi) are anticipated due to the continued use of the 10,000-ft ground hazard area at its current level (U.S. Department of the Navy, 1998a).

Table 4.3.2.1.1.1-2 lists major exhaust components from typical training-related and RDT&E missiles launched from PMRF. In the stratosphere (6.2 to 31 mi above the Earth's surface), missile launch emissions could potentially affect global warming (the greenhouse gas effect) and depletion of the stratospheric ozone layer. Of the chemical species that form during launches, the most environmentally significant are hydrochloric acid, aluminum oxide, nitrogen, and carbon dioxide.

Global Warming

Most propellant systems produce carbon dioxide, which is a greenhouse gas. Greenhouse gas emissions in the troposphere and stratosphere are of concern as they contribute to global warming by trapping re-radiated energy in the atmosphere (e.g., water vapor, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrofluorocarbons, and perfluorinated carbons). Table 4.3.2.1.1.1-2 shows the total quantity of carbon dioxide emissions ranges from 0 to 0.5 ton per launch, depending on the missile. The worst case estimated total carbon dioxide emissions from launches into the troposphere for the No-action Alternative would be 36 TPY. Alternative 1 emissions of carbon dioxide from launches would be 52 TPY, and Alternative 2 emissions of carbon dioxide from launches would be 56 TPY (see Table 2.2.2.3-1 for number of launches per year). In comparison, the amount of total carbon dioxide emissions from all sources in the United States was 5,945 million tons in 2005 (U.S. Office of Energy Statistics, Energy Information Administration, 2007). Although it is not easy to know with precision how long it takes greenhouse gases to leave the atmosphere, missile exhaust emissions per launch would be rapidly dispersed and diluted over a large geographic area. Because the missiles are relatively small and launches are short-term, discrete events, the time between launches would allow the dispersion of greenhouse gases. Therefore, carbon dioxide from launches would have an insignificant effect on global warming. On June 30, 2007 the Governor of Hawaii signed House Bill 226 regarding greenhouse gas emissions. It establishes that Hawaii shall reduce its statewide greenhouse gas emissions to 1990 levels by 2020. It establishes a Task Force to prepare a work plan and regulatory scheme to determine how that will be done. Hawaii Department of Health must adopt rules by January 1, 2011. Per its provisions, the Act became effective July 1, 2007. Military operations are not exempted from the Act's scope, and how it will apply to the military may be determined by the Task Force.

Ozone Depletion

Emissions from missile launches are of concern because during ascent, the missile injects substances that can lead to ozone depletion (hydrochloric acid, aluminum oxide, nitrogen). Table 4.3.2.1.1.1-2 shows the total quantity of ozone-depleting gases range from 0 to 9.5 tons per launch. It was shown in the Department of Transportation (DOT) Programmatic EIS for Licensing Launches that although ozone loss occurs in the plume wakes of large solid propellant boosters (i.e., Titan IV and Space Shuttle), the amount and duration of the loss appears to be temporary and limited. Emissions from licensed launches analyzed in the Programmatic EIS do contribute to the creation of "holes" in the stratospheric ozone layer as the launch vehicle passes through, although these "holes" tend to "fill back in" rapidly following a launch (U.S. Department of Transportation, 2001). In comparison, the missiles used by Navy at PMRF are smaller than those analyzed in the Programmatic EIS. Therefore, ozone depletion from launch exhaust is limited spatially and temporally, and these reactions do not have a globally significant impact on ozone depletion.

Table 4.3.2.1.1.1-2: Estimated Emissions from a Typical Missile Launch at PMRF/Main Base (tons per launch)

Missile	Aluminum Oxide[4]	Carbon Monoxide	Carbon Dioxide[5]	Hydrogen	Water	Hydrochloric Acid[4]	Nitrogen[4]	Lead	Others
Castor IV	2.698	2.863	0.340	0.249	0.866	2.213	0.889	0.000	0.004
Strategic Target System (1)	5.628	4.185	0.431	0.318	0.959	1.943	1.855	0.000	0.027
STRYPI	1.435	1.509	0.181	0.114	0.344	0.816	0.499	0.000	0.000
Vandal(2)	0.000	0.509	0.503	0.024	0.150	0.000	0.185	0.024	0.000
PAC-3	0.045	0.029	0.003	0.003	0.009	0.026	0.011	0.000	0.000
MEADS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THAAD	0.157	0.106	0.009	0.011	0.028	0.092	0.035	0.000	0.000
Hera (3)	4.418	1.459	0.316	0.129	0.853	1.542	0.600	0.000	0.082
Lance	0.000	0.022	0.232	0.001	0.279	0.001	0.210	0.002	0.020

Source: U.S. Department of the Navy, 1998a
Notes:
(1) Exhaust products are total for all three stages
(2) Exhaust products are for boosters only
(3) Stage-1 only
(4) Ozone-depleting Substances
(5) Greenhouse Gas

A variety of off-road support vehicles are used at PMRF during training and pre-missile launch activities. There are many types of these vehicles, both gasoline and diesel fueled. Since specific numbers and types of vehicles for each training or missile launch are difficult to obtain, emissions from this category are assumed to be proportional to the number of personnel added, with an emission factor derived from aggregate emissions for a typical facility. Since the current number of personnel will remain the same under the No-action Alternative, off-road support vehicles will not have a measurable air quality impact.

HRC RDT&E Activities—No-action Alternative

Ongoing RDT&E activities that can affect air quality at PMRF/Main Base include missile defense ballistic missile target flights and THAAD interceptor launch activities. RDT&E activities include missile launches from existing launch facilities at PMRF and KTF. The rate of launches, which is up to 46 per year, will not increase at PMRF/Main Base due to the No-action Alternative. Potential air quality impacts from missile launches are described above for HRC training.

Other onshore RDT&E activities at PMRF include Anti-Air Warfare RDT&E, EC/EW, High-Frequency Radio Signals, Joint Task Force Wide Area Relay Network, and Shipboard Electronic Systems Evaluation Facility (SESEF) tests. These RDT&E activities have little or no impact on air quality and will continue at current levels under the No-action Alternative.

Major Exercises—No-action Alternative

Under the No-action Alternative, the type and number of Major Exercises on PMRF/Main Base will continue at current levels. There is one RIMPAC Exercise every 2 years, with each RIMPAC lasting 10 days. There are up to six USWEXs per year, each lasting 3 or 4 days. These Major Exercises include ongoing training and, in some cases RDT&E activities. Therefore, the potential impacts on PMRF air quality are included in those impacts described above for the training and RDT&E activities.

4.3.2.1.1.2 Alternative 1 (Air Quality—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Increased training that has potential to impact air quality includes Navy's proposal to conduct FCLP. Except for the new FCLP, Alternative 1 has no increases in training and no change in training locations onshore at PMRF.

Under Alternative 1, the Navy proposes to use F/A-18 aircraft for FCLPs. PMRF/Main Base is one of the two sites proposed for this activity in Hawaii (the other is Marine Corps Base Hawaii [MCBH] on Oahu). Twelve FCLP periods are proposed, each consisting of a maximum of eight touch-and-go landings, for an annual increase of 96 touch-and-go landings. No aerospace ground equipment and no ground training are expected. Using the above mentioned screening tool, the estimated increase of annual mobile source emission levels for the F-18 aircraft, excluding aerospace ground support activities and engine testing, are:

- 0.04 TPY for carbon monoxide
- 0.01 TPY for VOCs
- 0.28 TPY for nitrogen oxides
- 0.02 TPY for sulfur dioxide
- 0.03 TPY for PM-10

Overall, under Alternative 1, the addition of FCLPs would not alter air quality on PMRF/Main Base. Further analysis is provided in Appendix C.

Enhanced and Future RDT&E Activities—Alternative 1

Increased and future RDT&E activities that have potential to impact air quality include incorporating new chemical simulants in target payloads launches, testing UAVs, and testing hypersonic vehicles.

Launch preparations involved in chemical simulants for target launches would be similar to those described in for the No-action Alternative. Flight testing of target launches with chemical simulants would result in aerial dispersal of TBP, which is a non-flammable, non-explosive, colorless, odorless liquid typically used as a solvent in commercial industry. The release of simulant would occur at a high altitude over the open ocean during a nominal flight test. The only potential impact on air quality at PMRF could occur in the case of a near pad/on-pad missile failure. The use and effects of TBP have been analyzed in the *Missile Defense Agency Vertical Gun Test Environmental Assessment* (U.S. Army Space Missile Defense Command, 2004). Tests were conducted using canisters containing 110 lb of thickened TBP that would be released at an altitude of 1,640 ft. This analysis showed that the concentration of TBP in the air following the test would be significantly lower than the Occupational Safety and Health Administration (OSHA) industrial standard for TBP exposure.

The impact on air quality from the launch of target missiles from existing launch facilities at PMRF/Main Base would be the uncontrolled emissions from the missile as discussed above. The proposed launch vehicles from PMRF/Main Base would produce similar emissions to those described in Table 4.3.2.1.1.1-2. This analysis showed that neither NAAQS nor health based standards applicable to the lower troposphere would be expected to be exceeded for distances greater than 10,000 ft from the launch site. In the stratosphere (6.2 to 31 mi above the Earth's surface), missile launch emissions could potentially affect global warming (the greenhouse gas effect) and depletion of the stratospheric ozone layer. The worst case estimated total carbon dioxide emissions from launches into the troposphere for Alternative 1 would be 52 TPY (see Table 2.2.2.3-1 for number of launches per year). However, because the missiles are relatively small and launches are short-term, discrete events, the time between launches would allow the dispersion of greenhouse gases and ozone-depleting substances.

HRC Enhancements—Alternative 1

A temporary increase in air emissions would be associated with construction of a new Range Operations Control Building and the dehumidified warehouse. The increase in operational air emissions would be negligible and therefore was not evaluated. Construction activities would include constructing the new facilities described in Chapter 2.0. The 90,000-square-foot (ft^2) Range Operations Control Building and the 4,200-ft^2 dehumidified warehouse would require 2 years to complete. Demolition of 13 buildings (some are trailers) with a combined floor area of over 55,000 ft^2 would start in 2008. Site grading was assumed to be 1.4 acres.

Construction emissions would include emissions generated from demolition of existing structures, grading of the site, and construction of new facilities. Emission sources include privately owned vehicles of construction workers (assumed approximately 50 trips per day to the site), grading equipment, grading activities, demolition activities, stationary and mobile equipment related to construction, and architectural coatings. Construction of new asphalt pavement was not significant and not included in the calculations of air emissions.

Table 4.3.2.1.1.2-1 shows the summary results of applying Air Conformity Applicability Model (ACAM) (U.S. Air Force, 2005) to the construction of a proposed Range Operations Control Building and the dehumidified warehouse at PMRF Main Base.

Table 4.3.2.1.1.2-1. Proposed Construction Air Emissions Summary (Tons per Year)

Year	Nitrogen Oxides (tons)	Sulfur Dioxide (tons)	Volatile Organic Compounds (tons)	PM-10 (tons)	Carbon Monoxide (tons)
2008	6.92	0.81	1.39	5.28	21.09
2009	18.46	2.18	3.66	1.43	57.53
2010	2.91	0.34	0.57	0.23	9.07
Conformity Threshold	>100.00	>100.00	>100.00	>100.00	>100.00

Note: PM-10 = Particulate Matter with an Aerodynamic Diameter Less Than or Equal to 10 Microns

While a conformity determination is not required in Hawaii, use of the screening model is a useful tool to assess the principal air quality concern during construction. The principal emissions would be PM-10 generated during grading or first year of construction, and nitrogen oxides and carbon monoxide from operating equipment and construction worker commutes during the second year of construction. These PM-10 emissions were calculated assuming implementation of standard dust suppression methods (frequent watering, covering truck loads, and hauling on paved roads). None of the emissions generated by the construction of the new facilities would exceed the highest *de minimis* or “conformity threshold” levels of 100 TPY of carbon monoxide, VOCs, nitrogen oxides, particulate matter with an aerodynamic diameter less than or equal to 2.5 microns (PM-2.5), and sulfur dioxide if regulatory conformity thresholds were to exist in Hawaii. See Appendix C for further analysis.

New Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). This would amount to an average increase of approximately 9 percent for onshore training. While training events would increase in number, the likelihood of a similar increase in impacts on air quality is small because (1) there would be no additional stationary sources added to PMRF because of the proposed new training, and (2) Hawaii is in attainment for all criteria air pollutants, and increased military activity is not likely to change this status due to the weather conditions.

4.3.2.1.1.3 Alternative 2 (Air Quality—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

While training events would increase in number, emissions would be similar to existing levels. Increases would occur in the following training: Expeditionary, Swimmer, C2, Air Operations, and FCLP. The types of Major Exercises that would occur at PMRF/Main Base would be similar to those described in Alternative 1.

Under Alternative 2, the Navy proposes to use F/A-18 aircraft for FCLPs. PMRF/Main Base is one of the two sites proposed for this activity in Hawaii (the other is MCBH on Oahu). Sixteen FCLP periods are proposed, each consisting of a maximum of 8 touch-and-go landings, for an annual increase of 128 touch-and-go landings. No aerospace ground equipment and no ground training are expected. Using the above-mentioned screening tool, the estimated increase of annual mobile source emission levels for the F-18 aircraft, excluding aerospace ground support training and engine testing, are:

- 0.05 TPY for carbon monoxide
- 0.01 TPY for VOC
- 0.37 TPY for nitrogen oxides
- 0.03 TPY for sulfur dioxide
- 0.04 TPY for PM-10

Overall, under Alternative 2, the addition of FCLPs would not alter air quality on PMRF/Main Base. See Appendix C for further analysis.

Future RDT&E Activities—Alternative 2

The proposed high-energy laser would require a 25,000-ft^2 building at PMRF/Main Base. Construction impacts would be similar to those described earlier—the principal emissions would be PM-10 generated during grading and nitrogen oxides and carbon monoxide from operating equipment and construction worker commutes during construction. Up to four air targets and up to four surface targets would be used for testing and operation of the high-energy laser. Air emissions from generators needed to generate up to 30 megawatts of power for testing and operation would require the current Title V permit for PMRF/Main Base to be modified or renewed. Additional environmental documentation would be required to analyze the specific location and operational requirements.

The testing of the Advanced Hypersonic Weapon would include two launches of a Strategic Target System booster from KTF and two launches of the new booster configuration from the same site. The Strategic Target System booster has been previously launched at KTF, and it is anticipated that the testing of the Advanced Hypersonic Weapon with the new booster configuration at the same site would have a similar air quality impact as described for the No-action Alternative. The Advanced Hypersonic Weapon tests would be similar to a ballistic missile test, and the potential impacts on air quality would be similar to that described for missile launches.

In the stratosphere (6.2 to 31 mi above the Earth's surface), missile launch emissions could potentially affect global warming (the greenhouse gas effect) and depletion of the stratospheric ozone layer. The worst case estimated total carbon dioxide emissions from launches into the troposphere for Alternative 2 would be 56 TPY (see Table 2.2.2.3-1 for number of launches per year). However, because the missiles are relatively small and launches are short-term, discrete events, the time between launches would allow the dispersion of greenhouse gases and ozone-depleting substances.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The proposed Major Exercises would be similar to those occurring during current Major Exercises, with impacts on air quality resources being similar to those described in the No-action Alternative and Alternative 1. The Multiple Strike Group training should not impact the continued good air quality of Hawaii.

Depending on the training being performed, PMRF/Main Base is a support facility and could provide support, although Sailors or Marines are not expected to come onshore to Kauai. The Navy would not need additional on-base or off-base employees to continue to support the Strike Groups. However, the potential for requiring FCLPs increases, as described above.

4.3.2.1.1.4 Alternative 3 (Air Quality—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on air quality under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.2 Airspace—PMRF/Main Base

The potential impacts on airspace in the PMRF/Main Base Area are discussed in terms of conflicts with the use of controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields. The airspace discussion includes the airspace above land and the offshore area out to 12 nm.

4.3.2.1.2.1 No-action Alternative (Airspace—PMRF/Main Base)

HRC Training—No-action Alternative

The ongoing training that can affect airspace includes mine laying, Flare Exercise, and Air Operations occurring above territorial waters.

Controlled and Uncontrolled Airspace

The Navy can accomplish the No-action Alternative without modifications or need for additional airspace to accommodate continuing mission training.

Special Use Airspace

Ongoing training identified above will continue to use the existing PMRF/Main Base special use airspace including Restricted Areas, Warning Areas, and Air Traffic Control Assigned Airspace (ATCAA) shown on Figure 3.3.2.1.2-1. Although the nature and intensity of utilization varies over time and by individual special use airspace area, the continuing training represent precisely the kinds of training for which the special use airspace was created to contain hazards to non-participating aircraft. Restricted Areas were designated to contain hazards to non-participating aircraft, and the Warning Areas are designed and set aside by the Federal Aviation Administration (FAA) to accommodate activities that present a hazard to other aircraft. As such, the continuing training does not represent an adverse impact on special use airspace and does not conflict with any airspace use plans, policies, and controls.

En Route Airways and Jet Routes

Two low altitude airways pass through the region of influence: V15 (through W-188), and V16 (through W-186). Use of these low altitude airways comes under the control of the Honolulu Air Route Traffic Control Center (ARTCC). In addition, the Navy surveys the airspace involved in each training event either by radar or patrol aircraft. Safety regulations dictate that hazardous activities will be suspended when it is known that any non-participating aircraft has entered any part of a training activity danger zone until the non-participating entrant has left the area or a thorough check of the suspected area has been performed. Aircraft using the V16 airway through the northern part of W-186 and over Niihau will not likely be re-routed by air traffic control if they are flying over 9,000 ft mean sea level, since W-186 extends up to but does not include 9,000 ft. Consequently, there are no airspace conflicts.

In terms of potential airspace use impacts on en route airways and jet routes, the continuing training will be in compliance with DoD Directive 4540.1, as directed by the Office of the Chief of Naval Operations Instruction (OPNAVINST) 3770.4A, which specifies procedures for conducting Air Operations and for missile/projectile firing. Namely "firing areas shall be selected so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (DoD Directive 4540.1, § E5). In addition, before conducting a training that is hazardous to non-participating aircraft, Notices to Airmen (NOTAMs) will be sent in accordance with the conditions of the directive specified in OPNAVINST 3721.20A.

As noted above, continuing training will use the existing special use airspace and will not require either: (1) a change to an existing or planned instrument flight rules (IFR) minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a visual flight rules (VFR) operation to change from a regular flight course or altitude.

Airports and Airfields

Ongoing training will continue to use the existing special use airspace and will not restrict access to or affect the use of the existing airfields and airports at PMRF. Training at the PMRF airfield will continue unhindered.

Similarly, the existing airfield or airport arrival and departure traffic flows will not be affected by the No-action Alternative. Access to the PMRF airfield, Kekaha airstrip, and the heliports at Kokee and Makaha Ridge will not be curtailed. With all arriving and departing aircraft, and all participating military aircraft, under the control of the PMRF Radar Control Facility, there will be no airfield or airport conflicts in the area under the No-action Alternative.

HRC RDT&E Activities—No-action Alternative

The ongoing RDT&E activities that could affect airspace include missile defense ballistic missile target flights and THAAD interceptor activities. RDT&E activities are conducted in PMRF Restricted Airspace and Warning Areas as shown on Figure 3.3.2.1.2-1. Missile launches from PMRF and KTF will move into Open Ocean Areas soon after launch.

Controlled and Uncontrolled Airspace

No new airspace proposal or any modification to the existing controlled airspace was identified to accommodate continuing RDT&E activities. Interceptor missile launches from PMRF and target missiles launched from KTF will be well above flight level (FL) 600 (60,000 ft) and still be within the R-3101 Restricted Airspace, which covers the surface to unlimited altitude, within 1 minute of the rocket motor firing. As such, all other local flight activities will occur at sufficient distance and altitude that the target missile and interceptor missiles will have minimal effect. Activation of the proposed stationary altitude reservation (ALTRV) procedures, where the FAA provides separation between non-participating aircraft and the missile flight test activities in the TOA, are discussed under the Open Ocean Section 4.1.1.

Special Use Airspace

Ongoing RDT&E activities identified earlier will be conducted within the existing special use airspace in Restricted Area R-3101 and extend into the adjacent W-188 Warning Area controlled by PMRF, and will not represent a direct special use airspace impact. The missile launches represent precisely the kinds of activities for which special use airspace was created: namely, to accommodate national security and necessary military activities, and to confine or segregate activities considered to be hazardous to non-participating aircraft.

Due to the coordination and planning procedures that are in place, the RDT&E activities do not represent an adverse impact on special use airspace and do not conflict with any airspace use plans, policies, and controls.

En Route Airways and Jet Routes

Two IFR en route low altitude airways are used by commercial aircraft that pass through the PMRF Warning Areas. The two low altitude airways are V15 (through W-188), and V16 (through W-186). Use of these low altitude airways comes under the control of the Honolulu ARTCC. In addition, during an RDT&E activity, provision is made for surveillance of the affected airspace either by radar or patrol aircraft. Target and defensive missile launches will be conducted in compliance with DoD Directive 4540.1, as enclosed by OPNAVINST 3770.4A. DoD Directive 4540.1 specifies procedures for conducting missile and projectile firing, namely "firing areas shall be selected so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (DoD Directive 4540.1, § E5).

Before conducting a missile launch and/or intercept test, NOTAMs will be sent in accordance with the conditions of the directive specified in OPNAVINST 3721.20. In addition, to satisfy airspace safety requirements, the responsible commander will obtain approval from the Administrator, FAA, through the appropriate Navy airspace representative. Provision is made for surveillance of the affected airspace either by radar or patrol aircraft. In addition, safety regulations dictate that hazardous activities will be suspended when it is known that any non-participating aircraft have entered any part of the danger zone until the non-participating entrant has left the area or a thorough check of the suspected area has been performed.

The airways and jet routes in the region of influence are protected because of the required coordination with the FAA. There is a scheduling agency identified for each piece of special use airspace that will be utilized. The procedures for scheduling each piece of airspace are performed in accordance with letters of agreement with the controlling FAA facility, and the Honolulu and Oakland ARTCCs. Schedules are provided to the FAA facility as agreed between the agencies involved. Aircraft transiting the Open Ocean Area region of influence on one of the low-altitude airways and/or high-altitude jet routes that will be affected by flight test activities within the PMRF/Main Base region of influence will be notified of any necessary rerouting before departing their originating airport and will therefore be able to take on additional fuel before takeoff. Real-time airspace management involves the release of airspace to the FAA when the airspace is not in use or when extraordinary events occur that require drastic action, such as weather requiring additional airspace.

The FAA ARTCCs are responsible for air traffic flow control or management to transition air traffic. The ARTCCs provide separation services to aircraft operating on IFR flight plans and principally during the en route phases of the flight. They also provide traffic and weather advisories to airborne aircraft. By appropriately containing military activities within the Restricted Airspace and Warning Areas non-participating traffic is advised or separated accordingly.

As noted above, continuing RDT&E activities will use the existing special use airspace and will not require either: (1) a change to an existing or planned IFR minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a VFR operation to change from a regular flight course or altitude.

Airports and Airfields

Impacts will be similar to those discussed for the HRC training, and there will be no airfield or airport conflicts in the region of influence for the No-action Alternative.

Major Exercises—No-action Alternative

Major Exercises, such as RIMPAC and USWEX, include ongoing training and, in some cases, RDT&E activities. Therefore, potential impacts from a Major Exercise on PMRF airspace will be similar to those described earlier for the training and RDT&E activities. RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. Each of the USWEX training events, up to six per year, will include coordination with the FAA well in advance of each 3- or 4-day Major Exercise.

The advanced planning and coordination with the FAA regarding ALTRV requirements for missile tests, scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, results in minimal impacts on airspace from Major Exercises.

4.3.2.1.2.2 Alternative 1 (Airspace—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Alternative 1 would include increases in the number of training events including mine laying, Flare Exercises, and Air Operations occurring above territorial waters. Training would occur in the same locations as for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described above for the No-action Alternative. The total number of training events that affect airspace would increase by approximately 18 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. Training would continue to use the existing special use airspace including the PMRF Restricted Airspace, Warning Areas, and ATCAA shown on Figure 3.3.2.1.2-1. By appropriately containing military activities within the Restricted Airspace and Warning Areas or coordinating the use of the ATCAA area, non-participating traffic is advised or separated accordingly.

As noted above, training events will use the existing special use airspace and will not require either: (1) a change to an existing or planned IFR minimum flight altitude, a published or special instrument procedure, or an IFR departure procedure; or (2) a VFR operation to change from a regular flight course or altitude. The increase in training under Alternative 1 would require an increase in coordination and scheduling by the Navy and FAA. The increase in training events would be readily accommodated within the existing airspace. Consequently, there are no airspace conflicts.

Enhanced and Future RDT&E Activities—Alternative 1

The proposed RDT&E activities include SM-6 launches from a sea-based platform, and high speed and UAV testing. The number of RDT&E activities that may affect airspace would increase by approximately 6 percent above the No-action Alternative.

HRC Enhancements—Alternative 1

Range safety for high-energy lasers at PMRF could affect airspace. Depending on the intensity of the lasers, nomenclature would need to be added to aeronautical charts, and certain test events could require NOTAMs and NOTMARs.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described above for missile launches. The establishment of laser range operational procedures, including horizontal and vertical buffers, would minimize potential impacts on aircraft. All activities would be in accordance with American National Standards Institute Z136.1, *Safe Use of Lasers*, which has been adopted by DoD as the governing standard for laser safety. Additional information on range safety for high-energy lasers is in Section 4.1.5, Health and Safety–Open Ocean.

Major Exercises—Alternative 1

Major Exercises, such as RIMPAC and USWEX, include ongoing training and, in some cases, RDT&E activities. Therefore, potential impacts from a Major Exercise would be similar to those described above for the training and RDT&E activities.

An additional proposed training event associated with Major Exercises is FCLP. This activity involves pilots from an aircraft carrier air wing practicing landings at a land runway. As discussed in Chapter 2.0, the runway at PMRF could be used for FCLP. For each pilot, the FCLP would include six to eight touch-and-go landings at the PMRF runway during both daytime and at night. The carrier wing aircraft would be operating within the PMRF Class D and Class E airspace, primarily within Restricted Airspace R-3101, and within the adjacent Warning Areas W-186 and W-188. FCLP activities would be below the V15 and V16 airways.

RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. Each of the USWEX training events, up to six per year, would include coordination with the FAA well in advance of the 3- or 4-day Major Exercise. FAA coordination would include discussions regarding the anticipated number of aircraft, including FCLP activities.

The advanced planning and coordination with the FAA regarding ALTRV requirements for missile tests, scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, results in minimal impacts on airspace from Major Exercises. The increase from 1 aircraft carrier to 2 during RIMPAC under Alternative 1 would require a minor increase in coordination and scheduling by the Navy and FAA. The increased training would be readily accommodated within the existing airspace.

4.3.2.1.2.3 Alternative 2 (Airspace—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Alternative 2 would include increases in the number of training events including mine laying, Flare Exercise, and Air Operations Training would occur in the same locations as for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described in Section 4.3.2.1.2.1 for the No-action Alternative. The total number of training events that affect airspace would increase by approximately 27 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. The training events would continue to use the existing PMRF special use airspace shown on Figure 3.3.2.1.2-1. By appropriately containing military activities within the Restricted Airspace, Warning Areas or coordinating the use of the ATCAA areas, non-participating traffic is advised or separated accordingly, thus avoiding potential adverse impacts on the low altitude airways and high-altitude jet routes in the region of influence.

Alternative 2 would include increases in the number of RDT&E activities including missile defense ballistic missile target flights, THAAD interceptor activities, A-S MISSILEX, A-A MISSILEX, and Surface-to-Air Missile Exercise (S-A MISSILEX). RDT&E activities would occur in the same locations as for the No-action Alternative.

The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described in Section 4.1.1.1 for the No-action Alternative. The total number of RDT&E activities that may affect airspace would increase by approximately 16 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. The RDT&E activities would continue to use the existing special use airspace including the PMRF Restricted Airspace, Warning Areas, and ATCAA shown on Figure 3.3.2.1.2-1. By appropriately containing military activities within these areas, non-participating traffic is advised or separated accordingly.

Enhanced and Future RDT&E Activities—Alternative 2

Planned RDT&E activities include a Maritime Directed Energy Test Center at PMRF and the Advanced Hypersonic Weapon test program at KTF.

The Directed Energy Test Center, which might include a High-Energy Laser Program, would have minimal impacts on airspace due to the required electromagnetic radiation/electromagnetic interference (EMR/EMI) coordination process. As discussed in Section 4.1.1.3, high-energy lasers at PMRF could affect airspace. Depending on the intensity of the lasers, nomenclature would need to be added to aeronautical charts, and certain test events could require NOTAMs and NOTMARs. The potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described previously for missile launches. The establishment of laser range operational procedures, including horizontal and vertical buffers, would minimize potential impacts on aircraft. All RDT&E activities would be in accordance with American National Standards Institute Z136.1, *Safe Use of Lasers*, which has been adopted by DoD as the governing standard for laser safety. Additional information on range safety for high-energy lasers is in Section 4.1.5, Health and Safety—Open Ocean.

The Advanced Hypersonic Weapon tests would be similar to a ballistic missile test, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described for missile launches.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Exercise consisting of training that involves Navy assets engaging in a schedule of events battle scenario, with U.S. forces (blue forces) pitted against a hypothetical opposition force (red force). Participants use and build upon previously gained training skill sets to maintain and improve the proficiency needed for a mission-capable, deployment-ready unit. The Major Exercise would occur over a 5- to 10-day period. The Multiple Strike Group training would involve many of the training events identified and evaluated under the No-action Alternative and Alternative 1 including Mine Laying Exercises, Flare Exercises, FCLP, and Air Operations.

Much of the Multiple Strike Group training would occur in the open ocean area. However, as part of this training, FCLP could occur at PMRF. Potential impacts would be similar to those described in Section 4.3.2.1.2.2.

A Multiple Strike Group Exercise planning conference would include coordination with the FAA well in advance of the Major Exercise. FAA coordination would include discussions regarding the anticipated number of aircraft including FCLP activities.

The advanced planning and coordination with the FAA regarding: scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, results in minimal impacts on airspace from Major Exercises. The use of three aircraft carriers during a Major Exercise would require an increase in coordination and scheduling by the Navy and FAA. The increased training would be readily accommodated within the existing airspace.

4.3.2.1.2.4 Alternative 3 (Airspace—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.3 Biological Resources—PMRF/Main Base

Potential impacts of construction, building modification, and missile launches on terrestrial biological resources within the PMRF region of influence have been addressed in detail in the Strategic Target System EIS, the Restrictive Easement EIS, the PMRF Enhanced Capability EIS, and the THAAD Pacific Flight Tests EA, (U.S. Army Strategic Defense Command, 1992; U.S. Army Space and Strategic Defense Command, 1993a; U.S. Department of the Navy, 1998a; U.S. Army Space and Missile Defense Command, 2002). Based on these prior analyses, and the effects of current and past missile launch activities, the potential impacts of training and RDT&E activities related to continuing RDT&E on terrestrial biological resources are expected to be minimal. The analytical approach for biological resources is discussed in Section 4.3.1.1.1.

4.3.2.1.3.1 No-action Alternative (Biological Resources—PMRF/Main Base)

HRC Training, HRC Support Events, and Major Exercises—No-action Alternative

Vegetation

Although ohai and lau`ehu have been observed north of PMRF/Main Base, there are no known listed plant species on PMRF. Amphibious landings have taken place at PMRF for many years. Damage to vegetation from movement of personnel, vehicles, and equipment across the beach and into upland areas during Expeditionary Assault and SPECWAROPS is not likely since the movement is restricted to existing routes. Damage to sensitive vegetation from other training events such as Swimmer Insertion/Extraction and HAO/NEO is also unlikely since troops are directed to avoid such areas. HAO/NEO use existing open areas and facilities, though some temporary structures including tents may be used in preselected locations. All participants follow current guidelines to avoid undue impacts on vegetation.

Compliance with relevant Navy policies and procedures during training limits the potential for introduction of invasive weed plant species. Amphibious vehicles are washed down after completion of activities to minimize the potential for introducing alien or invasive species. Military Customs Inspectors are responsible for implementing Federal customs statutes and agricultural regulations for transfers of military goods and personnel from overseas into U.S. jurisdiction. Military inspectors do not inspect goods and personnel transferred to Hawaii from the U.S. mainland, because inspections apply only to shipments entering Hawaii from foreign sources or those bound to the mainland from Hawaii. Military inspectors are trained to look for prohibited animals, soil, seeds, and other pests. Inbound flights carrying cargo from the mainland and landing at PMRF are advised to inspect and secure their cargo prior to shipment to ensure it is free of invasives. To prevent transport of invasive seeds from PMRF to Kokee, ground crews are tasked to blow/wash down vehicles and equipment prior to movement. (Burger, 2007c; Nature Conservancy and Natural Resources Defense Council, 1992)

Missile launches are performed at KTF facilities in the northern (KTF Launch Complex) and southern portions (Kokole Point Launch Complex) of PMRF. No listed plants have been identified adjacent to the Strategic Target System launch pad. The launch pad is kept clear, and the surrounding area contains landscaped vegetation. Analysis provided in the Strategic Target System EIS (U.S. Army Strategic Defense Command, 1992) concluded that although vegetation near the Strategic Target System launch pad can suffer some temporary distress from the heat generated at launch and from hydrogen chloride or aluminum oxide emissions, there is no evidence of any long-term adverse effect on vegetation from two decades of launches at PMRF. Similarly, it is expected that no vegetation impacts will occur at other launch sites on PMRF.

Measures were suggested in the PMRF Enhanced Capability EIS to further reduce possible environmental impacts. The installation of a portable blast deflector on the launch pad could protect the vegetation on the adjacent sand dunes. The potential for starting a fire would be further reduced by clearing dry vegetation from around the launch pad. Spraying the vegetation adjacent to the launch pad with water just before launch would reduce the risk of ignition. Emergency fire crews would be available during launches to quickly extinguish any fire and minimize its effects. An open (spray) nozzle will be used, when possible, rather than a directed stream when extinguishing fires, to avoid erosion damage to the sand dunes and to prevent possible destruction of cultural resources.

Wildlife

Potential impacts of past amphibious landings during Expeditionary Assault events have been monitored. The area of Majors Bay used for landing activities is located on part of the shoreline typically not used by sea turtles, monk seals, or wedge-tailed shearwaters. The landing areas are also not near Laysan albatross sites. In the event that nesting seabirds are discovered in the action area, the activities would be routed away from nests and the area would be marked until the birds depart. Within 1 hour prior to initiation of Expeditionary Assault landing activities, landing routes and beach areas are surveyed for the presence of sensitive wildlife. If any marine mammals or sea turtles are found to be present on the beach, the training is delayed as long as necessary until the animals voluntarily leave the area.

In accordance with the mitigation measures adopted for PMRF's Enhanced Capability EIS (U.S. Department of the Navy, 1998a), night lighting is shielded to the extent practical to minimize its potential effect on night-flying birds (Newell's shearwater and petrels) and Hawaiian hoary bats.

Launches of target missiles and drones from PMRF occur from existing ground-based target launch sites at the PMRF launch complex and KTF. Their potential effects are discussed below.

<u>Noise</u>

The effects of noise on wildlife vary from serious to no effect in different species and situations. Behavioral responses to noise also vary from startling to retreat from favorable habitat. Animals can also be very sensitive to sounds in some situations and very insensitive to the same sounds in other situations. (Larkin, 1996) Noise from launches and other events may startle nearby wildlife and cause flushing behavior in birds, but this startle reaction would be of short duration. The increased presence of personnel, vehicles, helicopters, and landing craft immediately before an event or launch would tend to cause birds and other mobile species of wildlife to temporarily leave the area that would be subject to the highest level of launch noise.

Noise from and movement of personnel, vehicles, helicopters, and landing craft during training events and Major Exercises may temporarily displace fish, birds, and other sensitive species. Foraging birds would be subjected to increased energy demands if flushed by the noise, but this should be a short-term, minimal effect. However, training events are short in duration and occur within regularly used range areas. Major Exercises incorporate avoidance procedures to avoid wildlife that are foraging, resting, or hauled out, such as green sea turtles or Hawaiian monk seals.

Figures 4.3.2.1.9.1-1 through 4.3.2.1.9.1-3 (see Section 4.3.2.1.9.1) show typical noise levels from missile launches at the northern and southern launch facilities at PMRF/Main Base. The brief noise peaks produced by missiles, such as THAAD, are comparable to levels produced by thunder at close range (120 decibel [dB] to 140 dB peak). Disturbance to wildlife from launches will be brief and is not likely to have long-term impacts. A rookery at Kennedy Space Center used by wood storks and other species of wading birds is located approximately 2,461 ft from a Shuttle launch pad. This rookery continues to be used successfully, even though it has received peak sound levels of up to approximately 138 dB (American Institute of Aeronautics and Astronautics, 1993). Monitoring of birds during the breeding season indicates that adults respond to Shuttle noise by flying away from the nest, but return within 2 to 4 minutes. Birds within 820 ft of Titan launch complexes at Cape Canaveral Air Station have shown no mortality or reduction in habitat use from the 170-dB sound levels from Titan IV launches. (U.S. Department of the Air Force, 1990) The launch area on PMRF is inspected following a launch, and no dead birds have been reported.

Air Emissions

Results of monitoring conducted following a Strategic Target System launch from KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions. The program included surveys of representative birds and mammals for both pre-launch and post-launch conditions. Birds flying through an exhaust plume may be exposed to concentrations of hydrogen chloride that could irritate eye and respiratory membranes (Federal Aviation Administration, 1996). However, most birds will not come into contact with the exhaust plume, because of their flight away from the initial launch noise. Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals will not cause injury because it is inert and not absorbed into the skin. U.S. Environmental Protection Agency (USEPA) has determined that non-fibrous aluminum oxide found in solid rocket motor exhaust is nontoxic (U.S. Air Combat Command, 1997). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions. (U.S. Department of the Navy, 1998a; U.S. Army Space and Missile Defense Command, 2004)

Debris

The probability for a launch mishap is very low. However, an early flight termination or mishap will cause missile debris to impact along the flight corridors. In most cases, the errant missile will be moving at such a high velocity that resulting missile debris will strike the water further downrange. If monk seals or sea turtles were observed in the launch safety zone, the launch will be delayed until the animals leave (U.S. Department of the Navy, 1998a; U.S. Army Strategic Defense Command, 1992).

In the unlikely event of an on-pad fire or early flight failure over land of a solid propellant missile, most or all of the fuel will likely burn up before being extinguished. Any remaining fuel will be collected and disposed of as hazardous waste. Soil contamination which could result from such an incident is expected to be localized, along with any impacts on vegetation or wildlife.

In the unlikely event of a launch mishap involving a liquid-propellant missile, if the fuel and/or oxidizer do not explode or burn, they will likely be deposited on the ground or water surface. For THAAD missiles, a maximum of 0.5 gal of hypergolic bi-propellants will be released from the Divert and Attitude Control System. For a Lance missile, up to several hundred pounds of

IRFNA and hydrazine can be released. The Liquid Fuel Target System has the potential to release up to several hundred gallons of IRFNA and coal tar distillate.

An on-pad spill or catastrophic missile failure of a liquid-fueled missile over land could result in the release of unsymmetrical dimethyl hydrazine fuel and/or IRFNA oxidizer. When released, the IRFNA will volatize into the atmosphere. Unsymmetrical dimethyl hydrazine is heavier than air, and if not oxidized when airborne will react and/or possibly ignite with the porous earth or will form dimethylamine and nitrogen oxides. Emergency crews will respond as soon as possible to extinguish any fires. All of these substances are soluble in water. On further oxidation of the dimethylamine, the amino substances serve as nutrients to plant life. Airborne nitrogen dioxide would return to earth as nitric acid rains in precipitation events and would react with the calcium carbonate soil to form the nitrates which are used in fertilizer for plant life (U.S. Army Space and Strategic Defense Command, 1995). Coal tar distillate fuel would not mix with the water, but would form a slick on the surface. Because of (1) the relatively small area that will be affected, and (2) the existing spill prevention, containment, and control measures in place at PMRF, minimal impacts on biological resources are expected.

Electromagnetic Radiation

Specific siting and orientation of the radar results in a cone shaped EMR zone being projected skyward yet within site boundaries. In terms of the potential for EMR impacts on wildlife, the main beam of the THAAD radar or other ground-based radar system during missile flight tests, will not be directed toward the ground and will have a lower limit of 4 to 5 degrees above horizontal, which precludes EMR impacts on terrestrial species on the beach at PMRF. The potential for main-beam (airborne) exposure thermal effects on birds exists. The potential for impacts on birds and other wildlife was addressed in the Ground-Based Radar Family of Radars EA (U.S. Army Space and Strategic Defense Command, 1993c). The analysis was based on the conservative assumption that the energy absorption rate of a bird's body was equal to its resting metabolic rate and that this could pose a potential for adverse effects. Birds in general typically expend energy at up to 20 times their resting metabolic rates during flight. Mitigating these concerns is the fact that radar beams are relatively narrow. To remain in the beam for any period requires that the bird flies directly along the beam axis, or that a hovering bird such as a raptor does so for a significant time. There is presently insufficient information to make a quantitative estimate of the joint probability of such an occurrence (beam stationary/bird flying directly on-axis or hovering for several minutes), but it is estimated to be insubstantial. Since birds are not likely to remain continuously within the radar beam, the likelihood of harmful exposure is not great. (U.S. Department of the Navy, 1998a)

Earlier analysis of ground-based radar's potential impacts on birds indicated that power densities of 243 to 390 milliwatts per square inch would be necessary to affect birds weighing up to 7.7 lbs. The power density of radars such as THAAD is not expected to exceed 32 milliwatts per square inch. (U.S. Army Space and Strategic Defense Command, 1993c)

Few field experiments have been performed to determine the potential effects of high-frequency EMR on wild animals. Aberdeen University researchers have over time observed that bat activity is reduced in the vicinity of the Civil Air Traffic Control radar station despite the proximity of habitat where bat activity would be expected. This observation raised the possibility that the radiofrequency radiation from the station might cause an aversive behavioral response in foraging bats. (Nicholls and Racey, 2007)

Nicholls and Racey (2007) predicted that if high-frequency EMR exerts an aversive response in foraging bats, the bat activity would be reduced at radar installations. The results of their study indicate that total bat activity was higher in control sites (0 volts/meter) when compared to sites with a high level (>2 volts/meter) of EMR. Nicholls and Racey (2007) proposed that thermal induction leading to an increased risk of overheating/hyperthermia and echolocation were the two likely mechanisms through which electromagnetic fields could induce an aversive response. To define the actual impact of radar on bats, field trials with a mobile radar that could be introduced into areas known to contain foraging would be required. (Nicholls and Racey, 2007)

Environmentally Sensitive Habitat

Training currently avoids the coastal dune systems. Conservation measures to minimize adverse effects on sensitive habitats developed as part of the 1998 PMRF Enhanced Capability EIS process included the following: (1) installation of a portable blast deflector on the launch pad could protect the vegetation the adjacent sand dunes; (2) potential for starting a fire would be further reduced by clearing dry vegetation from around the launch pad; (3) spraying the vegetation adjacent to the launch pad with water just before launch to reduce the risk of ignition; (4) emergency fire crews available during launches to quickly extinguish any fire and minimize its effects; and (5) the use of an open (spray) nozzle, when possible, rather than a directed stream when extinguishing fires, to avoid erosion damage to the sand dunes. Current training events do not occur in any of the wetland areas on base, including those associated with the Nohili Ditch and the Kawaiele Ditch.

HRC training and Major Exercises at PMRF do not occur in established critical habitat areas for lau`ehu that are located on or off base (Figure 3.3.2.1.3-1). Unexpected flight terminations or other launch mishaps have the potential to impact an area that has been designated as unoccupied critical habitat by fire, debris, and the resultant cleanup. However, the likelihood of a mishap occurring is small, and appropriate measures will be in place to minimize adverse effects.

HRC RDT&E Activities—No-action Alternative

PMRF's additional mission is supporting RDT&E projects. The at sea RDT&E activities are analyzed in the Open Ocean Section (4.1.2). Land sensor and missile defense effects will be the same or similar to those discussed above. Other RDT&E activities on PMRF include one-of-a-kind or short duration RDT&E activities conducted for both government and commercial customers. Examples include humpback whale detection, Maritime Synthetic Range, and numerous System Integration Checkout activities. Generally these types of activities have no or minimal effect on biological resources.

4.3.2.1.3.2 Alternative 1 (Biological Resources—PMRF/Main Base)

Increased Tempo and Frequency of Training, New Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). This would amount to an average increase of approximately 9 percent for onshore training. While training events would increase in number, the likelihood of a similar increase in impacts on biological resources is small, as described below.

Vegetation

Training would take place in current operating areas, with no expansion. Compliance with relevant Navy policies and procedures during these increased training events should continue to minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. No threatened or endangered plants have been observed on PMRF.

Wildlife

Impacts on wildlife from an increase in frequency and tempo of training would be similar to those described for the No-action Alternative since the additional training events would be performed throughout the HRC and not confined to one particular area. It is unlikely that an individual listed species or other wildlife on PMRF would be repeatedly exposed to noise, debris, EMR, or emissions as a result of increased training. The additional training would comply with relevant Navy policies and procedures, which would minimize the potential for effects on wildlife.

Environmentally Sensitive Habitat

The continued use of regular training areas and transit routes would avoid the wetland acreage and other environmentally sensitive habitat on PMRF, thus no impacts are anticipated.

New Training

An additional proposed training event associated with Major Exercises is FCLP. This event involves pilots from an aircraft carrier air wing practicing landings at a land runway. As discussed in Chapter 2.0, the runway at PMRF could be used for FCLP. For each pilot, the FCLP would include 8 to 10 touch-and-go landings at the PMRF runway during both daytime and at night. Sound levels from these training events would be similar to sound levels currently occurring at the PMRF runway (65 to 85 dB). Other than startle effects, no substantial impacts on wildlife, including threatened and endangered species, are anticipated.

While PMRF does not currently participate in night time FCLPs, there are other take-offs and landings that do occur at night at the PMRF airfield. In addition, no substantial impacts on nocturnal species are anticipated since: (1) the number of hoary bats observed on PMRF is limited and none have been observed in the runway areas; (2) wedge-tail shearwaters are not located within the runway approach; and (3) as described in Chapter 3.0, the Laysan albatross is being discouraged from nesting at PMRF to prevent interaction between the species and aircraft using the runway. Albatross on the airfield are tagged and released on the north portion of the base or returnees are relocated to Kilauea National Wildlife Refuge in order to prevent bird/aircraft strikes. Viable PMRF albatross eggs are being relocated to Kilauea Point and other north shore nest sites to replace eggs that would never hatch. This surrogate parenting program continues through the 2006/2007 nesting season and is anticipated to continue as long as viable eggs are available at PMRF/Main Base (Burger, 2007a). Any required lighting would be shielded in accordance with existing PMRF policy to minimize the potential for adverse impacts on Newell's shearwaters and stormy petrels that may traverse the area on their way out to sea. The Navy would attempt to avoid FCLPs during breeding and fallout seasons, if practicable. If not practicable, any potential impacts to listed endangered bird species would be addressed through coordination/consultation with the USFWS.

A 750-ft runway clear zone measured from the centerline of the runway is regularly mowed and maintained. No structures or trees exceeding certain height limitations are allowed within this zone. These practices deter wildlife from nesting and foraging along the runway and minimize the potential for bird strikes.

Enhanced and Future RDT&E Activities—Alternative 1

Payloads on some target vehicle launches from PMRF would incorporate additional chemical simulants, which include larger quantities of TBP and various glycols. The families of chemicals were selected based on the criteria to minimize potential toxicity and maximize the potential to simulate the more dangerous chemical warfare agents. Up to approximately 120 gal of simulant could be used in target vehicles. The simulant would be transported from the Continental United States to PMRF with the target vehicle and loaded into the target payload as part of the vehicle processing activities.

The use and effects of simulants have been analyzed in other PMRF-related documents (U.S. Department of the Navy, 1998a; U.S. Army Space and Missile Defense Command, 2002; 2003) and are further discussed in Sections 4.2.1.1.1 and 4.2.1.1.1.2. The release of simulant would continue to occur at a high altitude over the open ocean during a nominal flight test. Because of (1) the relatively small area that would be affected and (2) the existing spill prevention, containment, and control measures in place at PMRF, minimal impacts on biological resources are expected in the event of a launch mishap. The potential ingestion of toxins, such as the small amount of propellant or simulant remaining in the spent boosters or on pieces of missile debris, by terrestrial species would be remote.

An additional proposed training activity associated with Major Exercises is FCLP (addressed above), which would involve pilots from an aircraft carrier air wing practicing landings at the PMRF land runway.

Launches from Wake Island, the Reagan Test Site at USAKA, and Vandenberg AFB toward the vicinity of PMRF are proposed. Launches from those sites would be from existing launch facilities and the intercept areas would be in the Open Ocean Area and TOA of the PMRF Range. Targets would also be launched from sea-based and air-based platforms. The effects of these missile tests would be similar to those described above for the No-action Alternative and in Section 4.1.2.

HRC Enhancements—Alternative 1

Where possible, existing towers would be used for the placement of new equipment to enhance the PMRF electronic warfare (EW) training capability. The construction of any new towers on Kauai or on other islands (e.g., Molokai, Lanai, Maui, and Hawaii), would occur at locations selected by personnel familiar with local environmental constraints, including the presence of threatened or endangered species. Additional environmental documentation would be required once specific sites are identified. The placement of new equipment to enhance electronic warfare training capability would be collocated on an existing communication tower or other structure. Any new towers would not be sited in or near wetlands, other known bird concentration areas (e.g., state or Federal refuges, staging areas, rookeries), in known migratory or daily movement flyways, or in habitat of threatened or endangered species. The towers proposed for use are not located in Newell's shearwater nesting areas. Any required lighting would be shielded in accordance with existing PMRF policy. PMRF works directly with Save our Shearwaters to minimize effects on the birds from its activities. If avoidance of activities during bird fallout season is not practicable, monitoring for downed birds near the new towers would be conducted as appropriate.

Enhanced Automatic Identification System and Force Protection Capability

As part of the enhanced Automatic Identification System (AIS) and Force Protection Capability, antennas would be added to an existing structure on PMRF/Main Base, resulting in temporary elevated noise levels. No vegetation clearing or ground disturbance would be required for this effort. Because construction-related noise would be localized and short-term, the potential for impacts on biological resources would be minimal. If avoidance of activities during bird fallout season is not practicable, monitoring for downed birds near the antennas would be conducted as appropriate.

Pacific Missile Range Facility Enhancements

Construct Range Operations Control Building

PMRF would construct a new, almost 90,000-ft^2 building to consolidate range operations currently conducted in 13 buildings. Its proposed location is shown on Figure 2.2.3.6.4-5. An environmental review of the proposed consolidated Range Operations Control Building construction was conducted that determined that the effects of the proposed construction on the environment would be minimal and a categorical exclusion (CATEX) for the proposed project was approved on 14 May 2004.

Vegetation. The proposed building site is within the previously disturbed administrative area. No unique habitat or indigenous or native vegetation would be disturbed. No threatened or endangered vegetation has been identified as occurring on PMRF.

Wildlife. At 50 ft from construction equipment, noise levels typically range from 70 to 98 A-weighted decibels (dBA). The combination of increased noise levels and human activity would likely displace some small mammals and birds (e.g., common field and urban birds, and small rodents) that forage, feed, or nest within and adjacent to the construction site. Impacts on listed birds (Hawaiian duck, Hawaiian moorhen, Hawaiian coot, and Hawaiian stilt) that could be in or transiting the construction area would be limited to startle or flying away reactions. Foraging birds would be subjected to increased energy demands if flushed by the construction noise, but this should be a short-term, minimal effect. Construction would not affect the wetlands that these birds use for resting, nesting, and foraging, which are approximately 0.5 mi northeast of the proposed new building location as shown in Figure 3.3.2.1.3-1. Bird migration patterns would not be altered.

Any outdoor lighting associated with construction activities and permanent structures would be properly shielded, following U.S. Fish and Wildlife Service (USFWS) guidelines to minimize reflection and impact on light-sensitive wildlife, such as the Newell's shearwater and petrels.

Improve Fiber Optics Infrastructure

To improve communications and data transmission, PMRF would install fiber optic cable between the Main Base and Kokee. The cable would be hung on existing KIUC poles between PMRF/Main Base and Kokee; however, it is possible that additional poles might need to be installed in some areas where exceptionally long spans are encountered. To minimize ground disturbance and impacts on vegetation, it is expected that all equipment and installation activities would occur along existing public and KIUC access roads in previously disturbed areas. Effects from the noise and presence of additional personnel during this activity would be similar to those discussed in Section 4.3.2.1.3.1, PMRF/Main Base. Newell's shearwaters and Hawaiian dark-rumped petrels often fly into utility wires and poles and fall to the ground. KIUC has implemented a number of conservation measures to benefit listed seabird species on Kauai. The cooperative has shielded all streetlights on utility poles along county and state highways to reduce light-attraction impacts. KIUC has also placed power line marker balls in areas of concentrated seabird flight paths. (Kauai Island Utility Cooperative, 2006b) These measures could also be used for the proposed installation of additional poles and cable between PMRF and Kokee. The Navy would consult with USFWS regarding the potential for threatened and endangered bird takes.

Environmentally Sensitive Habitat. New construction would follow standard methods to control erosion during construction. Construction would thus not likely directly or indirectly affect any wetlands on base including those associated with the Nohili Ditch and the Kawaiele Ditch.

4.3.2.1.3.3 Alternative 2 (Biological Resources—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of events could also increase. Wildlife exhibits a wide variety of responses to noise. Some species are more sensitive to noise disturbances than others. Literature on the effects on wildlife from noise suggests that common responses to noise events include a startle or fright response, and ultimately, habituation (becoming accustomed to the noise). The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Enhanced and Future RDT&E Activities—Alternative 2

The high-energy laser would require a 25,000-ft^2, permanent operations building on PMRF. If Naval Sea Systems Command (NAVSEA) decides to build and operate this Maritime Directed Energy Test Center, separate environmental documentation would be required to analyze the specific location, and test and operational requirements, including the requirement of 30 megawatts of power.

PMRF would also add the capability to test non-eye-safe lasers. If Airborne Laser system testing were conducted at PMRF, separate environmental documentation would be required to analyze the specific test requirements.

Advanced Hypersonic Weapon

Launches of the new booster configurations as part of the Advanced Hypersonic Weapon testing would be similar to launches of the Strategic Target System previously analyzed in the Strategic Target System EIS and the PMRF Enhanced Capability EIS (U.S. Army Strategic Defense Command, 1992; U.S. Department of the Navy, 1998a). No new facilities would be required. The launch azimuth and flight termination system would be the same as that of the existing Strategic Target System. Existing radars and the ground hazard area would also be the same. As a result, impacts on biological resources would be minimal.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

A Multiple Strike Group Exercise consists of training that involves Navy assets engaging in a schedule of events battle scenario, with U.S. forces against a hypothetical opposition force. Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. Participants use and build upon previously gained training skill sets to maintain and improve the proficiency needed for a mission-capable, deployment-ready unit. The Major Exercise would occur over a 5- to 10-day period. Activities would mainly be offshore and in the Open Ocean. The Multiple Strike Group training would involve many of the training events identified and evaluated under the No-action Alternative and Alternative 1 including mine training events, Missile Defense, and FCLP. Increased activities should not result in new lighting, fire potential, noise, and EMR/electromagnetic fields, or introduction of non-native species.

4.3.2.1.3.4 Alternative 3 (Biological Resources—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on vegetation and wildlife under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.4 Cultural Resources—PMRF/Main Base

4.3.2.1.4.1 No-action Alternative (Cultural Resources—PMRF/Main Base)

HRC Training—No-action Alternative

Training with the potential to affect cultural resources at PMRF Main Base includes Swimmer Insertion/Extraction, Expeditionary Assault, MCM, and HAO/NEO. All three of these training events exhibit similar activities that involve personnel and equipment (e.g., AAVs, SDVs, supply trucks) crossing beach areas or following existing roads from the shoreline and dispersing into designated areas for from 1 to 18 days of training.

At PMRF, the insertion point for training is at Majors Bay and within a landing zone that has been specifically designated for these types of training events. The Majors Bay landing site is heavily disturbed from long-term use by both the military and the public, and contains no recorded cultural resources in either the landing or staging areas. This location also has a low potential for the unanticipated discovery of cultural materials or human remains. There is one significant recorded cultural site in the over-night area inland of the beach (Site 05-1834) (International Archaeological Resources Institute, Inc., 2005) ; however, the site is fully marked in the field and easily recognized as a “keep-out” area (U.S. Department of the Navy, 2002a). With adherence to prohibitions against entry into this area, no impacts on cultural resources will occur from training at Majors Bay.

If unanticipated cultural resources are encountered (particularly human remains) for any activity, training plans direct that all training events will cease in the immediate vicinity of the find and procedures outlined in the PMRF ICRMP, SOP II.3.3, followed (International Archaeological Resources Institute, Inc., 2005).

HRC RDT&E Activities—No-action Alternative

Missile activities at PMRF encompass a wide array of missile types and are conducted from existing launch facilities. Under the No-action Alternative, any or all of the following potential impacts could occur to cultural resources from ongoing or future launches:

- New construction, ground-clearing, and off-road traffic activities
- Sound pressure damage to buildings and structures from launch activities
- Inadvertent ignition of vegetation and subsequent fire suppression activities
- Increased human presence in archaeologically sensitive areas as a result of training or maintenance activities
- Alteration, modification, renovation, or demolition of existing potentially significant facilities.

Mitigation measures to reduce and/or eliminate any potential adverse effects on known or unidentified historic properties from ongoing and future missile activities have been developed and are presented in the PMRF ICRMP (International Archaeological Resources Institute, Inc., 2005). These include:

- Avoiding activities and construction in areas where cultural resources are known to exist
- Monitoring all ground-disturbing activities and construction in medium and high sensitivity archaeological areas
- Briefing personnel working in culturally sensitive areas, including providing information on Federal laws protecting cultural resources
- Spraying water on vegetation within the immediate area of the launch vehicle prior to launch. In the event that vegetation ignites as a result of launches, fire suppression personnel are instructed to use an open spray nozzle whenever possible to minimize erosion damage (such as to sand dunes) and prevent destruction of cultural resources.
- If extensive burning of dune vegetation occurs, conducting post-burn archaeological surveys in consultation with the Hawaii State Historic Preservation Office (SHPO) and Navy archaeologist
- Implementing data recovery/research and documentation program if cultural resources are discovered as a result of normal training and base operations activities.

As part of the PMRF Enhanced Capability EIS process, a Memorandum of Agreement for the protection of cultural resources was signed in 1999 (Appendix H), which includes a monitoring plan for ground-disturbing activities and a burial treatment plan. These plans have been integrated into the SOPs of the PMRF ICRMP as well (International Archaeological Resources Institute, Inc., 2005).

Because extensive measures described above are in place for the protection of cultural resources during missile activities at PMRF, no adverse effects are expected. With missile activities and all other military activities at PMRF, the Navy will continue to provide Native Hawaiians with access to traditional religious and cultural properties, in accordance with the American Indian Religious Freedom Act and Executive Order 13007, on a case-by-case basis.

Major Exercises—No-action Alternative

Elements of Major Exercises with the potential to affect cultural resources (e.g., Swimmer Insertion/Extraction, Expeditionary Assault, MCM, HAO/NEO, missile launches) are included in the above discussions.

4.3.2.1.4.2 Alternative 1 (Cultural Resources—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Increases in the numbers of training events required under Alternative 1 would have no effect on terrestrial cultural resources at PMRF. Baseline training (i.e., the No-action Alternative) analyzed above would have no adverse effect on known cultural resources at PMRF, and established guidance (e.g., the PMRF ICRMP and a Memorandum of Agreement) is in place for protection. Increased tempo and frequency of training under Alternative 1 would not be anticipated to produce adverse effects. (International Archaeological Resources Institute, Inc., 2005)

HRC Enhancements—Alternative 1

Enhanced Automatic Identification System and Force Protection

The AIS provides a ship-to-ship and ship-to-shore communications capability. To enhance the existing system, new antennas would be added to Building 282 at PMRF Main Base. Historic buildings surveys have been completed of PMRF/Main Base, and Building 282 has not been recommended as eligible for inclusion in the National Register of Historic Places (NRHP) either on individual merit or as an element of a historic district. As a result, installation of a new antenna on this building would have no effect on cultural resources (International Archaeological Resources Institute, Inc., 2005) (see Appendix H).

Pacific Missile Range Facility Enhancements

Training at PMRF/Main Base with the potential to affect terrestrial cultural resources includes construction of a new Range Operations Control Building and completion of a new fiber optic cable line between PMRF/Main Base and Kokee (see Figure 2.1-2).

<u>Range Operations Control Building</u>

There are no cultural resources sites identified within the direct region of influence for construction of the Range Operations Control Building. The areas have been surveyed for archaeological resources; however, subsurface features may still be present (International Archaeological Resources Institute, Inc., 2005). Construction of this facility would require coordination with the PMRF Environmental Engineer and would follow the guidance provided in the PMRF ICRMP, most specifically SOP II.3.1 (International Archaeological Resources

Institute, Inc., 2005). Mitigation measures would include, but not be limited to, archaeological monitoring during construction.

Fiber Optic Cable

Improving the fiber optics infrastructure between PMRF and Kokee would involve the installation of approximately 23 mi of fiber optic cable. The cable would be hung on existing Kauai Island Utility Cooperative (KIUC) poles.

Hanging the new fiber optic cable on existing KIUC utility poles between PMRF and Kokee would have no effect on cultural resources. However, any connections required between the existing cable terminal and the poles (i.e., trenching, installation of new ducts, or erection of new poles across PMRF to get to the KIUC intersection) could affect subsurface cultural materials. Mitigation measures would include, but may not be limited to, archaeological monitoring during construction.

Major Exercises—Alternative 1

Impacts associated with Major Exercises at PMRF/Main Base (e.g., Swimmer Insertion/Extraction, Expeditionary Assault, MCM, HAO/NEO, missile launches) would be similar to those discussed in Section 4.3.2.1.4.1.

4.3.2.1.4.3 Alternative 2 (Cultural Resources—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Increases in the numbers of training events required under Alternative 2 would have no effect on terrestrial cultural resources at PMRF. Baseline training (i.e., the No-action Alternative) analyzed earlier would have no adverse effect on known cultural resources at PMRF, and established guidance (e.g., the PMRF ICRMP and a Memorandum of Agreement) is in place for protection. Increased tempo and frequency of training under Alternative 1 would not be anticipated to produce adverse effects.

Future RDT&E Activities—Alternative 2

Directed Energy

The Directed Energy program would require the construction of a new operations building at PMRF/Main Base(see Figure 2.2.4.5-1). The potential building is currently sited in locations where there are no known archaeological sites; however, the location has not been finalized. There is always the potential for subsurface archaeological remains to occur. Once the exact facility location has been determined, construction would require coordination with the PMRF Environmental Engineer, following guidance provided in the PMRF ICRMP (International Archaeological Resources Institute, Inc., 2005).

Advanced Hypersonic Weapon

The Advanced Hypersonic Weapon involves multiple launches of a long range missile. Launches would be from the KTF area of PMRF. No construction is required for this program and, as described above, measures are in place for the protection of terrestrial cultural resources within the ground hazard area. As a result, adverse effects are not expected.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Training associated with the Multiple Strike Group primarily involves sea and air activities; therefore, adverse effects on terrestrial cultural resources at PMRF/Main Base are not expected.

4.3.2.1.4.4 Alternative 3 (Cultural Resources—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.5 Geology and Soils—PMRF/Main Base

4.3.2.1.5.1 No-action Alternative (Geology and Soils—PMRF/Main Base)

Ongoing training at PMRF/Main Base, Expeditionary Assault, ground maneuvers, and HAO/NEO, will have minimal direct impact on the beach and inland areas, and soils will not be permanently affected.

4.3.2.1.5.2 Alternatives 1, 2, and 3 (Geology and Soils—PMRF/Main Base)

Construction activities that could affect geology and soils include installation of AIS and Force Protection equipment, construction of a new Range Operations Control Building and construction of the proposed High-Energy Laser facility. New construction would follow standard methods to control erosion during construction. No adverse impacts on soils are likely to occur as a result of new construction because the proposed sites are located in modern alluvial and dune sands unsuitable for agricultural development. Soil disturbance would be limited to the immediate vicinity of the construction area and would be of short duration. Soils at the proposed sites may be subject to minor erosion from the wind during the construction period. Base personnel would exercise best management practices to reduce soil erosion.

4.3.2.1.6 Hazardous Materials and Waste—PMRF/Main Base

4.3.2.1.6.1 No-action Alternative (Hazardous Materials and Waste—PMRF/Main Base)

HRC Training and Support Activities—No-action Alternative

Under the No-action Alternative existing training at PMRF/Main Base will continue and there will be no increase in hazardous materials used and hazardous waste produced. PMRF/Main Base has plans in place to manage hazardous materials and waste.

Under the No-action Alternative, existing HRC training at PMRF will continue to occur. Training at PMRF/Main Base that can affect hazardous material and waste includes GUNEX, Swimmer Insertion/Extraction, Expeditionary Assault, and Missile Exercises. Section 3.3.2.1.6 details existing levels of hazardous materials and hazardous wastes at PMRF/Main Base. The No-action Alternative will continue to generate similar levels. PMRF activities follow applicable State and Federal requirements for the management of hazardous materials and waste generated. All hazardous materials and hazardous waste will continue to be shipped in accordance with DOT regulations.

Hazardous materials and wastes associated with GUNEX, Swimmer Insertion/Extraction, and Expeditionary Assault will primarily include fuels needed for vehicles used in the activities. These vehicles will be fueled prior to the start of the training. Any spills that occur will be handled in accordance with existing SOPs at PMRF. In addition, training materials will be expended offshore at PMRF/Main Base during training. Items that will be expended in the water offshore and those not recognized as training material typically will not be recovered.

Missile Exercises at PMRF/Main Base
Both solid and liquid propellant missiles launch activities will continue to occur at PMRF/Main Base. Pre-launch activities associated with these launches include transportation and handling of launch vehicles. All elements of the launch vehicle will be transported, handled, and stored at PMRF in accordance with applicable Federal and State regulations and standard range SOPs to limit any adverse impact.

Potential soil contamination could occur from rocket emissions forming hazardous residues in concentrations which would dictate a hazard to human health, or, in the event of an early flight termination, burning fuel may reach the ground. This local contamination could require soil sampling and analysis to determine if any clean-up is required. During nominal launches of a solid propellant missile, the primary emission products will include hydrogen chloride, aluminum oxide, carbon dioxide, carbon monoxide, nitrogen, and water.

No adverse changes to soil chemistry are predicted to occur as a result of hydrogen chloride or aluminum oxide deposition from solid fueled target and interceptor launches. No solid propellant missile launches will occur during rainy conditions, and the launch system will not use a water deluge system for cooling and noise suppression (a deluge system could increase the potential for ground deposition). As detailed in Section 3.3.2.1.6, potential deposition of aluminum oxide per launch is expected to be small relative to the background levels of aluminum present in the soil. Previous studies performed by the Department of Energy to evaluate the impact of potentially launching Strategic Target Systems at KTF measured high background levels of aluminum in the soils of the Mana Plain. Soil deposition of measurable levels of aluminum oxide from a moving exhaust cloud is predicted to be negligible (U.S. Army Strategic Defense Command, 1992). Additionally, because the launch location is on the western side of the island, the launch trajectory is away from the island, and there are strong persistent wind conditions, it is expected that very little of these emissions will be deposited at PMRF.

In the unlikely event of an on-pad fire or early flight failure over land of a solid propellant missile, most or all of the fuel will likely burn up before being extinguished. Any remaining fuel will be collected and disposed of as hazardous waste. Potential soil contamination which could result from such an incident is expected to be localized. Such contamination could require soil sampling and analysis to determine if any clean-up is required. An on-pad spill or catastrophic missile failure of a liquid-fueled missile over land could result in the release of unsymmetrical dimethyl hydrazine fuel and/or IRFNA oxidizer. Unsymmetrical dimethyl hydrazine is heavier than air, and if not oxidized when airborne will react and/or possibly ignite with the porous earth or will form dimethylamine and nitrogen oxides. All of these substances are soluble in water.

On further oxidation of the dimethyl amine, the amino substances serve as nutrients to plant life. Airborne nitrogen dioxide would return to earth as nitric acid rains in precipitation events and would react with the calcium carbonate soil to form the nitrates which are used in fertilizer for plant life (U.S. Army Space and Strategic Defense Command, 1995).

Likewise, IRFNA that reached the ground will react with calcium carbonate soils to form calcium nitrates (U.S. Army Space and Strategic Defense Command, 1995). Calcium nitrate, a strong oxidizer, is a dangerous fire risk in contact with organic materials, and may explode if shocked or heated (U.S. Army Space and Strategic Defense Command, 1995). Therefore, depending on the amount of the propellant and/or oxidizer released, soils contaminated with these liquid propellants may require removal to prevent subsequent fires or explosions. Calcium nitrate is also water soluble, so it is anticipated that any residual material or unreacted fuel will be washed into the groundwater or directly out to sea.

Potentially hazardous materials (external to those preloaded into the launch vehicles) to be used will be fuel required for electrical power generators, coating, sealants, and solvents needed for launch and launch preparation. The types of hazardous materials used and hazardous waste generated will be managed in accordance with existing PMRF procedures, which conform to Federal and State of Hawaii requirements.

In addition, the PMRF Fire Department and Spill Response Team are trained in the appropriate procedures to handle the materials associated with launches if a mishap occurs. All personnel involved in this training will wear protective clothing and receive specialized training in spill containment and cleanup. During launches there is the potential for a mishap to occur resulting in potentially hazardous missile debris and propellants falling within the ground hazard area. The hazardous materials that result from a flight termination will be cleaned up and any contaminated areas remediated. All hazardous waste generated from such a mishap will be disposed of in accordance with appropriate State and Federal requirements. Specific restoration actions, if necessary, will be determined on a case-by-case basis in coordination with the procedures of the Facility Services Division of Hazardous Materials.

HRC RDT&E Activities—No-action Alternative

Ongoing RDT&E activities that can affect hazardous materials and waste levels at PMRF/Main Base include missile defense ballistic missile target flights and THAAD interceptor activities.

RDT&E activities include conducting missile launches from both northern and southern PMRF/Main Base launch sites. Impacts will be as described above for HRC training. The types of hazardous materials used and hazardous waste generated will be similar to current materials and will not result in any existing procedural changes to the hazardous materials and hazardous waste management plans currently in place. The rate of launches will not increase at PMRF/Main Base due to the No-action Alternative.

Major Exercises—No-action Alternative

Major Exercises include ongoing training, and in some cases RDT&E activities. C2 is achieved through a network of communication devices strategically located at selected DoD installations around the islands with no hazardous material or hazardous waste impacts foreseen.

Potential impacts on hazardous materials and wastes at PMRF/Main Base from a Major Exercise will be similar to those described for training and RDT&E activities. The types of hazardous materials used and hazardous waste generated will be similar to current materials and will not result in any existing procedural changes to the hazardous materials and hazardous waste management plans currently in place.

4.3.2.1.6.2 Alternative 1 (Hazardous Materials and Waste—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

The types of training that would occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.6.1. While training events would increase in number, hazardous materials used and hazardous waste generated would be similar to existing usage and generation, and would not result in any changes to management plans currently in place.

The new training proposed for PMRF/Main Base is FCLP. The Navy proposes to conduct an FCLP for half an air wing's pilots once a year in Hawaii. An FCLP is a series of touch-and-go landings that would be conducted during day or night periods, each consisting of six to eight touch-and-go landings per pilot. Hazardous materials and waste associated with the proposed FCLPs would be consistent with existing management plans in place at PMRF/Main Base. Training would continue to follow applicable State and Federal requirements for the management of hazardous materials and waste generated. All hazardous materials and hazardous waste would continue to be shipped in accordance with DOT regulations. Any spills that occur would also be handled in accordance with existing SOPs.

Enhanced and Future RDT&E Activities—Alternative 1

Increased and future RDT&E activities include target missiles launched from Wake Island, Kwajalein Atoll, or Vandenberg AFB into the TOA, additional chemical simulants, High Speed UAV and surface vehicle testing, and Hypersonic Vehicle testing.

Proposed launches associated with increased and future RDT&E activities would have a similar impact on hazardous material used and wastes generated as those described for the No-action Alternative. The proposed solid and liquid propellants would be similar to past launches from PMRF and would follow the same hazardous materials and hazardous waste handling procedures developed under existing plans. The types of hazardous materials used and hazardous waste generated would be similar to current materials and would not result in any changes to the hazardous materials and hazardous waste management plans currently in place.

Section 4.3.2.1.7.2, Health and Safety, addresses the amounts of liquid fuels required and the appropriate health and safety measures. All liquid propellant fuel spills would be remediated and hazardous waste generated would be disposed of in accordance with appropriate requirements.

During launches of either solid or liquid propellant missiles there is the potential for a mishap to occur resulting in potentially hazardous missile debris and propellants falling within the ground hazard area. As addressed for previous launch programs on PMRF, the hazardous materials that result from a flight termination would be cleaned-up and any contaminated areas remediated. All hazardous waste generated in such a mishap would be disposed of in accordance with appropriate State and Federal requirements

Target launches from PMRF would incorporate additional chemical simulants to include larger quantities of TBP and various glycols. Approximately 120 gal of simulant would be used in target vehicles launched from PMRF. The simulant would be transported from the Continental United States to PMRF with the target vehicle and would be loaded into the target vehicle payload as part of the payload processing activities.

TBP is a non-flammable, non-explosive, colorless, odorless liquid typically used as a solvent in commercial industry. The release of simulant would occur at a high altitude over the open ocean during a nominal flight test. TBP is not considered a hazardous substance or constituent by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), and DOT. There are no reportable quantities or cleanup standards established for TBP. However, caution would be used when handling TBP, as recommended on Material Safety Data Sheets and in keeping with PMRF SOPs. Launch preparation activities, including loading and handling of the TBP payload, would have a minimal impact on hazardous materials and waste. Emergency response planning would be incorporated into RDT&E activities requirement to minimize any impact due to an unplanned release of TBP. Loading TBP would be similar to other project actions at PMRF and would not result in an increased hazard.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at PMRF/Main Base include construction of a Range Operations Control Building, range safety for high-energy lasers, and improvement of fiber optics infrastructure.

Construction of new facilities at PMRF/Main Base, including a Range Operations Control Building and improvement of fiber optics infrastructure, would be conducted in accordance with the U.S. Army Corps of Engineers (USACE) Safety and Health Requirements Manual. Before any facility modifications, the areas to be modified would be surveyed for asbestos and lead-based paint. These materials would be removed in accordance with Federal and State requirements prior to building modifications. Construction activities associated with HRC enhancements would be centralized to the greatest extent possible at the selected project site and on specific construction laydown areas. Hazardous materials and waste management would be performed in accordance with ongoing PMRF procedures, as well as applicable Federal, State, and local requirements. All construction activities would follow the PMRF spill control plan.

Proposed construction activities are anticipated to use small quantities of hazardous materials, which would result in the generation of some hazardous and nonhazardous wastes. The hazardous materials that are anticipated to be used are common to construction activities and could include diesel fuel, anti-freeze, hydraulic fluid, lubricating oils, welding gases, and small amounts of paints, thinners, and adhesives. Hazardous materials management techniques would be used during the construction period to minimize (1) the amount of hazardous materials stored, (2) the threat of their accidental and unplanned release into the environment, and (3) the quantity of hazardous waste generated.

PMRF would develop and implement the necessary SOPs and range safety requirements necessary to provide safe activities associated with future high-energy laser tests.

Major Exercises—Alternative 1

The types of Major Exercises that would occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.6.1 and would be similar to training. While these activities would increase in number, hazardous materials used and hazardous waste generated would be similar to existing usage and generation, and would not result in any changes to management plans currently in place.

4.3.2.1.6.3 Alternative 2 (Hazardous Materials and Waste—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Impacts on hazardous materials and waste at PMRF/Main Base from increased training would be similar to existing levels of hazardous materials used and waste generated. The total number of training events that affect hazardous material use and hazardous waste generation would increase by an average of approximately 31 percent above the No-action Alternative. While the number of training events would increase, the level of hazardous materials used and waste generated would continue to be managed by PMRF under appropriate State and Federal requirements.

Future RDT&E Activities—Alternative 2

The proposed high-energy laser would require a 25,000-ft^2 building at PMRF/Main Base. Construction impacts would be similar to those described earlier. However, separate environmental documentation would be required to analyze specific location and RDT&E activity requirements, including requirements associated with hazardous material use and hazardous waste generation.

The testing of the Advanced Hypersonic Weapon would include two launches of a Strategic Target System booster from KTF and two launches of the new booster configuration from the same site. The Strategic Target System booster has been previously launched at KTF, and hazardous materials and wastes would be the same for these launches. The testing of the Advanced Hypersonic Weapon with the new booster configuration would be anticipated to use similar hazardous materials and produce similar hazardous waste. While the number of launches would increase, hazardous material usage and waste generation would continue to be managed by PMRF under appropriate State and Federal requirements.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the HRC area for up to 10 days per Major Exercise. Training events that could occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.6.1 and would require similar levels of hazardous materials and produce similar levels of hazardous waste. While the number of training events would increase at PMRF/Main Base during Strike Group Training, the levels of hazardous materials and waste would continue to be managed by PMRF under the Navy's Consolidated Hazardous Material Reutilization and Inventory Management Program (CHRIMP) and PMRF's current status as a large-quantity hazardous waste generator by USEPA. The types of hazardous materials used and hazardous waste generated would be similar to current materials and would not result in any existing procedural changes to the hazardous materials and hazardous waste management plans currently in place.

4.3.2.1.6.4 Alternative 3 (Hazardous Materials and Waste—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on hazardous materials and waste under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.7 Health and Safety—PMRF/Main Base

4.3.2.1.7.1 No-action Alternative (Health and Safety—PMRF/Main Base)

Under the No-action Alternative, existing training and RDT&E activities at PMRF/Main Base will continue. PMRF takes every reasonable precaution during planning and execution of training and RDT&E activities to prevent injury to human life or property.

HRC Training and Support Activities—No-action Alternative

Under the No-action Alternative, existing HRC training at PMRF will continue to occur. The ongoing training associated with the No-action Alternative that can affect health and safety at PMRF/Main Base includes GUNEX, Swimmer Insertion/Extraction, Expeditionary Assault, and Missile Exercises.

Existing SOPs will be used during GUNEX, Swimmer Insertion/Extraction, and Expeditionary Assault training events. These procedures include the use of clearance zones, restricting landings to specific areas of the beach, publication of training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels. Every reasonable precaution is taken to prevent injury to human life or property.

Missile Exercises at PMRF/Main Base

Missile and aerial target launch activities can occur from the PMRF Launch Complex on the northern part of the base and from two Department of Energy KTF launch areas on the northern and southern ends of the base. The missile and aerial targets are launched from fixed or portable launchers using either solid or liquid propellants. Health and safety concerns stem from pre-launch, launch, and post-launch activities.

Missile launches by nature involve some degree of risk, and it is for this reason that DoD and PMRF have specific launch and range safety policies and procedures to ensure that any potential risk to the public and government assets (launch support facilities) is minimized. Potential issues related to health and safety include mishaps during the transportation of missile components, toxic and explosive risks during missile integration and assembly, mishaps during payload/warhead mating, mishaps during handling, and launch associated debris and emissions.

Hazards During Pre-flight Activities

Missiles and support equipment may arrive at Pearl Harbor before final shipment to PMRF. Equipment will be available at Pearl Harbor for the loading and unloading of missiles. Storage areas will be available for the temporary storage of any hazardous materials. Missiles and support equipment are routinely transported directly to PMRF by aircraft. Missiles and support equipment may also be transported by ship to Nawiliwili Harbor, then by DoD/DOT-approved over-the-road carrier truck to PMRF. Applicable State and Federal regulations and range safety plans and procedures are followed in transporting and handling potentially explosive ordnance and hazardous materials. Missile components, including any propellant, are transported in DOT and military designed and approved shipping containers.

The protection afforded by shipping containers is sufficient to protect solid rocket motors from the shock required to cause an explosion. In the unlikely event of a transportation accident, the solid propellants will likely burn rather than explode. The solid propellants would release combustion products, specifically hydrogen chloride, which would irritate the eyes and skin of persons nearby. Such an accident would not likely occur given the in-place safety procedures used by PMRF during transportation and handling of missile components. Explosive Safety Quantity-Distances (ESQDs) are established along transportation corridors.

On arrival at PMRF, support equipment is placed in secure storage until assembly and launch preparation. ESQDs are established around ordnance storage and Missile Assembly Buildings. Access to storage and support facilities is limited to trained and authorized PMRF/mission critical personnel.

A pre-launch accident would be characterized by either an explosion and/or detonation of the missile propellants, or a situation in which the missile propellants burn without detonation or explosion. An ESQD surrounding the launcher is calculated based on the equivalent explosive force of all propellant and pyrotechnic materials contained on the flight vehicle. All potentially hazardous debris resulting from an accident on the launcher will be contained entirely within the ESQD, which will already have been cleared of unprotected personnel. Figure 3.3.2.1.7-1 shows the ESQD arcs for the launch pads at PMRF/Main Base. Teams are available for fire suppression, hazardous materials emergency response, and emergency medical response during launch activities.

Hazards During Vehicle Launch/Flight

Many procedures are in place to mitigate the potential hazards of an accident during the flight of one of these missiles. The PMRF Flight Safety Office prepares a Range Safety Operational Procedure (RSOP) for each mission that involves missiles, supersonic targets, or rockets. The development of the RSOP also considers the hazards from debris of hit-to-kill intercept tests where an interceptor missile impacts a target missile. The Commanding Officer of PMRF approves each RSOP, which includes specific requirements and mission rules. The Flight Safety Office has extensive experience in analyzing the risks posed by such activities. In spite of the developmental nature of missile activities (which leads to a significant probability of mission failure), the United States has an unblemished record of public safety during missile and rocket launches. Appendix K describes the general approach to protect the public and involved personnel from launch accident hazards. A brief overview of missile flight procedures is presented here, with specific examples for some of the proposed programs. The procedures in place are designed such that there is a very low probability of any adverse health or safety consequences of missile or rocket activities.

To protect people from injury from either nominal launches or accidents, two primary mitigation measures are in place: flight termination and clearance of specified regions. Clearance areas include the ground hazard area for land areas, Ship Exclusion Zones for ocean areas, and Restricted Airspace and Altitude Reservations for airspace. In addition, launch times and trajectories are cleared with United States Space Command to prevent impacts on satellites (both manned and unmanned); this process is called Collision Avoidance. For some missions, no flight termination system is needed. This occurs when the vehicle properties are such that all potential debris from accidents is contained within the hazard area.

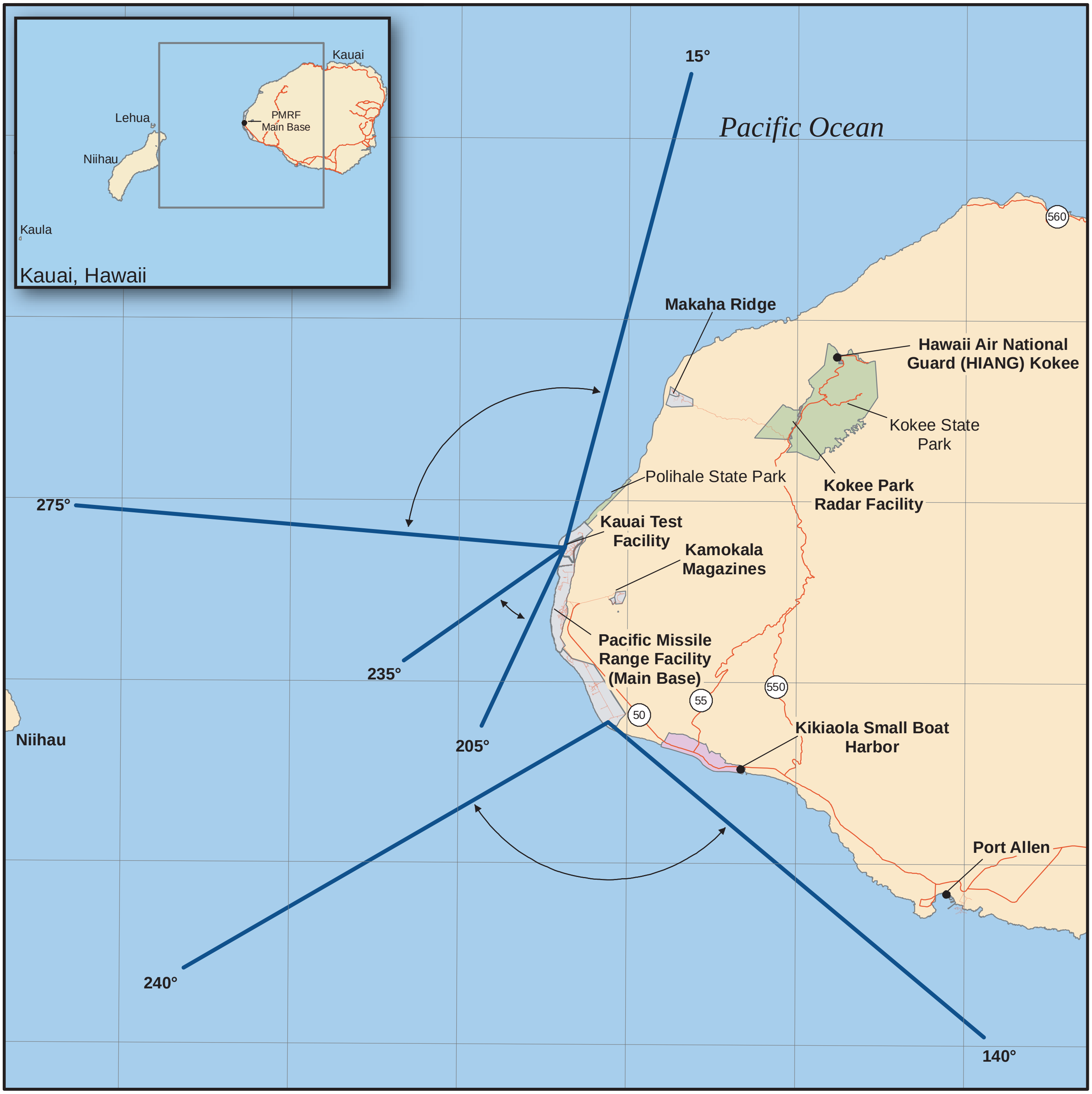
Flight termination is performed by the Missile Flight Safety Officer if a missile malfunctions and leaves a predefined region or violates other predefined mission rules. The acceptable flight region is bounded by Destruct Limits, which are defined to make impact of potentially hazardous debris on populated areas highly unlikely. The Missile Flight Safety Officer terminates flight if the Instantaneous Impact Point of a vehicle crosses a Destruct Limit. The range safety system includes highly-reliable in-flight tracking and command destruction systems. The Missile Flight Safety Officer monitors in real-time missile performance and evaluates flight termination criteria. The flight termination system provides a mechanism to protect the public with very high reliability, even in the unlikely case of a missile malfunction.

The sizes and locations of clearance regions, as well as the duration of closure, are determined for each particular launch through analysis and simulation.

The ground hazard area includes the area that may be at risk from a vehicle failure very early in flight. It is a region in the vicinity of the launch location, typically extending 1,000 to 20,000 ft from the launch point, depending on the vehicle and mission. Clearance of this region ensures that the public is excluded from any area that will be at risk from an errant missile in the time immediately after launch before Missile Flight Safety Officer could react to the malfunction (i.e., several seconds). For launches from the northern portion of PMRF Main Base (such as some Missile Defense, THAAD, Flexible Target Family), PMRF may activate the easement on State of Hawaii lands, and close roads on the Mana Plain (see Section 4.3.2.1.8).

The Ship and Aircraft Exclusion Areas ensure that vehicles are not in areas of unacceptable risk. These areas include the places where planned debris may impact (such as dropped stages of multi-stage vehicles or debris from hit-to-kill intercept engagements) and also the regions at risk if there is a failure (such as under the planned flight path). Aircraft regions are designed in a similar fashion. The specific definition of each of these regions is determined by a probabilistic risk analysis that incorporates modeling of the vehicle response to malfunctions, mission rules (such as Destruct Limits), and the vulnerability of vehicles to debris. NOTMARs and NOTAMs are issued for the entire region that may be at risk, encompassing both exclusion areas and warning areas (areas with very remote probability of hazard). Surveillance by aircraft and satellite is used to ensure that there are no ships or aircraft in cleared areas, and also that the collective risk meets acceptable risk criteria for the mission.

Figure 4.3.2.1.7.1-1 shows flight corridor azimuth limits, and Figure 3.3.2.1.7-1 shows typical ground hazard areas. A given mission would have different regions, but in all cases the same process to ensure mission personnel and public safety will be followed.



EXPLANATION

50 State Highway

Road

Flight Corridor Azimuth Limit

State Park

Installation Area

City of Kekaha

Land

Note: Azimuths between 235° and 275° from Kauai Test Facility are avoided to protect Niihau.

NORTH

0 3 6 12 Miles

Pacific Missile Range Facility Flight Corridor Azimuth Limits

Kauai, Hawaii

Figure 4.3.2.1.7.1-1

Sensor instrumentation activities will also occur during launches from PMRF/Main Base. EMR health and safety issues described below address hazards of EMR to people, fuel, and ordnance (HERP, HERF, and HERO, respectively).

HERP hazards are the result of tissue heating by radio frequency energy. Hazard levels are a result of radio frequency energy averaged over any 6-minute period. The hazard of EMR to fuel is the ignition of fuel vapors by arcing or ignition of fuel in contact with the radiofrequency (RF) heated metal in intense radio frequency fields. The hazard of EMR on ordnance is the potential to cause the ordnance to explode in intense RF fields.

Prior to installing any new radar or modifications to existing radar, the PMRF conducts an EMR hazard review that considers hazards of EMR on personnel, fuel, and ordnance. The review provides recommendations for sector blanking (areas off-limits to EMR) and safety systems.

Regular radiation hazard surveys occur of the radar and other EMR generating equipment used on PMRF. None of the EMR generated affects the public using the beaches on PMRF or the areas adjacent to the facility. EMR hazards to personnel on PMRF are minimized by conducting hazard surveys of existing systems to ensure appropriate safety precautions are implemented. In addition, each radar unit contains warning lights that operate to inform personnel when the system is emitting EMR. Overall, with the implementation of the existing safety procedures, EMR represents a minimal health and safety risk to personnel working on PMRF or the public.

Prior to each mission, the PMRF Flight Safety Office performs a comprehensive analysis of the proposed mission, including flight plans, planned impact areas, vehicle response to malfunctions, and effects of flight termination action. A probabilistic analysis is performed with sufficient conservative assumptions incorporated to ensure that the risks from the mission are acceptable. PMRF follows the guidance of the Range Commanders' Council (RCC) for acceptable risk (in RCC-321). These acceptable risk criteria are designed to ensure that the risk to the public from range operations is lower than the average background risk for other third-party activities (for example, the risk of a person on the ground being injured from an airplane crash).

Post-launch Hazards

Debris from a launch may impact the ground or open ocean (either from stage jettison or from a flight termination action). Debris can consist of metals, solid propellant, and batteries. Potentially hazardous debris will be recovered from the ground or ocean (if it floats or impacts in shallow water) and disposed of in accordance with applicable State, Federal, and range hazardous waste requirements and operating procedures.

HRC RDT&E Activities—No-action Alternative

PMRF's additional mission is supporting RDT&E projects. The at sea RDT&E activities are analyzed in the Open Ocean Section (4.1.5). Land sensor and missile defense were discussed previously. Every reasonable precaution will be taken during planning and execution of RDT&E activities to prevent injury to human life or property.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC and USWEX include ongoing training and, in some cases, RDT&E activities. Potential impacts on health and safety at PMRF/Main Base from a Major Exercise will be similar to those described for training and RDT&E activities and current SOPs will be used during Major Exercises. These procedures include using clearance zones, restricting landings to specific areas of the beach, publishing training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels. Every reasonable precaution will be taken to prevent injury to human life or property.

4.3.2.1.7.2 Alternative 1 (Health and Safety—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

While the tempo and frequency of training would increase in number under Alternative 1 and FCLPs are proposed as new training at PMRF/Main Base, current SOPs would continue to be used during training. These procedures include using clearance zones, restricting landings to specific areas of the beach, publishing training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels. Every reasonable precaution would continue to be taken to prevent injury to human life or property. The types of training that would occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.7.1.

Enhanced and Future RDT&E Activities—Alternative 1

Enhanced and future RDT&E activities include incorporation of additional non-lethal chemical simulants in target launches, interceptor targets launched from Wake Island, Kwajalein Atoll, or Vandenberg AFB into the TOA, High Speed UAV and surface vehicle testing, and Hypersonic Vehicle testing.

Proposed launches associated with enhanced and future RDT&E activities would have a similar impact on health and safety as those described for the No-action Alternative. The proposed solid and liquid propellants would be similar to past launches from PMRF/Main Base and would follow the same health and safety procedures developed under existing plans described in Section 3.3.2.1.7.1.

Target launches would incorporate additional chemical simulants and include larger quantities of currently used simulants. The top three preferred simulants would be TBP, glyceryl tributyrate, and propylene glycol. None of proposed simulants are considered hazardous substances or constituents; however, caution would be used when they are handled. The launch preparation activities would include loading and handling of the simulant payload. All simulant related RDT&E activities would be performed in accordance with OSHA standards and SOPs developed, reviewed, and approved by PMRF. Adherence to these procedures would minimize the potential for health and safety impacts on both workers and the public.

TBP is an odorless liquid, colorless to pale yellow in appearance, with applications in industrial and nuclear chemistry. High levels of TBP have been shown to have an irritant effect on the skin, eyes, and mucous membranes in humans. Glyceryl tributyrate is a colorless, clear, oily liquid used in food products as a flavoring agent. Glyceryl tributyrate may be harmful if swallowed, or act as a skin or eye irritant at high levels. Propylene glycol is a tasteless, odorless, and colorless oily liquid, which is approved for uses in food, cosmetics, and medicines by the U.S. Food and Drug Administration. High levels of propylene glycol can cause redness and pain to eyes. Personnel directly involved in the loading of the simulant would wear appropriate personal protection equipment. In addition, aerial dispersion of TBP during proposed target launches would not be at levels to cause a health and safety concern to the public. Previous analysis of using TBP as a chemical stimulant determined that the amount of TBP that could be ingested by humans would be magnitudes below the amount needed to reach the probable oral lethal dose (U.S. Army Space and Missile Defense Command, 2004). In addition, any dispersion of the proposed chemical stimulant would occur over the open ocean; therefore, deposition of TBP would not pose an ingestion hazard to the public.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at PMRF/Main Base include construction of a Range Operations Control Building, range safety for high-energy lasers, and improvement of fiber optics infrastructure. The Range Operations Control Building would be constructed in accordance with the USACE Safety and Health Requirements Manual. New facilities are routinely constructed for both military and civilian activities and present only potential occupational-related effects on safety and health for workers involved in the performance of the construction activity. The siting of the building would be in accordance with DoD standards.

PMRF would develop and implement the necessary SOPs and range safety requirements necessary to provide safe activities associated with future high-energy laser tests. The improvement of the fiber optics infrastructure at PMRF/Main Base would include hanging fiber optic cable on existing KIUC poles. In the event that exceptionally long spans are encountered, additional poles could be installed. Prior to installation, PMRF would coordinate with KIUC and the local DOT to ensure that every reasonable precaution would be taken to prevent injury to human life or property.

Major Exercises—Alternative 1

The types of Major Exercises that would occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.7.1 and would be similar to training. While these activities would increase in number, current SOPs, including the use of use of clearance zones, restricting landings to specific areas of the beach, publication of training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels would continue to be used. Every reasonable precaution would continue to be taken to prevent injury to human life or property.

4.3.2.1.7.3 Alternative 2 (Health and Safety—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

While training events would increase in number, current SOPs would continue to be used during training. These procedures include using clearance zones, restricting landings to specific areas of the beach, publishing training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels. Every reasonable precaution would be taken to prevent injury to human life or property.

Future RDT&E Activities—Alternative 2

The proposed high-energy laser would require a 25,000-ft^2 building at PMRF/Main Base. Construction impacts would be similar to those described earlier; however, separate environmental documentation would be required to analyze the specific location and operational requirements. Range safety is responsible for ensuring the safe usage of laser systems on the PMRF range. Range safety would require the proposed high-energy laser program to provide specific information about the proposed usage so that a safety analysis of all types of hazards could be completed and appropriate remedial procedures would be taken before initiation of potentially hazardous laser activities.

The high-energy laser program office would be responsible for providing all necessary documentation to PMRF prior to issuance of the Range Safety Approval (RSA) or RSOP. These include:

- Letter of Approval or a Letter of No Concern from the FAA for the use of the laser within Honolulu FAA airspace,
- Letter of Approval or a Letter of No Concern for the use of their laser if it will or has the potential of lasing above the horizon from United States Space Command (USSPACECOM) as well as clearance from USSPACECOM for each intended laser firing,
- Letter of Approval from the Laser Safety Review Board (LSRB) at Dahlgren for the use for their laser on Navy Ranges (this letter entails a survey and certification of the laser by the LSRB), and
- Range Safety Laser Data Package.

The Range Safety Laser Data Package is intended to provide the Range Safety Office with sufficient information to perform an evaluation of the safety of the laser and the proposed lasing activity and to approve the laser and its operation, and any risk mitigations required.

The Range Safety Office would analyze the submittal to ensure that it is in compliance with PMRF safety criteria, which is based on Range Commanders Council document RCC-316, OPNAVINST 5100.27A, and 2004 Laser Safety Survey Report for the Pacific Missile Range Facility Open Ocean Range. PMRF would be responsible for publishing an RSA or an RSOP specifying hazard areas and safety guidelines for the operation of the laser. The RSA/RSOP process would include an onsite safety inspection of the system by a PMRF Laser Safety Specialist to ensure that it complies with the Navy guidelines for lasers. As appropriate, the Range Safety Office would review the proposed laser systems for other non-optical hazard mechanisms, such as toxic releases.

Safety assurance would include defining exclusion areas, ensuring that the NOTAM and NOTMAR requests are submitted to the responsible agencies (FAA and Coast Guard respectively), ensuring that the laser operation falls within the approved operational areas, surveillance/clearance of the operational area and scheduling of the appropriate airspace and surface space. A Medical Surveillance Program would be required for any PMRF personnel or contractors whose duties lie within the hazard area of a laser program that is a permanent tenant or one whose tenancy is for an extended duration, and may require additional time to implement beyond the time normally required to generate an RSA or RSOP.

For general training scenarios of the proposed high-energy laser, the Range Safety Office would build on the *2004 Laser Safety Survey Report* performed by the Corona Division of the Naval Surface Warfare Center (Solis, 2004). This document defines the boundaries of the two laser target areas at PMRF: the outer W-186 Area and the outer W-188 Area are multipurpose bombing and laser target ranges used for aerial lasing. Only airborne laser designators may be used on the laser target areas. Procedures and restrictions for use of these areas are defined in this survey.

The testing of the Advanced Hypersonic Weapon would include two launches of a Strategic Target System booster from KTF and two launches of the new booster configuration from the same site. The Strategic Target System booster has been previously launched at KTF. The testing of the Advanced Hypersonic Weapon with the new booster configuration at the same site would have a similar potential health and safety impact as described for the No-action Alternative. The proposed solid and liquid propellants would be similar to past launches and would follow the same health and safety procedures developed under existing plans.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the HRC area for up to 10 days per Major Exercise. Training events and potential impacts on health and safety associated with this training that could occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.7.1. Current SOPs would continue to be used during Major Exercises, including the use of use of clearance zones, restricting landings to specific areas of the beach, publication of training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels.

4.3.2.1.7.4 Alternative 3 (Health and Safety—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.8 Land Use—PMRF/Main Base

Land use was evaluated by analyzing the training and RDT&E activities associated with each alternative presented in Chapter 2.0 of this Draft EIS/Overseas EIS (OEIS). If any activity indicates a potential environmental consequence it has been discussed in the appropriate section below. Land use associated with KTF has been evaluated within PMRF/Main Base.

4.3.2.1.8.1 No-action Alternative (Land Use—PMRF/Main Base)

Under the No-action Alternative, training, RDT&E activities, and Major Exercises were reviewed for current land use associated with PMRF/Main Base HRC.

HRC Training—No-action Alternative

The No-action Alternative stands as no change from current levels of training usage. PMRF/Main Base will continue to conduct current HRC training under the No-action Alternative. Land HRC training events include Expeditionary Assault, Swimmer Insertion/Extraction, SPECWAROPS, C2, Aircraft Support Operations, Air Operations, and HAO/NEO. These training events take place at Majors Bay, the airfield, and other facilities on PMRF Main/Base. The current baseline occurrence for each of these training events is listed on Table 2.2.2.3-1, a full description is found in Appendix D, and a description of current weapon systems is found in Appendix E. Under the No-action Alternative, these training events currently have little or no impact on land use (including recreation) and will continue at current baseline level.

On-base Land Use

PMRF/Main Base will continue to conduct the ongoing training events listed above within the designed conservation district/military lands at current capacity. All established safety measures will continue to be followed (ESQD Arcs, Ground Hazard Areas, Accident Potential Zones and Rocket Launchers). The continuation of training at PMRF/Main Base under the No-action Alternative will be consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program.

On-base Recreation

Recreational services available to military and civilian personnel at PMRF/Main Base will remain at current status during non-hazardous training. The installation's approximately 200-ft by 2-mi beach in the southern zone of PMRF will remain accessible to Kauai residents possessing an approved beach access pass. The beaches on PMRF only represent a small portion of the available beaches on Kauai. The requirement for 10 safety zones around PMRF has served to protect and preserve scenic areas.

Off-based Land Use

PMRF operates adjacent to County and State designated agricultural areas (Figure 3.3.2.1.8-2). There are no inhabited buildings within these areas. The current State and County designations limit any development of a conflicting use between these governmental agencies and the Navy. The Navy currently leases 215 acres within the Agricultural Preservation Initiative (API—See Chapter 3.0) area which contain the pumping system for the Mana Plain. The ongoing training events under the No-action Alternative are not conducted within these areas. Activities performed within missile ground hazard areas that extend off-base into these agricultural areas, which are only used during launch events, will continue to adhere to established safety measures (Section 3.3.2.1.7, Health and Safety-PMRF/Main Base).

To protect all persons, private property, and vehicles during training events at PMRF/Main Base, a 2,110-acre restricted easement has been established (Figure 3.3.2.1.7-1). Approximately 70 acres of the southern extent of Polihale State Park contain missile ground hazard areas which are within the restricted easement boundary for PMRF/Main Base. Ongoing training events for launches are not conducted in the Park, and the missile ground hazard areas are only used during launch events. In 2002 there were fewer than 4 launches, in 2006 there were fewer than 9 launches, and a total of 11 launches are anticipated for 2007 (Burger, 2007d). A review of Table 2.2.2.3-1 indicates that if PMRF provides support for training, under the No-action Alternative (remain at current status), Alternative 1, Alternative 2, and Alternative 3, the easement has the potential to be used during 7 to 28 possible missile launches. The safety restrictions are further ensured by restricting access to the land within a designated ground hazard area, prior to, during, and shortly after a launch. (U.S. Department of the Navy, 2005a, 1998a)

HRC RDT&E Activities—No-action Alternative

PMRF/Main Base will continue to conduct current HRC RDT&E activities. Table 2.2.2.5-1 lists the baseline number for the occurrence of each RDT&E activity. Land-RDT&E activities include Anti-Air Warfare RDT&E, EC/EW, High-Frequency Radio Signals, Missile Defense, and Joint Task Force Wide Area Relay Network. These RDT&E activities take place at shore sites and launch facilities on PMRF/Main Base. Under the No-action Alternative, these RDT&E activities currently have little or no impact on land use (including recreation) and will continue at current baseline level.

Major Exercises—No-action Alternative

Types of Major Exercises that occur within the HRC are the RIMPAC Exercise and USWEX. Major Exercises associated with PMRF/Main Base are C2, Air Operations, HAO/NEO, SPECWAROPS, and Expeditionary Assault. These training events are listed on Table 2.2.2.6-1 and Figure 2.2.2.6-1 shows the areas used by these Major Exercises. These Major Exercises have historically been conducted on PMRF Main Base since the 1960s. PMRF/Main Base provides land-based support for Major Exercises by launching ground-based targets from the PMRF launch complex, onshore training at Majors Bay, airfield support, and C2 support from a land facility on PMRF/Main Base. All land support locations are within the installation's boundary. Public accessibility to the Majors Bay beach is not allowed during training events. Additionally, missile ground hazard areas are in use during launching activities which affect off-base land use (launch complex in northern area of PMRF adjacent to Polihale State Park) by restricting access to the land. Potential land use impacts typically stem from encroachment of one land use or activity on another or an incompatibility between adjacent land uses that lead to encroachment. The support provided by PMRF/Main Base for these Major Exercises is compatible with the land use of the installation and with adjacent land uses. Under the No-action Alternative, the type and number of training events on PMRF/Main Base associated with Major Exercises will continue at current baseline level.

4.3.2.1.8.2 Alternative 1 (Land Use—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Under Alternative 1, PMRF would continue those ongoing training events described under the No-action Alternative with a potential increase in the number of these training events performed per year.

Alternative 1 includes all ongoing training events associated with the No-action Alternative and proposes an increased tempo and frequency of such events. HRC training associated with land-based use for PMRF/Main Base under Alternative 1 includes Expeditionary Assault, Swimmer Insertion/Extraction, SPECWAROPS, C2, Aircraft Support Operations, Air Operations, HAO/NEO and the proposed addition of FCLP. Table 2.2.2.3-1 list the number of training events proposed under Alternative 1. The number of training events would not change from the baseline training events listed under the No-action Alternative; therefore, the land support provided by PMRF/Main Base for these training events would not change.

Under Alternative 1, the Navy is proposing to conduct 12 FCLPs for a small number of pilots each year at the PMRF/Main Base airfield. The FCLP is a series of touch-and-go landings conducted to train and field qualify pilots for aircraft carrier landings. The aircraft would be operating within the PMRF airspace and Warning Areas. The airfield currently provides support for Air Operations during HRC training and Major Exercises, and there are no conflicts with on-base use or adjacent land use. FCLP activities would not involve land acquisition or new construction. Overall, under Alternative 1, the addition of FCLPs would not alter on-base or off-base land use patterns on PMRF/Main Base nor adjacent properties.

Enhanced and Future RDT&E Activities—Alternative 1

The Navy proposes to enhance RDT&E activities from current levels as necessary as shown in Table 2.2.2.3-1. Under Alternative 1, PMRF/Main Base would continue current ongoing RDT&E activities under the No-action Alternative and proposes the use of additional chemical simulant, testing UAV Vehicles and Hypersonic Vehicles, construction of a Range Operations Control Building, and improvement of fiber optics infrastructure. These activities do not involve land acquisition, new construction, or conflict with adjacent land-use.

Under Alternative 1 the number of Anti-Air Warfare RDT&E activities would increase by approximately 14 percent, EC/EW operations would increase by approximately 11 percent, High-Frequency Radio Signals would increase by approximately 11 percent, and Joint Task Force Wide Area Relay Network activities would increase by 50 percent. These increases do not involve land acquisition, new construction, or conflict with adjacent land-use.

Under Alternative 1 additional simulant would be used in target vehicles launched from PMRF. This addition is considered as an upgrade process, and the Navy would not require additional land or new construction to perform this RDT&E activity. Additionally, there is no conflict with adjacent land use. UAVs, remotely piloted or self-pilot aircraft, would be tested at PMRF/Main Base and storage and ground-support would be provided at PMRF/Main Base. No new facilities are planned for this RDT&E activity, and it would not conflict with adjacent land use. Proposed Hypersonic Vehicles would be attached under aircraft at PMRF/Main Base. In support of training, no new facilities would be needed.

Construction (consolidation) of the proposed new 90,000 ft^2 Range Operations Control Building also includes demolition and conversions of current buildings to consolidate activities currently being performed on PMRF/Main Base. The construction would occur in an area previously disturbed, does not involve land acquisition, and would not affect adjacent properties off-base.

The installation of approximately 23 mi of fiber optic cable would be hung on existing KIUC poles between PMRF/Main Base and Kokee. This upgrade would not affect the on-base land use or adjacent property. Overall, under Alternative 1, RDT&E activities would not alter on-base or off-base land use patterns on PMRF/Main Base.

Major Exercises—Alternative 1

The Navy proposes to continue RIMPAC and USWEX Exercises described in the No-action Alternative. Under Alternative 1, RIMPAC would include two Strike Groups and FCLPs would occur in association with transiting Strike Groups participating in Major Exercises. Appendix D shows the matrix of training events generally used during a USWEX by location. The training associated with the Major Exercises would be chosen from the list of training events in Appendix D. The increases in land (onshore) training events under Alternative 1 (see Table 2.2.2.6-1) are within the installation's boundary. Public accessibility to the Majors Bay beach area would not be allowed during training and all missile ground hazard areas used during launching activities, which affect off-base land use, would restrict access to the land, before, during and after launches. These increases do not involve land acquisition, new construction, or expansion of military presence on Kauai. Land use would continue to be compatible with the land use on the installation, and, compatible with adjacent land uses. Overall, under Alternative 1, Major Exercise activities associated with RIMPAC and USWEX would not alter on-base or off-base land use patterns on PMRF/Main Base.

4.3.2.1.8.3 Alternative 2 (Land Use—PMRF/Main Base)

Alternative 2 includes all the events of Alternative 1 plus an increase in training and RDT&E activities, as well as new RDT&E activities, and additional Major Exercises. Tables 2.2.2.3-1 and 2.2.2.5-1 show the number of training and RDT&E activities proposed for Alternative 2, compared to the baseline and the number of activities proposed for Alternative 1. A description of training events found in Appendix D, with current weapon systems discussed in Appendix E.

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the Navy also proposes to increase the tempo and frequency of training (above Alternative 1 levels) and compress the tempo of training events in the HRC (Table 2.2.2.3-1). Events usually lasting 5 days would be completed in 3 days. Under Alternative 2, training for Expeditionary Assault would increase by 9 percent, Swimmer Insertion/Extraction would increase by approximately 10 percent, C2 would increase by 100 percent, and Aircraft Support would increase by 100 percent. Under Alternative 2, 16 FCLPs would be an increase of approximately 33 percent (from 12 to 16 training events) from the proposed FCLPs under Alternative 1. FCLPs are not conducted under the No-action Alternative.

The Navy would not need to acquire additional land or require any new construction to support these increases. These training events are currently provided by PMRF/Main Base, and the training events are compatible with on-base land and adjacent land use.

Sixteen FCLPs are proposed to be conducted at the airfield at PMRF/Main Base. The aircraft would operate within PMRF airspace and Warning Areas. The airfield currently provides support for Air Operations and Aircraft Support Operations during HRC training and Major Exercises, and there are no conflicts with on-base use or adjacent land use. The increase in training does not involve land acquisition, new construction, or expansion of military presence in Kauai. Overall, under Alternative 2, increase in training would not alter on-base or off-base land use patterns on PMRF/Main Base.

Enhanced and Future RDT&E Activities—Alternative 2

The Navy proposes to enhance RDT&E activities from Alternative 1 levels as shown in Table 2.2.2.5-1. PMRF would develop the capability to support the Directed Energy and Advanced Hypersonic Weapon programs.

Under Alternative 2, Anti-Air Warfare RDT&E would increase by approximately 26 percent, EC/EW operations would increase by 23 percent, High-Frequency Radio Signals would increase by 22 percent, Missile Defense would increase by approximately 9 percent, and Joint Task Force Wide Area Relay Network would increase by 100 percent. These increases would not involve land acquisition, new construction, or conflict with on-base or adjacent land-use off-base.

Additional chemical simulant, testing UAVs and Hypersonic Vehicles, construction of a Range Operations Control Building, and improvement of fiber optics infrastructure are proposed for Alternative 2. The details of these proposed RDT&E activities are discussed under Alternative 1. The upgrades associated with these RDT&E activities would not involve land acquisition, and are not in conflict with adjacent properties.

For future RDT&E, under Alternative 2, PMRF proposes to develop the capability to support Directed Energy and Advanced Hypersonic Weapons. In support of the Directed Energy Test Center a permanent 25,000 ft^2 operations building would be constructed on PMRF and up to 100 personnel would support this program. The construction of the Center would require separate/additional environmental documentation. The one Advanced Hypersonic Weapon would be launched from KTF on PMRF/Main Base. The increases in RDT&E activities do not involve land acquisition and are not in conflict with adjacent properties. Construction and operation of the Center and the Advanced Hypersonic Weapon would be compatible with current on-base land use. Overall, under Alternative 2, land use at PMRF/Main Base would not be impacted due to future RDT&E activities. Overall, under Alternative 2, increases in RDT&E activities would not alter on-base or off-base land use patterns on PMRF/Main Base.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be allowed to conduct training simultaneously in the HRC (Figure 1.2-3). Appendix D lists the proposed Multiple Strike Group Matrix training events. The Strike Groups would not be homeported in Hawaii, but would be in Hawaii for up to 10 days per Major Exercise. Multiple Carrier Strike Group activities receiving support from PMRF/Main Base include C2, Air Operations, HAO/NEO, SPECWAROPS, and Expeditionary Assault. PMRF/Main Base is a support facility and could provide support for training, as described in Section 4.3.2.1.8.1. The Navy would not acquire additional land on-base or off-base to continue to support the Strike Groups. Additionally, the potential for requiring FCLPs increases. These FCLPs would be conducted at the airfield on PMRF/Main Base, which could bring transient personnel to the airfield, but would not involve land acquisition on-base or off-base to conduct the FCLP training. Overall, under Alternative 2, additional Major Exercise activities would not alter on-base or off-base land use patterns on PMRF/Main Base.

4.3.2.1.8.4 Alternative 3 (Land Use—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on land use under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.9 Noise—PMRF/Main Base

Noise impacts on human receptors are evaluated based on whether a noise event will exceed DoD or OSHA guidelines. Sensitive receptors at PMRF/Main Base consist of on-base housing, which is located approximately 5 mi south of the northern KTF and PMRF launch areas and 1 mi from the southern launch site. The nearest off-base residential area is Kekaha, which is approximately 8 mi south of the northern launch areas and 3 mi from the southern launch site. Noise effects on wildlife are discussed in Section 4.3.2.1.3, Biological Resources.

4.3.2.1.9.1 No-action Alternative (Noise—PMRF/Main Base)

HRC Training and Support—No-action Alternative

Under the No-action Alternative, existing training at PMRF/Main Base will continue and there will be no increase to existing noise levels. Existing training events include airfield and range activities, missile, rocket and drone launches, and ambient noise. Airfield activities include take-offs and landings of high performance and cargo/passenger aircraft and helicopter activities. Range activities include training support. Ambient noise stems from natural sources such as wind, surf, and wildlife. PMRF maintains a hearing protection program that includes monitoring the hearing of personnel exposed to high noise levels and identifying and posting notification of noise hazard areas. Personnel who work in noise-hazard areas are required to use appropriate hearing protection to bring noise levels within established safety levels.

Under the No-action Alternative, existing HRC training at PMRF will continue to occur. Training events at PMRF/Main Base that can affect the noise environment include GUNEX, Swimmer Insertion/Extraction, Expeditionary Assault, and Missile Exercises. There will be no increase in existing noise levels during the continuing training events listed above. The noise levels will be a combination of ambient noise and noise by training under during the No-action Alternative. Ambient noise sources may include wind, surf, highway traffic, Air Operations, and other local noise-generating land uses.

Mine laying occurs as either an airborne or underwater activity. Underwater mine laying produces no airborne noise. Mine laying training comprises two major types of activities: MINEXs and Mine Readiness Certification Inspections. MINEXs generally involve a single aircraft sortie (FA-18 or P-3), whereas Mine Readiness Certification Inspections are aircrew pre-deployment evaluations of entire units (i.e., supply, personnel, loading, aircrew weapon delivery, and recovery). Both training events are conducted in the PMRF range. In the single aircraft MINEX, the aircraft may make multiple passes in the same flight pattern, dropping one or more shapes each time. MINEX activities typically last approximately 1 hour.

The Mine Readiness Certification Inspections are similar to the MINEX except that multiple aircraft are used. Several aircraft usually take off from an aircraft carrier (or a shore station in the case of a P-3 wing), obtain clearance from Range Control, and verify visually that the range is clear of small boats. After flying over the Initial Point, they drop their shape in a predetermined pattern and return to the carrier (or shore base). Typical range time for this mission is approximately 1 hour. As with the MINEX activities, localized noise areas surrounding the activities site are expected. Due to the flight paths of the aircraft over water, the inert character of the mine shapes, and the remoteness of the sites with respect to sensitive receptors, potential noise impacts are minimal.

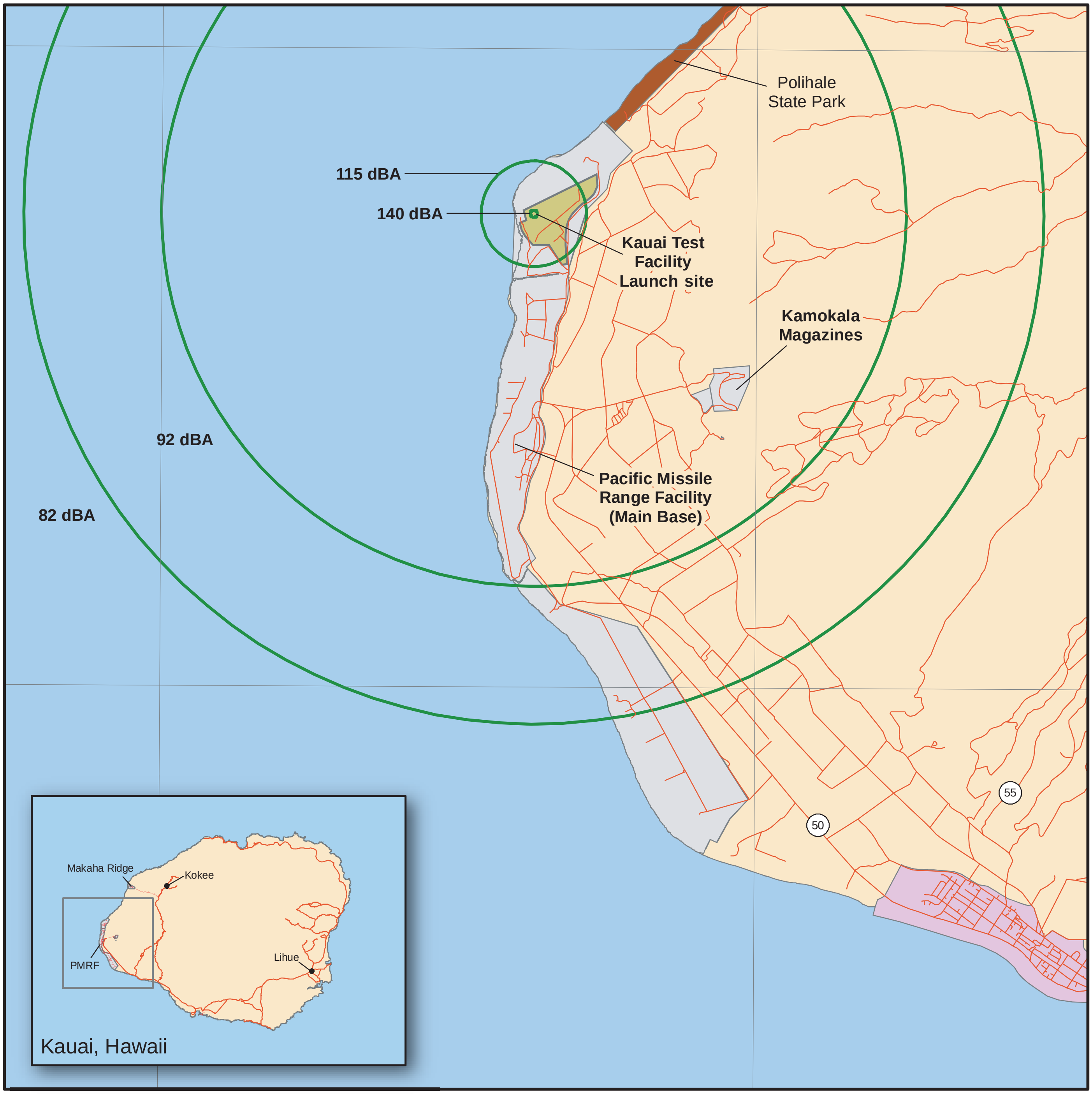
During GUNEX, small arms fire (using blank ammunition during the beach assault) will produce minor, short-term increases in ambient noise levels, and cannot be avoided. The landing beach at Major's Bay varies from 1,000 to 3,000 ft in distance from military housing, but previous GUNEX activities with small arms have occurred at least 3,000 ft from housing. Another type of GUNEX, part of the RIMPAC Exercises, involves a beach landing and overland transport of up to six 155 howitzers to the northern area of Barking Sands, and will produce short-term noise impacts associated with the simultaneous firing of the six. Exposure to impulsive or impact noise will not exceed 140 unweighted peak decibels (dBP) at any time. The radius of exposure to 140 dBP (threshold for permanent damage to unprotected human ears) during the simultaneous firing of all six was calculated at 4,331 ft from the center of the gun emplacement. The emplacement is several miles from base housing.

During Swimmer Insertion/Extraction and Expeditionary Assault training events, the noise sources can include helicopters, fixed-wing aircraft and airship activities, and activities of diesel engines of landing craft and tracked vehicles. Airfield operations are analyzed in the current Air Installation Compatible Use Zone (AICUZ) study, *Final Noise and Accident Potential Zone Study for the Pacific Missile Range Facility Barking Sands* (U.S. Department of the Navy, Engineering Field Activity Chesapeake, 2006). The majority of high noise levels associated with Air Operations are contained within the PMRF/Main Base boundary. Some Day-Night Average Sound Level (L_{dn}) contours of 65 dB do extend to the adjacent sugar cane fields, which are considered a compatible land use in accordance with Navy AICUZ recommendations. PMRF/Main Base Air Operations do not affect off-base residential areas or other sensitive receptors (Figure 3.3.2.1.9-1). On-base facilities have appropriate noise abatement to limit impacts from airfield operations.

In addition, Swimmer Insertion and Extraction activities that occur beneath the water have no airborne noise sources. Other insertion techniques involve helicopter insertion. The expected noise level for this activity is 90 dBA at 50 ft. These activities take place near the coast on military training areas away from population centers.

Missile Exercises at PMRF/Main Base
Noises produced during pre-launch activities include noise from mechanical equipment (see Table 3.3.2.1.9-1 for typical noise levels), as well as an increase in traffic noise levels due to the increase in support personnel. This increase is considered temporary, and does not permanently impact the surrounding area.

Noise produced during launches stems from the interaction of the exhaust jet with the atmosphere and the combustion of the fuel. The sound pressure from a missile is related to the engine's thrust level and other design features. Figures 4.3.2.1.9.1-1 through 4.3.2.1.9.1-3 show typical noise levels from launches at PMRF and KTF launch facilities. Limits have been set by DoD and OSHA to prevent damage to human hearing. Except at the launch pad/rail launcher, noise levels above 140 dBA will not be exceeded at any time. A time-weighted limit for 15 minutes (or less) exposure is 115 dBA. In onbase areas where these noise levels will be exceeded, personnel are required to wear hearing protection. None of the noise levels outside the ground hazard areas, where non-essential personnel and the public are excluded, will exceed either DoD or OSHA safety requirements.



EXPLANATION

- 50 State Highway
- Road
- Calculated Noise Level
- Polihale State Park
- Installation Area
- City of Kekaha
- Kauai Test Facility
- Land

Note: Noise levels calculated from modeling data and not based on the terrain or climate of the facility or surrounding area.

dBA = A-weighted decibels

NORTH

0 0.5 1 2 Miles

Typical Launch Noise Levels (dBA) for Kauai Test Facility Launch Area

Kauai, Hawaii

Figure 4.3.2.1.9.1-1

EXPLANATION

- 50 State Highway
- Road
- Calculated Noise Level
- Polihale State Park
- Installation Area
- City of Kekaha
- Kauai Test Facility
- Land

Note: Noise levels calculated from modeling data and not based on the terrain or climate of the facility or surrounding area.
dBA= A - weighted decibels

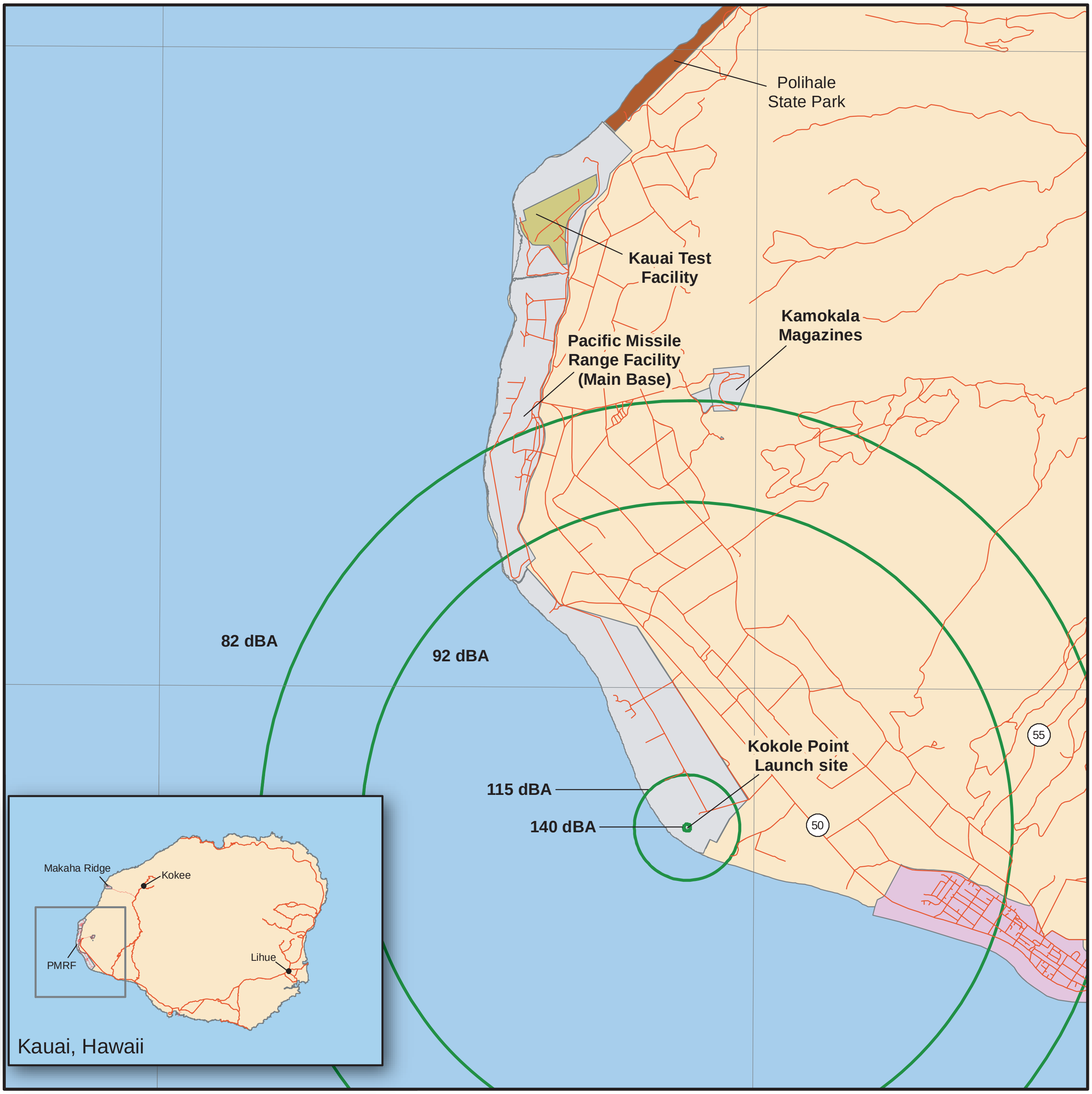
NORTH

0 0.5 1 2 Miles

Typical Launch Noise Levels (dBA) for Pacific Missile Range Facility Launch Area

Kauai, Hawaii

Figure 4.3.2.1.9.1-2



EXPLANATION

50 State Highway

Road

Calculated Noise Level

Polihale State Park

Installation Area

City of Kekaha

Kauai Test Facility

Land

Note: Noise levels calculated from modeling data and not based on the terrain or climate of the facility or surrounding area.
dBA= A - weighted decibels

NORTH

0 0.5 1 2 Miles

Typical Launch Noise Levels (dBA) for Kokole Point Launch Area

Kauai, Hawaii

Figure 4.3.2.1.9.1-3

In addition to the noise of the rocket engine, sonic booms are possible. Sonic booms from PMRF/Main Base launches do not occur over land. Offshore vessels impacted by sonic booms will be expected to experience sound resembling mild thunder. Sonic booms generated during launch activities will occur over the Pacific Ocean, and will not affect the public on Kauai or Niihau because the proposed missile trajectory will not include overflight of populated areas.

Noise levels from a flight termination or explosion of the missile system will be greater than that of a normal launch; however, the potential for such a mishap is low, as detailed in Section 4.3.2.1.7. All public, civilian, and nonessential personnel are required to be outside of ground hazard areas (see Figure 3.3.2.1.7-1) where expected noise levels will be below the 115 dBA limit for short-term exposure. Noise generated during the removal of all mobile equipment and assets during post-launch activities have minimal impacts on the noise environment on or off of PMRF/Main Base.

To limit noise impacts on nonessential personnel and the public, beach access to the areas of each of the Missile Exercises is restricted for the duration of the training. PMRF implements safety procedures for personnel in the PMRF-controlled areas, which can include evacuation of non-essential personnel for the duration of the training. PMRF also coordinates appropriate safety measures with adjacent private land users. The noise exposure areas of concern are not anticipated to impact people because of these safety measures.

HRC RDT&E Activities—No-action Alternative

Ongoing RDT&E activities that can affect noise levels at PMRF/Main Base include missile defense ballistic missile target flights and THAAD interceptor launch activities. HRC RDT&E activities includes conducting missile launches from PMRF and KTF launch sites. Potential impacts will be as described for HRC training. The rate of launches will not increase at PMRF/Main Base due to the No-action Alternative.

Additional sources of noise at PMRF/Main Base include heavy machinery and generators. Each of these noise sources can generate localized high noise levels. The heavy equipment, such as heavy trucks and construction equipment, is a mobile source of noise and typically causes short-term elevated noise levels. Generators are generally stationary. The emergency generators on PMRF/Main Base typically run only 3 to 4 hours per month to maintain readiness. Table 3.3.2.1.9-1 list noise levels associated with these noise sources. Noise associated with these RDT&E activities does not affect off-base areas. On-base personnel are required to wear hearing protection in noise hazard areas.

Major Exercises—No-action Alternative

Major Exercises include ongoing training, and in some cases RDT&E activities. In addition to routine training at PMRF/Main Base, C2, Aircraft Support Operations, HAO/NEO, missile launches, SPECWAROPS, and underwater demolition are conducted during Major Exercises.

C2 is achieved through a network of communication devices strategically located at selected DoD installations around the islands with no impacts on the noise environment. Potential impacts on the noise environment from Aircraft Support Operations, HAO/NEO, Missile Launches, and SPECWAROPS will be similar to those described for the training and RDT&E activities.

Underwater demolition will generate noise from the detonation of relatively small charges (less than 20 lb) of explosive. Clearance zones will also be used to limit noise levels. To limit noise impacts, beach access to the areas of the training will be restricted for the duration of the training. PMRF implements safety procedures for personnel in the PMRF-controlled areas, which can include evacuation of non-essential personnel for the duration of the training. PMRF also coordinates appropriate safety measures with adjacent private land users to limit noise impacts.

4.3.2.1.9.2 Alternative 1 (Noise—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

While training events and Major Exercises would increase in number, noise levels would be similar to existing noise levels. The types of training events that would occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.9.1 and would not occur simultaneously.

Field Carrier Landing Practice
The Navy proposes to conduct an FCLP for half an air wing's pilots once a year in Hawaii. An FCLP is a series of touch-and-go landings that would be conducted during day or night periods, each consisting of six to eight touch-and-go landings per pilot. PMRF/Main Base is one of the sites proposed for this activity in Hawaii.

The *2006 Noise and Accident Potential Zone Study for PMRF Barking Sands* (U.S. Department of the Navy, Engineering Field Activity Chesapeake, 2006) considered the possibility of 25,486 flight activities in 2009, of which the proposed use of F/A-18 aircraft for FCLPs accounted for 34 percent of those activities. This proposed level of activity in the Noise and Accident Potential Study is an increase of approximately 90 percent over current flight activities at PMRF/Main Base. Figure 4.3.2.1.9.2-1 depicts the modeled noise levels for the 2009 condition. The figure shows that the 65 to 75 dB noise contours would extend off the PMRF/Main Base boundary to the north, south, and east. It is anticipated that 727 acres of land off-base would be affected by the noise levels. Based on U.S. Census Bureau data, the off-base land in the 65 to 75 dB contour contains no housing units or population. The 65 dB contours cuts through at least one Military Family Housing unit on PMRF/Main Base as well as beach cottages used by transient personnel. There would be 168 acres of land off-base within the 75 dB contour. As shown in Figure 4.3.2.1.9.2-1, most noise contours are over water. (U.S. Department of the Navy, Engineering Field Activity Chesapeake, 2006)

While the proposed FCLPs in the study would account for only 34 percent of the 2009 modeled activities, the Noise and Accident Potential Zone Study determined that the FCLPs would account for the majority of the modeled noise levels. No noise-sensitive land uses would be affected by noise levels. (U.S. Department of the Navy, Engineering Field Activity Chesapeake, 2006)

Under Alternative 1, 12 FCLP periods are proposed. It is anticipated that the noise levels for the proposed activities would not exceed the levels described in the *2006 Noise and Accident Potential Zone Study for PMRF Barking Sands* (U.S. Department of the Navy, 2006a). Twelve FCLP periods would account for approximately 1 percent of the modeled flight activities.

EXPLANATION

Note: dB = Decibels

Noise contours shown are Day-Night Average Sound Levels

Pacific Missile Range Facility Noise Contours for 2009 Prospective Flight Operations

Kauai, Hawaii

Figure 4.3.2.1.9.2-1

Enhanced and Future RDT&E Activities—Alternative 1

Increased and future RDT&E activities would include Interceptor targets launched from Wake Island, Kwajalein Atoll, or Vandenberg AFB into the TOA, High Speed UAV and Surface Vehicle testing, and Advanced Hypersonic Weapon testing.

Interceptors would be launched from existing launch facilities at PMRF and KTF, and the intercept areas would be in the Open Ocean Area and TOA of the HRC. It is anticipated that the proposed launch vehicles would produce similar noise levels to previously analyzed launch vehicles at PMRF. Figures 4.3.2.1.9.1-1 through 4.3.2.1.9.1-3 show noise levels produced during launches the PMRF and KTF launch facilities. Launch events would be audible for only short periods of time.

All public, civilian, and nonessential personnel would be required to be outside the ground hazard area where the expected noise levels would be below the 115 dBA limit for short-term exposure. The launches would be infrequent and of short duration and similar to previous launches.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at PMRF/Main Base would include a newly constructed Range Operations Control Building, enhanced range safety for high-energy lasers, and improvement of fiber optics infrastructure.

Construction noise levels associated with Alternative 1 activities would result in intermittent, short-term noise effects that would be temporary, lasting for the duration of the noise generating construction activities. Noise-generating construction activities would include excavation and grading, utility construction and paving, and frame building.

The specific types of equipment that would be used during construction of the Range Operations Control Building and improvement of fiber optics infrastructure are not known at this time. Excavation and grading would normally involve the use of bulldozers, scrapers, backhoes, and trucks. The construction of buildings would likely involve the use of pile drivers, concrete mixers, pumps, saws, hammers, cranes, and forklifts. Typical sound levels from construction equipment are listed in Table 3.3.2.1.9-1.

Due to the exclusion of the public from the immediate vicinity of construction, the public would not be exposed to hazardous noise levels that could cause hearing damage. To minimize noise level impacts, personnel or contractors involved in the proposed construction activities would be required to wear hearing protection in areas where noise levels would exceed limits set by OSHA.

The use of the Range Operations Control Building would not result in an increase in noise levels. The proposed facility would replace existing buildings on PMRF/Main Base used for similar activities.

Major Exercises—Alternative 1

Major Exercises such as RIMPAC and USWEX include ongoing training events and, in some cases, RDT&E activities. PMRF maintains a hearing protection program that includes monitoring the hearing of personnel exposed to high noise levels and identifying and posting notification of noise hazard areas. Personnel who work in noise-hazard areas would be required to use appropriate hearing protection to bring noise levels within established safety levels. In addition, noise impacts on nonessential personnel and the public would be limited through existing safety procedures. Procedures would include restricting beach access to the areas of each of the training for the duration of the Major Exercise. PMRF would also implement safety procedures for personnel in the PMRF-controlled areas, which can include evacuation of non-essential personnel for the duration of the Major Exercise. PMRF would also coordinate appropriate safety measures with adjacent private land users. The noise exposure areas of concern are not anticipated to impact people because of these safety measures.

4.3.2.1.9.3 Alternative 2 (Noise—PMRF/Main Base)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Activities associated with the increased tempo and frequency of training that could occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.9.1 and would produce similar noise levels.

Under Alternative 2, 16 FCLP periods are proposed. It is anticipated that the noise levels for the proposed activities would not exceed the levels described in the *2006 Noise and Accident Potential Zone Study for PMRF Barking Sands* (U.S. Department of the Navy, 2006a). Sixteen FCLP periods would account for approximately 1 percent of the modeled flight activities.

Future RDT&E Activities—Alternative 2

The proposed high-energy laser would require a 25,000-ft^2 building at PMRF/Main Base. Construction impacts would be similar to those described in Section 4.3.2.1.9.2; however, separate environmental documentation would be required to analyze the specific location and operational requirements.

The testing of the Advanced Hypersonic Weapon would include two launches of a Strategic Target System booster from KTF, and two launches of the new booster configuration from the same site. The Strategic Target System booster has been previously launched at KTF, and noise levels would be the same as previous launches. Testing the Advanced Hypersonic Weapon with the new booster configuration would produce similar noise levels to launches at KTF (see Figure 4.3.2.1.9.1-1).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the HRC area for up to 10 days per Major Exercise. Training events and potential impacts on noise levels associated with this training that could occur at PMRF/Main Base would be similar to those described in Section 4.3.2.1.9.1 and would produce similar noise levels.

4.3.2.1.9.4 Alternative 3 (Noise—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on noise under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.10 Socioeconomics—PMRF/Main Base

Socioeconomic characteristics are evaluated by analyzing action alternatives presented in Chapter 2.0 of this EIS/OEIS. If any activity associated with an alternative indicates a potential environmental consequence, it is discussed in the appropriate section below.

4.3.2.1.10.1 No-action Alternative (Socioeconomics—PMRF/Main Base)

Under the No-action Alternative, HRC training, RDT&E activities, and Major Exercises associated with PMRF/Main Base were reviewed. The No-action Alternative stands as no change from current levels of training usage, and the Navy will continue its current activities at the HRC. PMRF/Main Base is a major contributor to the economy of Kauai County, particularly on the western side of the island. PMRF/Main Base employs nearly 1,000 military, civilian, and contract personnel and has a $130M impact annually on the local economy. In fiscal year (FY) 2005 expenditures for PMRF and other defense initiates on Kauai totaled about $113M. Additionally, in FY 2005-06, $5.5 million was provided to improve infrastructure for Hawaii's public schools with high enrollments of military children.

Current HRC training associated with PMRF/Main Base are Expeditionary Assault, Swimmer Insertion/Extraction, SPECWAROPS, C2, Aircraft Support Operations, Air Operations, and HAO/NEO. Training events are listed in Table 2.2.3.1-1, and a full description is found in Appendix D. A description of current weapon systems is found in Appendix E. HRC RDT&E activities at PMRF/Main Base include Anti-Air Warfare RDT&E, EC/EW, High-Frequency Radio Signals, Missile Defense and the Joint Task Force Wide Area Relay Network. Table 2.2.2.5-1 lists the baseline number for the occurrence of each RDT&E activity. Types of Major Exercises that occur within the HRC are the RIMPAC and USWEX. Major Exercises associated with PMRF/Main Base are C2, Air Operations, HAO/NEO, SPECWAROPS, and Expeditionary Assault. These training events and RDT&E activities are listed on Table 2.2.2.6-1, and Figure 2.2.2.6-1 shows the areas used. The support provided to HRC training, RDT&E activities, and Major Exercises from PMRF/Main Base will continue. The level of employment and defense initiatives on Kauai will continue to benefit the local economy of Kauai.

4.3.2.1.10.2 Alternative 1 (Socioeconomics—PMRF/Main Base)

Under Alternative 1, PMRF would continue training and RDT&E activities described under the No-action Alternative; the number of training events and RDT&E activities performed per year would increase. Additionally, Alternative 1 includes FCLPs.

Increased Tempo and Frequency of Training and New Training—Alternative 1

Under Alternative 1, the Navy proposes to increase the tempo and frequency of training events in the HRC (see Table 2.2.2.3-1). Under Alternative 1, PMRF/Main Base would continue current HRC training and proposes the addition of FCLPs. Under Alternative 1, there is no increase in the current HRC training. The socioeconomic impact on the economy of Kauai from these training events would be the same as discussed under the No-action Alternative.

The airfield located on PMRF/Main Base is a proposed site for the FCLP. The proposed FCLPs would affect a small number of pilots each year in Hawaii. Under Alternative 1 there are 12 proposed FCLPs per year. Normally, four FCLP periods would be required per pilot (two day and two night practice landings). The pilots would be carrier based and would not bring transient or permanent personnel to PMRF/Main Base.

Enhanced and Future RDT&E Activities—Alternative 1

The Navy proposes to enhance RDT&E activities from current levels as necessary as shown on Table 2.2.2.5-1. Under Alternative 1, PMRF/Main Base would continue ongoing RDT&E activities listed for the No-action Alternative and proposes additional chemical simulant, testing UAV and Hypersonic Vehicles, construction of a Range Operations Control Building, and improvement of fiber optics infrastructure. Under Alternative 1 the number of Anti-Air Warfare RDT&E would increase by approximately 14 percent, EC/EW activities would increase by approximately 11 percent, High-Frequency Radio Signals test and evaluation would increase by approximately 11 percent, and Joint Task Force Wide Area Relay Network activities would increase by 50 percent. The Navy does not require new construction or an increase in personnel to support the increase in these RDT&E activities.

The additional chemical simulant would be used in target vehicles launched from PMRF. UAVs, which are remotely piloted or self-pilot aircraft, would be tested at PMRF/Main Base and storage and ground-support would be provided at PMRF/Main Base. Hypersonic Vehicles would be attached under aircraft at PMRF/Main Base. In support of these RDT&E activities, the Navy would not require new construction or an increase in personnel.

The proposed location for a new Range Operations Control Building is on PMRF/Main Base. The facility would be approximately 90,000 ft^2, and constructing the new facility includes demolishing and conversions of current buildings. The facility would consolidate activities currently being performed on PMRF/Main Base. Range users, who require support in terms of space equipment and technical services, would vary from small teams working for 3 to 6 months to as many as 300 individuals visiting for 1 to 2 days to witness and participate in a specific mission. The construction (consolidation) of a Range Operations Control Building would bring transient personnel to PMRF Main Base. The construction (consolidation) of the new Range Operations Control Building could positively affect the local economy on Kauai through the employment of some sectors of the local construction community. The potential of as many as 300 individuals visiting for 1 to 2 days to witness and participate in a specific mission at the Range Operations Control building could also positively affect the local economy of Kauai through tourism-related-services and the use of lodging facilities. Additionally, the total number of civilian and contractor personnel assigned to the range operations is anticipated to grow by 34 percent (from 120 to 161). This increase in personnel (41 additional military personnel) would have a positive impact on the local real estate market (renter-occupied homes or single-family homes).

The proposed upgrade of approximately 23 mi of fiber optic cable would be hung on existing KIUC poles between PMRF/Main Base and Kokee. This improvement would not bring transient or permanent personnel to PMRF/Main Base. However, the installation of the fiber optic cable could have a positive effect on the local economy on Kauai through the employment of some sectors of the local construction community.

Major Exercises—Alternative 1

The Navy proposes to continue RIMPAC and USWEX Exercises as described in the No-action Alternative. Appendix D shows the matrix of training events generally used during a USWEX by location. The training associated with Major Exercises would be chosen from the list of training events in Appendix D. USWEX and RIMPAC training under Alternative 1 would not bring permanent personnel to PMRF/ Main Base, or, require new construction to complete the training.

The FCLPs would be conducted during a Major Exercise and a small number of pilots would train at the airfield located on PMRF/Main Base. The pilots would be carrier based, and the training events would not bring transient or permanent personnel to PMRF/Main Base.

4.3.2.1.10.3 Alternative 2 (Socioeconomics—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the Navy proposes to increase the tempo and frequency of training events (above Alternative 1 levels) and compress the tempo of training events in the HRC. The Expeditionary Assault would increase by 9 percent, Swimmer Insertion/Extraction would increase by approximately 10 percent, C2 would increase by 100 percent, and Aircraft Support would increase by 100 percent. The Navy would not require new construction or additional personnel to support the increases in these training events.

Sixteen FCLPs are proposed to be conducted at the airfield at PMRF/Main Base. Sixteen FCLPs would be an increase of approximately 33 percent (from 12 to 16 FCLPs per year) from the proposed number under Alternative 1. The Navy would not require any new construction to support the FCLPs at the airfield. The FCLP pilots would be carrier based and would not bring permanent personnel to PMRF/Main Base.

Future RDT&E Activities—Alternative 2

The Navy proposes to enhance RDT&E activities from Alternative 1 levels as shown in Table 2.2.2.5-1. Under Alternative 2, PMRF/Main Base would continue RDT&E activities and would develop the capability to support the Directed Energy and Advanced Hypersonic Weapon program.

Under Alternative 2, Anti-Air Warfare RDT&E would increase by approximately 26 percent, EC/EW operations would increase by 23 percent, High-Frequency Radio Signals would increase by 22 percent, Missile Defense activities would increase by approximately 9 percent, and Joint Task Force Wide Area Relay Network activities would increase by 100 percent. These increases would not bring permanent or transient personnel to Kauai and no new construction is required.

Additional chemical simulant, testing UAV and Hypersonic Vehicles, construction of a Range Operations Control Building, and improvement of fiber optics infrastructure are proposed for Alternative 2. The details/analysis for these proposed RDT&E activities are discussed under Alternative 1.

In support of the Directed Energy Test Center a permanent 25,000 ft^2 operations building would be constructed on PMRF and up to 100 personnel would support this program. The construction of the building could positively affect the local economy on Kauai through the employment of some sectors of the local construction community. If the 100 personnel required to support the Directed Energy Test Center are permanent additional personnel, this RDT&E activity could have a positive impact on the local real estate market (renter-occupied homes or single-family owned homes). Construction of this test center would require separate/additional environmental documentation. The Advanced Hypersonic Weapon is a U.S. Army Space and Missile Defense Command RDT&E program that would eventually involve launches from the KTF launch site at PMRF/Main Base. Launches would average one per year. This activity would not require new construction or additional personnel.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be allowed to conduct training simultaneously in the HRC (Figure 1.2-3). The Strike Groups would not be homeported in Hawaii, but would be in Hawaii for up to 10 days per Major Exercise. Depending on the Major Exercise being performed, PMRF/Main Base could provide support for training events. There are no piers available to support the docking of Strike Groups at PMRF/Main Base; therefore, sailors or marines are not expected to come ashore.

The potential for requiring FCLPs increases. These FCLPs would be conducted on PMRF/Main Base. The pilots would be carrier based, and the training would not bring transient or permanent personnel to PMRF/Main Base.

4.3.2.1.10.4 Alternative 3 (Socioeconomics—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on socioeconomics under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.11 Transportation—PMRF/Main Base

Transportation impacts are evaluated by analyzing training and RDT&E activities associated with each alternative presented in Chapter 2.0 of this EIS/OEIS. If any proposed activity indicates a potential environmental impact, it has been discussed in the appropriate section below. Transportation for KTF has been evaluated within PMRF/Main Base.

4.3.2.1.11.1 No-action Alternative (Transportation—PMRF/Main Base)

HRC Training—No-action Alternative

The No-action Alternative stands as no change from current levels of training usage, and the Navy will continue activities at the HRC. Under the No-action Alternative, HRC training includes Expeditionary Assault, Swimmer Insertion/Extraction, SPECWAROPS, C2, Aircraft Support Operations, Air Operations, and HAO/NEO. RDT&E activities under the No-action Alternative include Anti-Air Warfare RDT&E, EC/EW, High-Frequency Radio Signals, Missile Defense, and Joint Task Force Wide Area Relay Network. PMRF takes every reasonable precaution during planning and execution of training events. PMRF transports ordnance by truck from Nawiliwili Bay to PMRF along Highway 50 (see Figure 2.1-2). All ordnance is transported in accordance with U.S. DOT regulations. PMRF has established PMRFINST 8023.G, which covers the handling and transportation of ammunition, explosives, and hazardous materials on the facility. In addition, liquid fuels are transported to KTF. These fuels can be shipped to the site by truck. This transport does not affect transportation routes on the island of Kauai and there are no road closures during transport. Transportation of these materials is conducted in accordance with U.S. DOT regulations and specific safety procedures developed for the location. Under the No-action Alternative, no negative impacts have been identified that affect transportation systems on PMRF/Main Base or adjacent properties.

4.3.2.1.11.2 Alternative 1 (Transportation—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Under Alternative 1, the Navy proposes to increase the tempo and frequency of training in the HRC (see Table 2.2.2.3-1). Under Alternative 1, the Navy is also proposing to conduct FCLP. Under Alternative 1 there is no increase in training events. With no increases in these training events, transportation systems on-base and those off-based associated with PMRF/Main Base (Highway 50) would not change from the No-action Alternative, where no negative impacts have been identified that affect transportation systems on PMRF/Main Base or adjacent properties.

The Navy is proposing to conduct 12 FCLPs for a small number of pilots each year at the airfield on PMRF/Main Base. Additional personnel are not required for PMRF/Main Base to support the FCLP training. The pilots would be operating the aircraft within the PMRF airspace and Warning Areas. The airfield currently provides support for Air Operations during HRC training and Major Exercises and is compatible with on-base transportation regulations and specific safety systems. The FCLPs would bring only transient personnel to the airfield.

HRC Enhancements—Alternative 1

The Navy proposes to enhance RDT&E activities from current levels as necessary as shown in Table 2.2.2.5-1. Under Alternative 1, PMRF/Main Base would continue RDT&E activities as listed for the No-action Alternative and proposes additional chemical simulant, test of UAV and Hypersonic Vehicles, Construction of a Range Operations Control Building, and improvement to fiber optics infrastructure.

Under Alternative 1 the number of Anti-Air Warfare RDT&E would increase by approximately 14 percent, EC/EW activities would increase by approximately 11 percent, High-Frequency Radio Signals would increase by approximately 11 percent, and Joint Task Force Wide Area Relay Network would increase by 50 percent. The Navy would not require new construction, or, an increase in personnel to support the increase in these activities.

The additional chemical simulant would be used in target vehicles launched from PMRF. UAVs, which are remotely piloted or self-pilot aircraft, would be tested at PMRF/Main Base and the storage and ground-support would occur at PMRF/Main Base. The proposed Hypersonic Vehicles would be attached under aircraft at PMRF/Main Base. In support of these RDT&E activities, the Navy would not require new construction or an increase in personnel to perform these RDT&E activities.

The amount of traffic on Highway 50 and roadways on-base may be affected by the temporary increase in construction traffic due to the installation of the optic fibers and due to construction traffic for the Range Operations Control Building. The improvements of the fiber optics Infrastructure between PMRF and Kokee would not bring permanent personnel to PMRF/Main Base. During operational periods of the completed new Range Operations Control Building, the potential for range users would vary from small teams working for 3 to 6 months to as many as 300 individuals visiting for 1 to 2 days to witness and participate in a specific mission. The amount of traffic on PMRF/Main Base and Highway 50 and potentially other local roadways could be temporarily affected during these RDT&E activities. As part of the construction of the new Range Operations Control Building, roadways on-base would be realigned to provide access to the new Range Operations Control Building. The number of permanent personnel needed for the operation of the proposed Range Operations Control building is anticipated to increase by 34 percent (from 120 to 161) or 41 additional personnel. This could increase the daily number of vehicles traveling to and from PMRF/Main Base by 41. The installation employs nearly 1,000 military, civilian, and contract personnel, and 41 additional personnel entering the main gate (Highway 50) of PMRF/Main Base would increase by 4.1 percent. Overall, the effect on roadways due to construction would be temporary. The effect on roadways from operation of the Range Operations Control Building would increase the daily amount of traffic traveling to PMRF/Main Base.

Major Exercises—Alternative 1

The Navy proposes to continue RIMPAC and USWEX Exercises as described in the No-action Alternative. Alternative 1 would include up to six USWEXs per year; RIMPAC would include two Strike Groups; and FCLPs would occur in association with transiting Strike Groups participating in Major Exercises. Appendix D shows the matrix of training events generally used during a USWEX by location. The training associated with the Major Exercises would be chosen from the list of training events in Appendix D. The increase in USWEX activities would not bring permanent personnel to PMRF/Main Base or require new construction.

FCLPs would be conducted during a Major Exercise, and a small number of pilots would train at the airfield located on PMRF/Main Base. Nominally, four FCLP periods would be required per pilot (two day and two night training sessions). The pilots would be carrier based and would not bring permanent personnel to PMRF/Main Base.

4.3.2.1.11.3 Alternative 2 (Transportation—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the Navy proposes to increase the tempo and frequency of training (above Alternative 1 levels) in the HRC. The Expeditionary Assault would increase by 9 percent, Swimmer Insertion/Extraction would increase by approximately 10 percent, C2 would increase by 100 percent, and Aircraft Support Operations would increase by 100 percent. The Navy would not require new construction or additional personnel to support the increase in these training events. The transportation systems on-base or off-base (Highway 50) associated with PMRF/Main Base would remain at the status as addressed under the No-action Alternative.

Sixteen FCLPs are proposed to be conducted at the airfield at PMRF/Main Base. Under Alternative 2, 16 FCLPs would be an increase of approximately 33 percent (from 12 to 16 FCLP) from Alternative 1. FCLPs are not conducted under the No-action Alterative. The airfield currently provides support for Air Operations and Aircraft Support Operations during HRC training and Major Exercises. The Navy would not require any construction to support the FCLP. The FCLPs would bring transient personnel to the airfield, but they would only be on PMRF/Main Base for a short amount of time.

Future RDT&E Activities—Alternative 2

The Navy proposes to enhance RDT&E activities from Alternative 1 levels as shown on Table 2.2.2.5-1. PMRF would also develop the capability to support the Directed Energy and Advanced Hypersonic Weapon programs.

Under Alternative 2, Anti-Air Warfare RDT&E would increase by approximately 26 percent, EC/EW activities would increase by 23 percent, High-Frequency Radio Signals would increase by 22 percent, Missile Defense activities would increase by approximately 9 percent, and Joint Task Force Wide Area Relay Network activities would increase by 100 percent. These increases would not bring permanent or transient personnel to Kauai.

The Navy would not require new construction or an increase in personnel for the additional chemical simulant, testing the UAVs, and Hypersonic Vehicles. The effects on roadway traffic for the construction of the new Range Operations Control Building and the installation of the fiber optics are discussed under Alternative 1.

In support of the proposed Directed Energy Test Center, a permanent 25,000 ft^2 operations building would be constructed on PMRF and up to 100 personnel would support this program. The amount of traffic on Highway 50 and roadways on-base may be affected by the temporary increase in construction traffic during the construction of the test center. If the 100 personnel needed to support the Directed Energy Test Center are permanent, this RDT&E activity would increase the amount of traffic on-base and off-base (Highway 50) of PMRF/Main Base. A Basic Facility Requirements report has not been completed for this proposed center. Construction of this test center would require separate/additional environmental documentation.

The Advanced Hypersonic Weapon is a U.S. Army Space and Missile Defense Command RDT&E program that would eventually involve launches from the KTF Strategic Target System at PMRF/Main Base. Launches would average one per year. This RDT&E activity would not require new construction or additional personnel. This proposed RDT&E activities would not affect roadway traffic on PMRF/Main Base or off-base (Highway 50).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be allowed to conduct training simultaneously in the HRC (Figure 1.2-3). The Strike Groups would not be homeported in Hawaii, but would be in Hawaii for up to 10 days per Major Exercise. Depending on the Major Exercise being performed PMRF/Main Base could provided support. There are no piers available at PMRF/Main Base to support the docking of Strike Groups; therefore, sailors or marines are not expected to come ashore on Kauai during Multiple Strike Group Training

The potential for requiring FCLPs increases during additional Major Exercises. These FCLPs would be conducted on PMRF/Main Base and would require a small number of pilots to be trained each year. The pilots would be carrier based and would not bring permanent personnel to PMRF/Main Base.

4.3.2.1.11.4 Alternative 3 (Transportation—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on transportation under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.12 Utilities—PMRF/Main Base

Impacts on utilities were evaluated by analyzing training and RDT&E activities associated with each alternative presented in Chapter 2.0 of this EIS/OEIS. Utilities associated with KTF Utilities have been evaluated within PMRF/Main Base.

4.3.2.1.12.1 No-action Alternative (Utilities—PMRF/Main Base)

The No-action Alternative stands as no change from the current level of training, and the Navy will continue its current activities at the HRC. Under the No-action Alternative, HRC training events are Expeditionary Assault, Swimmer Insertion/Extraction, SPECWAROPS, Aircraft Support Operations, Air Operations, and HAO/NEO. RDT&E activities under the No-action Alternative include Anti-Air Warfare RDT&E, EC/EW, High-Frequency Radio Signals, Missile Defense, and Joint Task Force Wide Area Relay Network. Training events associated with Major Exercises at PMRF/Main Base are C2, Aircraft Operation, HAO/NEO, SPECWAROPS, and Expeditionary Assault.

The No-action Alternative will not require a change to ongoing utilities demands to continue current baseline for HRC training events (Table 2.2.2.3-1), RDT&E activities (Table 2.2.2.5-1), or Major Exercises (Table 2.2.2.6-1) at PMRF/Main Base. Water will continue to be supplied by the Mana Well and the Kauai County Water Department. Electrical power will continue to be purchased from the KIUC, and wastewater and solid waste will continue to be processed by current procedures (see Section 3.3.2.1.12).

4.3.2.1.12.2 Alternative 1 (Utilities—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Under Alternative 1, the Navy proposes to increase the tempo and frequency of training events in the HRC (see Table 2.2.2.3-1). Under Alternative 1, PMRF/Main Base would continue HRC training events listed for the No-action Alternative and the proposed addition of FCLP.

Under Alternative 1 there is no increase in current HRC training events at PMRF/Main Base. The utilities demand would remain the same as discussed under the No-action Alternative.

Under Alternative 1, the Navy is proposing to conduct 12 FCLPs for a small number of pilots each year at the airfield on PMRF/Main Base. This training event would not require new construction or additional personnel. Nominally, four FCLP periods would be required per pilots (two day and two night training session). Under Alternative 1, this increase in training would be short-term and intermittent and would not be expected to have a significant effect on current utilities demand on PMRF/Main Base.

HRC Enhancements—Alternative 1

The Navy proposes to enhance RDT&E activities from current levels as necessary as shown in Table 2.2.2.5-1. Under Alternative 1, PMRF/Main Base would continue RDT&E activities as listed for the No-action Alternative and proposes the use of additional chemical simulant, test of UAVs and Hypersonic Vehicles, construction of a Range Operations Control Building, and improvements to fiber optics infrastructure.

Under Alternative 1 the number of Anti-Air Warfare RDT&E would increase by approximately 14 percent, EC/EW activities would increase by approximately 11 percent, High-Frequency Radio Signals would increase by approximately 11 percent, and Joint Task Force Wide Area Relay Network activities would increase by 50 percent. This increase would not bring permanent or transient personnel to PMRF Main Base, and the Navy would not require new construction for the increase in these RDT&E activities. The increase on utilities demand for these increases would occur during the RDT&E activity periods, which are discrete and intermittent.

The additional chemical simulant would be used in target vehicles launched from PMRF. UAVs, which are remotely piloted or self-pilot aircraft, would be tested at PMRF/Main Base, and the storage and ground-support would also occur at PMRF/Main Base. Proposed Hypersonic Vehicles would be attached under aircraft at PMRF/Main Base. In support of these RDT&E activities, the Navy would not require new construction or an increase in personnel to perform these activities. There is no indication that there would be any additional demands on utility systems to complete these RDT&E activities.

The utility upgrade of installing 23 mi of fiber optic cable from PMRF/Main Base to Kokee does not require construction or an increase in personnel. All equipment and installation activities would be expected to occur along existing public and KIUC access roads. The installation of the fiber optic cable would not affect the utilities demand on PMRF Main Base.

PMRF would construct a new 90,000 ft^2 building to consolidate range operations. Range users, who require support in terms of space equipment, and technical services, would vary from small teams working for 3 to 6 months to as many as 300 individuals visiting for 1 to 2 days to witness and participate in a specific mission. Range operations currently occur in 13 buildings (Figure 2.2.3.6.4-5). The 13 buildings have a combined space of 55,000 ft^2 and would be demolished. The construction of a new building would add approximately 35,000 ft^2 of additional space that would require utilities (electrical, water, wastewater, solid waste disposal). The demand factor for electrical service for the proposed Range Operations Control Building would be 1,727 kW/hour, whereas the current demand for the range operation buildings is 700 to 800 kW/hour. Also as part of the project for the new Range Operations Control Building is a 4,200 ft^2

dehumidified warehouse that would replace Building 106. Building 106 currently measures 4,000 ft^2; therefore, 200 additional square feet would require utilities. The KIUC service to PMRF/Main Base comprises 12.47 kV of electricity (overhead), originating from the KIUC Mana Substation. An emergency generator would not be provided since the power plant is deemed to be reliable power during mission activities. The 12.47-kV power supply would remain sufficient for the additional 35,200 ft^2 associated with the proposed Range Operations Control Building and the dehumidified warehouse. Additionally, there are three 320-kW generators and two 600-kW generators on PMRF/Main Base that could be used for backup power. The current power supply from KIUC is sufficient to support the new Range Operations Control Building and associated building conversions or relocations. Domestic waterlines would be added to accommodate increases in demand and the wastewater treatment system would be constructed and connected to the current system. (Naval Facilities Engineering Command, 2004)

The total number of civilian and contractor personnel assigned to the range operations is anticipated to grow by 34 percent (from 120 to 161). This increase in personnel would have an effect on the utilities demand for water and wastewater treatment. An existing 2-inch waterline is available to provide both potable and fire protection water service for the new Range Operations Control Building. A new 2-inch waterline would be installed to provide domestic water service to the Range Operations Control Building. The current capacity of the water systems on PMRF/Main Base is sufficient for the increase. Sanitary sewer system does not exist in the central portion of PMRF where the new Range Operations Control Building and the new (replacement) dehumidified warehouse would be located. Sanitary sewer service would be provided by a gravity sewer line connection to an existing sewer line that is located north of the proposed project side. A new gravity sewer for the new dehumidified warehouse would be provided. (Naval Facilities Engineering Command, 2004)

The proposed Range Operations Control Building would block the line of sight for the current Q1 radar; therefore, a new site target for the Q-1 radar would be constructed. Also, the Building 105 annex would be converted into an electrical and electronic system laboratory. There is no indication that additional utilities would be required to support the replaced Q1 radar tower site or the conversion for Building 105. (Naval Facilities Engineering Command, 2004)

Major Exercises—Alternative 1

The Navy proposes to continue RIMPAC and USWEX Exercises as described in the No-action Alternative. The training associated with the Major Exercises would be chosen from the list of training events in Appendix D. The RIMPAC and USWEX training under Alternative 1 would not bring permanent personnel to PMRF/Main Base.

FCLPs would be conducted during a Major Exercise, and a small number of pilots would train at the airfield located on PMRF/Main Base. These pilots would be transient, and nominally four FCLP periods would be required per pilot (two day and two night training sessions). Under Alternative 1, this increase in training would be short-term and intermittent and would not be expected to have a significant effect on current utilities demand on PMRF/Main Base.

4.3.2.1.12.3 Alternative 2 (Utilities—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the Navy proposes to increase the tempo and frequency of training events (above Alternative 1 Levels). Table 2.2.2.3-1 lists the number of training events proposed under Alternative 1. Under Alternative 1, PMRF/Main Base would continue HRC training events listed for the No-action Alternative and the proposed addition of FCLPs.

Under Alternative 2 Expeditionary Assault training events would increase by 9 percent, Swimmer Insertion/Extraction would increase by approximately 10 percent, and Aircraft Support Operations would increase by 100 percent. The Navy would not require new construction or additional personnel to support the increase in training.

Sixteen FCLPs are proposed to be conducted at the airfield at PMRF/Main Base. Under Alternative 2, 16 FCLPs would be an increase of approximately 33 percent (from 12 to 16) from Alternative 1. The airfield currently provides support for Air Operations and Aircraft Support Operations during HRC training and Major Exercises. The Navy would not require any construction or additional personnel to support FCLPs at the airfield. In addition, the pilots would be carrier based and would not bring permanent personnel to PMRF/Main Base. Under Alternative 2, this increase would be short-term and intermittent and would not be expected to have a significant effect on current utilities demand on PMRF/Main Base.

Future RDT&E Activities—Alternative 2

The Navy proposes to enhance RDT&E activities from Alternative 1 levels as shown on Table 2.2.2.5-1. PMRF would develop the capability to support the Directed Energy and Advanced Hypersonic Weapon programs.

Under Alternative 2, Anti-Air Warfare RDT&E would increase by approximately 26 percent, EC/EW activities would increase by 23 percent, High-Frequency Radio Signals would increase by 22 percent, Missile Defense would increase by approximately 9 percent, and Joint Task Force Wide Area Relay Network activities would increase by 100 percent. These increases would not bring permanent or transient personnel to PMRF/Main Base.

The Navy would not require new construction, nor any increase in personnel for use of the additional chemical simulant, test of the UAVs, and the Hypersonic Vehicles. The details and analysis for the proposed Range Operations Control building are discussed under Alternative 1. There is no indication that there would be any additional demands on utility systems to complete these RDT&E activities.

In support of the proposed Directed Energy Test Center, a permanent 25,000 ft^2 operations building requiring 30 megawatts of power would be constructed on PMRF/Main Base. Up to 100 personnel would be needed to support this center. A Basic Facility Requirements report has not been completed for this proposed center. Construction of this test center would require separate/additional environmental documentation. The effect of this center on the utilities demand on PMRF/Main Base would be determined during a separate documentation process.

The Advanced Hypersonic Weapon is a U.S. Army Space and Missile Defense Command RDT&E program that would eventually involve launches from the KTF launch site at PMRF/Main

Base. Launches would average one per year. This RDT&E activity would not require new construction or additional personnel. This proposed RDT&E activity is not expected to have a significant effect on current utilities demand on PMRF/Main Base.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be allowed to conduct training simultaneously in the HRC (Figure 1.2-3). The Strike Groups would not be homeported in Hawaii, but would be in Hawaii for up to 10 days per Major Exercise. There are no piers available at PMRF/Main Base to support the docking of Strike Groups; therefore, sailors or marines are not expected to come ashore on Kauai. However, the potential for requiring FCLPs increases. FCLPs would be conducted during a Major Exercise, and a small number of pilots would train at the airfield located on PMRF/Main Base. These pilots would be transient, and nominally four FCLP periods would be required per pilot (two day and two night training sessions). Under Alternative 2, this increase in training would be short-term and intermittent and would not be expected to have a significant effect on current utilities demand on PMRF/Main Base.

4.3.2.1.12.4 Alternative 3 (Utilities—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on utilities under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.1.13 Water Resources—PMRF/Main Base

4.3.2.1.13.1 No-action Alternative (Water Resources—PMRF/Main Base)

Under the No-action Alternative, training and RDT&E activities that can affect water resources include expeditionary assault and ground maneuvers, areas that are used for handling materials in support of training, and HAO/NEO training events.

HRC Training—No-action Alternative

Expeditionary assault and ground maneuvers, areas that are used for handling materials in support of training, and HAO/NEO have minimal direct impact on the beach and inland areas. Surface drainage is not affected because there are no surface water features that exist in the areas that are used for training. In addition, training events are generally restricted to existing roads and/or previously disturbed areas. Therefore, there are no impacts on water resources.

HRC RDT&E Activities—No-action Alternative

Analysis of launch-related impacts is covered in the Strategic Target System EIS (U.S. Army Strategic Defense Command, 1992). The EIS evaluated the potential impacts of launch emissions, spills of toxic materials, and early flight termination. The analysis concluded that hydrogen chloride emissions would not significantly affect the chemical composition of surface or groundwater; that there would be no significant increase in aluminum oxide in surface waters due to launches; that sampling of surface waters in the vicinity of the launch site showed that hydrogen chloride, potentially deposited during past launches, has not affected surface water quality on PMRF or adjacent areas; and that contamination from spills of toxic materials would be highly unlikely.

Subsequent sampling and analysis, prior to and following a 26 February 1993 Strategic Target System target launch, showed little or no evidence that the launch produced any adverse impact on water, soil, or vegetation (U.S. Army Space and Strategic Defense Command, 1993a). Based on the *Calendar Year 2005 Annual Site Environmental Report for Tonopah Test Range and Kauai Test Facility* (Sandia National Laboratories, 2006), there were no reportable releases at the Kauai Test Facility under EPCRA or CERCLA in 2005. In addition, there were no compliance issues with respect to any state or federal water pollution regulations in 2005. As reported in the Annual Site Environmental Report, a National Pollutant Discharge Elimination System (NPDES) permit is not required due to the lack of significant storm water runoff discharging into “Waters of the U.S.,” as defined in 40 CFR 122.

The results of soil sampling conducted in 1999, 2002, and 2007 are presented in the KTF Report (Sandia National Laboratories, 2008). The results show that most reported values are below the EPA residential screening levels. Iron and thallium exceed the residential screening level however; they are below the industrial screening level. Arsenic exceeds the EPA industrial screening level however; the State of Hawaii has identified action levels based on bioavailable arsenic. As presented in the Hawaii Department of Health Technical Report (Hawaii Department of Health, 2006) background concentrations of arsenic in soil in Hawaii may range up to 20 milligrams per kilogram (mg/kg) or higher (up to 50 mg/kg in some cases). In addition, much of the arsenic in pesticide-contaminated soil appears to be tightly bound to soil particles and not *available* for uptake in the human body. This portion of the arsenic is essentially nontoxic. These two factors led to a need for further guidance, particularly with respect to the use of *bioaccessible* arsenic data in human health risk assessments and in the development of risk-based, soil action levels.

The highest level found in the KTF report was 56 mg/kg. This would fall into the Hawaii Department of Health *Category 2 Soils (C-2): Bioaccessible Arsenic >19 mg/kg and <95 mg/kg.* Long-term exposure to Category 2 (C-2) soils is not considered to pose a significant risk to workers provided that lawns and landscaping are maintained to minimize exposure and control fugitive dust.

Impacts on water resources have not been identified from these constituents at the levels found on PMRF. As described in Chapter 3.0, sampling for perchlorate was conducted at PMRF in October and November 2006, and the results indicated perchlorate levels were within guidelines.
Based on this previous analysis and sampling, HRC RDT&E activities do not adversely affect water resources.

Major Exercises—No-action Alternative

Major Exercises under the No-action Alternative, such as RIMPAC and USWEX, include combinations of ongoing training events. Therefore, potential impacts from Major Exercises will be the same to those described above for HRC training.

4.3.2.1.13.2 Alternative 1 (Water Resources—PMRF/Main Base)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Under Alternative 1, training associated with expeditionary assault and ground maneuvers, areas that are used for handling materials in support of training, and HAO/NEO would increase. Proposed increases in training tempo and frequency would have minimal direct impact on the beach and inland areas. Surface drainage is not affected because there are no surface water features that exist in the areas that are used for training. In addition, training events are generally restricted to existing roads and/or previously disturbed areas.

Enhanced and Future RDT&E Activities—Alternative 1

Under Alternative 1, RDT&E activities that could affect water resources include high speed UAV and surface vehicle testing and hypersonic vehicle testing. These launches would produce some additional exhaust emissions; however, the level of impacts on water resources would not be expected to increase above those identified for the No-action Alternative. Based on previous analysis and sampling programs, the emissions from enhanced and future RDT&E activities would be similar to existing RDT&E activities and would not adversely affect water resources.

HRC Enhancements—Alternative 1

Under Alternative 1, activities that could affect water resources include installation of Automatic Identification System and Force Protection equipment, and construction of a new Range Operations Control Building. If construction of a facility results in a total area disturbed greater than 1 acre, a Stormwater Pollution Prevention Plan would be prepared and submitted prior to construction. The plan would specify all of the measures to be used during construction to minimize and avoid adverse water quality impacts. The dry climate, level topography, and high permeability of the soils results in limited runoff and erosion during construction projects, reducing the potential for impacts on water resources from construction activities.

In addition, all construction activities would follow Spill Prevention, Control, and Countermeasures Plans and transportation safety measures; therefore, potential effects on surface and groundwater resulting from accidental spills of hazardous materials would be minimized.

Major Exercises—Alternative 1

Major Exercises include combinations of ongoing training events. Under Alternative 1, the intensity and number of these Major Exercises would be increased; however, since no new areas are proposed for training, impacts would be the same to those described under the No-action Alternative.

4.3.2.1.13.3 Alternative 2 (Water Resources—PMRF/Main Base)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, training associated with Expeditionary Assault and ground maneuvers, areas that are used for handling materials in support of training, and HAO/NEO would increase. Proposed increases in training tempo and frequency would have minimal direct impact on the beach and inland areas. Surface drainage is not affected because there are no surface water features in the areas that are used for training. In addition, training events are generally restricted to existing roads and/or previously disturbed areas.

Enhanced and Future RDT&E Activities—Alternative 2

Under Alternative 2, RDT&E activities that could affect water resources include those described under Alternative 1 and the development of a Maritime Directed Energy Test Center at PMRF/Main Base and launches of an Advanced Hypersonic Weapon from the KTF launch site.

Under Alternative 2, if development of a facility results in a total area disturbed greater than 1 acre, a Stormwater Pollution Prevention Plan would be prepared and submitted prior to construction. The plan would specify all of the measures to be used during construction to minimize and avoid adverse water quality impacts. The dry climate, level topography, and high permeability of the soils result in limited runoff and erosion during construction projects, reducing the potential for impacts on water resources from construction activities.

HRC Enhancements—Alternative 2

Under Alternative 2, all HRC enhancements would be the same as those described under Alternative 1; therefore, impacts would be the same.

Major Exercises—Alternative 2

Major Exercises include combinations of ongoing training events. Under Alternative 2, the intensity and number of these Major Exercises would be increased; however, since no new areas are proposed for training, impacts would be the same as those described under the No-action Alternative.

4.3.2.1.13.4 Alternative 3 (Water Resources—PMRF/Main Base)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on water resources under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.2 MAKAHA RIDGE

Table 4.3.2.2-1 lists ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 at Makaha Ridge. Alternative 3 is the preferred alternative.

Table 4.3.2.2-1. Training and RDT&E Activities at Makaha Ridge

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Special Warfare Operations (SPECWAROPS)	• FORCEnet Antenna (Alternative 1) • Enhanced Auto Identification System and Force Protection Capability (Alternative 1)

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Makaha Ridge. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on airspace, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

Any impacts on airspace that are associated with Makaha Ridge are included within the PMRF/Main Base discussion. Use of this site would not require control of the airspace. Planned construction or alterations at either Makaha Ridge or Kokee would not affect land forms, geology, and associated soils. Training and RDT&E activities associated with this site would adhere to policies and regulations governing noise, as discussed in Appendix C. There would be no impact on Kauai's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training and RDT&E activities at the site would not generate any hazardous waste streams that could impact local water quality.

4.3.2.2.1 Air Quality—Makaha Ridge

4.3.2.2.1.1 No-action Alternative (Air Quality—Makaha Ridge)

HRC Training and Major Exercises—No-action Alternative

Existing training events will continue at Makaha Ridge, and there will be no increase in air emissions. Existing sensor activities includes the minimal use of diesel power generators, which are operated under a "Non-Covered" Source Air Permit issued by the state.

SPECWAROPS at PMRF includes reconnaissance and survey inserts at Makaha Ridge. These training events cause a short-term elevation in mobile source emissions from off-road vehicles; however, these air emissions are intermittent and will increase proportionally to the additional number of trainees.

C2 is achieved through a network of communication devices strategically located at Makaha Ridge and other locations around Kauai with no impacts on the regional air quality. Increased training will have no impact.

4.3.2.2.1.2 Alternative 1 (Air Quality—Makaha Ridge)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Training events and Major Exercises would increase in number, as described in Chapter 2.0; however, mobile emissions would be similar to existing emission levels.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at either Makaha Ridge or Kokee include:

- The Proposed FORCEnet integration laboratory, which would use an existing building or portable trailer.
- An antenna would be added to Building 720 as part of the Enhanced AIS and Force Protection Capability.

Construction emissions would include emissions generated from privately owned vehicles of construction workers, and stationary and mobile equipment related to construction. The principal air emissions would be nitrogen oxides and carbon monoxide from operating equipment and commuting during construction. None of the emissions generated by the enhancements to facilities would exceed Clean Air Act de minimis or "conformity threshold" levels, which do not apply to Hawaii but are a useful comparison to assess the principal air quality concerns during construction.

4.3.2.2.1.3 Alternative 2 (Air Quality—Makaha Ridge)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

While training events would increase in number, emissions would be similar to existing levels. The types of training events that would occur at Makaha Ridge were described in the No-action Alternative. Air emissions would continue to be within the existing limits of the "non-covered" source Air Permit.

4.3.2.2.1.4 Alternative 3 (Air Quality—Makaha Ridge)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on air quality under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.2.2 Biological Resources—Makaha Ridge

4.3.2.2.2.1 No-action Alternative (Biological Resources—Makaha Ridge)

HRC Training and Major Exercises—No-action Alternative

Existing sensors at Makaha Ridge will continue to be used for HRC training and Major Exercises. The potential for impacts on birds, including threatened and endangered species, on

Makaha Ridge will be minor and similar to those discussed in Section 4.3.2.1.3. The protection provided by the restricted access and grassy habitat within Makaha Ridge will continue to have a positive effect on the small population of nene (Hawaiian goose) (Pacific Missile Range Facility, 2000).

SPECWAROPS are performed by Navy SEALs and Marines and include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. These activities occur within regularly used areas at Makaha Ridge with little potential for long-term impacts on listed species such as those listed in Table 3.3.2.2.2-1. Existing cleared areas, trails, and roads are used. All participants will be briefed on current guidelines to avoid undue impacts on vegetation and wildlife, including sensitive biological resource areas. Makaha Ridge will also continue to provide sensor support for MISSILEX and Air Operations Support. In terms of the potential for EMR impacts on wildlife, the main beam of the radars during missile flight tests will not be directed toward the ground and will have a lower limit of at least 4 to 5 degrees above horizontal, which precludes EMR impacts on terrestrial species. As discussed in Section 4.3.2.1.3, it is also unlikely that a bird, such as a nene, will remain within the radar beam for any considerable length of time. (U.S. Army Space and Missile Defense Command, 2004) Effects of EMR are further discussed in Sections 4.3.1.1.1.1 and 4.3.2.1.3.

4.3.2.2.2.2 Alternative 1 (Biological Resources—Makaha Ridge)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Under Alternative 1, training events would increase as shown in Table 2.2.2.3-1. Major Exercises would continue to be supported at Makaha Ridge. While training events would increase in number, the likelihood of a similar increase in impacts on biological resources on or adjacent to Makaha Ridge would be minimal due to implementation of guidelines established for the training as described below.

Vegetation

Training and Major Exercises would continue to take place at current locations; no expansion of the area would occur. All participants would continue to be briefed on current guidelines to avoid undue impacts on vegetation. SPECWAROPS troops would avoid sensitive biological resources, such as the dwarf iliau, since regular existing routes are used. Training would comply with relevant Navy policies and procedures (e.g., blow/wash down of vehicles and equipment between locations), which should limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. It is unlikely that a listed species or other wildlife would be injured or killed as a result of increased training at Makaha Ridge. The additional training would comply with relevant Navy policies and procedures, which would minimize the potential for effects on wildlife. This would include the briefing of all participants on current guidelines to avoid undue impacts on wildlife. Radars would not radiate lower than 5 degrees above horizontal, which precludes EMR impacts on wildlife on the ground as discussed in Sections 4.3.1.1.1.1 and 4.3.2.1.3. It is also very unlikely that a bird would remain within the radar beam for any considerable length of time. (U.S. Army Space and Missile Defense Command, 2004)

HRC Enhancements—Alternative 1

Enhanced Cooperative Engagement Capability

A site would be chosen at Makaha Ridge (Figure 2.2.3.6.4-3) or Kokee (Figure 2.2.3.6.4-4) to be the location of a FORCEnet integration laboratory. The laboratory would be sited in an existing building or in a portable trailer located in a previously disturbed area. Effects on wildlife from the noise and presence of additional personnel during this activity would be minimal. No effects are anticipated during use of the facility.

Enhanced Automatic Identification System and Force Protection Capability

As part of the enhanced AIS and Force Protection Capability, antennas would be added to Building 720 on Makaha Ridge, resulting in temporary elevated noise levels. No vegetation clearing or ground disturbance would be required for this effort. Because construction-related noise would be localized, intermittent, and occur over a relatively short-term, the potential for impacts on biological resources would be minimal. The installation of the antennas would not require additional lighting or changes to the physical size of the structure. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). If avoidance of activities during bird fallout season is not practicable, monitoring for downed birds near the antennas would be conducted as appropriate.

4.3.2.2.2.3 Alternative 2 (Biological Resources—Makaha Ridge)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. Impacts on wildlife from an increase in frequency and tempo of training would be similar to those described for the No-action Alternative since the additional training would be performed throughout the HRC and not confined to one particular area. It is therefore unlikely that an individual listed species or other wildlife offshore would be repeatedly exposed to noise, debris, EMR, or emissions as a result of increased training. As stated in Section 4.3.2.1.3.3, the intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

The Major Exercises proposed could require additional support from the sensors at Makaha Ridge. However, effects on birds and other wildlife would be minor and similar to those occurring during current Major Exercises, as described above. No new lighting, fire potential, noise, electromagnetic radiation/electromagnetic fields from increased training, or introduction of non-native species would occur.

4.3.2.2.2.4 Alternative 3 (Biological Resources—Makaha Ridge)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on vegetation and wildlife under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.2.3 Cultural Resources—Makaha Ridge

4.3.2.2.3.1 No-action Alternative (Cultural Resources—Makaha Ridge)

HRC Training and Major Exercises—No-action Alternative

Makaha Ridge has been surveyed for archaeological, historical, and Native Hawaiian resources, and none have been identified. As a result, No-action Alternative training will not affect cultural resources.

4.3.2.2.3.2 Alternative 1 (Cultural Resources—Makaha Ridge)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Makaha Ridge has been surveyed for archaeological, historical, and Native Hawaiian resources, and none have been identified. As a result, an increase in tempo and frequency of training would not affect cultural resources.

HRC Enhancements—Alternative 1

Enhanced Cooperative Engagement Capability

A new integration laboratory for FORCEnet would be established at Makaha Ridge. The proposed location for the new facility is shown on Figure 2.2.3.6.4-3. The laboratory would use an existing facility or may be a portable trailer. Because Makaha Ridge has been surveyed for cultural resources and there are none present, no effects are expected. If archaeological or Native Hawaiian resources are unexpectedly encountered as the new facility is established (i.e., if ground disturbance occurs), then the Hawaii SHPO would be notified in accordance with the Programmatic Agreement described in Appendix H.

Enhanced Automatic Identification System and Force Protection

The AIS provides a ship-to-ship and ship-to-shore communications capability. To enhance the existing system, new antennas would be added to Building 720 on Makaha Ridge (see Figure 2.2.3.6.4-3). Building 720 has not been recommended as eligible for inclusion in the NRHP either on individual merit or as an element of a historic district; therefore, installation of a new antenna on this building would not affect cultural resources (International Archaeological Resources Institute, Inc., 2005).

4.3.2.2.3.3 Alternative 2 (Cultural Resources—Makaha Ridge)

Increased Tempo and Frequency of Training—Alternative 2

Makaha Ridge has been surveyed for archaeological, historical, and Native Hawaiian resources and none have been identified. As a result, an increase in tempo and frequency of training would not affect cultural resources.

4.3.2.2.3.4 Alternative 3 (Cultural Resources—Makaha Ridge)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.2.4 Hazardous Materials and Waste—Makaha Ridge

4.3.2.2.4.1 No-action Alternative (Hazardous Materials and Waste—Makaha Ridge)

HRC Training and Major Exercises—No-action Alternative

Existing training at Makaha Ridge will continue. No increase in hazardous material used or generated will occur. PMRF has appropriate plans in place to manage hazardous materials and waste at Makaha Ridge.

Existing sensor activities will continue to use small amounts of hazardous materials. Reconnaissance and survey inserts associated with SPECWAROPS will continue to have a minimal impact on the hazardous materials used at Makaha Ridge. These materials are handled in accordance with PMRF hazardous materials and hazardous waste plans described in Chapter 3.0. Past handling of these materials at Makaha Ridge has not resulted in any impacts on the environment around the facilities.

4.3.2.2.4.2 Alternative 1 (Hazardous Materials and Waste—Makaha Ridge)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

While the number of training events and Major Exercises would increase, the types of hazardous materials consumed would be similar to existing types and levels currently at Makaha Ridge. The types of hazardous materials used would not result in any changes to the existing hazardous materials management plans currently in place.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at Makaha Ridge include a FORCEnet integration laboratory and an antenna for AIS and Force Protection Capability. The proposed FORCEnet integration laboratory would use an existing building or portable trailer. An antenna would be added to building 720 as part of the Enhanced AIS and Force Protection Capability. Any construction activities would occur under existing PMRF spill plans, and all hazardous materials and waste would be handled in accordance with State and Federal regulations. No impact from hazardous materials and waste would be anticipated. Due to the exclusion of the public from the immediate vicinity of construction, the public would not be exposed to any hazardous materials or waste.

4.3.2.2.4.3 Alternative 2 (Hazardous Materials and Waste—Makaha Ridge)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

While the number of training events and Major Exercises would increase, it is anticipated that the level of hazardous materials used would continue to be managed by PMRF under appropriate State and Federal requirements.

4.3.2.2.4.4 Alternative 3 (Hazardous Materials and Waste—Makaha Ridge)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on hazardous materials and waste under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.2.5 Health and Safety—Makaha Ridge

4.3.2.2.5.1 No-action Alternative (Health and Safety—Makaha Ridge)

HRC Training and Major Exercises—No-action Alternative

Existing training at Makaha Ridge, including use of tracking radars and the primary PMRF telemetry station, will continue and PMRF will take every reasonable precaution during planning and execution of training events to prevent injury to human life or property.

Hazards to health and safety stemming from existing sensor operations that can potentially occur include generation of EMR at Makaha Ridge. Hazards of EMR to personnel and fuel (called HERP and HERF, respectively) are the primary concerns at Makaha Ridge. To ensure conditions are safe, the site is regularly surveyed for hazardous radiation, and all systems have warning lights to inform personnel when the radar units are operating and to remain outside of the personnel exclusion area. SPECWAROPS at PMRF will include reconnaissance and survey inserts at Makaha Ridge. In addition, Makaha Ridge is located at the end of a ridge and away from the public; therefore, there are no adverse public health and safety issues. All hazardous materials used and hazardous waste generated at the site will be handled according to Federal and State requirements.

4.3.2.2.5.2 Alternative 1 (Health and Safety—Makaha Ridge)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

The number of training events would increase. However, health and safety concerns would be similar to existing concerns. Established SOPs and procedures would be used.

HRC Enhancements

Proposed HRC enhancements at Makaha Ridge include a FORCEnet integration laboratory and an antenna for AIS and Force Protection Capability.

The proposed FORCEnet integration laboratory would use an existing building or portable trailer. An antenna would be added to Building 720 as part of the Enhanced AIS and Force Protection Capability. Construction would be conducted in accordance with the USACE Safety and Health Requirements Manual. Construction is routinely accomplished for both military and civilian activities, and presents safety and health concerns for workers involved in the performance of the construction activity. The siting of facilities would be in accordance with DoD standards, taking into account HERO, HERP, HERF, ESQD, and other facility compatibility issues.

4.3.2.2.5.3 Alternative 2 (Health and Safety—Makaha Ridge)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

While the number of training events occurring at Makaha Ridge would increase, current health and safety procedures would continue to be used to ensure that every reasonable precaution is taken to prevent injury to human life or property.

4.3.2.2.5.4 Alternative 3 (Health and Safety—Makaha Ridge)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.3 KOKEE

Table 4.3.2.3-1 lists ongoing RDT&E activities for the No-action Alternative and proposed RDT&E activities for Alternatives 1, 2, and 3 at Kokee. Alternative 3 is the preferred alternative.

Table 4.3.2.3-1. RDT&E Activities at Kokee

Research, Development, Test, and Evaluation (RDT&E) Activities	
• FORCEnet Antenna (Alternative 1)	• Improve Fiber Optics Infrastructure (Alternative 1)

A review of the 13 resources against RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Kokee. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on airspace, cultural resources, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

Any impacts on airspace that are associated with Kokee are included within the PMRF/Main Base discussion. Use of this site would not require control of the airspace. Kokee has no prehistoric and historic artifacts, archaeological sites (including underwater sites), historic buildings or structures, or traditional resources that would be affected by HRC RDT&E activities. Planned construction or alterations at either Makaha Ridge or Kokee would not affect land forms, geology, and associated soils. RDT&E activities associated with this site would adhere to policies and regulations governing noise, as discussed in Appendix C. There would be no impact on Kauai's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. RDT&E activities at the site would not generate any hazardous waste streams that could impact local water quality.

4.3.2.3.1 Air Quality—Kokee

4.3.2.3.1.1 No-action Alternative (Air Quality—Kokee)

HRC Training and Major Exercises—No-action Alternative

Existing training will continue at Kokee, and there will be no increase to existing emissions. Kokee will also continue to provide support for MISSILEX and Aircraft Support Operations through use of sensors. Existing sensor activities will continue to include the intermittent use of diesel power generators, which are operated under a "Non-Covered" Source Air Permit issued by the state. Since their operating time is usually minimal, these emergency generators will have minimal impact on the air quality of Kokee.

C2 is achieved through a network of communication devices strategically located at Kokee and other sites around Kauai with no impacts on the regional air quality. Increased training will have no impact.

4.3.2.3.1.2 Alternative 1 (Air Quality—Kokee)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Emissions anticipated from the proposed additional training events would stem from the use of existing sensors at Kokee. Emissions from the generators used to power the sensors are covered under the current non-covered source permit.

HRC Enhancements—Alternative 1

Proposed HRC enhancements to be sited at either Kokee or Makaha Ridge include:

- Proposed FORCEnet integration laboratory, which would use an existing building or portable trailer.
- An antenna would be added to Building 720 as part of the Enhanced AIS and Force Protection Capability.
- Improved fiber optics infrastructure would require the cable to be hung on existing KIUC poles between PMRF/Main Base and Kokee.

Construction emissions would include emissions generated from privately owned vehicles of construction workers, and stationary and mobile equipment related to construction. The principal air emissions would be nitrogen oxides and carbon monoxide from operating equipment and commuting during construction. None of the emissions generated by the enhancements to facilities would exceed Clean Air Act *de minimis* or “conformity threshold” levels, which do not apply to Hawaii but are a useful comparison to assess the principal air quality concerns during construction.

4.3.2.3.1.3 Alternative 2 (Air Quality—Kokee)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

The increased tempo and frequency of training and additional Major Exercises proposed would be similar to those described in the No-action Alternative for Kokee. While training would increase, emissions would be similar to existing levels. Emissions would continue to be within the limits of the existing “Non-Covered” Source Air Permit.

4.3.2.3.1.4 Alternative 3 (Air Quality—Kokee)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on air quality under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.3.2 Biological Resources—Kokee

4.3.2.3.2.1 No-action Alternative (Biological Resources—Kokee)

HRC Training and Major Exercises—No-action Alternative

Existing sensors at Kokee will continue to be used for HRC training and Major Exercises. The potential for impacts on birds, including threatened and endangered species, at Kokee will be minor and similar to those discussed in Section 4.3.2.1.3. Existing radars will not radiate lower than at least 4 to 5 degrees above horizontal, which precludes EMR impacts on wildlife on the ground. It is also very unlikely that a bird will remain within the radar beam for any considerable length of time. (U.S. Army Space and Missile Defense Command, 2004) Effects of EMR are further discussed above in Sections 4.3.1.1.1.1 and 4.3.2.1.3. Kokee will continue to provide sensor support for MISSILEX, Aircraft Support Operations, and RDT&E programs. This support is generally non-intrusive in nature.

4.3.2.3.2.2 Alternative 1 (Biological Resources—Kokee)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Under Alternative 1, training events would increase as shown in Table 2.2.2.3-1. Major Exercises would continue to be supported at Kokee. While training events would increase in number, the likelihood of a similar increase in impacts on biological resources on or adjacent to Kokee would be minimal due to implementation of guidelines established for the training as described below.

Vegetation

Training and Major Exercises would continue to take place at current locations; no expansion of the area would occur. All participants would continue to be briefed on current guidelines to avoid undue impacts on vegetation. Training events would comply with relevant Navy policies and procedures (e.g., blow/wash down of vehicles and equipment between locations), which should limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. It is unlikely that a listed species or other wildlife would be injured or killed as a result of increased training at Kokee. The additional training would comply with relevant Navy policies and procedures, which would minimize the potential for effects on wildlife. This would include the briefing of all participants on current guidelines to avoid undue impacts on wildlife. Radars would not radiate lower than 5 degrees above horizontal, which precludes EMR impacts on wildlife on the ground. It is also very unlikely that a bird would remain within the radar beam for any considerable length of time. Effects of EMR are further discussed in Sections 4.3.1.1.1.1 and 4.3.2.1.3. (U.S. Army Space and Missile Defense Command, 2004)

HRC Enhancements—Alternative 1

Enhanced Cooperative Engagement Capability

A site would be chosen at Makaha Ridge (Figure 2.2.3.6.4-3) or Kokee (Figure 2.2.3.6.4-4) to be the location of a FORCEnet integration laboratory. The laboratory would be sited in an existing building or in a portable trailer located in a previously disturbed area. Effects on wildlife from the noise and presence of additional personnel during this activity would be minimal. The installation of the antennas would not require additional lighting or changes to the physical size of the structure. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). If avoidance of activities during bird fallout season is not practicable, monitoring for downed birds near the antennas would be conducted as appropriate.

Improve Fiber Optics Infrastructure

To improve communications and data transmission, PMRF would install fiber optic cable between the Main Base and Kokee. The cable would be hung on existing KIUC poles between PMRF/Main Base and Kokee; however, it is possible that additional poles might need to be installed in some areas where exceptionally long spans are encountered. To minimize ground disturbance and impacts on vegetation, it is expected that all equipment and installation activities would occur along existing public and KIUC access roads in previously disturbed areas. Effects from the noise and presence of additional personnel during this activity would be similar to those discussed in Section 4.3.2.2.2, PMRF/Main Base. Newell's shearwaters and Hawaiian dark-rumped petrels often fly into utility wires and poles and fall to the ground. KIUC has implemented a number of conservation measures to benefit listed seabird species on Kauai. The cooperative has shielded all streetlights on utility poles along county and state highways to reduce light-attraction impacts. KIUC has also placed power line marker balls in areas of concentrated seabird flight paths. (Kauai Island Utility Cooperative, 2006b) These measures could also be used for the proposed installation of additional poles and cable between PMRF and Kokee. The Navy would consult with USFWS regarding the potential for threatened and endangered bird takes.

4.3.2.3.2.3 Alternative 2 (Biological Resources—Kokee)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of training events would also increase. Impacts on wildlife from an increase in frequency and tempo of training would be similar to those described for the No-action Alternative since the additional training would be performed throughout the HRC and not confined to one particular area. It is therefore unlikely that an individual listed species or other wildlife offshore would be repeatedly exposed to noise, debris, EMR, or emissions as a result of increased training. As stated in Section 4.3.2.2.2.3, the tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises–Multiple Strike Group Training—Alternative 2

The Major Exercises proposed might require additional support from the sensors at Kokee. However, effects on birds and other wildlife would be minor and similar to those occurring during current Major Exercises, as described earlier.

4.3.2.3.2.4 Alternative 3 (Biological Resources—Kokee)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on vegetation and wildlife under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.3.3 Hazardous Materials and Waste—Kokee

4.3.2.3.3.1 No-action Alternative (Hazardous Materials and Waste—Kokee)

HRC Training and Major Exercises—No-action Alternative

Existing training at Kokee will continue and there will be no increase in hazardous materials used or any hazardous waste generated. PMRF has appropriate plans in place to manage hazardous materials and waste at Kokee. Existing sensors at Kokee will continue to use small amounts of hazardous materials. Kokee will also continue to provide support for MISSILEX and Aircraft Support Operations through use of sensors. These materials will continue to be handled in accordance with PMRF hazardous materials and hazardous waste plans.

4.3.2.3.3.2 Alternative 1 (Hazardous Materials and Waste—Kokee)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

While the tempo and frequency of training and the number of Major Exercises would increase, the types of hazardous materials consumed would be similar to existing types and levels at Kokee. The types of hazardous materials used would not result in any existing changes to the hazardous materials management plans currently in place.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at Kokee include a FORCEnet integration laboratory and improvement of fiber optics infrastructure.

The proposed FORCEnet integration laboratory would use an existing building or portable trailer. Fiber optic cable would be installed on existing KIUC poles between PMRF/Main Base and Kokee; however, it is possible that additional poles might need to be installed in areas with long spans. Construction activities would be handled under existing PMRF spill plans, and all hazardous materials would be handled in accordance with State and Federal regulations. In addition, use of the proposed FORCEnet laboratory would not use new types of hazardous materials, and appropriate plans are in place to handle these materials.

4.3.2.3.3.3 Alternative 2 (Hazardous Materials and Waste—Kokee)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

The increase in tempo and frequency of training and additional Major Exercises proposed would use hazardous materials similar to those described for the No-action Alternative. While the number of training events and Major Exercises would increase, it is anticipated that the level of hazardous materials used would continue to be managed by PMRF under appropriate State and Federal requirements.

4.3.2.3.3.4 Alternative 3 (Hazardous Materials and Waste—Kokee)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on hazardous materials and waste under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.3.4 Health and Safety—Kokee

4.3.2.3.4.1 No-action Alternative (Health and Safety—Kokee)

HRC Training and Major Exercises—No-action Alternative

PMRF will continue to take every reasonable precaution during planning and execution of training events to prevent injury to human life or property at Kokee.

Hazards to health and safety can potentially occur as a result of EMR generated at the site during HRC training. The main concerns at Kokee are HERP and HERF. The only fuel stored at the site (diesel fuel for the electrical generators) is located outside of any EMR generating areas, so there are no HERF issues at the site. Appropriate sector blanking, filtering, and the elevation of the radar units above the ground have eliminated any potential HERP issues at Kokee. In addition, radiation hazards are contained within the boundaries of the sites. To ensure conditions are safe, the site is regularly surveyed for radiation hazards, and all systems have warning lights to inform personnel when the radar units are operating. The public is not exposed to any unsafe EMR levels. All hazardous materials used at the site are handled according to Federal and State regulations. Kokee will also continue to provide support for MISSILEX and Aircraft Support Operations through use of sensors.

4.3.2.3.4.2 Alternative 1 (Health and Safety—Kokee)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

The number of Major Exercises and the tempo and frequency of training would increase, however, the health and safety concerns would be would be similar to existing concerns. Existing SOPs and procedures would be used to prevent injury to human life or property.

HRC Enhancements—Alternative 1

Proposed HRC enhancements at Kokee include a FORCEnet integration laboratory and improvement of fiber optics infrastructure.

The proposed FORCEnet integration laboratory would use an existing building or portable trailer. Any construction would be conducted in accordance with Corps of Engineers Safety and Health Requirements Manual. The siting of facilities would be in accordance with DoD standards, taking into account HERO, HERP, HERF, ESQD, and other facility compatibility issues. All hazardous materials used and hazardous waste generated during construction would be handled according to Federal and State requirements.

4.3.2.3.4.3 Alternative 2 (Health and Safety—Kokee)

Increased Tempo and Frequency of Training and Additional Major Exercises—Multiple Strike Group Training—Alternative 2

The increased tempo and frequency of training and additional Major Exercises proposed would be similar to those described for the No-action Alternative for Kokee, and health and safety procedures would be similar. Current health and safety procedures would be used to ensure that every reasonable precaution is taken to prevent injury to human life or property.

4.3.2.3.4.4 Alternative 3 (Health and Safety—Kokee)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.4 HAWAII AIR NATIONAL GUARD KOKEE

Hawaii Air National Guard Kokee provides operation and maintenance of the Hawaii Digital Microwave System and a radar site. Microwave systems at PMRF provide voice and data communications between PMRF/Main Base and support facilities, including Hawaii Air National Guard Kokee. The Hawaii Digital Microwave System also links the Hawaii Air National Guard facility at Kokee to the Hawaii Regional Operations Center at Wheeler Army Airfield, Oahu. The Hawaii Air National Guard Wing's 150th Aircraft Control and Warning Flight operate the radar site. The radar site is linked to the Hawaii Region Air Operations Center at Wheeler Army Airfield, Oahu, where 24-hour air surveillance of the Hawaiian Islands chain is provided. Training at the Hawaii Air National Guard Kokee radar site follows all applicable regulations and procedures established by the Air Force and the Navy to protect human health and the environment. These facilities would continue to be used during ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3. Alternative 3 is the preferred alternative.

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Hawaii Air National Guard Kokee. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, hazardous materials and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There are no air emission sources introduced by the alternatives proposed at the Hawaii Air National Guard Kokee. Any impacts on airspace that are associated with Hawaii Air National Guard Kokee are included within the PMRF/Main Base discussion. Use of this site would not require control of the airspace. Hawaii Air National Guard Kokee has no prehistoric and historic artifacts, archaeological sites (including underwater sites), historic buildings or structures, or traditional resources that would be affected by HRC training. There is no planned construction or alterations that would affect land forms, geology, and associated soils. Training associated with this site would adhere to policies and regulations governing noise and health and safety, as discussed in Appendix C. There would be no impact on Kauai's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the site would not generate any hazardous waste streams that could impact local water quality

4.3.2.4.1 Biological Resources—Hawaii Air National Guard Kokee

4.3.2.4.1.1 No-action Alternative (Biological Resources—Hawaii Air National Guard Kokee)

HRC Training and Major Exercises—No-action Alternative

Existing sensors at Hawaii Air National Guard Kokee will continue to be used for HRC training. Navy training at the site would be performed in accordance with all applicable biological opinions and existing Air National Guard regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Hawaii Air National Guard regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed. There have been no reports of birds being affected by EMR from the existing sensors located in the Hawaii

Air National Guard Kokee complex. Impacts on threatened and endangered birds (nene, Hawaiian dark-rumped petrel, and Newell's Townsend's shearwater) and the Hawaiian hoary bat that may be in the area will be minor and similar to those discussed in Section 4.3.2.1.3.

Support for MISSILEX provided by the sensors will continue as part of Major Exercises. Due to the non-intrusive continuing nature of these training events, no additional impacts on biological resources are anticipated.

4.3.2.4.1.2 Alternative 1 (Biological Resources—Hawaii Air National Guard Kokee)

Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1), an overall increase of approximately 9 percent. While sensor usage would increase, the likelihood of a similar increase in impacts on biological resources is minimal. Training would take place at existing locations; no expansion of the sensor operating area would occur.

4.3.2.4.1.3 Alternative 2 (Biological Resources—Hawaii Air National Guard Kokee)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of events could also increase. Thus, the frequency of sensor operation is expected to increase as well. However, effects on birds and other wildlife would be minor and similar to those occurring during current Major Exercises, as described earlier.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

The Major Exercises proposed may require additional support from the sensors at Hawaii Air National Guard Kokee. However, effects on birds and other wildlife would be minor and similar to those occurring during current Major Exercises, as described above.

4.3.2.4.1.4 Alternative 3 (Biological Resources—Hawaii Air National Guard Kokee)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on vegetation and wildlife under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.5 KAMOKALA MAGAZINES

The Kamokala Magazines provide secure storage of ordnance material. The magazines are in continuous use by PMRF, the Hawaii Air National Guard, and the Department of Energy. Other commands conducting training events and needing storage are also accommodated at the facility intermittently. These facilities would continue to be used during ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3. Alternative 3 is the preferred alternative.

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Kamokala Magazines. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, biological resources, cultural resources, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources. Use of the Kamokala storage magazine does not require control of the airspace above this land area. Any air quality, biological, cultural resources, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water issues are included within the PMRF/Main Base discussion.

4.3.2.5.1 Hazardous Materials and Waste—Kamokala Magazines

4.3.2.5.1.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Kamokala Magazines)

Under the No-action Alternative existing training and RDT&E activities at Kamokala Magazines will continue. New hazardous materials will not be used, and new hazardous waste will not be generated. Training and RDT&E activities proposed for Alternative 1, Alternative 2, and Alternative 3 would not result in the need for additional hazardous materials to be used and no hazardous waste to be generated at Kamokala Magazines. Storage and transportation of ordnance would be conducted in accordance with established DOT, DoD, and Navy safety procedures. PMRF has appropriate plans in place to manage existing and future hazardous materials and waste levels at Kamokala Magazines.

4.3.2.5.2 Health and Safety—Kamokala Magazines

4.3.2.5.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Kamokala Magazines)

Under the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3, there would be no change in the type of ordnance stored at the Kamokala Magazines and no increased safety risks. Storage and transportation of ordnance are conducted in accordance with established DOT, DoD, and Navy safety procedures. The storage magazines have appropriate ESQD arcs for the amount and type of ordnance stored (Figure 3.3.2.1.7-1). The existing uses around the magazine and within the ESQD arcs are considered compatible. If a mishap should occur, the hazard associated with the explosion would be contained within the ESQD arcs.

4.3.2.6 PORT ALLEN

Port Allen is a small, fully developed industrial seaport that supports PMRF's Range Support Boats and maintenance facilities. Port Allen also provides pier space, protected anchorage, and small boat launch facilities. Lights would be shielded to the extent practicable to minimize the potential for impacts to nocturnal species. In addition, PMRF leases warehouse space at the facility.

A review of the 13 resources against program training determined there were no impacts from training events under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 at Port Allen. There are no reports of emission from Navy training affecting the air quality for Port Allen. Use of Port Allen does not require control of the airspace above this land area.

Ports and harbors can be initial invasion sites for non-native species transported via ships. Activities would follow existing procedures used to prevent the introduction of non-native species. Various instructions, as well as training event-specific operations orders such as the RIMPAC Operations Order, advise commanding officers of requirements regarding the protection of Hawaii from additional alien or invasive species. Introduction of any plant or animal into Hawaii without permission of the State of Hawaii Department of Agriculture is prohibited. All ship commanding officers and aircraft are required by the Defense Transportation Regulation, DoD 4500.9-R, to conduct inspections of equipment, cargo, supplies and waste prior to entering their first port of entry into the OPNAVINST 6210.2, Quarantine Regulations of the Navy, is intended to prevent the introduction and dissemination, domestically or internationally originated, of diseases affecting humans, plants, and animals; prohibited or illegally taken wildlife; arthropod vectors; and pests of health and agricultural importance.

According to OPNAVINST 5090.1B, Chapter 19, and the RIMPAC Operations Order, surface ships shall routinely wash down anchors, chains, and appendages with seawater when retrieving them to prevent on board collection of sediment, mud and silt. When possible, following anchor retrieval, surface ships shall wash down chain lockers outside 12 nm from land to flush out sediment, mud, or silt.

All equipment and unmanned vehicles to be placed in the ocean are to be clean and free of residual materials from prior use to avoid introduction of new species. For ships arriving from foreign ports, hulls of ships' small boats are to be cleaned of any marine growth (algae, barnacles, crustaceans, etc.) before placing them into ocean or harbor waters.

Amphibious vessels launching and recovering amphibious vehicles shall ensure those vehicles, including their treads, are washed down after completion of training. Ships shall dispose of wash water before entering 12 nm of the next operating area.

State of Hawaii Department of Agriculture inspectors may be invited by the commanding officer to board U.S. flag vessels to assist with inspection of food stores, plants, and animals to ensure compliance with State animal quarantine laws.

No snakes are known to inhabit Hawaii. Commanding officers of all vessels and aircraft shall, prior to arrival in Hawaii, ensure that all stores originating from Australia and Guam are inspected for the brown tree snake. This inspection may be accomplished during on-loading of such stores or while underway. If any snake is sighted aboard a ship or aircraft entering Hawaii, the snake is to be restrained, contained, or killed and the snake retained until entry into Hawaii.

Naval Station Pearl Harbor Security (911) is to be contacted and advised and will take control of the snake for appropriate reporting to State Agriculture authorities.

Because no ground disturbance or building modifications would occur, there would be no impact on cultural resources or geology and soils. Additionally, there are no known significant archaeological sites at Port Allen.

Training at this site would require small amounts of hazardous materials for maintenance and would generate small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with PMRF's hazardous materials management plans as described under PMRFINST 5100.2c and all other applicable regulations. No noise-sensitive land receptors are affected by existing noise levels at the site. All training events at Port Allen are conducted in accordance with OSHA and OPNAVINST 5100.23D, Navy Occupational Safety and Health Program Manual; there are no public health and safety issues.

Port Allen is compatible with existing surrounding land uses, and land use does not conflict with recreational activities occurring in or adjacent to the harbor. Any transportation and utility issues associated with Port Allen are included within the PMRF/Main Base discussion. There is no socioeconomic impact from training at the site. Training at the site would not generate any waste streams that could impact local water quality.

4.3.2.7 KIKIAOLA SMALL BOAT HARBOR

Kikiaola Small Boat Harbor hosts PMRF Range Support Boats and small-boat launch facilities. PMRF's Seaborne Powered Targets are launched from Kikiaola.

A review of the 13 resources against program training determined there were no impacts from training events under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 at the Kikiaola Small Boat Harbor. Any emissions from training associated with the use of range support boats and small-boat-launch facilities would not affect the air quality of the area. The Navy would not require control of the airspace above this land area. Additionally, all training would adhere to Navy policy, statutory and regulatory requirements for hazardous materials and hazardous waste, range safety guidelines, and noise, as discussed in Appendix C.

Activities would follow existing procedures used to prevent the introduction of non-native species as discussed in Section 4.3.2.6. There would be no ground-disturbing activities or building modifications that could affect biological and geology and soils resources at Kikiaola Small Boat Harbor. Additionally, there are no training events that could affect the land-based use, including recreation and tourism-related-activities. The work force assigned to the site would not affect local transportation levels of service or utilities. There is no socioeconomic impact from HRC training.

4.3.2.8 MT. KAHILI

Training at Mt. Kahili consists of existing telemetry towers and communications. A review of the 13 environmental resources against program training determined there would be no impacts from training events under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 at Mount Kahili. Alternative 3 is the preferred alternative.

No air emissions would be generated from training at Mt. Kahili unless use of diesel generators would be required for backup power for Command and Control activities at this site. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). There is no lighting at the facility. No impacts are expected to the endangered Newell's shearwater, Hawaiian petrel, or Hawaiian hoary bat that may traverse the area. If avoidance of activities during bird fallout season is not practicable, monitoring for downed birds near the antennas would be conducted as appropriate. Because no ground disturbance or building modifications would occur, there would be no impact on cultural resources, or geology and soils. Training at this site would require small amounts of hazardous materials for maintenance and would generate small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations. There is no electromagnetic radiation generated at the site; therefore, there are no public health and safety issues.

Mt. Kahili is compatible with existing surrounding land uses. No noise is generated by activities at the site. The site, which is only manned during activities, employs two to four persons. Such a small work force would not affect local transportation levels of service or utilities. There is no socioeconomic impact from use of the site. Training at the site would not generate any waste streams that could impact local water quality.

4.3.2.9 NIIHAU

Table 4.3.2.9-1 lists ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 at Niihau. Alternative 3 is the preferred alternative.

Table 4.3.2.9-1. Training and RDT&E Activities at Niihau

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Special Warfare Operations (SPECWAROPS) • Humanitarian Assistance/Non-combatant Evacuation Operations (HAO/NEO)	• Electronic Combat/Electronic Warfare (EC/EW) • Enhanced Electronic Warfare Training (Alternative 1)

A review of the 13 resources against onshore training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Niihau. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

Air emissions from HRC training and RDT&E activities would not change the regional air quality surrounding Niihau. Any impacts on airspace that are associated with Niihau are included within the PMRF/Main Base discussion. Use of this site would not require control of the airspace. Niihau has no prehistoric and historic artifacts, archaeological sites (including underwater sites), historic buildings or structures, or traditional resources that would be affected by HRC training and RDT&E activities. Planned construction or alterations would not affect land forms, geology, and associated soils. Training and RDT&E activities associated with this site would adhere to policies and regulations governing noise, as discussed in Appendix C. There would be no impact on Kauai's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. The transportation infrastructure on Niihau is rudimentary and is not used during HRC training and RDT&E activities. There is no central utility system on the island. Training and RDT&E activities at the site would not generate any hazardous waste streams that could impact local water quality.

4.3.2.9.1 Biological Resources—Niihau

4.3.2.9.1.1 No-action Alternative (Biological Resources—Niihau)

HRC Training and Major Exercises—No-action Alternative

PMRF remotely operates a radar unit at Paniau (northeast corner of the island) and the Niihau Perch site electronic warfare system. These training events will continue intermittently under the No-action Alternative with minimal impacts on biological resources. In terms of the potential for EMR impacts on wildlife, the main beam of the Paniau radar during missile flight tests is not directed toward the ground and has a lower limit of at least 4 to 5 degrees above horizontal, which precludes EMR impacts on terrestrial species on the beach. The potential for main-beam (airborne) exposure thermal effects on birds or bats exists. Helping to alleviate this concern is the fact that radar beams are relatively narrow and operate non-continuously; that is, radars generate EMR in a rapid pulse as opposed to other EMR sources that radiate continuously (e.g., microwave antennas). The beam will also normally be in motion. To remain in the beam for any period requires that birds fly directly along the beam axis or hover within the beam for a significant time. Thus, the probability for the Paniau radar to harm birds or bats with any frequency is judged to be low. (U.S. Department of the Navy, 1998a) Effects of EMR are further discussed above in Sections 4.3.1.1.1.1 and 4.3.2.1.3.

Vegetation

Vegetation on Niihau is dominated by non-native plant species and plant communities. SPECWAROPS training on Niihau uses existing openings, trails, and roads and thus avoids areas that contain threatened or endangered plants. Helicopter landings are in areas designated as suitable and absent of listed biological resources. HAO/NEO activities at Niihau will be similar to SPECWAROPS training. HRC training comply with relevant Navy and USFWS policies and procedures (e.g., blow/wash down of vehicles and equipment) during these training events and Major Exercises, which should limit the potential for introduction of invasive plant species.

Target drones are flown along the east coast of the island away from inhabited areas. There is the potential for a drone to crash and start a brush fire on the island. However, during activities that present the potential for fires, a ground fire-fighting crew and helicopters with water buckets are airborne to minimize any fire hazard.

Wildlife

Wildlife on Niihau is dominated by non-native species such as feral pigs, sheep, cattle, and horses. Noise and movement of personnel, vehicles, helicopters, and landing craft during these training events can temporarily displace sensitive species, such as the green turtle and Hawaiian monk seal if they are basking on the island. However, all ocean vessel landings are first checked to ensure the sites are clear of monk seals. Also, training will avoid any beach area with green turtle nests, as they occasionally nest on Niihau beaches.

Environmentally Sensitive Habitat

An area of 357 acres on the northern portion of Niihau has been designated as critical habitat for the endangered alula (U.S. Fish and Wildlife Service, 2003a). Training events will not affect this area, and current transmitter sites are not located within the critical habitat.

4.3.2.9.1.2 Alternative 1 (Biological Resources—Niihau)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). While training would increase in number, the likelihood of a similar increase in impacts on biological resources is small as discussed below.

Vegetation

Training at Niihau would take place at existing locations; no expansion of the area would occur. All participants would continue to be briefed on current guidelines to avoid undue impacts on vegetation. Training would comply with relevant Navy policies and procedures (e.g., blow/wash down of vehicles and equipment between locations), which should limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. It is unlikely that a listed species or other wildlife would be injured or killed as a result of increased training on Niihau since the additional training would still comply with relevant Navy policies and procedures, which would minimize the potential for effects on wildlife. This would include the briefing of all participants on current guidelines to avoid undue impacts on wildlife. EMR impacts on birds or wildlife on the ground would be minimal as described in Section 4.3.2.1.3.1. (U. S. Army Space and Missile Defense Command, 2004)

4.3.2.9.1.3 Alternative 2 (Biological Resources—Niihau)

Increased Tempo and Frequency of Training—Alternative 2

Impacts on wildlife would be similar to those described previously for the No-action Alternative since the additional training would be performed throughout the HRC and not confined to one particular area. While Electronic Combat activities would double, the activities would not necessarily increase on Niihau. It is unlikely that a listed species or other wildlife on Niihau would be injured or killed as a result of increased training since the additional training events would continue to comply with relevant Navy policies and procedures.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The training events proposed would be similar to those occurring during current Major Exercises, in various areas of the HRC, with impacts on biological resources being similar to those described above.

4.3.2.9.1.4 Alternative 3 (Biological Resources—Niihau)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on vegetation and wildlife under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.9.2 Hazardous Materials and Waste—Niihau

4.3.2.9.2.1 No-action Alternative (Hazardous Materials and Waste—Niihau)

HRC Training—No-action Alternative

Under the No-action Alternative, PMRF will continue ongoing HRC training at Niihau. The hazardous material/used oil issues associated with these training events are the fueling and maintenance of diesel generators which are operated intermittently to power remotely operated radar and the electronic warfare facility. These materials will continue to be handled by Niihau

Ranch. Past handling of these materials at Niihau has not resulted in any impacts on the environment around the facilities. PMRF only brings hazardous materials onto the island when required for maintenance. Diesel fuel required for fueling is stored in a portable fuel trailer.

Target drones are currently flown along the east coast of the island away from inhabited areas. The drones do not fly over occupied areas; however, there is the potential for a drone to crash and deposit hazardous waste onto the island. The PMRF Hazardous Material Spill Response Team will be dispatched to the crash site of any mishap to ensure proper removal of all hazardous material/hazardous waste.

Major Exercises—No-action Alternative

Major Exercises at Niihau include HAO/NEO training events. These training events will use helicopters, trucks, Landing Craft, Air Cushioned (LCAC), Landing Craft, Utility (LCU) and/or Combat Rubber Raiding Craft (CRRC) to shuttle supplies. Any diesel fuel required for fueling vehicles will be provided by Niihau Ranch.

4.3.2.9.2.2 Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Niihau)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1, Alternative 2, and Alternative 3

While the tempo and frequency of training and the number of Major Exercises would increase, the types of hazardous materials consumed would be similar to existing types and levels at Niihau. The types of training events that would occur at Niihau would be similar to those described in Section 4.3.2.9.2.1. The types of hazardous materials used would not result in any procedural changes to the hazardous materials management plans currently in place.

HRC Enhancements—Alternative 1, Alternative 2, and Alternative 3

Proposed HRC enhancements at Niihau include the installation and use of an antenna for AIS and Force Protection Capability. Potential construction impacts for this antenna would be minimal. Construction would be conducted in accordance with the USACE Safety and Health Requirements Manual. Hazardous materials used during construction could include engine oil, oil filters, paint, paint thinners, and solvents generated during maintenance of equipment. Construction activities would be handled under existing PMRF spill plans, and all hazardous materials and hazardous waste would be handled in accordance with State and Federal requirements.

Use of the AIS and Force Protection antenna would require minimal use of hazardous materials. However, materials would continue to be handled in accordance with PMRF hazardous materials and hazardous waste plans. Past handling of hazardous materials and hazardous waste at Niihau has not resulted in any impacts on the environment.

4.3.2.9.3 Health and Safety—Niihau

4.3.2.9.3.1 No-action Alternative (Health and Safety—Niihau)

Under the No-action Alternative existing activities at Niihau will continue and there will be no adverse impacts on health and safety. PMRF takes every reasonable precaution during planning and execution of training and RDT&E activities to prevent injury to human life or property at Niihau.

HRC Training—No-action Alternative

Under the No-action Alternative, HRC training will continue on Niihau. The primary health and safety issues associated with these training events are the generation of EMR emissions from radar and Electronic Warfare Operations. The covert penetration activities only involve military personnel trying to avoid detection by ground observers and do not involve any hazardous activities to the public.

EMR emissions do not represent a health and safety risk to the island residents because the radar and Perch site electronic warfare sites are located away from the island village. The radar unit is located on top of a facility and presents no HERP hazards at ground level where any island residents could be affected. During use of the Perch site, appropriate warning lights and signs are placed around the facility.

Target drones are flown along the east coast of the island away from inhabited areas. Because the drones do not fly over occupied areas, there is no direct health and safety risk; however, there is the potential for a drone to crash and start a brush fire on the island. During activities that present the potential for fires, a ground fire-fighting crew and helicopters with water buckets are airborne to minimize any fire hazard.

Major Exercises—No-action Alternative

Training events at Niihau that are a part of Major Exercises include HAO/NEO training events. These training events will use helicopters, trucks, LCAC, LCU and/or CRRC to shuttle supplies. Every reasonable precaution is taken during Major Exercises to prevent injury to human life or property at Niihau; therefore no adverse impacts will occur during ongoing Major Exercises.

4.3.2.9.3.2 Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Niihau)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1, Alternative 2, and Alternative 3

The number of training events would increase in tempo and frequency and the number of Major Exercises would increase, however, the health and safety concerns would be similar to existing concerns and existing SOPs and procedures would be used. The types of training events that would occur at Niihau would be similar to those described in Section 4.3.2.9.3.1 and would not occur simultaneously.

HRC Enhancements—Alternative 1, Alternative 2, and Alternative 3

Proposed HRC enhancements at Niihau includes the installation and use of an antenna for AIS and Force Protection Capability. Construction would be conducted in accordance with the Corps of Engineers Safety and Health Requirements Manual. It is the policy on Niihau to minimize the contact between island residents and workers brought to the island. This policy would continue under the proposed construction activities, which would minimize the potential for an island resident to contract any illnesses that personnel may have. Transportation of hazardous materials on Niihau would be conducted under DOT regulations, and any generation of hazardous waste would be in accordance with Federal and State requirements.

Operation of the AIS and Force Protection antenna would result in no adverse impacts on health and safety risk to the island residents; it would be located away from the island village.

4.3.2.10 KAULA

Table 4.3.2.10-1 lists ongoing training events for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Kaula. Alternative 3 is the preferred alternative.

Table 4.3.2.10-1. Training at Kaula

Training
• Bombing Exercises
• Air-to-Ground Gunnery Exercise (GUNEX)

A review of the 13 resources against onshore program training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Kaula. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, hazardous material and waste, noise, socioeconomics, transportation, utilities, and water resources.

Air emissions from HRC training would not change the regional air quality surrounding Kaula. Training associated with this site would adhere to policies and regulations, including the Military Munitions Rule, governing hazardous materials and waste, as discussed in Appendix C. Because access to the island is restricted, no noise impacts on civilian or military personnel would occur. Potential noise impacts on wildlife are addressed under the biological resources section. There would be no impact on Kauai's socioeconomics, transportation, or utilities because access to the island is restricted. There are no facilities, transportation, or utility systems on the island. Training at the site would not generate any hazardous waste streams that could impact local water quality.

4.3.2.10.1 Airspace—Kaula

4.3.2.10.1.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Airspace—Kaula)

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, Alternative 3

The ongoing, continuing BOMBEX and GUNEX at Kaula will have no impact on controlled and uncontrolled airspace or special use airspace. Restricted Area R-3107 and the surrounding Warning Area W-187 were specifically designed to accommodate these kinds of hazards to non-participants' activities.

En route airways and jet routes will not be affected. The closest airway, V16, is located 18 nm north of Kaula. There are no airports or airfields in the area. The use of the airspace at Kaula will be coordinated with the FAA and PMRF prior to use for BOMBEX, GUNEX, and Major Exercises such as RIMPAC and USWEX.

The increased training under Alternative 1 (31 percent increase above the No-action Alternative) and Alternatives 2 and 3 (52 percent increase above No action) would still not impact the controlled and uncontrolled airspace or special use airspace at Kaula. The advance planning and coordination with the FAA and FACSFACPH prior to the use of Kaula for BOMBEX, GUNEX, and Major Exercises such as RIMPAC, USWEX and the Multiple Strike Group Exercise results in minimal impacts on airspace.

4.3.2.10.2 Biological Resources—Kaula

4.3.2.10.2.1 No-action Alternative (Biological Resources—Kaula)

HRC Training and Major Exercises—No-action Alternative

The Navy uses the southeastern tip of Kaula for aircraft gunnery, inert ordnance target practice, Strike Warfare Exercises (STW), and Close Air Support Exercise (CASEX). Potential effects on biological resources are discussed below.

Vegetation

Vegetation on Kaula is very sparse, and there are no known threatened or endangered plant species. Because of the sparse vegetation, brush fires occurring from gunnery and inert ordnance practice are unlikely to occur, and no fires have ever been reported from prior training. Thus, any vegetative impacts on the southeastern tip of the island should continue to be minimal.

Wildlife

Under the No-action Alternative, current GUNEX and STW training will continue. Some individual migratory seabirds may be lost to GUNEX training in the designated impact area. Gunnery rounds that may occasionally miss the designated impact area may also result in the loss of some individuals elsewhere on the island. However, current migratory seabird populations appear to be healthy and reproducing normally.

RIMPAC Exercises use non-explosive rounds on Kaula. However, impacting and ricocheting projectiles likely will startle nesting birds, and can result in the loss of a few individuals. Spotting charges from practice bombs will also likely startle birds nesting near the targets. Birds frightened off their nests may abandon the nest and not breed again that season. Nest abandonment is highly species dependent. If the nest is abandoned, the bird may re-nest during the breeding season or not, depending in large part on the species and the point in the breeding season at which the nest is abandoned. RIMPAC Exercises occur biennially and USWEX will occur only up to six times per year, for a maximum of 4 days per Major Exercise. Since these Major Exercises will affect less than 10 percent of the island over less than 10 percent of the year, the effects on seabirds such as the sooty tern, brown noddy, and red-footed or masked booby will be reduced to the extent practicable.

Small numbers of Hawaiian monk seals now haul-out on a small limestone bench on Kaula. USWEX/RIMPAC may cause monk seals to leave this haul-out site and enter the water temporarily. Based on the Navy’s level of use of Kaula and the number of Hawaiian monk seals continually sighted at Kaula, it is likely that monk seals will return once the disturbance from USWEX/RIMPAC Exercises has ended. Major Exercises thus will have only an occasional, short-term effect on monk seals at this site.

Environmentally Sensitive Habitat

Critical habitat that has been designated for sea turtles and other listed species is outside the region of influence and will not be affected by current training and Major Exercises (National Oceanic and Atmospheric Administration, 1979).

4.3.2.10.2.2 Alternative 1 (Biological Resources—Kaula)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Under Alternative 1, training events would increase as shown in Table 2.2.2.3-1. Major Exercises, such as STW and GUNEX, would continue to be supported at Kaula. While training events would increase in number, the likelihood of a similar increase in impacts on biological resources on or adjacent to Kaula would be minimal due to implementation of guidelines established for training as described below.

Vegetation

No rare, threatened, or endangered plant species are known to occur on Kaula. Training would continue to take place at current locations; no expansion of the area would occur. All participants would continue to be briefed on current guidelines to avoid undue impacts on vegetation. Training would comply with relevant Navy, NMFS, and USFWS policies and procedures during these increased training events.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The additional training would comply with relevant Navy, NMFS, and USFWS policies and procedures, which would minimize the potential for effects on wildlife. All participants would continue to be briefed on current guidelines to avoid undue impacts on wildlife.

4.3.2.10.2.3 Alternative 2 (Biological Resources—Kaula)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of training events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c). An increased tempo and frequency of GUNEX and inert ordnance target practice would possibly result in an increased loss of individual birds. However, no potential impacts are foreseen to migratory seabird populations, which appear to be healthy and reproducing normally.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

The Major Exercises proposed might require an additional number of training events at Kaula. However, effects on birds and other wildlife would be minor and similar to those occurring during current Major Exercises, as described above.

4.3.2.10.2.4 Alternative 3 (Biological Resources—Kaula)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in

Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on vegetation and wildlife under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.10.3 Cultural Resources—Kaula

4.3.2.10.3.1 No-action Alternative (Cultural Resources—Kaula)

HRC Training—No-action Alternative

BOMBEX and GUNEX

The southwestern tip of Kaula (a 10-acre ordnance impact zone) is used for BOMBEX and GUNEX activities. The impact zone has only been partially surveyed for cultural resources because of the presence of unexploded ordnance; however, there are no known sites within that area. The remainder of the islet displays no evidence of long-term human habitation; however, six archaeological sites recorded in the northern portion indicate some level of visitation. None of the identified sites have been recommended as eligible for inclusion in the NRHP. As a result, training events on Kaula will have no impacts on cultural resources.

Major Exercises—No-action Alternative

BOMBEX and GUNEX are elements of Major Exercises (e.g., RIMPAC) and have been analyzed in the above discussion on HRC training. These training events are restricted to the southwestern tip of Kaula and will have had no impacts on cultural resources.

4.3.2.10.3.2 Alternative 1 (Cultural Resources—Kaula)

Increased Tempo and Frequency of Training—Alternative 1

Increased tempo and frequency of training would not affect Kaula. Training events are confined to the impact zone at the southwestern tip of the island where there are no known cultural resources. Ongoing training events have not been found to have any effect on cultural resources, and an increased frequency or tempo would also have no effects.

4.3.2.10.3.3 Alternative 2 (Cultural Resources—Kaula)

Increased Tempo and Frequency of Training—Alternative 2

Increased frequency or tempo of training would not have new or additional effects at Kaula. Ongoing training events have not been found to have any effect on cultural resources, and an increased frequency or tempo would also have no effects.

4.3.2.10.3.4 Alternative 3 (Cultural Resources—Kaula)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.10.4 Geology and Soils—Kaula

4.3.2.10.4.1 No-action Alternative (Geology and Soils—Kaula)

HRC Training—No-action Alternative

Training will include the continued use of the southeast end of Kaula for bombing and Air-to-Ground GUNEX training. Permanent adverse soil and geologic effects have been noted by the Navy resulting from shattering of rocks in explosions and the possibility of inert ordnance (duds), which may remain in the target area (U.S. Department of the Navy, 1980). The Navy minimizes the impact by managing the targeting to the southeast tip of the island, approximately 8 percent of the island land area (U.S. Department of the Navy, 1980).

Major Exercises—No-action Alternative

Major Exercises will include the continued use of the southeast end of Kaula for bombing and Air-to-Ground GUNEX training. Impacts will be the same as described above for training.

4.3.2.10.4.2 Alternative 1 (Geology and Soils—Kaula)

Increased Tempo and Frequency of Training—Alternative 1

Increased tempo and frequency of training would have similar impacts on those described under the No-action Alternative.

Major Exercises—Alternative 1

Major Exercises such as RIMPAC and USWEX would include the continued use of the southeast end of Kaula for bombing and Air-to-Ground GUNEX training. Impacts would be the same as described for the No-action Alternative.

4.3.2.10.4.3 Alternative 2 (Geology and Soils—Kaula)

Increased Tempo and Frequency of Training—Alternative 1

Increased tempo and frequency of training would have similar impacts on those described under the No-action Alternative.

Additional Major Exercises—Multiple Strike Group Training—Alternative 1

Major Exercises would include Multiple Strike Group training that could include the continued use of the southeast end of Kaula for bombing and Air-to-Ground GUNEX training. Impacts would be the same as described for the No-action Alternative.

4.3.2.10.4.4 Alternative 3 (Geology and Soils—Kaula)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of

Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on geology and soils under Alternative 3 would be the same as those described for Alternative 2.

4.3.2.10.5 Health and Safety—Kaula

4.3.2.10.5.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Kaula)

Under the No-action Alternative, Kaula will continue to be used for aircraft gunnery and inert ordnance target practice. To minimize health and safety risks, a Surface Danger Zone has been established around the island, and the island and surrounding tidal zone are closed to unauthorized personnel. In addition, prior to any gunnery activities, an aircraft flies over the island and determines if it is safe to conduct the mission. While Alternatives 1, 2, and 3 would result in the total number of Major Exercises and training events increasing, the health and safety concerns would be similar to existing concerns, and existing SOPs and procedures would be used.

4.3.2.10.6 Land Use—Kaula

4.3.2.10.6.1 No-action Alternative (Land Use—Kaula)

HRC Training—No-action Alternative

The No-action Alternative stands as no change from current levels of training usage, and the Navy will continue its current activities in the HRC. Approximately 10 acres of the 108-acre island of Kaula will continue to be used for Bombing Exercises and Air-to-Ground GUNEX (Table 2.2.2.3-1). The State has included the island within the conservation protective subzone use designation, which will limit any development on the island. The open undeveloped conservation use and designation of the island is compatible with the Navy's gunnery practice activities. According to the Hawaii Department of Land and Natural Resources, the Hawaii State Seabird Sanctuary consists of and includes 40 State-owned or controlled islands, islets, and rocks (Hawaii Department of Land and Natural Resources, 1981). Kaula was listed erroneously by the State as one of these islands; it remains Federally owned and controlled. Training at Kaula will continue to be consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program. Under the No-action Alternative, the land-based use of Kaula will not change.

4.3.2.10.6.2 Alternative 1 (Land Use—Kaula)

Increased Tempo and Frequency of Training—Alternative 1

Under Alternative 1, the number of training events for bombing and Air-to-Ground GUNEX associated with STW would increase. STW includes the bombing activities, which would increase by approximately 31 percent and the Air-to-Ground GUNEX, which would increase by approximately 13 percent on Kaula. Overall, the increase in activities would not change or alter land use on Kaula.

Major Exercises—Alternative 1

STWs and CASEX are activities included in Major Exercises that would continue to be supported at Kaula. The land-base use of Kaula would not change under Major Exercises.

4.3.2.10.6.3 Alternative 2 (Land Use—Kaula)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the number of BOMBEX (land) would increase by approximately 52 percent and Air-to-Ground GUNEX would increase by 13 percent. Under Alternative 2 the increase in training would not change or alter land-base use on Kaula.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would conduct training simultaneously in the HRC (Figure 1.2-3) The Strike Groups would not be homeported in Hawaii, but would stop in Hawaii en route to a final destination. The Strike Group would be in Hawaii for up to 10 days per year. Under Alternative 2, BOMBEX (land) would increase by approximately 52 percent and Air-to-Ground GUNEX would increase by 13 percent. These increases in training events would not change or alter land-based use on Kaula.

4.3.2.10.6.4 Alternative 3 (Land Use—Kaula)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (as described in Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities, and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on land use under Alternative 3 would be the same as those described for Alternative 2.

4.4 OAHU

4.4.1 OAHU OFFSHORE

4.4.1.1 PUULOA UNDERWATER RANGE—OFFSHORE

Table 4.4.1.1-1 lists ongoing training and research, development, test and evaluation (RDT&E) activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2 and 3 at the Puuloa Underwater Range. Alternative 3 is the preferred alternative.

Table 4.4.1.1-1. Training and RDT&E Activities at Puuloa Underwater Range—Offshore

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Mine Neutralization	• Mobile Diving and Salvage Unit Training Area
• Special Warfare Operations (SPECWAROPS)	
• Salvage Operations	

A review of the 13 resources against offshore training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Puuloa Underwater Range. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emission sources associated with Puuloa Underwater Range. Use of the Puuloa Underwater Range would not require control of the airspace offshore. Training and RDT&E activities associated with this site would adhere to policies and regulations governing noise, as discussed in Appendix C.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population at the Puuloa Underwater Range is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training and RDT&E activities at the site would not generate any hazardous waste streams that could impact local water quality. Additionally, there is no planned construction or alteration that would affect land forms, geology, and associated soils.

4.4.1.1.1 Biological Resources—Puuloa Underwater Range—Offshore

4.4.1.1.1.1 No-action Alternative (Biological Resources—Puuloa Underwater Range—Offshore)

HRC Training and Major Exercises—No-action Alternative

Under the No-action Alternative, up to 62 Mine Neutralization training activities per year will continue to occur at locations such as Puuloa Underwater Range, or about 5 to 6 per month. Mine Neutralization activities involve the detection, identification, evaluation, rendering safe, and disposal of mines and unexploded ordnance (UXO) that constitutes a threat to ships or personnel. Mine Neutralization training involves a diver placing a specific amount of explosives which, when detonated underwater at a specific distance from a mine, results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by fleet ships in open-ocean areas are detonated at the surface. In support of a military Expeditionary Assault, the Navy deploys in very shallow water depths (10 to 40 feet [ft]) to locate mines and obstructions. Training uses explosives charges of no more than 20 pounds (lb) net explosive weight. High-order detonations result in almost complete conversion of explosives (99.997 percent or more [U.S. Army Corps of Engineers, 2003]) into such inorganic compounds as water, carbon dioxide, carbon monoxide, and nitrogen. This is further discussed in Section 4.4.1.1.3.1. Training will follow the relevant Navy policies and procedures to minimize impacts on biological resources.

Prior to actual detonation, the area is determined to be clear of marine mammals and sea turtles. When the divers enter the water, they have an opportunity to detect marine mammals and humpback whales visually or audibly (if the whales are vocalizing). The training does not proceed if marine mammals are in the vicinity. The delay between initiating the fuse and the detonation of the explosives is only 30 minutes, minimizing the opportunity for marine mammals to enter the area. Given the relatively small size of the charge, the area within which marine mammals would be at risk from the explosive is quite limited. Standard procedures require tethered mines to be suspended at least 10 ft below the surface of the water. Impacts on marine mammals and sea turtles from underwater explosions are discussed in Section 4.1.2. Only sandy areas that avoid/minimize potential impacts on coral are used for explosive charges on the shallow water floor (less than 40 ft of water).

Salvage Operations take place in any of the shoal waters, harbors, ports, and in-land waterways throughout the Hawaii Range Complex (HRC). The Navy's Mobile Diving and Salvage Unit One (MDSU-1) and divers from other countries practice ship and barge salvage, towing, battle damage repair, deep ocean recovery, harbor clearance, removal of objects from navigable waters, and underwater ship repair capabilities. Staging for these activities is from the MDSU-1 Facility located on the southwestern side of Hickam Air Force Base (AFB). Small cutting charges may be used during Salvage Operations training. There can be minor and localized loss of some fish and benthic community populations from the explosions. All waters around Naval Station Pearl Harbor have been designated as Essential Fish Habitat (EFH) for eggs and larvae of a number of species. The harbor has not been designated as a Habitat Area of Particular Concern. (U.S. Department of the Navy, Commander Navy Region Hawaii, 2001) After training involving underwater detonations is complete, the area will be searched for injured animals.

Because of the diluting affects of ocean currents and the distance from the range, demolition activities are not expected to impact the aquaculture farm located 0.5 nautical mile (nm) outside the range boundary. Any effects from noise, shock, or residual chemicals will be localized and temporary.

Special Warfare Operations (SPECWAROPS) are performed by Navy Sea, Air and Land (SEALs) and U.S. Marines. Activities include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access using a boat. The training events involve fewer than 20 troops and have minimal interaction with the environment, since one of the purposes of the training event is to operate undetected. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Department of the Navy, 2002a)

Potential effects on marine biological resources from mid-frequency active/high-frequency active (MFA/HFA) sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.1.1.2 Alternative 1 (Biological Resources—Puuloa Underwater Range—Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six Undersea Warfare Exercises (USWEXs) per year, the biennial Rim of the Pacific (RIMPAC) exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training events (See Table 2.2.2.3-1). No increase in the training events performed in the Puuloa Underwater Range is anticipated. Impacts on biological resources would be similar to those described previously for the No-action Alternative. Impacts on marine mammals, sea turtles, and fish from underwater sound levels produced by the use of MFA/HFA sonar and from underwater explosions are discussed in Section 4.1.2.

HRC Enhancements—Alternative 1

The Navy would establish an underwater training area in which MDSU-1 can conduct military diving and salvage training, including submerging a 100-ft by 50-ft vessel. Prior to the sinking of any vessels or deployment of steel frames for Naval Special Warfare exercises, environmental documents would be developed and reviewed as appropriate. The Navy would begin early coordination with regulatory agencies as applicable to reduce environmental impacts and to assist with the development of any required mitigative measures. Figure 2.2.3.6.2-2 shows three proposed locations (Sites A, B, and C) with Site B (in the Naval Defensive Sea Area) being the preferred location. Site C is located within the Puuloa Range. The vessel would be placed within a 328- by 328-ft area. The type of training to be conducted would consist of various underwater projects designed to develop mission critical skills, such as hot tapping, welding, cutting, patching, plugging, drilling, tapping, and grinding. Sensitive biological resource areas and species would be avoided during the establishment of this training area. Impacts would be similar to those from Salvage Operations.

The Navy proposes to develop targets and support target maintenance for exposed beach obstacles and fortified beach or offshore defenses, at least some of which must be cleared for live Naval Special Warfare (NSW) weapons and explosives. NSW targets are steel frames and shapes that can be lowered into the water to simulate hulls of ships, or amphibious obstacles. Explosive Ordnance Disposal (EOD) targets would be inert mine and bomb shapes. Some targets would be removed following the training. Others, including NSW obstacles and EOD targets, would be destroyed in place and are not recoverable. Impacts would be similar to those from Mine Neutralization and Salvage Operations.

4.4.1.1.1.3 Alternative 2 (Biological Resources—Puuloa Underwater Range—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of training events could also increase, including an additional six Mine Neutralization training events. Since Mine Neutralization training events occur in other areas of the HRC, not all of the additional six per year would necessarily take place in the Puuloa Underwater Range. Prior to actual detonation, the area would be determined as clear of marine mammals. Explosive charges, in less than 40 ft of water, would be placed/neutralized only in sandy areas to avoid/minimize potential impacts on coral. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.1.1.1.4 Alternative 3 (Biological Resources—Puuloa Underwater Range—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.1.2 Cultural Resources—Puuloa Underwater Training Range—Offshore

4.4.1.1.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Puuloa Underwater Training Range—Offshore)

No known cultural resources exist in the Puuloa Underwater Range. The area has been used for underwater demolition training for many years, and no impacts on cultural resources have been identified. No impacts on cultural resources will occur from either the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.4.1.1.3 Hazardous Materials and Waste—Puuloa Underwater Range—Offshore

4.4.1.1.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Puuloa Underwater Range—Offshore)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Under the No-action Alternative and Alternative 1, approximately 62 Mine Neutralization training events per year will occur at Puuloa Underwater Range, or about 5 to 6 per month. Under Alternatives 2 and 3, approximately 68 Mine Neutralization training events per year could occur. In addition, one salvage training event per year can be held on this range under the No-action Alternative or Alternative 1, Alternative 2, or Alternative 3. Training will use explosives charges of no more than 20 lb each, net explosive weight.

The major explosive byproducts of organic nitrated compounds such as trinitrotoluene (TNT), cyclotrimethylenetrinitramine, and Royal Demolition Explosive (RDX) include water, carbon dioxide, carbon monoxide, and nitrogen (Department of Health and Human Services, Agency for Toxic Substance and Disease Registry, 2003; Renner and Short, 1980; Cook and Spillman, 2000). High-order detonations result in almost complete conversion of explosives (99.997% or more [U.S. Army Corps of Engineers, 2003]) into such inorganic compounds. Table 4.4.1.1.3-1 lists the calculated chemical byproducts of high-order underwater detonation of TNT, RDX, and related materials.

Table 4.4.1.1.3-1: Chemical Byproducts of Underwater Detonations

Byproduct	Percent by Weight, by Explosive Compound			
	TNT	RDX	Composition B	PBX
Nitrogen	18.2	37.0	29.3	33.2
Carbon dioxide	27.0	24.9	34.3	32.0
Water	5.0	16.4	8.4	13.2
Carbon monoxide	31.3	18.4	17.5	7.1
Carbon (elemental)	10.6	-	2.3	3.2
Ethane	5.2	1.6	5.4	7.1
Hydrogen	0.2	0.3	0.1	0.1
Propane	1.6	0.2	1.8	2.8
Ammonia	0.3	0.9	0.6	1
Methane	0.2	0.2	0.2	0.1
Hydrogen cyanide	<0.0	<0.0	<0.0	<0.0
Methyl alcohol	<0.0	<0.0	-	-
Formaldehyde	<0.0	<0.0	<0.0	<0.0
Other compounds	<0.0	<0.0	<0.0	<0.0

Source: Renner and Short, 1980

Explosives use will total about 1,240 lb per year under the No-action Alternative and Alternative 1, and about 1,360 lb per year under Alternative 2 and Alternative 3. The transport, handling, and use of such modest quantities of hazardous materials by trained Navy personnel on an infrequent basis, primarily within Navy-controlled areas, will have no effect on ongoing hazardous materials management activities. No hazardous wastes would be generated by these training events.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and, in some cases, RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Strike Groups would conduct limited, short-term Demolition and SPECWAROPS at Puuloa Range. The potential impacts of Major Exercises will be similar to those described above for training and RDT&E activities.

4.4.1.1.4 Health and Safety—Puuloa Underwater Range—Offshore

4.4.1.1.4.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Puuloa Underwater Range—Offshore)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Underwater Demolition activities at Puuloa Underwater Range under the No-action Alternative and Alternative 1 will consist of up to 62 training events per year, using no more than 20 lb net explosive weight of ordnance. Under Alternative 2 and Alternative 3, up to 68 Mine Neutralization events per year could occur. In addition, one salvage training event per year can be held on this range under the No-action Alternative or Alternative 1, Alternative 2, or Alternative 3.

The public will not be exposed to the energetic effects of the detonations because the range will be cleared, and these effects will be completely contained within the range. Existing Navy safety protocols for the use of explosives will ensure that no non-participants will be in the area during training. The Coast Guard is notified of each planned detonation.

Demolition activities will be conducted in accordance with Commander, Naval Surface Force, U.S. Pacific Fleet (COMNAVSURFPAC) Instruction 3120.8F (U.S. Department of the Navy, 1993). COMNAVSURFPAC Instruction 3120.8F specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and, in some cases, RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Strike Groups would conduct limited, short-term Demolition and SPECWAROPS at Puuloa Range. The potential impacts of Major Exercises will be similar to those described above for training and RDT&E activities.

4.4.1.2 NAVAL DEFENSIVE SEA AREA—OFFSHORE

Table 4.4.1.2-1 lists ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2 and 3 offshore at the Naval Defensive Sea Area. Alternative 3 is the preferred alternative.

Table 4.4.1.2-1. Training and RDT&E Activities at Naval Defensive Sea Area—Offshore

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Salvage Operations	• Mobile Diving and Salvage Unit Training Area (Alternative 1)

A review of the 13 resources against offshore training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Naval Defensive Sea Area. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and waste, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emission sources associated with the Naval Defensive Sea Area. Use of this site would not require control of the airspace offshore. Training and RDT&E activities associated with this site would adhere to policies and regulations governing noise and hazardous materials and waste, as discussed in Appendix C.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population at the Naval Defensive Sea Area is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training and RDT&E activities at the site would not generate any hazardous waste streams that could impact local water quality. Additionally, there is no planned construction or alteration that would affect land forms, geology, and associated soils.

4.4.1.2.1 Biological Resources—Naval Defensive Sea Area—Offshore

4.4.1.2.1.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Biological Resources—Naval Defensive Sea Area—Offshore)

Potential effects on marine biological resources from MFA/HFA sonar usage determined for the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 are discussed in the applicable Open Ocean sections.

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Current Salvage Operations have not resulted in any significant impacts on the four endangered waterbirds that have been identified in the region of influence. The green turtle has rarely been seen in the harbor and no nesting has been reported. The Hawaiian monk seal has been seen in the channel, but never reported in the harbor, and only one unusual humpback whale sighting has occurred in the region of influence.

All waters around Naval Station Pearl Harbor have been designated as Essential Fish Habitat (EFH) for eggs and larvae of a number of species. None of the current Salvage Operations have the potential to affect EFH. Acoustic effects on fish are discussed in Section 4.1.2 under Open Ocean Biological Resources. RIMPAC Exercises have procedures and practices in place to prevent the introduction of invasive species, consistent with Executive Order (EO) 13112 and Navy guidelines. The Navy requests that multinational participants purge bilge/ballasts tanks in their ships prior to entering U.S. territorial waters. The movement and berthing of ships and small training events in the harbor area are part of ongoing training at Naval Station Pearl Harbor. Marine mammal collision avoidance and encounter reporting procedures are already in place and implemented.

HRC Enhancements—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

The Navy would establish an underwater training area in which MDSU-1 can conduct military diving and salvage training, including submerging a 100-ft by 50-ft vessel. Prior to the sinking of any vessels or deployment of steel frames for Naval Special Warfare Exercises, environmental documents would be developed and reviewed as appropriate. The Navy would begin early coordination regulatory agencies as applicable to reduce environmental impacts and to assist with the development of any required mitigative measures. Figure 2.2.3.6.2-2 shows three proposed locations (Sites A, B, and C) with Site B (in the Naval Defensive Sea Area) being the preferred location. The vessel would be placed within a 328- by 328-ft area. The type of training to be conducted would consist of various underwater projects designed to develop mission critical skills, such as hot tapping, welding, cutting, patching, plugging, drilling, tapping, and grinding. Sensitive biological resource areas and species would be avoided during the establishment of this training area. Impacts would be similar to those from Salvage Operations.

4.4.1.2.2 Cultural Resources—Naval Defensive Sea Area—Offshore

4.4.1.2.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Naval Defensive Sea Area—Offshore)

No known cultural resources exist in the Naval Defensive Sea Area. The area has been used for underwater training for many years, and no impacts on cultural resources have been identified. No impacts on cultural resources will occur from either the No-action Alternative or Alternative 1, Alternative 2, or Alternative 3.

4.4.1.2.3 Health and Safety—Naval Defensive Sea Area—Offshore

4.4.1.2.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Naval Defensive Sea Area—Offshore)

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Salvage training can be held on this range under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3. The public will not be exposed to training occurring in the Naval Defensive Sea Area because the area will be cleared, and the training will be completely contained. Existing Navy safety protocols will ensure that no non-participants will be in the area during training. The Coast Guard is notified of each planned training event.

HRC Enhancements—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

In a proposed underwater training area, MDSU-1 would conduct military diving and salvage training, including submerging a 100-ft by 50-ft barge. Figure 2.2.3.6.2-2 shows the alternative sites in the Naval Defensive Sea Area. The type of training to be conducted would consist of various underwater projects designed to develop mission critical skills, such as hot tapping, welding, cutting, patching, plugging, drilling, tapping, and grinding. Because the Navy has jurisdiction over the Naval Defensive Sea Area, the proposed training would be restricted to vessels owned and operated by military and Department of Defense (DoD) personnel. The restricted access in this area would minimize the potential for public safety issues.

4.4.1.3 MARINE CORPS BASE HAWAII (MCBH)—OFFSHORE

Table 4.4.1.3-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Marine Corps Base Hawaii (MCBH). Alternative 3 is the preferred alternative.

Table 4.4.1.3-1. Training at MCBH—Offshore

Training	
• Special Warfare Operations (SPECWAROPS)	• Mine Neutralization • Expeditionary Assault

A review of the 13 resources against offshore training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for MCBH. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at MCBH from offshore training other than that from an occasional aircraft event. The aircraft events would not change regional air quality. The proposed alternatives would not affect the existing airspace structure in the region. Training associated with this site would adhere to policies and regulations governing noise and hazardous materials and waste, as discussed in Appendix C. Airspace would be affected within existing Takeoff Safety Zones and Approach-Departure Clearance Surfaces that are delineated over the runways and do not extend off-base.

Geology and soils impacts at MCBH would be limited to short-term minor disturbance of beach sand and near-shore ocean floor along existing Expeditionary Assault access routes. Movement from the beach would also result in minor, short-term disturbance to soils along pre-defined access routes. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the site would not generate any hazardous waste streams that could impact local water quality.

4.4.1.3.1 Biological Resources—MCBH—Offshore

4.4.1.3.1.1 No-action Alternative (Biological Resources—MCBH—Offshore)

HRC Training and Major Exercises—No-action Alternative

Under the No-action Alternative, up to 62 Mine Neutralization training events per year will continue to occur at MCBH, or up to about 5 to 6 per month. Mine Neutralization activities involve the detection, identification, evaluation, rendering safe, and disposal of mines and UXO that constitutes a threat to ships or personnel. Mine neutralization training involves a diver placing a specific amount of explosives which, when detonated underwater at a specific distance from a mine, results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by fleet ships in open-ocean areas are detonated at the surface. In support of a military Expeditionary Assault, the Navy deploys in very shallow water depths (10 to 40 ft) to locate mines and obstructions. Training uses explosives charges of no more than 20 lb net explosive weight. Training will follow the relevant Biological Opinions and Navy/Marine Corps policies and procedures to minimize impacts on biological resources. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Marine Corps regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Prior to actual detonation, the area is determined to be clear of marine mammals. When the divers enter the water, they have an opportunity to detect marine mammals and humpback whales visually or audibly (if the whales are vocalizing). The training does not proceed if marine mammals are in the vicinity. The delay between initiating the fuse and the detonation of the explosives is approximately 30 minutes, minimizing the opportunity for marine mammals to enter the area. Given the relatively small size of the charge, the area within which marine mammals would be at risk from the explosive is quite limited. Standard procedures require tethered mines to be suspended at least 10 ft below the surface of the water. Impacts on marine mammals and sea turtles from underwater explosions are discussed in Section 4.1.2. Only sandy areas that avoid/minimize potential impacts on coral are used for explosive charges on the shallow water floor (less than 40 feet of water).

Landing sites are selected to minimize potential impacts on exposed reefs and coral colonies, and associated benthic communities. Assault amphibious vehicles and Landing Craft, Air Cushion with drafts exceeding 6 ft could inadvertently damage live coral present in shallow offshore waters at the Hale Koa/West Field and Fort Hase beach areas. However, the Landing Craft, Air Cushion (LCAC) and Combat Rubber Reconnaissance Craft (CRRC) used have drafts less than 3 ft and are unlikely to have such impacts.

LCAC landings are allowed at Hale Koa/West Field Beach, but they are restricted from Pyramid Rock and Fort Hase beaches. The physical boundaries of the landing sites are marked to avoid impacts on live coral and unique habitats. Landing Craft, Utility (LCU) landings are restricted to Pyramid Rock Beach or the LCU ramp at the base Fuel Pier.

The purpose of most SPECWAROPS is to operate undetected. The training events generally involve fewer than 20 troops and have minimal interaction with the environment. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1997)

Expeditionary Assault activities are restricted to specific areas of designated beaches. The activities are conducted in compliance with EO 13089, *Coral Reef Protection*. Before each Expeditionary Assault is conducted, a hydrographic survey is performed to map out the precise transit routes through sandy bottom areas. Within 1 hour of initiation of the landing activities, the landing routes and beach areas are determined to be clear of marine mammals and sea turtles. If any are seen, the training event is delayed until the animals leave the area. During the landing the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. Other measures include publication of training overlays that identify the landing routes and any restricted areas. Where necessary, surveys for turtles are conducted prior to the training event so their feeding and nesting areas can be avoided. (U.S. Department of the Navy, 2002a)

Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.3.1.2 Alternative 1 (Biological Resources—MCBH—Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, their tempo may increase, but the likelihood of a similar increase in adverse impacts on biological resources is small, as discussed below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Marine Corps and Navy policies and procedures during training would minimize the potential for effects on seagrass as well as limit the potential for introduction of invasive plant species. No threatened or endangered plant species are known to occur on MCBH.

Wildlife

The increased training events would comply with relevant Marine Corps and Navy policies and procedures, which would further reduce the potential for effects on wildlife. The beach and offshore waters would continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during training. If any are seen, then the training event would be delayed until the animals leave the area. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean sections.

4.4.1.3.1.3 Alternative 2 (Biological Resources—MCBH—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of training events could also increase, including an additional six Mine Neutralization training events. Since Mine Neutralization events occur in other areas of the HRC, not all of the additional six per year would necessarily take place in the MCBH. Prior to actual detonation, the area would be determined to be clear of marine mammals. Explosive charges, in less than 40 ft of water, would be placed/neutralized only in sandy areas to avoid/minimize potential impacts on coral. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.1.3.1.4 Alternative 3 (Biological Resources—MCBH—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.1.3.2 Cultural Resources—MCBH—Offshore

4.4.1.3.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—MCBH—Offshore)

According to the National Oceanic and Atmospheric Administration's (NOAA's) location maps there are several shipwrecks and Native Hawaiian fishponds in the vicinity of MCBH (see Figures 3.1.3-2 and 3.4.1.3.2-1); however, none are located within the direct offshore region of influence for HRC training. In the event unanticipated cultural remains are identified, all training will cease in the immediate vicinity and the Hawaii State Historic Preservation Officer (SHPO) immediately notified in accordance with the Programmatic Agreement (see Appendix H). No impacts on cultural resources would occur as a result of the additional training events and frequency of conducting those training events under Alternative 1, Alternative 2, and Alternative 3.

4.4.1.4 MARINE CORPS TRAINING AREA/BELLOWS (MCTAB)—OFFSHORE

Table 4.4.1.4-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Marine Corps Training Area/Bellows (MCTAB). Alternative 3 is the preferred alternative.

Table 4.4.1.4-1. Training Offshore of MCTAB—Offshore

Training	
• Expeditionary Assault	• Swimmer Insertion/Extraction
• Mine Neutralization	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against offshore training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for MCTAB. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at MCTAB from training other than that from an occasional Aircraft Operation. The Aircraft Operations would not change regional air quality. Airspace use at MCTAB is limited to rotary wing aircraft. The proposed alternatives would not affect the existing airspace structure in the region.

Training associated with this site would adhere to policies and regulations governing noise and hazardous materials and waste, as discussed in Appendix C. Geology and soils impacts at MCTAB–Offshore would be limited to short-term minor disturbance of beach sand and offshore ocean floor along existing Expeditionary Assault access routes. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the site would not generate any hazardous waste streams that could impact local water quality.

4.4.1.4.1 Biological Resources—MCTAB—Offshore

4.4.1.4.1.1 No-action Alternative (Biological Resources—MCTAB—Offshore)

HRC Training and Major Exercises—No-action Alternative

Under the No-action Alternative, up to 62 Mine Neutralization training events per year will continue to occur at MCTAB, or up to about 5 to 6 per month. Mine Neutralization activities are described in Section 4.4.1.2.1.1. Training will follow the relevant Biological Opinions and Navy/Marine Corps policies and procedures to minimize impacts on biological resources. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Marine Corps regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Prior to actual detonation, the area is determined to be clear of marine mammals. When the divers enter the water, they have an opportunity to detect marine mammals and humpback whales visually or audibly (if the whales are vocalizing). The training event does not proceed if marine mammals are in the vicinity. The delay between initiating the fuse and the detonation of the explosives is only 30 minutes, minimizing the opportunity for marine mammals to enter the area. Given the relatively small size of the charge, the area within which marine mammals would be at risk from the explosive is quite limited. Standard procedures require tethered mines to be suspended at least 10 ft below the surface of the water. Impacts on marine mammals and sea turtles from underwater explosions are discussed in Section 4.1.2. Only sandy areas that avoid/minimize potential impacts on coral are used for explosive charges on the shallow water floor (less than 40 ft of water).

Landing sites are selected to minimize potential impacts on exposed reefs and coral colonies, and associated benthic communities. The physical boundaries of the landing sites are marked to avoid impacts on live coral and unique habitats. There are no live coral colonies along the coastal areas because of shifting sand and scouring caused by wave action. Impacts on live coral further seaward from tracked vehicles are minimized by use of regular transit routes through sandy bottom areas.

Green turtles occur frequently in the offshore water, and hawksbill turtles occasionally feed in these waters. Hawaiian monk seals have also been sighted in the area. An occasional humpback whale could use Waimanalo Bay. Well-trained crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals, or sea turtles. The landing routes and beach areas will continue to be determined clear of marine mammals and sea turtles within 1 hour of the landing activities. If any are seen, the training event will be delayed until the animals leave the area.

The purpose of most SPECWAROPS is to operate undetected. The training event generally involves fewer than 20 troops and has minimal interaction with the environment. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1997)

Expeditionary Assault activities are restricted to specific areas of designated beaches. The activities are conducted in compliance with EO 13089, *Coral Reef Protection*. Before each Expeditionary Assault is conducted, a hydrographic survey is performed to map out the precise transit routes through sandy bottom areas. Within 1 hour of initiation of the landing activities, the landing routes and beach areas are determined to be clear of marine mammals and sea turtles. If any are seen, the training event is delayed until the animals leave the area. During the landing the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. Other measures include publication of training overlays that identify the landing routes and any restricted areas. Where necessary, surveys for turtles are conducted prior to the training event so their feeding and nesting areas can be avoided. (U.S. Department of the Navy, 2002a)

Naval Special Warfare personnel conduct underwater swimmer insertion and extraction training in the Hawaii Offshore Areas using either the Sea, Air, Land (SEAL) Delivery Vehicle (SDV), or the Advanced SEAL Delivery System (ASDS). Both submersibles are designed to deliver Special Operations forces for clandestine activities.

Underwater Swimmer Insertion and Extraction training focuses on undersea use of the SDV or ASDS, and does not typically involve SEAL personnel landing ashore or conducting shore training. Although undersea range areas are usually reserved for a 24-hour period, the insertion/extraction training event itself lasts approximately 8 hours. Swimmer insertion and extraction training can also include the use of helicopters to insert or extract personnel using a variety of techniques.

To further minimize potential impacts on biological resources, instructions to Service elements engaged in Swimmer Insertion/Extraction, Expeditionary Assault, and Mine Neutralization activities will include:

- Conducting surveys prior to use of amphibious launch vehicles to ensure that humpback whales are not disturbed.
- Establishing buffer zones in locations where green sea turtles are known to feed so that Amphibious Landing training events do not disturb these areas.
- Marking and monitoring green turtle nests discovered on beaches so they are not affected by training.

Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.4.1.2 Alternative 1 (Biological Resources—MCTAB—Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, their tempo may, but the likelihood of a similar increase in adverse impacts on biological resources is small, as discussed below.

Vegetation

Training would take place at existing locations; no expansion of the area would be involved. Compliance with relevant Marine Corps and Navy policies and procedures during training would minimize the potential for effects on seagrass as well as limit the potential for introduction of invasive plant species. No threatened or endangered plant species are known to occur on MCTAB.

Wildlife

The increased training events would comply with relevant Marine Corps and Navy policies and procedures, which would further reduce the potential for effects on wildlife. The beach and offshore waters would continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during training. If any are seen, then the training event would be delayed until the animals leave the area. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean sections.

4.4.1.4.1.3 Alternative 2 (Biological Resources—MCTAB—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and an additional six Mine Neutralization events would occur. Since Mine Neutralization events occur in other areas of the HRC, not all of the additional six per year would necessarily take place in the MCTAB. Prior to actual detonation, the area would be determined as clear of marine mammals. Explosive charges, in less than 40 ft of water, would be placed/neutralized only in sandy areas to avoid/minimize potential impacts on coral. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.1.4.1.4 Alternative 3 (Biological Resources—MCTAB—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.1.4.2 Cultural Resources—MCTAB—Offshore

4.4.1.4.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—MCTAB—Offshore)

According to NOAA's location maps there are several shipwrecks and Native Hawaiian fishponds in the vicinity of MCTAB (see Figure 3.1.3-2 and 3.4.1.3.2-1); however, none are located within the direct offshore region of influence for HRC training. In the event unanticipated cultural remains are identified, all training will cease in the immediate vicinity and the Hawaii SHPO will be immediately notified. The nearest cultural resources include scattered shipwrecks in nearby waters (see Figure 3.1.3-2). With the implementation of established procedures, no impacts on cultural resources would occur during HRC training.

4.4.1.5 MAKUA MILITARY RESERVATION—OFFSHORE

Table 4.4.1.5-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Makua Military Reservation. Alternative 3 is the preferred alternative.

Table 4.4.1.5-1. Training at Makua Military Reservation—Offshore

Training
• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against offshore training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Makua Military Reservation. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, land use, noise, socioeconomics, transportation, utilities, and water resources.

There are no air emission issues from HRC training associated with Makua Military Reservation. There would be no airspace use. Geology and soils impacts would be limited to short-term minor disturbance of beach sand and near-shore ocean floor along existing SPECWAROPS access routes. Movement from the beach would also result in minor, short-term disturbance to soils along pre-defined access routes.

Water resources at Makua Military Reservation would not be affected by the short-term temporary foot traffic during the SPECWAROPS. Training associated with this site adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise as discussed in Appendix C. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative.

4.4.1.5.1 Biological Resources—Makua Military Reserve—Offshore

4.4.1.5.1.1 No-action Alternative (Biological Resources—Makua Military Reservation—Offshore)

HRC Training and Major Exercises—No-action Alternative

The National Centers for Coastal Ocean Science/NOAA benthic habitat maps show no coral reefs along the western side of Oahu from the Naval Reservation to the Makua Military Reservation. The only non-listed marine mammals potentially present in the region of influence are the bottlenose dolphin and rough-toothed dolphin (U.S. Department of the Navy, 2005b).

The only threatened and endangered marine mammals potentially present in the region of influence are the Hawaiian monk seal and the humpback whale (U.S. Department of the Navy, 2005b). Of the five species of sea turtles that occur in Hawaiian waters, only the green turtle and rarely the leatherback turtle are likely to be in the region of influence (U.S. Department of the Army, 2005).

The purpose of most SPECWAROPS is to operate undetected. The training event generally involves fewer than 20 troops and has minimal interaction with the environment. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Training will follow the relevant Biological Opinions and Army policies and procedures to minimize impacts on biological resources. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1997)

Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.5.1.2 Alternative 1 (Biological Resources—Makua Military Reservation—Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events at Makua would not increase in number, their tempo may increase, but the likelihood of a similar increase in adverse impacts on biological resources is small, as described below.

Vegetation

Training would take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy guidelines, and other applicable Army procedures, during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive algal species.

Wildlife

The beach and offshore waters would continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during training. If any are seen, then the training event would be delayed until the animals leave the area. Impacts are similar to those in Section 4.4.1.1.1.1. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean sections.

4.4.1.5.1.3 Alternative 2 (Biological Resources—Makua Military Reservation—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased but the frequency of training events would not change. Training would continue to take place at existing locations; no expansion of the area would be involved. With the exception of impacts associated with MFA sonar use (Section 4.1.2), impacts on biological resources would be the same as those discussed in Section 4.4.1.5.1.1. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.1.5.1.4 Alternative 3 (Biological Resources—Makua Military Reservation—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.5.2 Cultural Resources—Makua Military Reservation—Offshore

4.4.1.5.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Makua Military Reservation—Offshore)

According to NOAA's location map there are several shipwrecks in the vicinity of Makua Military Reservation (see Figure 3.1.3-2); however, none are located within the direct offshore region of influence for HRC training. However, in the event unanticipated cultural remains are identified, all training will cease in the immediate vicinity and the Hawaii SHPO will be immediately notified. With the implementation of established procedures no impacts on underwater cultural resources would occur during HRC training.

4.4.1.6 DILLINGHAM MILITARY RESERVATION—OFFSHORE

Table 4.4.1.6-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Dillingham Military Reservation. Alternative 3 is the preferred alternative.

Table 4.4.1.6-1. Training at Dillingham Military Reservation—Offshore

Training
• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against offshore training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Dillingham Military Reservation. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at Dillingham Military Reservation from offshore training other than that from an occasional Aircraft Operation. The Aircraft Operations would not change regional air quality. There would be only localized use of rotary wing aircraft within pre-defined areas. Most training would be conducted at night when the airfield is not in use. Geology and soils impacts would be limited to short-term minor disturbance of beach sand and offshore ocean floor along existing SPECWAROPS access routes.

Water resources at Dillingham Military Reservation would not be affected by the short-term temporary foot traffic during the SPECWAROPS. Training associated with this site adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise as discussed in Appendix C. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative.

4.4.1.6.1 Biological Resources—Dillingham Military Reservation—Offshore

4.4.1.6.1.1 No-action Alternative (Biological Resources—Dillingham Military Reservation—Offshore)

HRC Training and Major Exercises—No-action Alternative

Vegetation

SPECWAROPS activities at the range include a reconnaissance and survey mission, and a tactical aircrew recovery event. All participants in training are to adhere to the Navy's guidelines as well as the relevant Biological Opinions and Army policies and procedures to minimize potential impacts on the endangered vegetation, as well as limit the potential for introduction of invasive plant species. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Wildlife

SPECWAROPS activities generally include reconnaissance activities and a helicopter raid. Short helicopter hovering periods could result in noise levels at ground level of 88 decibels (dB). Although these noise levels can cause flushing of individual birds, such as the endangered `alae ke`oke`o (Hawaiian coot), `alae`ula (Hawaiian moorhen), koloa maoli (Hawaiian duck), and nene (Hawaiian goose), the effects are temporary.

Because Dillingham Military Reservation is adjacent to a small segment of beachfront, a portion of the region of influence extends to the offshore waters. Humpback whales and several dolphin species are often present in the region of influence. Hawaiian monk seals and green turtles also have the potential to occur. All training participants are briefed on resource protection guidelines for training on Oahu, which minimizes the potential for harm to endangered species. The beach and offshore waters are monitored for the presence of marine mammals and sea turtles 1 hour before and during Major Exercises. If any are seen, the training event is delayed until the animals leave the area. Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.6.1.2 Alternative 1 (Biological Resources—Dillingham Military Reservation—Offshore)

Increased Tempo Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). SPECWAROPS training would remain at 30 per year for all of the HRC. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean sections.

Vegetation

Impacts on vegetation would be similar to those described previously for the No-action Alternative.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased training would comply with relevant Army and Navy policies and procedures, which would further reduce the potential for effects on wildlife. The beach and offshore waters would continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during an increase in Major Exercises. If any are seen, the training event would be delayed until the animals leave the area.

4.4.1.6.1.3 Alternative 2 (Biological Resources—Dillingham Military Reservation—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased, but the frequency of training events would remain at 30 per year for all of the HRC. With the exception of impacts associated with MFA sonar use (Section 4.1.2), impacts on vegetation and wildlife would be similar to those described previously for the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.1.6.1.4 Alternative 3 (Biological Resources—Dillingham Military Reservation—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.6.2 Cultural Resources—Dillingham Military Reservation—Offshore

4.4.1.6.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Dillingham Military Reservation—Offshore)

Underwater cultural resources within the offshore Dillingham region of influence include scattered shipwrecks (Figure 3.1.3-2); none of which are known to have been evaluated for eligibility in the National Register of Historic Places (NRHP). In the event cultural materials are unexpectedly encountered during SPECWAROPS (particularly human remains), training in the vicinity of the find will cease and the appropriate military branch protocols would be followed. If the find is made by Marine Corps or Navy personnel, the Hawaii SHPO will be immediately notified in accordance with the Programmatic Agreement (see Appendix H). If the find is unexpectedly encountered during Army activities, the Schofield Barracks Cultural Resources Manager will be immediately notified.

4.4.1.7 EWA TRAINING MINEFIELD—OFFSHORE

Table 4.4.1.7-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Ewa Training Minefield. Alternative 3 is the preferred alternative.

Table 4.4.1.7-1. Training at Ewa Training Minefield—Offshore

Training	
• Mine Neutralization	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against offshore training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Ewa Training Minefield. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would not be any air emission sources from HRC training associated with the Ewa Training Minefield. Use of this site would not require control of the airspace above this area. Training associated with Ewa Training Minefield adheres to policies and regulations governing noise, as discussed in Appendix C. There are no prehistoric, historic, or archaeological sites associated with Ewa Training Minefield. Additionally, there is no planned construction or alteration associated with the Navy that would affect the land use, land forms, geology, and associated soils development.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the Ewa Training Minefield would not generate any waste streams that could impact local water quality.

4.4.1.7.1 Biological Resources—Ewa Training Minefield—Offshore

4.4.1.7.1.1 No-action Alternative (Biological Resources—Ewa Training Minefield—Offshore)

HRC Training and Major Exercises—No-action Alternative

No Mine Neutralization is planned for the Ewa Training Minefield. However, if performed, no more than 20 lb net explosive weight of ordnance will be used. Training will follow Navy procedures to minimize impacts on biological resources. There can be minor and localized loss of some fish and benthic populations from the explosions. After training involving underwater detonations, the area is searched for injured animals. Impacts will be similar to those discussed in Section 4.4.1.1.1.1. Impacts on marine mammals and sea turtles from MFA/HFA sonar usage and from underwater explosions are discussed in Section 4.1.2. Only sandy areas that avoid/minimize potential impacts on coral are used for explosive charges on the shallow water floor (less than 40 ft of water).

4.4.1.7.1.2 Alternative 1 (Biological Resources—Ewa Training Minefield—Offshore)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events in general would increase in number, the likelihood of a similar increase in the potential for impacts on biological resources at the Ewa Training Minefield is small, as described above for the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean sections.

4.4.1.7.1.3 Alternative 2 (Biological Resources—Ewa Training Minefield—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. While training events in general would increase in number, the likelihood of a similar increase in the potential for impacts on biological resources at the Ewa Training Minefield is small, as described above for the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above for the No-action Alternative.

4.4.1.7.1.4 Alternative 3 (Biological Resources—Ewa Training Minefield—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.7.2 Hazardous Materials and Waste—Ewa Training Minefield—Offshore

4.4.1.7.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Ewa Training Minefield—Offshore)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3, underwater demolition training, if held, will use explosives charges of no more than 20 lb each, net explosive weight. The transport, handling, and use of such quantities of hazardous materials on an infrequent basis will have no effect on ongoing hazardous materials management activities. No hazardous wastes will be generated by these training events.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and, in some cases, RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Carrier Strike Groups will conduct no Demolition and SPECWAROPS at Ewa. The potential impacts of Major Exercises will be similar to those described above for training.

4.4.1.7.3 Health and Safety—Ewa Training Minefield—Offshore

4.4.1.7.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Ewa Training Minefield—Offshore)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Underwater Demolition activities at Ewa Training Minefield are not anticipated under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3. If conducted, however, they will use no more than 20 lb net explosive weight of ordnance. The public will not be exposed to the energetic effects of the detonations because the range will be cleared, and these effects will be completely contained within the range. Existing Navy safety protocols for the use of explosives will ensure that non-participants would not be in the area during training.

Demolition activities will be conducted in accordance with COMNAVSURFPAC Instruction 3120.8F (U.S. Department of the Navy, 1998a). COMNAVSURFPAC Instruction 3120.8F specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and, in some cases, RDT&E activities. Multiple Strike Groups will conduct no Demolition and SPECWAROPS at Ewa. The potential impacts of Major Exercises will be similar to those described above for training.

4.4.1.8 BARBERS POINT UNDERWATER RANGE—OFFSHORE

Table 4.4.1.8-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Barbers Point Underwater Range. Alternative 3 is the preferred alternative.

Table 4.4.1.8-1. Training at Barbers Point Underwater Range—Offshore

Training	
• Mine Neutralization	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against offshore training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Barbers Point Underwater Range. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would not be any air emission sources from HRC training associated with the Barbers Point Underwater Range. Use of this site would not require control of the airspace above this area. Training associated with Barbers Point Underwater Range adhere to policies and regulations governing noise, as discussed in Appendix C. There are no prehistoric, historic, or archaeological sites associated with Barbers Point Underwater Range. Additionally, there is no planned construction or alteration associated with the Navy that would affect the land use, land forms, geology, and associated soils development.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at Barbers Point Underwater Range would not generate any waste streams that could impact local water quality.

4.4.1.8.1 Biological Resources—Barbers Point Underwater Range—Offshore

4.4.1.8.1.1 No-action Alternative (Biological Resources—Barbers Point Underwater Range—Offshore)

HRC Training and Major Exercises—No-action Alternative

If conducted, Mine Neutralization (underwater Demolition) will use no more than 20 lb net explosive weight of ordnance. Training will follow Navy procedures to minimize impacts on biological resources as discussed in Section 4.4.1.1.1.1.

Mine Neutralization and SPECWAROPS activities in the offshore environment include destruction of inert mines by detonation of no more than 20 lb of explosive per inert mine. Prior to actual detonation, the area is determined to be clear of marine mammals and sea turtles. Explosive charges are placed in sandy bottom areas away from exposed reefs and coral. There can be minor and localized loss of some fish and benthic populations from the explosions. All waters around Naval Station Pearl Harbor have been designated as EFH for eggs and larvae of a number of species. The harbor has not been designated as a Habitat Area of Particular Concern. (U.S. Department of the Navy, Commander Navy Region Hawaii, 2001a) After training involving underwater detonations, the area is searched for injured animals.

Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.8.1.2 Alternative 1 (Biological Resources—Barbers Point Underwater Range—Offshore)

Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would slightly increase in number in some locations, impacts would be similar to those described above for similar actions. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 1 are discussed in the applicable Open Ocean sections.

4.4.1.8.1.3 Alternative 2 (Biological Resources—Barbers Point Underwater Range—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training could also increase. Impacts would be similar to those described above for similar actions. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.1.8.1.4 Alternative 3 (Biological Resources—Barbers Point Underwater Range—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.8.2 Hazardous Materials and Waste—Barbers Point Underwater Range—Offshore

4.4.1.8.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Barbers Point Underwater Range—Offshore)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3, no training will occur at Barbers Point Underwater Range. The transport, handling, and use of hazardous materials will occur on an infrequent basis in accordance with existing hazardous materials management regulations and Standard Operating Procedures (SOPs). No hazardous wastes will be generated.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and, in some cases, RDT&E activities. Potential impacts from Major Exercises will be similar to those described above for training. Under Alternative 2 and Alternative 3, Multiple Strike Groups would conduct Demolition and SPECWAROPS at Barbers Point. This very limited, short-term use of the range would use minor amounts of hazardous materials and generate minor to no hazardous wastes.

4.4.1.8.3 Health and Safety—Barbers Point Underwater Range—Offshore

4.4.1.8.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Barbers Point Underwater Range—Offshore)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

No underwater Demolition activities are planned at Barbers Point Underwater Range under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3. If held, however, they will use no more than 20 lb net explosive weight of ordnance. The public will not be exposed to the energetic effects of the detonations because the range will be cleared, and these effects will be completely contained within the range. Existing Navy safety protocols for the use of explosives will ensure that non-participants will not be in the area during training. Accordingly, Navy activities at Barbers Point Underwater Range under the No-action Alternative will have no effect on public safety.

Demolition activities will be conducted in accordance with COMNAVSURFPAC Instruction 3120.8F (U.S. Department of the Navy, 1993). COMNAVSURFPAC Instruction 3120.8F specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and, in some cases, RDT&E activities. Potential impacts of Major Exercises will be similar to those described above for training. Under Alternative 2 and Alternative 3, Multiple Strike Groups would conduct Demolition and SPECWAROPS at Barbers Point. These training events would involve limited, short-term use of the range away from public use areas.

4.4.1.9 NAVAL UNDERSEA WARFARE CENTER (NUWC) SHIPBOARD ELECTRONIC SYSTEMS EVALUATION FACILITY (SESEF)—OFFSHORE

Table 4.4.1.9-1 lists ongoing RDT&E activities for the No-action Alternative and proposed RDT&E activities for Alternatives 1, 2, and 3 offshore at the Naval Undersea Warfare Center (NUWC) Shipboard Electronic Systems Evaluation Facility (SESEF). Alternative 3 is the preferred alternative.

Table 4.4.1.9-1. RDT&E Activities at SESEF—Offshore

Research, Development, Test, and Evaluation (RDT&E) Activities	
• Shipboard Electronic Systems Evaluation Facility (SESEF) Quick Look Tests	• SESEF System Performance Tests

A review of the 13 resources against offshore RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the SESEF. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, hazardous materials and hazardous waste, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emission sources from HRC RDT&E activities associated with the SESEF range. Use of this site would not require control of the airspace above this area. RDT&E activities associated with the SESEF adhere to policies and regulations governing noise, and hazardous materials and hazardous waste as discussed in Appendix C. There would be no prehistoric, historic, or archaeological sites associated with the SESEF. Additionally, there is no planned construction or alteration associated with the RDT&E activities that would affect the land use, land forms, geology, and associated soils development.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Water resources would not be affected by the ships and submarines within the SESEF during electromagnetic transmitting and receiving equipment testing.

4.4.1.9.1 Biological Resources—SESEF—Offshore

4.4.1.9.1.1 No-action Alternative (Biological Resources—SESEF—Offshore)

HRC RDT&E Activities—No-action Alternative

NUWC provides underwater target services and range pinger installation services. Under the No-action Alternative, the SESEF range will be in nearly continuous use, with an average of about 10 to 15 concurrent tests per day, and an average duration of about 2 hours per test. During SESEF tests, Navy vessels will generate different levels of electromagnetic radiation (EMR) emissions. The intensities of the EMR fields generated by these RDT&E activities will decrease rapidly with increasing distance from the source.

Specific siting and orientation of the radar results in a cone-shaped EMR zone being projected skyward, yet within site boundaries. In terms of the potential for EMR impacts on wildlife, the main beam of the radar during missile flight tests, will not be directed toward the ground, and will have a lower limit of 4 to 5 degrees above horizontal.

Marine mammals and sea turtles are normally found below the surface of the water. Radiofrequency radiation does not penetrate the surface of water to any great degree. The power density level just below the surface of the ocean will not exceed the permissible human exposure level for uncontrolled environments. (U.S. Department of the Navy, 2002a) No adverse impacts should occur to whales, other marine mammals, or sea turtles at least 0.5 inch below the surface. It is also unlikely that an individual would be on or substantially above the surface of the water in the location of the main beam for a significant amount of time during the radar's use. (U.S. Army Space and Missile Defense Command, 2003)

Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.9.1.2 Alternative 1 (Biological Resources—SESEF—Offshore)

Increased RDT&E Activities—Alternative 1

Under Alternative 1, the SESEF range would be in continuous use, with an average of about 12 to 16 concurrent tests per day and an average duration of about 2 hours per test. With the exception of impacts associated with MFA/HFA sonar use (Section 4.1.2), impacts would be similar to those discussed above for the No-action Alternative.

4.4.1.9.1.3 Alternative 2 (Biological Resources—SESEF—Offshore)

Increased RDT&E Activities—Alternative 2

Under Alternative 2, the SESEF range would be in continuous use, with an average of about 12 to 16 concurrent tests per day and an average duration of about 2 hours per test. With the exception of impacts associated with MFA/HFA sonar use, impacts would be similar to those discussed above for the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

4.4.1.9.1.4 Alternative 3 (Biological Resources—SESEF—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.9.2 Health and Safety—SESEF—Offshore

4.4.1.9.2.1 No-action Alternative (Health and Safety—SESEF—Offshore)

HRC Training—No-action Alternative

No training will occur on the SESEF range.

HRC RDT&E Activities—No-action Alternative

Under the No-action Alternative, the SESEF range will be in nearly continuous use, with an average of about 10 to 15 tests per day, and an average duration of about 2 hours per test. During SESEF tests, Navy vessels will generate different kinds of EMR emissions (e.g., radar). The intensities of the EMR fields generated by these RDT&E activities will decrease rapidly with increasing distance from the source. However, Navy personnel aboard ship and the recreational or commercial public in the vicinity of the SESEF range potentially will be exposed to low intensity levels of EMR. Any exposures will be very brief because the position of the Navy vessel relative to the receptor will constantly be changing.

With regard to public safety, the Navy does not have exclusive use of the SESEF area, and collisions with commercial and recreational vessels are possible. However, both the personnel at the SESEF facility and the Navy personnel aboard ship constantly monitor the proximity of non-participants and adjust their activities accordingly, thus minimizing the potential for a vessel undergoing a SESEF test to be involved in a collision.

4.4.1.9.2.2 Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—SESEF—Offshore)

Increased RDT&E Activities—Alternative 1, Alternative 2, and Alternative 3

Under Alternatives 1, 2, and 3, the SESEF range would be in continuous use, with an average of about 12 to 16 tests per day and an average duration of about 2 hours per test. During SESEF tests, Navy vessels would generate different kinds of EMR emissions. The intensities of the EMR fields generated by these RDT&E activities would decrease rapidly with increasing distance from the source. However, neither Navy personnel aboard ship nor the recreational or commercial public in the vicinity of the SESEF range would be exposed to harmful levels of EMR. Any low-intensity exposures would be very brief because the position of the Navy vessel relative to the receptor would constantly be changing.

With regard to public safety, the Navy does not have exclusive use of the SESEF area, and collisions with commercial and recreational vessels are possible. However, both the personnel at the SESEF facility and the Navy personnel aboard ship constantly monitor the proximity of non-participants and adjust their activities accordingly, thus minimizing the potential for a vessel undergoing a SESEF test to be involved in a collision.

4.4.1.10 NAVAL UNDERSEA WARFARE CENTER (NUWC) FLEET OPERATIONAL READINESS ACCURACY CHECK SITE (FORACS)—OFFSHORE

Table 4.4.1.10-1 lists ongoing RDT&E activities for the No-action Alternative and proposed RDT&E activities for Alternatives 1, 2, and 3 offshore at the NUWC Fleet Operational Readiness Accuracy Check Site (FORACS). Alternative 3 is the preferred alternative.

Table 4.4.1.10-1. RDT&E Activities at FORACS—Offshore

Research, Development, Testing, and Evaluation (RDT&E) Activities
• Fleet Operational Readiness Accuracy Check Site (FORACS) Tests

A review of the 13 resources against offshore RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the FORACS. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, hazardous materials and hazardous waste, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emission sources from HRC RDT&E activities associated with the FORACS. Use of this site would not require control of the airspace above this area. RDT&E activities associated with the FORACS adhere to policies and regulations governing noise, and hazardous materials and hazardous waste as discussed in Appendix C. There would be no prehistoric, historic, or archaeological sites associated with the FORACS. Additionally, there is no planned construction or alteration associated with the Navy that would affect the land use, land forms, geology, and associated soils development.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Water resources would not be affected by the ships and submarines operating within the FORACS during electromagnetic transmitting and receiving equipment testing.

4.4.1.10.1 Biological Resources—FORACS—Offshore

4.4.1.10.1.1 No-action Alternative (Biological Resources—FORACS—Offshore)

HRC Training—No-action Alternative

No training will occur on the FORACS range.

HRC RDT&E Activities—No-action Alternative

NUWC provides underwater target services and range pinger installation services. Inshore areas at depths of 40 to 70 ft have a modestly diverse coral community. Fish are generally rare, except where a coral colony or ocean debris provides habitat. Green turtles are abundant in the area. The purpose of the FORACS tests are to provide accuracy checks of ship and submarine sonar, both in active and passive modes, and to evaluate the accuracy of a ship's radar. The ship will conduct a series of "runs" on the range, each taking approximately 1.5 hours. Both active and passive sonar can be checked on a single run. Impacts from ships' radars would be similar to those discussed in Section 4.4.1.9.1.1.

Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.4.1.10.1.2 Alternative 1 (Biological Resources—FORACS—Offshore)

Increased RDT&E Activities—Alternative 1

FORACS tests proposed under Alternative 1 would have all the components of the No-action Alternative, but at an increased rate (i.e., from two to five FORACs tests per year). With the exception of impacts associated with MFA/HFA sonar use, impacts would be similar to those discussed above for the No-action Alternative.

4.4.1.10.1.3 Alternative 2 (Biological Resources—FORACS—Offshore)

Increased RDT&E Activities—Alternative 2

FORACS tests would increase from five to six. With the exception of impacts associated with MFA/HFA sonar use, impacts would be similar to those discussed above for the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 2 are discussed in the applicable Open Ocean sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Multiple Strike Groups would not conduct testing on the FORACS range.

4.4.1.10.1.4 Alternative 3 (Biological Resources—FORACS—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.4.1.10.2 Health and Safety—FORACS—Offshore

4.4.1.10.2.1 No-action Alternative (Health and Safety—FORACS—Offshore)

HRC Training—No-action Alternative

No training will occur on the FORACS range.

HRC RDT&E Activities—No-action Alternative

Communications and electronic devices such as radar, electronic jammers, and other radio transmitters produce EMR. Equipment that produces an electromagnetic field could generate hazardous levels of EMR. Although the sea space where FORACS tests are conducted is unrestricted and is not controlled by NUWC or the Navy, the Navy notifies the public of hazardous activities through the use of Notices to Mariners. In addition, the NUWC Range Control Officer conducts a visual lookout and radar search of the FORACS range to identify any transient units. The NUWC Range Control Officer determines if range RDT&E activities can continue. The general public is typically not exposed in areas that can contain EMR hazards from Navy equipment; therefore, the public will not be inadvertently exposed to EMR.

4.4.1.10.2.2 Alternative 1 (Health and Safety—FORACS—Offshore)

Increased RDT&E Activities—Alternative 1

FORACS tests proposed under Alternative 1 would have all the components of the No-action Alternative, and would occur at the same rate (i.e., five FORACs tests per year). The same safety procedures described under the No-action Alternative would be implemented. The use of safety procedures and access clearance would minimize potential safety issues during these RDT&E activities.

4.4.1.10.2.3 Alternative 2 (Health and Safety—FORACS—Offshore)

Increase RDT&E Activities—Alternative 2

FORACS tests proposed under Alternative 2 would have all the components of Alternative 1, but at an increased rate (i.e., six FORACS tests per year). The same safety procedures described under the No-action Alternative would be implemented. The use of safety procedures and access clearance would minimize potential safety issues during these RDT&E activities.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Multiple Strike Groups would not conduct training on the FORACS range.

4.4.1.10.2.4 Alternative 3 (Health and Safety—FORACS—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.4.2 OAHU ONSHORE

4.4.2.1 NAVAL STATION PEARL HARBOR

Table 4.4.2.1-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Naval Station Pearl Harbor. Alternative 3 is the preferred alternative.

Table 4.4.2.1-1. Training at Naval Station Pearl Harbor

Training	
• Command and Control (C2)	• Personnel Support Operations
• In-Port Support Operations	• Special Warfare Operations (SPECWAROPS)
	• Salvage Operations

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Naval Station Pearl Harbor. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, transportation, utilities, and water resources.

There would be no air emissions generated other than that from an occasional Aircraft Operation at Naval Station Pearl Harbor. The Aircraft Operations would not change regional air quality. Airspace is not affected by the types of ongoing and proposed training at Naval Station Pearl Harbor. All training adheres to policies and regulations governing hazardous materials and waste, health and safety, and noise, as discussed in Appendix C.

There are no current or proposed training that could affect land use, land forms, geology, and associated soils development on Naval Station Pearl Harbor. There would be no impact on Oahu's transportation, utilities, or land use because all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the site would not generate any waste streams that could impact local water quality.

4.4.2.1.1 Biological Resources—Naval Station Pearl Harbor

Command and Control (C2) is achieved through a network of communication devices strategically located at selected Department of Defense (DoD) installations around the islands with no impacts on biological resources. The purpose of Personnel Support Operations is to meet the housing and facilities needs of the personnel that support range training. This includes in-port briefings and debriefings and in-port training activities, with no impacts on biological resources. As part of the Visit, Board, Search, and Seizure event, helicopter and boat crews train to transport teams to board vessels and inspect the ship's cargo and personnel. Typical In-Port Support Operations include the maintenance and supply of foreign and U.S. warships and submarines berthed at Naval Station Pearl Harbor. These training events do not affect vegetation and wildlife in the area.

4.4.2.1.1.1 No-action Alternative (Biological Resources—Naval Station Pearl Harbor)

HRC Training and Major Exercises—No-action Alternative

Vegetation

Exotic imported grasses and trees make up the majority of the vegetative community at Naval Station Pearl Harbor. The alien red mangrove dominates vegetation along the shoreline. No threatened and endangered plant species have been identified at Naval Station Pearl Harbor. Procedures and practices are in place to minimize impacts on vegetation and to prevent the introduction of invasive plant species (Table 4.4.2.1.1.1-1).

Table 4.4.2.1.1.1-1: Training Guidelines for Resource Protection— All Oahu Training Areas

APPLIES TO	
The following list of actions and limitations applies to all Oahu training areas. Additional limitations are imposed in the Sensitive Ecological and Cultural Resource Areas.	
AUTHORITY	
Enforcement of the following rules is under the authority of the Directorate of Plans, Training, Mobilization and Security, Range and Training Support Division.	
REQUIRED ACTIONS	
Access	Before entering a training area, troops must clean all vehicles, equipment, personal gear, shoes, and clothing.
Fire	All fires must be reported immediately.
	In case of fire, troops will stop training and begin fighting the fire.
	Troops will continue to fight the fire until released by the Fire Department.
Water	All aviation or other training area fuels or chemicals and other potentially toxic and polluting substances must be handled and stored to avoid spills and fires.
LIMITATIONS FOR SENSITIVE ECOLOGICAL AND CULTURAL RESOURCE AREAS	
Access	No troops may go beyond signs or fences marking the presence of rare or endangered plants and animals or archaeological sites.
Bivouacking	No bivouacking within 3,280 feet of posted signs marking the presence of rare or endangered native plants and animals or restoration projects.
	No training units larger than platoon size (more than 30 troops) may bivouac outside of reusable bivouac sites provided with portable or fixed latrines.
	No open fires.
	No burying or leaving trash.
	No food preparation.
	No refueling.
	No cutting, clearing, or disturbing of vegetation. This includes mosses, grasses, shrubs, bushes, and trees.
Maneuvers	No vehicle traffic off existing roads.
	No use of rocks from rock piles or walls for training purposes.
	No establishment or new vehicle tracks.
	No digging, including entrenchment and foxholes, except in areas specifically designated by Range Control.
	Dillingham Military Reservation and Kahuku Training Area: No pyrotechnic or incendiary training devices except during the wet season (October to April) OR outside areas designed to control fire.
	No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences.
	Dillingham Military Reservation and Kahuku Training Area: No use of live fire or tracer ammunition.
	No road, trail, or firebreak clearing without permission form Range Control.
	No grading or construction of buildings or other permanent structures without permission from Range Control.

Source: U.S. Department of the Navy, 2002a

SPECWAROPS activities include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access using a boat. The training event involves fewer than 20 troops and has minimal interaction with the environment, since one of the purposes of the training event is to operate undetected. During amphibious inserts, the troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Department of the Navy, 2002a)

Wildlife

Current In-Port Support Exercises and Salvage Operations have not resulted in any significant impacts on the four endangered waterbirds that have been identified in the harbor area. Military readiness activities are exempt from the take prohibitions of the Migratory Bird Treaty Act (MBTA) provided they do not result in a significant adverse effect on the population of a migratory bird species. While individual birds may be startled, the training (C2, In-port and Personnel Support Operations, SPECWAROPS, and Salvage Operations) being currently performed are not likely to significantly impact a population of any of the 46 migratory species that occur in the Naval Station Pearl Harbor area and thus would be exempt from the MBTA take prohibitions.

The green turtle has rarely been seen in the harbor, and no nesting has been reported. The Hawaiian monk seal has been seen in the channel, but never reported in the harbor, and only one unusual humpback whale sighting has occurred in the region of influence.

Salvage training takes place in any of the shoal waters, harbors, ports, and in-land waterways throughout the HRC. The Navy's MDSU-1 and divers from other countries practice ship and barge salvage, towing, battle damage repair, deep ocean recovery, harbor clearance, removal of objects from navigable waters, and underwater ship repair capabilities. Staging for these activities is from the MDSU-1 Facility located on the southwestern side of Hickam AFB. Small cutting charges may be used during Salvage Operations training. There can be minor and localized loss of some fish and benthic community populations from the explosions. After training involving underwater detonations are complete, the area will be searched for injured animals.

SPECWAROPS activities include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access using a boat. The training event involves fewer than 20 troops and has minimal interaction with the environment, since one of the purposes of the training event is to operate undetected. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Department of the Navy, 2002a)

All waters around Naval Station Pearl Harbor have been designated as EFH for eggs and larvae of a number of species. None of the current training has the potential to affect EFH. Acoustic effects on fish are discussed in Section 4.1.2 under Open Ocean Biological Resources. RIMPAC Exercises have procedures and practices in place to prevent the introduction of invasive species, consistent with EO 13112 and Navy guidelines (Table 4.4.2.1.1.1-1). The Navy requests that multinational participants purge bilge/ballasts tanks in their ships prior to entering U.S. territorial waters. The movement and berthing of ships and small training in the harbor area are part of ongoing training at Naval Station Pearl Harbor. Marine mammal collision avoidance and encounter reporting procedures are already in place and implemented.

Environmentally Sensitive Habitat

Current training and Major Exercises do not occur in the Naval Station Pearl Harbor National Wildlife Refuge or within wetland areas on the installation.

4.4.2.1.1.2 Alternative 1 (Biological Resources—Naval Station Pearl Harbor)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, biennial RIMPAC Exercises, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). Training event numbers would not increase, but the tempo may. The likelihood of a similar increase in adverse impacts on biological resources would be small, as described below.

Vegetation

Training events and Major Exercises would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Naval Station Pearl Harbor and Navy policies and procedures (Table 4.4.2.1.1.1-1) during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species. No rare, threatened, or endangered plant species are known to occur at Naval Station Pearl Harbor.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. It is unlikely that a migratory bird, listed bird species, or other wildlife at Naval Station Pearl Harbor would be harmed as a result of increased training. The additional training would comply with relevant Navy policies and procedures (Table 4.4.2.1.1.1-1), which would minimize the potential for effects on wildlife.

Prior to the sinking of any vessels for MDSU-1 training, environmental documentation would be developed and reviewed as appropriate. The Navy would begin early coordination with regulatory agencies as applicable to reduce environmental impacts and to assist with the development of any required mitigative measures.

Environmentally Sensitive Habitat

Just as for the No-action Alternative, increased training events and Major Exercises would not occur in the Pearl Harbor National Wildlife Refuge or within wetland areas on the installation.

4.4.2.1.1.3 Alternative 2 (Biological Resources—Naval Station Pearl Harbor)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c). Impacts on wildlife would be similar to those described previously for the No-action Alternative since the additional training would be performed throughout the HRC and not confined to one particular area. The additional training would continue to comply with relevant Navy policies and procedures, such as existing clearance procedures, which would minimize the potential for effects on wildlife.

Additional Major Exercises—Multiple Carrier Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would visit the area for up to 10 days per Major Exercise. Participants use and build upon previously gained training skill sets to maintain and improve the proficiency needed for a mission-capable, deployment-ready unit. The Major Exercises would occur over a 5- to 10-day period. Activities would mainly be offshore and in the open ocean. The Multiple Strike Group training would involve many of the training events identified and evaluated under the No-action Alternative and Alternative 1. The Major Exercises proposed would be similar to those occurring during current RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.1.1.4 Alternative 3 (Biological Resources—Naval Station Pearl Harbor)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.1.2 Cultural Resources—Naval Station Pearl Harbor

4.4.2.1.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Naval Station Pearl Harbor)

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Salvage Operations

Salvage Operations provide a realistic training environment for fire at sea, de-beaching of ships, and harbor clearance training by Navy diving and salvage units. Activities include battle damage repair, ship and barge salvage, towing, deep ocean recovery, removal of objects from navigable waters, and underwater ship inspection and repair (use of welding and other power equipment). Salvage Operations will occur primarily at the Puuloa Underwater Range, within Naval Station Pearl Harbor, and in the Keehi Lagoon; however, they may also take place in any of the shoal waters, harbors, ports, and inland waterways throughout the HRC.

Naval Station Pearl Harbor contains the wrecks of World War II-era warships and warship remnant fields, Japanese aircraft, and Japanese midget submarines. There are also several Native Hawaiian fishponds within the harbor. Of these submerged cultural resources, several are listed on the NRHP and designated National Historic Landmarks (e.g., *USS Arizona* and *USS Utah*). In addition, the entirety of Naval Station Pearl Harbor is within the Pearl Harbor National Historic Landmark boundary (International Archaeological Resources Institute, Inc., 2005). Because of the number and significance of the identified features, cultural resources within Naval Station Pearl Harbor are comprehensively and effectively managed through various in-place agency documents. Among these are policies, guidelines, and SOPs that are outlined in the *Integrated Cultural Resources Management Plan (ICRMP), Pearl Harbor Naval Complex.* The ICRMP, which has been in place since 2002, was developed in consultation with the Advisory Council on Historic Preservation, the Hawaii State Historic Preservation Officer, the National Trust for Historic Preservation, the Historic Hawaii Foundation, the National Park Service, the Oahu Council of Hawaiian Affairs, and The Outdoor Circle. Salvage Operations will be conducted in accordance with this guidance and coordinated with the Navy Region Hawaii's Historic Preservation Coordinator, as well as any other agreement documents (e.g., Memoranda of Agreement or Programmatic Agreements) promulgated since completion of the ICRMP (U.S. Department of the Navy, Commander Navy Region Hawaii, 2002). As a result, there will be no adverse effects on cultural resources from Salvage Operations.

4.4.2.1.3 Socioeconomics—Naval Station Pearl Harbor

4.4.2.1.3.1 No-action Alternative (Socioeconomics—Naval Station Pearl Harbor)

The No-action Alternative stands as no change from current levels of training, and the Navy will continue its current activities at the HRC. Under the No-action Alternative, HRC Training, RDT&E Activities, and Major Exercises associated with Naval Station Pearl Harbor were reviewed. Current HRC training associated with Naval Station Pearl Harbor are listed in Table 2.2.2.3-1 and a full description is found in Appendix D. A description of current weapon systems is found in Appendix E. There are no RDT&E activities associated with Naval Station Pearl Harbor, and Table 2.2.2.6-1 lists current Major Exercise events.

Naval Station Pearl Harbor is a major contributor to the economy of Oahu, and Pearl Harbor Naval Shipyard is the largest industrial employer in Hawaii. The DoD is the second major source of revenue to the State of Hawaii. In 2001, the U.S. military employed 64,074 people in the State of Hawaii, and the amount employed by the Navy and Marine Corps was 24,654. Major locations for active duty military and civilian personnel on Oahu in 2001 were Schofield Barracks (12.699 jobs), Naval Station Pearl Harbor (12,407 jobs), Kaneohe (6,847 jobs), Hickam AFB (5,374 jobs), Tripler Army Medical Center (2,856 jobs), Fort Shafter (2,337 jobs), Honolulu (1,879 jobs), Wheeler AFB (1,816 jobs), Kunia (1,495 jobs) and Camp H.M. Smith (1,045 jobs). In fiscal year (FY) 2005-2006, $5.5 million was provided to improve infrastructure for Hawaii's public schools with high enrollments of military children.

These training events include C2, which can provide continuous command and control support from a land location on Naval Station Pearl Harbor, and In Port Support Operations, which provide major support for Navy ships and submarines which are berthed at Naval Station Pearl Harbor. Additional training includes In Port Support Exercises, C2, SPECWAROPS, Demolition Exercises, which are provided support by a 2.75 acre facility at Naval Magazine Pearl Harbor West Loch, and Salvage Operations where staging for these activities occur on Bishop Point, an annex of Naval Station Pearl Harbor. Under the No-action Alternative, the support provided to

HRC training events from Naval Station Pearl Harbor will continue. The level of employment and defense initiatives on Oahu will continue to benefit the local economy of Oahu.

4.4.2.1.3.2 Alternative 1 (Socioeconomics—Naval Station Pearl Harbor)

Increased Tempo and Frequency of Training—Alternative 1

Under Alternative 1, there are no increases in the occurrence of onshore training events on Naval Station Pearl Harbor.

Increased RDT&E Activities—Alternative 1

There are no onshore RDT&E activities associated with Naval Station Pearl Harbor.

Major Exercises—Alternative 1

Under Alternative 1, USWEX frequency would increase by 50 percent (from 4 to 6 times per year). Appendix D shows the matrix of training events generally used during a USWEX by location. A review of Table 2.2.2.3-1 indicates that under Alternative 1 there are no increases in the training events on Naval Station Pearl Harbor that are associated with USWEX. The USWEX events under Alternative 1 would not affect Naval Station Pearl Harbor. The level of employment and defense initiatives associated with the No-action Alternative on Oahu would continue to benefit the local economy of Oahu.

4.4.2.1.3.3 Alternative 2 (Socioeconomics—Naval Station Pearl Harbor)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, HRC training associated with Naval Station Pearl Harbor that would increase is C2. Under Alternative 2 each of these training events would increase by 100 percent (from 1 to 2 events/year). Support would continue to be provided from facilities on Naval Station Pearl Harbor. The Navy would not require new construction or an increase in personnel in order to provide the support for these increases. Support would not change from the requirements under the No-action Alternative.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be allowed to conduct training simultaneously in the HRC (Figure 1.2-3). Depending on the Major Exercise being performed, Naval Station Pearl Harbor would provide support for training. The Strike Groups would not be homeported in Hawaii, but would be in Hawaii for up to 10 days per Major Exercise. During this time, sailors and marines could visit Oahu while transiting. An increase in the income generated on Oahu could be expected for tourism-related services, which would affect the personal income of some Oahu residents during the 10-day training period. No increase in population size, renter-occupied homes, or single-family owned homes would be expected.

4.4.2.1.3.4 Alternative 3 (Socioeconomics—Naval Station Pearl Harbor)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of

Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on socioeconomics under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.2 FORD ISLAND

Table 4.4.2.2-1 lists ongoing RDT&E activities for the No-action Alternative and proposed RDT&E activities for Alternatives 1, 2, and 3 at Ford Island. Alternative 3 is the preferred alternative.

Table 4.4.2.2-1. RDT&E Activities at Ford Island

Research, Development, Testing, and Evaluation (RDT&E) Activities
• MK-84/MK-72 Pinger Acoustic Training Area (Alternative 1)

A review of the 13 resources against RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Ford Island. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, and utilities.

There would be no air emissions generated at Ford Island other than that from an occasional Aircraft Operations and the temporary impacts from construction of the proposed Acoustic Test Facility (ATF). Any minimal Air Support Operations at Ford Island would be limited to the types and number of aircraft that currently operate there. Neither Aircraft Operations nor construction would change regional air quality. Airspace is not affected by the types of ongoing and proposed RDT&E activities.

RDT&E activities associated with Ford Island adhere to policies and regulations governing hazardous materials and hazardous waste, health and safety, and noise, as discussed in Appendix C. There are no current or proposed RDT&E activities that could affect land use, land forms, geology, and associated soils development on the site. There would be no impact on Oahu's transportation, utilities, or land use because all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative.

4.4.2.2.1 Biological Resources—Ford Island

4.4.2.2.1.1 No-action Alternative (Biological Resources—Ford Island)

HRC Training and Major Exercises—No-action Alternative

Under the No-action Alternative, no HRC training or Major Exercises are occurring at Ford Island.

4.4.2.2.1.2 Alternative 1 (Biological Resources—Ford Island)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Under Alternative 1, no HRC training would occur at Ford Island; therefore, biological resources would not be affected.

HRC Enhancements—Alternative 1

The Navy proposes to develop a new open-water ATF capability near NUWC's Ford Island facility in Naval Station Pearl Harbor, shown in Figure 2.2.3.6.2-1. Testing would take place in the water to the west of Ford Island, between Middle Loch and East Loch. The pinger (noise source) could be located at one of several sites. Possible locations include Pier S291 on Ford Island, Beckoning Point piers, or a mobile test site that could operate within the test area. Pinger training typically runs for an 8-hour period once a week. Development of the ATF would require minor modification to the pier to provide electrical cabling and pinger attach points, with no impacts on vegetation. Vegetation on Ford Island consists primarily of non-native grasses, shrubs, and trees. No threatened or endangered plant species have been reported. No marine mammals occur in the area, and most fish do not respond to pingers (Stiles, 2004). Acoustic effects on fish are discussed in Section 4.1.2.

4.4.2.2.1.3 Alternative 2 (Biological Resources—Ford Island)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, no additional HRC training or Major Exercises would occur at Ford Island; therefore, biological resources would not be affected.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would not be performed on Ford Island.

4.4.2.2.1.4 Alternative 3 (Biological Resources—Ford Island)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.2.2 Cultural Resources—Ford Island

4.4.2.2.2.1 No-action Alternative (Cultural Resources—Ford Island)

There are no training events or Major Exercises with the potential to affect cultural resources at Ford Island.

4.4.2.2.2.2 Alternative 1 (Cultural Resources—Ford Island)

Increased Tempo and Frequency of Training—Alternative 1

There are no training events with the potential to affect cultural resources at Ford Island.

HRC Enhancements—Alternative 1

MK-84/MK-72 Pinger Acoustic Test Facility

The entirety of Ford Island falls within the Pearl Harbor Naval Complex National Historic Landmark. Ford Island also is a designated Historic Management Zone (see Section 3.4.2.1.2). Installation of equipment to support the new ATF has the potential to affect historic properties. To avoid adverse effects, guidance in the Pearl Harbor ICRMP will be followed and coordination with the Navy Region Hawaii's designated cultural resources coordinator would be required (U.S. Department of the Navy, Commander Navy Region Hawaii, 2002).

4.4.2.2.2.3 Alternative 2 (Cultural Resources—Ford Island)

There are no Major Exercises or training with the potential to affect cultural resources at Ford Island.

4.4.2.2.2.4 Alternative 3 (Cultural Resources—Ford Island)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.2.3 Water Resources—Ford Island

4.4.2.2.3.1 No-action Alternative (Water Resources—Ford Island)

Under the No-action Alternative, no HRC training or Major Exercises are occurring at Ford Island; therefore, water resources are not affected.

4.4.2.2.3.2 Alternative 1 (Water Resources—Ford Island)

Under Alternative 1, no HRC training would occur at Ford Island; therefore, water resources would not be affected.

HRC Enhancements—Alternative 1

Under Alternative 1, HRC enhancements would include the development of a new open-water ATF near the NUWC Ford Island Facility. The pinger (noise source) could be located at one of several sites. Possible locations include Pier S291 on Ford Island, Beckoning Point piers, or a mobile test site that could operate within the test area. Development of the ATF would require minor modification to the pier to provide electrical cabling and pinger attach points and would not require the preparation of a Stormwater Pollution Prevention Plan.

4.4.2.2.3.3 Alternative 2 (Water Resources—Ford Island)

Under Alternative 2, no HRC training or Major Exercises would occur at Ford Island; therefore, water resources would not be affected.

4.4.2.2.3.4 Alternative 3 (Water Resources—Ford Island)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on water resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.3 NAVAL INACTIVE SHIP MAINTENANCE FACILITY, PEARL HARBOR

Table 4.4.2.3-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Ford Island. Alternative 3 is the preferred alternative.

Table 4.4.2.3-1. Training at Naval Inactive Ship Maintenance Facility, Pearl Harbor

Training	
• Special Warfare Operations (SPECWAROPS)	• Mine Neutralization

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the Naval Inactive Ship Maintenance Facility, Pearl Harbor. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, health and safety, land use, noise, socioeconomics, transportation, and utilities.

There would not be any air emission sources associated with the Naval Inactive Ship Maintenance Facility, Pearl Harbor. Use of this site would not require control of the airspace above this land area. Additionally, there is no planned construction or alteration associated with the Navy that would affect cultural resources in the area. Training associated with this site adhere to policies and regulations governing health and safety and noise, as discussed in Appendix C.

There is no current or proposed training that could affect land forms, geology, and associated soils development. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative.

4.4.2.3.1 Biological Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor

The Naval Inactive Ship Maintenance Facility is located in the Middle Loch.

4.4.2.3.1.1 No-action Alternative (Biological Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor)

HRC Training and Major Exercises—No-action Alternative

Under the No-action Alternative, up to 62 Mine Neutralization training events per year will continue to occur at locations such as the Inactive Ship Maintenance Facility, or about 5 to 6 per month. Mine Neutralization activities involve the detection, identification, evaluation, rendering safe, and disposal of mines and UXO that constitutes a threat to ships or personnel. Mine neutralization training involves a diver placing a specific amount of explosives which, when detonated underwater at a specific distance from a mine, results in neutralization of the mine. Individual training events use explosives charges no greater than 20 lb net explosive weight.

Training will follow the relevant Pearl Harbor and Navy policies and procedures to minimize impacts on biological resources.

Prior to actual detonation, the area is determined to be clear of marine mammals. When the divers enter the water, they also have an opportunity to detect marine mammals and humpback whales visually or audibly (if the whales are vocalizing). The training event does not proceed if marine mammals are in the vicinity. The delay between initiating the fuse and the detonation of the explosives is only 30 minutes, minimizing the opportunity for marine mammals to enter the area. Given the relatively small size of the charge, the area within which marine mammals would be at risk from the explosive is quite limited. Standard procedures require tethered mines to be suspended at least 10 ft below the surface of the water. Impacts on marine mammals and sea turtles from underwater explosions are discussed in Section 4.1.2. Only sandy areas that avoid/minimize potential impacts on coral are used for explosive charges on the shallow water floor (less than 40 ft of water). After training involving underwater detonations, the area is searched for injured animals. Applicable procedures are implemented during charge placement and the detonations occur infrequently. The Waiawa Unit of the Pearl Harbor National Wildlife Refuge, which supports breeding populations of endangered waterbirds, is across the Loch from the Naval Inactive Ship Maintenance Facility, Pearl Harbor. Mine Neutralization activities could startle these birds, but suspension of the mines at least 10 ft underwater should dampen the potential for airborne noise effects.

SPECWAROPS include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access using a boat. The training event involves fewer than 20 troops and has minimal interaction with the environment, since one of the purposes of the exercise is to operate undetected. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Department of the Navy, 2002a)

4.4.2.3.1.2 Alternative 1 (Biological Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). No increases in the number of training events performed in the Inactive Ship Maintenance Facility are anticipated. Impacts on biological resources would be similar to those described previously for the No-action Alternative. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2.

4.4.2.3.1.3 Alternative 2 (Biological Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and an additional six Mine Neutralization activities would occur. Since Mine Neutralization activities occur in other areas of the HRC, not all of the additional six per year would necessarily take place in the Naval Inactive Ship Maintenance Facility. Prior to actual detonation, the area would be determined as clear of marine mammals. Explosive charges, in less than 40 ft of water, would be placed/neutralized only in sandy areas to avoid/minimize potential impacts on coral. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above in Section 4.4.2.3.1.1.

4.4.2.3.1.4 Alternative 3 (Biological Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.3.2 Hazardous Materials and Waste—Naval Inactive Ship Maintenance Facility, Pearl Harbor

4.4.2.3.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Naval Inactive Ship Maintenance Facility, Pearl Harbor)

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Training at the Naval Inactive Ship Maintenance Facility, Pearl Harbor would use explosives charges of no more than 20 lb net explosive weight each for a total of about 580 lb per year of explosives. Demolition activities in the offshore environment include destruction of inert mines by detonation of less than 20 lb of explosive per inert mine. The transport, handling, and use of hazardous materials on an infrequent basis would have no effect on ongoing hazardous materials management activities. No Resource Conservation and Recovery act (RCRA) hazardous wastes would be generated by this training.

4.4.2.3.3 Water Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor

4.4.2.3.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Water Resources—Naval Inactive Ship Maintenance Facility, Pearl Harbor)

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

The detonation of explosives releases fragments and residues of explosives, as well as of associated ordnance constituents (e.g., primers, wires, casings). For underwater detonations, these materials are absorbed into the water column and, excluding those fragments large enough to settle to the bottom, disperse from the detonation site according to the local water circulation pattern. Underwater detonations also may, depending upon their size and placement relative to the bottom, create a crater and disperse the displaced bottom sediments into the water column. The size of explosives charge used in training at the Naval Inactive Ship Maintenance Facility, Pearl Harbor, will not result in substantial craters in the bottom sediments.

4.4.2.4 EXPLOSIVE ORDNANCE DISPOSAL (EOD) LAND RANGE–NAVAL MAGAZINE (NAVMAG) PEARL HARBOR WEST LOCH

Table 4.4.2.4-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at the EOD Land Range–Naval Magazine (NAVMAG) Pearl Harbor West Loch. Alternative 3 is the preferred alternative.

Table 4.4.2.4-1. Training at EOD Land Range-NAVMAG Pearl Harbor West Loch

Training
• Land Demolitions

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the EOD Land Range–NAVMAG Pearl Harbor West Loch. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, hazardous materials and hazardous waste, land use, noise, socioeconomics, transportation, and utilities.

This level of in-place detonation of ordnance at the EOD Land Range is not expected to affect regional air quality. Use of the EOD Land Range would not require control of the airspace. The small increase in training would result only in minor changes to the noise environment.

Training at the EOD Land Range would adhere to policies and regulations governing noise, and hazardous materials and hazardous waste (including ordnance) as discussed in Appendix C. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative.

4.4.2.4.1 Biological Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch

4.4.2.4.1.1 No-action Alternative (Biological Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

HRC Training—No-action Alternative

EOD training at West Loch involves the detonation of explosives with a net explosive weight of up to 2.5 lb. Although training at this facility can take place at any time, training most often occurs during daylight hours. Under the No-action Alternative, up to 85 such training events can occur per year.

Training at the EOD pit is not expected to have any adverse impacts on vegetation at the site. No direct effects on wildlife are anticipated. No threatened or endangered species have been observed at West Loch. Intrusive noise from the site, however, could startle noise-sensitive wildlife in the vicinity, most notably at the Pearl Harbor National Wildlife Refuge. Assuming that a detonation at the EOD pit generated a noise level of about 160 dB sound exposure level

(SEL) at 50 ft,[1] noise levels at 500 ft will be reduced to about 130 dB SEL.[2] Because this is predominately low-frequency noise, the dB value is not comparable to A-weighted noise levels. There is no significance cut-off for noise impacts on wildlife, including birds. While individual foraging or transient birds in the vicinity of the EOD pit may be startled, the event is unlikely to significantly impact a population of one of the 46 migratory species that occur in Pearl Harbor vicinity. At 4,000 ft from the EOD pit, the noise levels would be reduced to approximately 94 dB. The EOD Land Range is approximately 3 mi from the Honouiliuli Unit of the refuge, which would result in even lower noise levels at that site.

4.4.2.4.1.2 Alternative 1 (Biological Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

Increased Tempo and Frequency of Training—Alternative 1

Under Alternative 1, EOD training intensity at West Loch would not increase. Impacts would be the same as those discussed above for the No-action Alternative.

4.4.2.4.1.3 Alternative 2 (Biological Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, EOD training intensity at the EOD Land Range would increase from 85 to 93 training events per year, an approximately 9 percent increase. The small increase in training would result only in minor changes to the noise environment.

4.4.2.4.1.4 Alternative 3 (Biological Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.4.2 Cultural Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

4.4.2.4.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

There are no ongoing land-based training events at the EOD Land Range with the potential to affect cultural resources.

---

[1] Based on equations in Blasters Handbook (DuPont, 1980), and assuming 10-12 dB reduction in noise level from berm/barrier around EOD pit).

[2] Based on an assumed attenuation rate of 9 dB per doubling of distance from the source, and barrier attenuation as described in the previous footnote.

Land Demolitions take place at the West Loch EOD Training Facility, and are designed to train forces in the use of explosives. West Loch has been surveyed for archaeological and traditional Hawaiian resources, and a number or archaeological sites were identified; however, none were identified within the EOD Land Range (International Archaeological Resources Institute, Inc., 2005; Jensen, et al., 1997).

The EOD Land Range facilities used for Land Demolitions have also been surveyed for their historic significance. These facilities include two concrete blast chambers and one concrete safety bunker. None of these buildings have been recommended as eligible for inclusion in the NRHP.

Proposed increases in training under Alternative 1, Alternative 2, and Alternative 3 would result in increases in training; however, no cultural resources would be affected because there are none present in the area.

4.4.2.4.3 Geology and Soils—EOD Land Range–NAVMAG Pearl Harbor West Loch)

4.4.2.4.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Geology and Soils—EOD Land Range–NAVMAG Pearl Harbor West Loch)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Navy EOD Training

Navy EOD training is not expected to affect the geology of the EOD Land Range, inasmuch as no construction or excavation is planned. The nature of the training, however, is such that contamination of surface soils is a concern.

The in-place detonation of ordnance typically generates fragments and residues of explosives and other ordnance constituents (e.g., inorganic compounds such as perchlorates and metals such as lead, mercury, chromium, copper, and nickel from primers, wires, and casings). Based on analysis of military blow-in-place activities, ordnance expended material, remnants, and residues deposited on and near an EOD pit may account for up to 40 percent[3] of the weight of small ordnance items (the remaining 60 percent being dispersed in the atmosphere as gases or particulates) (Kelleher, 2002). Larger fragments are periodically cleared from the site during EOD sweeps, whereas fine fragments and residues typically remain in place. This practice is consistent with the Military Munitions Rule, which allows expended munitions and constituents to remain on the range as long as the range remains open. Fine particulate residues may settle up to 197 ft from the point of detonation.

Some explosives residues will degrade over time, while others persist. Royal Demolition Explosive (RDX), for example, resists degradation while trinitrotoluene typically degrades to dinitrotoluene over time. Inorganic salts and metals may react with their surroundings to form insoluble compounds, or may migrate into surface soils and ground water dissolved in rain water. Sheet flows of precipitation during periods of heavy rainfall can disperse surface contaminants laterally. In summary, some ordnance constituents will accumulate in on-site soils while other constituents migrate from the site.

---

[3] 85 (93) events / year x 2.5 lb / event x 0.4 = 85 (93) lb.

The rate at which ordnance residues accumulate in on-site soils will depend upon the relative rates of generation, degradation, and offsite migration. The degree to which accumulating residues contribute to soil contamination will depend upon the nature of the residue constituents. Under the No-action Alternative and Alternative 1, up to about 85 lb per year of ordnance fragments and residues will be deposited on the site.[4] Under Alternative 2 and Alternative 3, no more than 93 lb per year of ordnance fragments and residues would be deposited.[5] At this intensity of use, such residues will constitute a very small fraction of the surface materials in the vicinity of the EOD pit.[6] This level of use is not expected to affect soil chemistry at the EOD range.

EOD Land Range Use by Others

In addition to Navy EOD training, the EOD Land Range will continue to be used by law enforcement agencies and private companies. The frequency of use by these agencies and the types and amounts of ordnance to be used in their activities are not known. However, the restriction on the maximum net explosive weight of ordnance detonated at the Land Range, 2.5 lb, will apply to all users of the Land Range.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

EOD training for Major Exercises would be the same as described above for HRC Training. Major Exercises would not be new training events, but would be an aggregate of existing training events. Under Alternative 2 and Alternative 3, Multiple Strike Group Training would result in an unspecified number of additional training events at the EOD Land Range. These additional events would be substantially fewer than the number of training events estimated for HRC Training, and thus are unlikely to have substantial adverse effects on geology and soils.

4.4.2.4.4 Health and Safety—EOD Land Range–NAVMAG Pearl Harbor West Loch

4.4.2.4.4.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—EOD Land Range–NAVMAG Pearl Harbor West Loch)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Navy EOD Training

EOD Land Range training under the No-action Alternative and Alternative 1 will consist of up to 85 training events per year, using no more than 2.5 lb net explosive weight of ordnance. Under Alternative 2 and Alternative 3, up to 93 training events per year would be held. The public will not be exposed to the energetic effects (overpressure and fragments) of the detonations because the ESQD arc for these training munitions lies completely within the West Loch lands and adjacent waters controlled by the Navy and from which the public is excluded. Accordingly, Navy training events at the EOD Land Range will have no effect on public safety.

---

[4] For these alternatives, 85 exercises / year x 2.5 lb (maximum) per exercise x 40% residue = 85 lb (38.6 kg)
[5] For this alternative, 93 exercises / year x 2.5 lb (maximum) per exercise x 40% residue = 93 lb (42.3 kg)
[6] Assuming deposition within 100 ft of the detonation, area would be about 31,400 ft^2. 85 - 93 lb/year would be about 0.003 lb/ft^2 (15 grams/square meter) per year.

EOD Land Range Use by Law-Enforcement Agencies

In addition to Navy EOD training, the EOD Land Range will continue to be used by law enforcement agencies and private companies. The frequency of use by these agencies and the types and amounts of ordnance to be used in their activities are not known. However, the restriction on the maximum net explosive weight of ordnance detonated at the Land Range, 2.5 lb, would apply to all users of the Land Range. Thus, law enforcement and private activities at the EOD Land Range will have no effect on public safety.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and in some cases RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Strike Group Training would result in an unspecified number of additional training events at the EOD Land Range. Potential impacts from Major Exercises would be similar to those described above for training and RDT&E activities. These additional training events are unlikely to have substantial adverse health and safety effects.

4.4.2.4.5 Water Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch

4.4.2.4.5.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Water Resources—EOD Land Range–NAVMAG Pearl Harbor West Loch)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Under the No-action Alternative and Alternative 1, up to 85 training events per year can be held at the EOD Land Range, each training event involving the demolition of up to 2.5 lb net explosive weight of ordnance. Under Alternative 2 and Alternative 3, up to 93 training events per year could be held. Based on published accounts, up to 40 percent[7] of the initial weight of the ordnance item, for small ordnance, will be deposited on the ground as fragments or residues (Kelleher, 2002). Thus, about 85 to 93 lb per year of solid munitions expended material will be deposited on the site.

These solids will include both soluble and insoluble materials, consisting mostly of inorganic metals (e.g., aluminum, steel, iron) and metallic compounds of low to negligible toxicity. Plastics, soft metals, and explosive compounds will disperse during detonation, and thus will be substantially under-represented in the solids deposited on the site. A small, but unknown percentage of the solids on the site will consist of heavy metals (e.g., chromium, cadmium, lead, nickel) and organic residues (e.g., explosives and their breakdown products, polycyclic aromatic hydrocarbons, dioxins).

Assuming, solely for purposes of analysis, that the entire weight of these residual materials is soluble in the rain water falling on the site (about 7.3 acre-ft, as described in Chapter 3.0), then their concentration will be about 36 parts per million (ppm) to 40 ppm. A portion of the rain water will percolate into the soils on the site, but the relatively impermeable capstone underlying the site will prevent downward movement, and shallow groundwater will eventually migrate horizontally into the adjacent waters of Pearl Harbor. Rain water that does not infiltrate the ground—or evaporate—will flow directly overland into Pearl Harbor.

---

[7] 85 (93) events / year x 2.5 lb / event x 0.4 = 85 (93) lb.

Based on the estimated total concentrations of munitions constituents dissolved in rainwater migrating from the EOD Land Range, their contribution to concentrations of water pollutants in Pearl Harbor will be negligible. These inputs would be periodic, and tidal flushing would further substantially disperse and dilute them. Thus, these intermittent, short-term discharges of very small amounts of munitions constituents into surface waters will have no effect on water resources.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and in some cases RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Strike Group training would result in an unspecified number of additional training at the EOD Land Range. Potential impacts from Major Exercises would be similar to those described above for training and RDT&E activities.

4.4.2.5 LIMA LANDING

Table 4.4.2.5-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Lima Landing. Alternative 3 is the preferred alternative.

Table 4.4.2.5-1. Training at Lima Landing

Training	
• Mine Neutralization	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed at Lima Landing. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would not be any air emission sources at Lima Landing associated with training. Use of this site would not require control of the airspace above this land area. Training associated with this site adheres to policies and regulations governing noise, as discussed in Appendix C. There is no current or proposed training that could affect land forms, geology, and associated soils development.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at Lima Landing would not generate any waste streams that could impact local water quality.

4.4.2.5.1 Biological Resources—Lima Landing

4.4.2.5.1.1 No-action Alternative (Biological Resources—Lima Landing)

HRC Training and Major Exercises—No-action Alternative

Under the No-action Alternative, up to 62 Mine Neutralization training events per year will continue to occur at locations such as Lima Landing, or about 5 to 6 per month. Individual training events use explosives charges no greater than 0.25 lb net explosive weight. Up to about 1.25 lb of explosives will be used per year. Training follows the relevant Naval Station Pearl Harbor and Navy policies and procedures to minimize impacts on biological resources Table 4.4.2.1.1.1-1.

Explosive Ordnance Disposal Ranges—No-action Alternative

Vegetation

No threatened or endangered plant species have been identified in the region of influence.

Wildlife

Under the No-action Alternative, up to 62 Mine Neutralization training events per year will continue to occur at locations such as Lima Landing, or about 5 to 6 per month. Mine

Neutralization activities may include destruction of inert mines by detonation of no more than 0.25 lb of explosive per inert mine. Prior to actual detonation, the area will be determined to be clear of marine mammals. Training follows the relevant Navy policies and procedures to minimize impacts on biological resources. Standard procedures require tethered mines to be suspended at least 10 ft below the surface of the water. Explosive charges on or near the shallow water bottom will be placed in sandy areas away from exposed reefs and coral. There can be minor and localized loss of some fish and benthic populations from the explosions. All waters around Naval Station Pearl Harbor have been designated as EFH for eggs and larvae of a number of species. The harbor has not been designated as a Habitat Area of Particular Concern. (U.S. Department of the Navy, Commander Navy Region Hawaii, 2001) After training involving underwater detonations, the area will be searched for injured animals. Such detonations occur infrequently.

Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2. Only sandy areas that avoid/minimize potential impacts on coral are used for explosive charges on the shallow water floor (less than 40 feet of water). Lima Landing is approximately 3 mi from the Honouiliuli Unit of the refuge. Mine Neutralization activities could startle these birds, but suspension of the mines at least 10 ft underwater should dampen the potential for airborne noise effects.

SPECWAROPS include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. The training event involves fewer than 20 troops and has minimal interaction with the environment, since one of the purposes of the training event is to operate undetected. During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops (Training Guidelines for Resource Protection—All Oahu Training Areas). (U.S. Department of the Navy, 2002a)

Environmentally Sensitive Habitat

No environmentally sensitive habitat has been identified in the immediate area.

4.4.2.5.1.2 Alternative 1 (Biological Resources—Lima Landing)

Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). No increase in the number of training events performed at Lima Landing is anticipated. Impacts on biological resources would be similar to those described previously for the No-action Alternative. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2.

Vegetation

Training would take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy policies and procedures (Table 4.4.2.1.1.1-1) during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. There would continue to be a minor and localized loss of some fish and benthic populations from the explosions. The increased training would comply with relevant Navy policies and procedures (Table 4.4.2.1.1.1-1), which would minimize the potential for effects on wildlife.

Environmentally Sensitive Habitat

No environmentally sensitive habitat has been identified in the immediate area.

4.4.2.5.1.3 Alternative 2 (Biological Resources—Lima Landing)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and an additional six Mine Neutralization events would occur. Since Mine Neutralization events occur in other areas of the HRC, not all of the additional six per year would necessarily take place at Lima Landing. Prior to actual detonation, the area would be determined as clear of marine mammals. Explosive charges, in less than 40 ft of water, would be placed/neutralized only in sandy areas to avoid/minimize potential impacts on coral. Impacts on marine mammals, sea turtles, and fish from underwater explosions are discussed in Section 4.1.2.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.5.1.4 Alternative 3 (Biological Resources—Lima Landing)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.5.2 Cultural Resources—Lima Landing

4.4.2.5.2.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Cultural Resources—Lima Landing)

Lima Landing is a small underwater range situated within the Pearl Harbor National Historic Landmark boundary. Within the vicinity are numerous submerged cultural resources as noted for Naval Station Pearl Harbor; however, none are directly within the region of influence for Lima Landing's underwater demolition activities. Given the restricted size of the explosives used during training (and their associated concussive effects), and the distance from known Landmark features, no effects on underwater cultural resources are expected. If the locations for underwater demolition activities are changed in the future (i.e., expanded north or south where sensitive cultural resources could be encountered), coordination with the Navy Region Hawaii's designated cultural resources coordinator would be required.

4.4.2.5.3 Hazardous Materials and Waste—Lima Landing

4.4.2.5.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Hazardous Materials and Waste—Lima Landing)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Under the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3, up to five training events per year can occur at Lima Landing. Training would use explosives charges of no more than 0.25 lb net explosive weight each, for a total of about 1.25 lb per year of explosives under the No-action Alternative, Alternative 1, and Alternative 2. The transport, handling, and use of such small quantities of hazardous materials on an infrequent basis will have no effect on ongoing hazardous materials management activities. No RCRA hazardous wastes will be generated by this training.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and in some cases RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Strike Groups would conduct demolition and SPECWAROPS at Lima Landing. This very limited, short-term use of the range is not expected to substantially affect hazardous materials use on or hazardous waste generation from the range. Potential impacts from Major Exercises would be similar to those described above for training and RDT&E activities.

4.4.2.5.4 Health and Safety—Lima Landing

4.4.2.5.4.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Health and Safety—Lima Landing)

HRC Training—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Underwater demolition activities at Lima Landing under the No-action Alternative and Alternatives 1 and 2 would consist of up to five training events per year, using no more than 0.25 lb net explosive weight of ordnance per training event. The public would not be exposed to the energetic effects of the detonations because these effects would be completely contained within the range and adjacent waters controlled by the Navy and from which the public is excluded. Existing Navy safety protocols for the use of explosives would ensure that no non-participants would be in the area during training. Accordingly, future Navy training at Lima Landing would have no effect on public health and safety.

Demolition activities will be conducted in accordance with COMNAVSURFPAC Instruction 3120.8F (U.S. Department of the Navy, 1993). COMNAVSURFPAC Instruction 3120.8F specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Major Exercises under all Alternatives, such as RIMPAC and USWEX, include training and in some cases RDT&E activities. Under Alternative 2 and Alternative 3, Multiple Strike Groups would conduct limited, short-term Demolition and SPECWAROPS at Lima Landing. Potential impacts from Major Exercises would be similar to those described above for training and RDT&E activities.

4.4.2.6 U.S. COAST GUARD AIR STATION BARBERS POINT/KALAELOA AIRPORT

Table 4.4.2.6-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at the U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport. Alternative 3 is the preferred alternative.

Table 4.4.2.6-1. Training at Coast Guard Air Station Barbers Point/Kalaeloa Airport

Training	
• Air Operations	• Special Warfare Operations (SPECWAROPS)
• Aircraft Support Operations	

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for the U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, cultural resources, geology and soils, hazardous materials and hazardous waste, health and safety, land use, socioeconomics, transportation, utilities, and water resources.

HRC training associated with Coast Guard Air Station Barbers Point/Kalaeloa Airport would not impact regional air quality. There is no planned construction or alteration associated with the Navy that would affect the cultural resources in the vicinity. There are no current or proposed training that could affect land use, land forms, geology, and associated soils development. Training associated with this site adhere to policies and regulations governing hazardous materials and hazardous waste, and health and safety, as discussed in Appendix C.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the site would not generate any waste streams that could impact local water quality.

4.4.2.6.1 Airspace—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport

4.4.2.6.1.1 No-action Alternative (Airspace—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

HRC Training—No-action Alternative

Aircraft Support Operations will require coordination with the State of Hawaii and the Coast Guard and will use existing facilities for fueling and minor maintenance.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace will not be used, and aircraft will use existing approach and departure procedures. Coordination with Kalaeloa Airport will be the same as for other military aircraft using the runways.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC and USWEX can include Aircraft Support Operations at Kalaeloa Airport. These Major Exercises include extensive planning and coordination with the Federal Aviation Administration (FAA). RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC Exercise. USWEX training would generally not include Aircraft Support Operations at Kalaeloa Airport. If aircraft support were required, it would be coordinated with the FAA well in advance of each 3- or 4-day Major Exercise.

The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.6.1.2 Alternative 1 (Airspace—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

Increased Tempo and Frequency of Training—Alternative 1

Aircraft Support Operations would require coordination with the State of Hawaii and the Coast Guard and would use existing facilities for fueling and minor maintenance. Increased training would result in a minor increase in the number of Aircraft Support Operations.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace would not be used, and aircraft would use existing approach and departure procedures. Coordination with Kalaeloa Airport would be the same as for other military aircraft using the runways.

Major Exercises—Alternative 1

RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC Exercise. The increase from one aircraft carrier to two during RIMPAC under Alternative 1 would require a minor increase in Aircraft Support Operations and subsequent coordination between the Navy and FAA. USWEX training would generally not include Aircraft Support Operations at Kalaeloa Airport. If aircraft support was required it would be coordinated with the FAA well in advance of each 3- or 4-day Major Exercise.

The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.6.1.3 Alternative 2 (Airspace—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

Increased Tempo and Frequency of Training—Alternative 2

An increased tempo and frequency of training would be similar to the ongoing training support. Aircraft Support Operations would require coordination with the State of Hawaii and the Coast Guard and would use existing facilities for fueling and minor maintenance. Increased tempo and frequency of training would result in a minor increase in the number of Aircraft Support Operations.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace would not be used, and aircraft would use existing approach and departure procedures. Coordination with Kalaeloa Airport would be the same as for other military aircraft using the runways.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Training Exercise. However, the Multiple Strike Group Training would generally not include Aircraft Support Operations at Kalaeloa Airport. If aircraft support was required it would be coordinated with the FAA well in advance of the Major Exercise. The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.6.1.4 Alternative 3 (Airspace—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.6.2 Biological Resources—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport

4.4.2.6.2.1 No-action Alternative (Biological Resources—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

HRC Training and Major Exercises—No-action Alternative

There are few biological resources associated directly with the facility. Aircraft Support Operations use existing facilities for fueling and minor maintenance. SPECWAROPS also use existing facilities, concrete aprons, hangars, and adjacent open areas for various activities. Navy activities at the site would be performed in accordance with all applicable biological opinions and existing Coast Guard regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Coast Guard regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Vegetation

Areas known to contain the endangered `akoko shrub or the round-leafed chaff-flower are avoided.

Wildlife

Air Support Operations and SPECWAROPS would continue to result in noise and movement of personnel, vehicles, helicopters, and landing craft. However, training events are generally short in duration and they occur in areas regularly used for such training. Air Operations are a routine occurrence on the installation. All participants in training events are to adhere to the Navy guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Coast Guard procedures, to assist in minimizing impacts on biological resources. Any potential impacts to listed bird species such as the ae`o (Hawaiian stilt) would be addressed through coordination/consultation with the USFWS. While individual migratory birds may be startled, the training events (Air Operations, Aircraft Support Operations, and SPECWAROPS) being currently performed are not likely to significantly impact a population of any of the migratory species that occur in the U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport area and thus would be exempt from the MBTA take prohibitions.

Environmentally Sensitive Habitat

The Kalaeloa Unit of the Pearl Harbor National Wildlife Refuge supports the second largest population of endangered ewa hina hina (*Achyranthes splendens*). Activities performed on U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport would avoid this unit of the refuge.

4.4.2.6.2.2 Alternative 1 (Biological Resources—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). Air Operations, Aircraft Support Operations, and SPECWAROPS would not increase in number, but may increase in tempo.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Coast Guard and Navy policies and procedures (Table 4.4.2.1.1.1-1) during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species. No threatened or endangered plant species are known to occur at the airport.

Wildlife

Although not necessarily their preferred habitat, there is additional suitable habitat nearby for birds, the most common form of wildlife on the site, such as the black-crowned night heron, great frigate bird, Pacific golden plover, and sanderling on U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport to use if they temporarily leave the area affected by an increase in training. The increased training would comply with relevant Coast Guard and Navy policies and procedures (Table 4.4.2.1.1.1-1), which would further reduce the potential for effects on wildlife.

Environmentally Sensitive Habitat

The Kalaeloa Unit of the Pearl Harbor National Wildlife Refuge supports the second largest population of endangered ewa hina hina. Activities performed on U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport would avoid this unit of the refuge.

4.4.2.6.2.3 Alternative 2 (Biological Resources—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.6.2.4 Alternative 3 (Biological Resources—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.6.3 Noise—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport

Impacts of noise on human receptors are evaluated based on whether or not a noise event would exceed DoD or Occupational Safety and Health Administration (OSHA) guidelines.

4.4.2.6.3.1 No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 (Noise—U.S. Coast Guard Air Station Barbers Point/Kalaeloa Airport)

HRC Training and Major Exercises—No-action Alternative, Alternative 1, Alternative 2, and Alternative 3

Under the No-action Alternative, Aircraft Support Operations, SPECWAROPS, and Air Operations will continue to occur at U.S. Coast Guard Station Barbers Point/ Kalaeloa Airport. SPECWAROPS use existing facilities, concrete aprons, hangars, and adjacent open areas for various activities. Due to the non-intrusive nature of these activities, a limited amount of noise will continue to be produced and will stay within the existing noise contours.

These same training events are proposed for Alternatives 1 and 2. Noise levels associated with the increased tempo and frequency of training events and Major Exercises would be similar to existing noise levels. The total number of training events that affect noise would increase; however, there would be no anticipated increase to the level of noise produced.

4.4.2.7 MARINE CORPS BASE HAWAII (MCBH)

Table 4.4.2.7-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at MCBH. Alternative 3 is the preferred alternative.

Table 4.4.2.7-1. Training at Marine Corps Base Hawaii

Training	
• Air Operations	• Command and Control
• Humanitarian Assistance/Non-combatant Evacuation Operations (HAO/NEO)	• Humanitarian Assistance/Disaster Relief Operations (HA/DR)
• Aircraft Support Operations	• Special Warfare Operations (SPECWAROPS)
• Field Carrier Landing Practice (FCLP) (Alternative 1)	• Expeditionary Assault

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for MCBH. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, geology and soils, hazardous materials and hazardous waste, health and safety, land use, transportation, utilities, and water resources.

There would be no air emissions generated at MCBH other than that from an occasional aircraft training and Expeditionary Assault training. The Air Operations and Aircraft Support Operations would not change regional air quality. The addition of Field Carrier Landing Practice (FCLP) would not alter air quality at MCBH as air emissions would be the same as existing activities. There is no current or proposed training that could affect land use, land forms, geology, and associated soils development. Geology and soils impacts would be limited to short-term minor disturbance of beach sand and near-shore ocean floor along existing Expeditionary Assault access routes.

Training associated with MCBH adhere to policies and regulations governing hazardous materials and hazardous waste, and health and safety, as discussed in Appendix C. There would be no impact on Oahu's transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Water resources would not be affected by the training events which, after moving from the beach, would primarily occur in developed areas on MCBH.

4.4.2.7.1 Airspace—MCBH

4.4.2.7.1.1 No-action Alternative (Airspace—MCBH)

HRC Training—No-action Alternative

No use of controlled airspace is planned for HRC training other than localized use of rotary and fixed-wing aircraft within predefined areas.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC include training and, in some cases, RDT&E activities. At MCBH this training will include rotary and fixed wing aircraft. These Air Operations and Aircraft Support Operations are a part of ongoing training routinely conducted by the air wings at MCBH. RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.7.1.2 Alternative 1 (Airspace—MCBH)

Increased Tempo and Frequency of Training—Alternative 1

Increased training would involve minor increases in the use of rotary and fixed-wing aircraft.

Major Exercises—Alternative 1

An additional proposed training activity associated with Major Exercises is FCLP. This activity involves pilots from an aircraft carrier air wing practicing landings at a land runway. As discussed in Chapter 2.0, the runway at MCBH could be used for FCLP. For each pilot the FCLP would include 8 to 10 touch-and-go landings at the MCBH runway during both daytime and at night. The carrier wing aircraft would be operating within the MCBH Class D and Class E airspace and the adjacent area. FCLP activities would be below and north of the V12-13 airway.

RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. Each of the USWEX training events, up to six per year, would include coordination with the FAA well in advance of the 3- or 4-day Major Exercise. FAA coordination would include discussions regarding the anticipated number of aircraft including FCLP activities.

The advance planning and coordination with the FAA regarding scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, result in minimal impacts on airspace from Major Exercises. The increase from one aircraft carrier to two during RIMPAC under Alternative 1 would require a minor increase in coordination and scheduling by the Navy and FAA. The increased training would be readily accommodated within the existing airspace.

4.4.2.7.1.3 Alternative 2 (Airspace—MCBH)

Increased Tempo and Frequency of Training—Alternative 2

Increased training would involve minor increases in the use of rotary and fixed-wing aircraft.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Training Exercise that would include rotary and fixed wing aircraft. These Air Operations and Aircraft Support Operations are a part of ongoing training routinely conducted by the air wings at MCBH.

An additional proposed training activity associated with Major Exercises is FCLP. This activity involves pilots from an aircraft carrier air wing practicing landings at a land runway. As discussed in Chapter 2.0, the runway at MCBH could be used for FCLP. For each pilot the FCLP would include 8 to 10 touch-and-go landings at the MCBH runway during both daytime and at night. The carrier wing aircraft would be operating within the MCBH Class D and Class E airspace and the adjacent area. FCLP activities would be below and north of the V12-13 airway.

Multiple Strike Group training would include coordination with the FAA well in advance of the Major Exercise. FAA coordination would include discussions regarding the anticipated number of aircraft including FCLP activities. The advance planning and coordination with the FAA regarding scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes, result in minimal impacts on airspace from Major Exercises. The use of three aircraft carriers during a Major Exercise would require an increase in coordination and scheduling by the Navy and FAA. The increased training would be readily accommodated within the existing airspace.

4.4.2.7.1.4 Alternative 3 (Airspace—MCBH)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.7.2 Biological Resources—MCBH

4.4.2.7.2.1 No-action Alternative (Biological Resources—MCBH)

Navy activities at the site would be performed in accordance with all applicable biological opinions and existing Marine Corps regulations. Adherence to established SOPs at MCBH would result in minimal impacts on the physical environment and avoid potential impacts on threatened and endangered species. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Marine Corps regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

The terrestrial habitat typically consists of sparse ground cover composed of indigenous grasses and shrubs. Most of the vegetation on MCBH is dominated by introduced species. Humanitarian Assistance Operations and Non-Combatant Evacuation Operations (HAO/NEO) and Humanitarian Assistance/Disaster Relief (HA/DR) and SPECWAROPS use existing open areas and facilities. Some temporary structures, including tents, may be used. All participants are briefed on current guidelines to avoid undue impacts on vegetation. Training follows the guidelines provided in Table 4.4.2.1.1.1-1, which assist in minimizing the potential for impacts on beach vegetation.

Wildlife

Navy activities would continue to result in noise and movement of personnel, vehicles, helicopters, and landing craft. However, training events are short in duration and are not expected to affect the areas where the birds are most likely to nest. Training within the range areas regularly used for training should not substantially increase the threat to these species. Night lighting is shielded to the extent practical to minimize its potential effect on night-flying species in the beach area. Any potential impacts to listed bird species, such as the koloa maoli (Hawaiian duck), \`alae ke\`oke\`o (Hawaiian coot), \`alae \`ula (Hawaiian common moorhen) and ae\`o (Hawaiian stilt), would be addressed through coordination/consultation with the USFWS. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. While individual birds may be startled, the training events (C2, Air Operations, Aircraft Support Operations, FCLPs, and SPECWAROPS) being currently performed are not likely to significantly impact a population of any of the migratory species, such as the Pacific golden-plover and ruddy turnstone, that occur in the MCBH area and thus would be exempt from the MBTA take prohibitions.

Beach surveys are conducted prior to a training event to identify any sea turtle nests. If present, these sites are marked and the immediate area placed off limits to personnel. Adherence to established SOPs at MCBH results in minimal impacts on the physical environment and avoids potential impacts on threatened and endangered species. The beach and offshore waters are monitored for the presence of marine mammals and sea turtles 1 hour before and during Major Exercises. If any are seen, the training event is delayed until the animals leave the area.

Environmentally Sensitive Habitat

Nearby wetlands, including the Nuupia Ponds complex at the southern boundary of the base, are avoided during range activities.

4.4.2.7.2.2 Alternative 1 (Biological Resources—MCBH)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, their tempo may, but the likelihood of a similar increase in adverse impacts on biological resources is small, as discussed below.

Vegetation

Training would take place at existing locations; no expansion of the area would be involved. Compliance with relevant Marine Corps and Navy policies and procedures (Table 4.4.2.1.1.1-1) during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species. No threatened or endangered plant species are known to occur on MCBH.

Wildlife

Although not necessarily their preferred habitat, there is additional suitable habitat nearby for birds on MCBH to use if they temporarily leave the area affected by an increase in training. The increased training would comply with relevant Marine Corps and Navy policies and procedures (Table 4.4.2.1.1.1-1), which would further reduce the potential for effects on wildlife.

The beach and offshore waters would continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during training. If any are seen, then the training event would be delayed until the animals leave the area.

New Training

An additional proposed training event associated with Major Exercises is FCLP, which involves pilots from an aircraft carrier air wing practicing landings at a land runway. For each pilot, the FCLP would include 8 to 10 touch-and-go landings during both daytime and at night. Sound levels from this training would be similar to sound levels currently occurring at the MCBH. Other than startle effects, no substantial impacts on wildlife, including threatened and endangered species, are anticipated.

Environmentally Sensitive Habitat

Nearby wetlands, including the Nuupia Ponds complex at the southern boundary of the base, would be avoided during training.

4.4.2.7.2.3 Alternative 2 (Biological Resources—MCBH)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. The increased tempo and frequency of training would comply with relevant Marine Corps and Navy policies and procedures (Table 4.4.2.1.1.1-1), which would further reduce the potential for effects on wildlife. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.7.2.4 Alternative 3 (Biological Resources—MCBH)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.7.3 Cultural Resources—MCBH

4.4.2.7.3.1 No-action Alternative (Cultural Resources—MCBH)

HRC Training and Major Exercises—No-action Alternative

HAO/NEO and HA/DR

Training with the potential to affect terrestrial cultural resources at MCBH includes HAO/NEO and HA/DR. Both of these training events exhibit similar activities that involve personnel and equipment (e.g., Amphibious Assault Vehicles [AAVs], SDVs, supply trucks) crossing beach areas or following existing transit routes from the shoreline and dispersing into designated areas for from 1 to 18 days of realistic training. HA/DR activities also include the establishment of a safe haven camp or Civil-Military Operations Center, which can use either existing buildings or the erection of tents and portable latrines. The MCBH insertion points are shown in Appendix D. Training will take place within a landing zone that has been heavily disturbed through long-term use by the military and the public and near existing, heavily used trails and roads. Roads may require grading; however, the grading will not exceed the existing road width or alignment. Although there are areas of MCBH that are sensitive for cultural resources, none have been identified within the HAO/NEO or HA/DR training areas. Training overlays that identify the transit route, camp location, and any nearby restricted areas or sensitive biological and cultural resource areas are used by participants. As a result, adverse effects on cultural resources are not expected. However, in the event unanticipated cultural remains are identified (particularly human remains), all training will cease in the immediate vicinity and the Hawaii SHPO will be immediately notified in accordance with the Programmatic Agreement (see Appendix H).

According to NOAA's location maps there are several shipwrecks and Native Hawaiian fishponds in the vicinity of MCBH (see Figures 3.1.3-2 and 3.4.1.3.2-1); however, none are located within the direct offshore region of influence for HA/DR insertion.

4.4.2.7.3.2 Alternative 1 (Cultural Resources—MCBH)

Increased Tempo and Frequency of Training—Alternative 1

Increased tempo and frequency of training under Alternative 1 would not increase the potential for impacts to occur on cultural resources in sensitive areas. There are no sensitive cultural resources within or adjacent to the training areas for HAO/NEO and HA/DR at MCBH. Training currently use designated beach zones, transit routes, and staging areas, and mitigation measures are in place that would avoid adverse impacts. No impacts on cultural resources will occur as a result of the additional training and frequency of conducting those training events under Alternative 1.

4.4.2.7.3.3 Alternative 2 (Cultural Resources—MCBH)

Increased Tempo and Frequency of Training—Alternative 2

Increased tempo and frequency of training under Alternative 2 would not increase the potential for impacts to occur on cultural resources in sensitive areas. Training currently uses designated beach zones and transit routes and mitigation measures are in place that would avoid adverse impacts. No impacts on cultural resources would occur as a result of the additional training under Alternative 2.

4.4.2.7.3.4 Alternative 3 (Cultural Resources—MCBH)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.7.4 Noise—MCBH

Impacts of noise on human receptors are evaluated based on whether a noise event would exceed DoD or OSHA guidelines. Noise effects on wildlife are discussed in Section 4.4.2.7.2, Biological Resources.

4.4.2.7.4.1 No-action Alternative (Noise—MCBH)

HRC Training—No-action Alternative

Under the No-action Alternative existing training at MCBH will continue and there will be no increase to existing noise levels. MCBH maintains a hearing protection program that includes monitoring the hearing of personnel exposed to high noise levels and identifying and posting notification of noise hazard areas. Personnel required to work in noise hazard areas are required to use appropriate hearing protection to bring noise levels within established safety levels.

Major Exercises—No-action Alternative

Under the No-action Alternative, existing Major Exercises at MCBH typically include C2, Air Operations, Underwater Mine Warfare Exercises, HAO/NEO, HA/DR, SPECWAROPS, and Expeditionary Assault.

During a typical training event at MCBH, a combination of ambient noise and noise produced during the training will be heard. Ambient noise sources can include wind, surf, highway traffic, Aircraft Support Operations, and other local noise-generating land uses. Noise sources from the listed training events can include helicopter training and amphibious assault vehicles and craft.

Typical Amphibious Assault Operations include landings at MCTAB and Barking Sands by three to four AAVs or one LCAC and will in the future include Expeditionary Fighting Vehicles (EFVs). LCAC craft, powered by four gas turbine engines, produce noise in proportion to their lift (i.e., load requirements). Noise levels associated with LCAC activities have been known to exceed 95 to 105 A-weighted decibels (dBA) at 50 ft from the source. Measured noise levels for the AAV moving over land are 87 dBA SEL, and for EFV are slightly higher at 90 dBA. Four EFVs operating simultaneously will generate an increased source level of approximately 96 dBA. These activities are conducted in the offshore and on-island environment, and the nearest non-participant human receptors will be at MCTAB, where a housing development lies approximately 2,500 ft southwest of the Expeditionary Assault Operations. Using a single LCAC at 105 dBA as the greatest source level, the sound will decrease to a theoretical level of less than 75 dBA (which assumes a 6-dB drop each doubling of the distance). The actual received level will be lower due to the sound attenuation caused by almost solid tree cover between the training location and the housing area, likely to a level of 60 to 65 dBA. Therefore, no adverse impacts are expected.

The noise levels of landing craft activities are less than those projected for current airfield activities. However, under certain weather conditions, the sound generated by a landing craft can reach off-post areas. This impact will be mitigated by public notification and restricting training in the bay to daylight hours.

4.4.2.7.4.2 Alternative 1 (Noise—MCBH)

Increased Tempo and Frequency of Training—Alternative 1

Noise levels associated with increased tempo and frequency of training would be similar to existing noise levels. The total number of training events that affect noise would increase by approximately 9 percent above the No-action Alternative. Training would take place at existing locations. While the number of training events would increase, the types of training would be the same and would not overlap. There would be no anticipated increase to the level of noise produced.

The Navy proposes to conduct an FCLP for a small number of pilots each year in Hawaii using F/A-18 aircraft. An FCLP is a series of touch-and-go landings conducted during day or night periods, each consisting of six to eight touch-and-go landings per pilot. The MCBH is one of the sites proposed for this activity in Hawaii.

F/A-18 aircraft have been previously stationed at MCBH. F/A-18 flight activities included FCLPs. In 1993, 12,692 day F/A-18 flight activities and 99 night F/A-18 flight activities occurred and were considered in the *1990 AICUZ Update for MCBH Kaneohe Bay.* Between 1993 and 1994, the F/A-18 aircraft squadrons were relocated from MCBH to other locations. While F/A-18s are not longer based at MCBH, transient flight activity using F/A-18s continue to occur on an irregular basis.

The current AICUZ for MCBH (*MCBH Kaneohe Bay Air Installations Compatible Use Zones* [Naval Facilities Engineering Command, 2003]) modeled for 176,850 flight activities. Modeling performed was based on 1999 flight activity levels at MCBH, including 1,476 day F/A-18 flight activities and six night F/A-18 flight activities. These flight activities by F/A-18 accounted for less than 0.01 percent of the modeled flight activities at MCBH. Figure 3.4.2.7.4-1 depicts modeled noise contours based on these flight activities for MCBH. Modeling analysis determined that the only off-base land areas that would be impacted by noise levels greater than DNL 60 are Coconut Island and other small uninhabited islands. Land uses within the DNL 65 noise contour on-base include the industrial area near the runway, maintenance facilities, portions of the officers' family housing and bachelor enlisted quarters, a portion of the golf course, beach areas, operational and maintenance uses on both sides of the runway, and the runway itself. (Naval Facilities Engineering Command, 2003)

Alternative 1 proposes that to accommodate the needs of three pilots per year that may arrive in Hawaii in need of field qualification, up to 12 FCLP periods would be required. Twelve FCLP periods would be within the currently modeled flight activities for MCBH, and it is anticipated that the noise levels for the proposed activities would not exceed the levels described in the *MCBH Kaneohe Bay Air Installations Compatible Use Zones* (Naval Facilities Engineering Command, 2003)

4.4.2.7.4.3 Alternative 2 (Noise—MCBH)

Increased Tempo and Frequency of Training—Alternative 2

Noise levels associated with increased training, including up to 16 FCLP periods, would be similar to existing noise levels described in Section 4.4.2.7.4.2. Sixteen FCLP periods would also be within the currently modeled flight operations for MCBH, and it is anticipated that the noise levels for the proposed activities would not exceed the levels described in the *MCBH Kaneohe Bay Air Installations Compatible Use Zones* (Naval Facilities Engineering Command, 2003). The total number of training events that affect noise would increase, but there would be no anticipated increase to the level of noise produced.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The training proposed would be similar to those occurring during current Major Exercises, with impacts on noise levels similar to those described above.

4.4.2.7.4.4 Alternative 3 (Noise—MCBH)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on noise under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.7.5 Socioeconomics—MCBH

4.4.2.7.5.1 No-action Alternative (Socioeconomics—MCBH)

The No-action Alternative stands as no change from current levels of training, and the Navy will continue its current activities at the HRC. Table 2.2.2.3-1 lists current HRC training associated with MCBH, and Appendix D includes a full description. Appendix E includes a description of current weapon systems. There are no RDT&E activities associated with MCBH, and Table 2.2.2.6-1 lists current Major Exercise events. Training events include Expeditionary Assault where amphibious landing could occur on MCBH; SPECWAROPS which are performed by Naval SEALs and Marines; C2, which can provide continuous command and control support from MCBH; Aircraft Support Operations, which include space for the various types or aircraft, equipment for refueling and maintenance; Aircraft Operations, which are a part of daily and Major Exercises; HAO/NEO which provides training for humanitarian assistance; and HA/DR which provide training in responding to a United Nations request for complex emergency support. Additionally, training for Major Exercises includes C2, Aircraft Operations, Underwater Mine Warfare Exercise which occurs offshore, HAO/NEO, HA/DR, SPECWAROPS and Expeditionary

Assault. Section 4.4.2.1.3 discusses the socioeconomic characteristics of Oahu which include the Kailua and Kaneohe communities.

4.4.2.7.5.2 Alternative 1 (Socioeconomics—MCBH)

Increased Tempo and Frequency of Training and New Training—Alternative 1

Under Alternative 1, there are no increases in the occurrence of onshore training on Marine Corps Base Hawaii.

The airfield located on MCBH is a proposed site for the FCLP. The proposed FCLPs would affect a small number (exact number is not known) of pilots each year in Hawaii. An FCLP is a series of touch-and-go landings conducted to train and field qualify pilots for aircraft carrier landings. Under Alternative 1 there are 12 proposed FCLP events per year. Normally, four FCLP periods would be required per pilot (2 day/ 2 night practice landings). The FCLP pilots would be carrier based and would not bring permanent personnel to MCBH.

The civilian communities closest to MCBH are Kailua and Kaneohe. These communities are predominately single-family suburban "bedroom communities." Of the two communities, Kaneohe is likely to be more affected by MCBH airfield activities because the major flight tracks are closer to Kaneohe, and airfield activities are more visible to Kaneohe residents. Figure 3.4.2.7.4-1 indicates that Kaneohe is located outside the 55 L_{dn} (Day-Night Average Sound Level), and the *MCBH Kaneohe Bay Air Installation Compatible Use Zones* (Naval Facilities Engineering Command, 2003) determined that only off-base areas impacted by noise levels greater than 60 L_{dn} are Coconut Island and other small uninhabited islands. The L_{dn} is the average noise level over a 24-hour period except for noise occurring at night (between the hours of 10:00 p.m. and 7:00 a.m.). The proposed FCLPs would not occur outside the 60 L_{dn} which only impacts Coconut Island. The Kaneohe residents could be economically impacted by the increase in the number of aircraft due to the 12 FCLPs if it was determined that the socioeconomic characteristics of Kaneohe (population size, and the type and cost of housing) would be negatively affected by the 12 FCLPs events per year. For additional analysis see Section 4.4.2.7.4.

Increased RDT&E Activities—Alternative 1

There are no onshore RDT&E activities associated with MCBH.

Major Exercises—Alternative 1

Under Alternative 1, USWEX frequency would increase by 50 percent (from 4 to 6 times per year). Appendix D shows the matrix of training generally used during a USWEX Exercise by location. Under Alternative 1 there are no increases in the training on Marine Corps Base Hawaii that are associated with USWEX. The USWEX events under Alternative 1 would not affect Marine Corps Base Hawaii. The level of employment and defense initiatives associated with the No-action Alternative on Oahu would continue to benefit the local economy of Oahu.

The FCLPs would be conducted during a Major Exercise, and a small number of pilots would train at the airfield located on MCBH. The Kaneohe residents could be economically impacted by the increase in the number of aircraft due to the 12 FCLPs if it was determined that the socioeconomic characteristics of Kaneohe (population size, and the type and cost of housing) would be negatively affected by the 12 FCLPs events per year. For additional analysis see Section 4.4.2.7.4.

4.4.2.7.5.3 Alternative 2 (Socioeconomics—MCBH)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, HRC training events associated with Marine Corps Base Hawaii that would increase are Expeditionary Assault, C2 and Aircraft Support Operations. Under Alternative 2 Expeditionary Assault would increase by 9 percent and the C2 and Aircraft Support Operations each would increase by 100 percent. Support would continue to be provided from facilities on MCBH. The Navy would not require new construction or an increase in personnel in order to provide the support for these increases. Support would not change from the requirements under the No-action Alternative.

Sixteen FCLPs events are proposed to be conducted at the airfield at MCBH. FCLPs are not conducted under the No-action Alterative. Under Alternative 2, 16 FCLPs would be an increase of approximately 33 percent (from 12 to 16 FCLP events per year) from the proposed number under Alternative 1. The Navy would not require any new construction to support the FCLP events at the airfield. The FCLP pilots would be carrier based and would not bring permanent personnel to MCBH. The Kaneohe residents could be economically impacted by the increase in the number of aircraft due to the 16 FCLPs if it was determined that the socioeconomic characteristics of Kaneohe (population size, and the type and cost of housing) would be negatively affected by the 16 FCLPs events per year. For additional analysis see Section 4.4.2.7.4.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Under Alternative 2, up to three Strike Groups would be allowed to conduct training simultaneously in the HRC (Figure 1.2-3). Depending on the Major Exercise being performed MCBH would provide support for training. The Strike Groups would not be homeported in Hawaii, but would be in Hawaii for up to 10 days per Major Exercise. During this time, sailors and marines could visit Oahu while transiting. An increase in the income generated on Oahu could be expected for tourism-related services, which would affect the personal income of some Oahu residents during the 10-day training period. No increase in population size, renter-occupied homes, or single-family owned homes would be expected. The potential for requiring FCLPs increases. These FCLPs would be conducted on MCBH; however, the FCLP pilots would be carrier based and would not bring permanent personnel to MCBH. The Kaneohe residents could be economically impacted by the increase in the number of aircraft due to the 16 FCLPs if it was determined that the socioeconomic characteristics of Kaneohe (population size, and the type and cost of housing) would be negatively affected by the 16 FCLPs events per year. For additional analysis see Section 4.4.2.7.4.

4.4.2.7.5.4 Alternative 3 (Socioeconomics—MCBH)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1

and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on socioeconomics under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.8 MARINE CORPS TRAINING AREA/BELLOWS (MCTAB)

Table 4.4.2.8-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at MCTAB. Alternative 3 is the preferred alternative.

Table 4.4.2.8-1. Training at MCTAB

Training	
• Expeditionary Assault	• Special Warfare Operations (SPECWAROPS)
• Humanitarian Assistance/Non-combatant Evacuation Operations (HAO/NEO)	• Humanitarian Assistance/Disaster Relief Operations (HA/DR)
• Swimmer Insertion/Extraction	

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for MCTAB. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at MCTAB other than that from an occasional Aircraft Operation and Expeditionary Assault training. The Aircraft Operations would not change regional air quality. Airspace use at MCTAB is limited to rotary wing aircraft. MCTAB does not affect the existing airspace structure in the region. Training associated with MCTAB adheres to policy and regulation for hazardous materials and hazardous waste, health and safety, and noise, as discussed in Appendix C. Most training would be within existing Takeoff Safety Zones and Approach-Departure Clearance Surfaces that are delineated over the runways and do not extend off-base.

Geology and soils impacts at MCTAB would be limited to short-term minor disturbance of beach sand and near-shore ocean floor along existing Expeditionary Assault access routes. Movement from the beach would also result in minor, short-term disturbance to soils along pre-defined access routes. Primary surface water features are defined as off-limits during the training events, therefore avoiding impact on groundwater. There would be no impact on Oahu's socioeconomics, transportation, utilities, and land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative.

4.4.2.8.1 Biological Resources—MCTAB

4.4.2.8.1.1 No-action Alternative (Biological Resources—MCTAB)

Navy activities at the site would be performed in accordance with all applicable biological opinions and existing Marine Corps regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Marine Corps regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

Native vegetation on MCTAB has largely been replaced by exotic species. However, unique strand vegetation can be found on sea cliffs and sand dunes at MCTAB. Amphibious landings have taken place for many years at MCTAB. According to previous research, Marines and Soldiers training on foot are not expected to adversely affect vegetation in the beach landing areas. Damage to vegetation from tracked vehicles during Expeditionary Assault training events is not likely as long as the vehicles continue to use existing tank trails and do not travel off-road. Training guidelines for resource protection on Oahu are listed Table 4.4.2.1.1.1-1.

C2 is achieved through a network of communication devices strategically located at selected DoD installations around the islands with no impacts on biological resources. HAO/NEO and HA/DR events use existing open areas and facilities. Some temporary structures, including tents, may be used. All participants are briefed on current guidelines to avoid undue impacts on vegetation. Amphibious landings have taken place for many years at MCTAB, and damage to vegetation from training is not likely if vehicles are restricted to existing tank trails and do not travel off-road. No rare, threatened, or endangered plant species are known to occur on or near MCTAB.

Wildlife

Navy activities would continue to result in noise and movement of personnel, vehicles, helicopters, and landing craft may temporarily displace sensitive bird species from feeding, resting, and nesting areas. Training events are short in duration, however, and are not expected to affect the areas where birds are most likely to nest. Training within the range areas regularly used for current activities should not substantially increase the threat to these species. Threatened and endangered bird species (the endangered koloa maoli [Hawaiian duck], `alae ke`ok`o [Hawaiian coot], alae ula [Hawaiian common moorhen], and ae`o [Hawaiian black-necked stilt]) have been observed in wetlands along Waimanalo Stream north of the amphibious landing beach. Any potential impacts to these listed bird species would be addressed through coordination/consultation with the USFWS. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. While individual birds may be startled, the training (Expeditionary Assault, HAO/NEO, and SPECWAROPS) being currently performed is not likely to significantly impact a population of any of the migratory species, such as the Pacific golden plover and wandering tattler, that occur in the MCTAB area and thus would be exempt from the MBTA take prohibitions.

To further minimize potential impacts on biological resources, instructions to Service elements engaged in Swimmer Insertion/Extraction, Expeditionary Assault, HAO/NEO, HA/DR, and Mine Countermeasures (MCM) activities will include:

- Conducting surveys prior to use of amphibious launch vehicles to ensure that humpback whales are not disturbed.
- Establishing buffer zones in locations where green turtles are known to feed so that amphibious training events do not disturb these areas.
- Marking and monitoring green turtle nests discovered on beaches so they are not affected by training.

Environmentally Sensitive Habitat

Regular transit routes are used to avoid wetland acreage on MCTAB.

4.4.2.8.1.2 Alternative 1 (Biological Resources—MCTAB)

Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, the tempo may increase, but the likelihood of a similar increase in adverse impacts on biological resources is small as discussed below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant MCTAB and Navy policies and procedures during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive weed plant species. No rare, threatened, or endangered plant species are known to occur on or near MCTAB.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. It is not likely that a bird or any other species of wildlife on MCTAB would be injured or killed as a result of increased training. The increased training would comply with relevant MCTAB and Navy policies and procedures (Table 4.4.2.1.1.1-1), which would further reduce the potential for effects on wildlife.

Environmentally Sensitive Habitat

The continued use of regular transit routes should avoid the wetland acreage on MCTAB.

4.4.2.8.1.3 Alternative 2 (Biological Resources—MCTAB)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. Wildlife exhibits a wide variety of responses to noise. Some species are more sensitive to noise disturbances than others. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.8.1.4 Alternative 3 (Biological Resources—MCTAB)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.8.2 Cultural Resources—MCTAB

4.4.2.8.2.1 No-action Alternative (Cultural Resources—MCTAB)

HRC Training and Major Exercises—No-action Alternative

Training with the potential to affect terrestrial cultural resources at MCTAB includes Swimmer Insertion/Extraction, Expeditionary Assault, boat raids, HAO/NEO, and HA/DR.

All of these training events similarly involve personnel and equipment (e.g., AAVs, SDVs) crossing beach areas or following existing transit routes from the shoreline and dispersing into designated areas for from 1 to 18 days of realistic training. HA/DR also include the establishment of a safe haven camp or Civil-Military Operations Center, which can use either existing buildings or erect tents and portable latrines. At MCTAB, the insertion point for training is within a landing zone that has been heavily disturbed through long-term use by the military and the public and has been specifically designated for these types of training events (see Appendix D).

Nonetheless, large portions of MCTAB are sensitive for archaeological and traditional Hawaiian resources, in particular the banks of Waimanalo and Inoaole Streams and some sections of beach dunes. Archaeological excavation at a former waste disposal site adjacent to the northern end of the amphibious landing beach yielded no artifacts of traditional Hawaiian manufacture (U.S. Air Force, 15th Airlift Wing, 2005). However, an Environmental Impact Statement prepared for the Bellows Air Force Station (AFS) land use and development plan determined that crossing Waimanalo Stream and other training events can adversely affect cultural resources. Measures identified to mitigate this potential impact include having proper documents in place in advance, crossing streams only at pre-selected locations, restricting vehicle crossings to existing bridges or pre-selected fords with no sensitive resources, and selecting stream crossings to avoid known cultural deposits. In the event unanticipated cultural remains are identified (particularly human remains), all training will cease in the immediate vicinity and the Bellows AFS designated cultural resources coordinator will be notified.

There are known terrestrial archaeological areas within and adjacent to MCTAB. There are no underwater cultural resources within the direct MCM region of influence. The nearest cultural resources include scattered shipwrecks in nearby waters (see Figure 3.1.3-2) and Site 4854 (a shoreline burial complex) north of the region of influence. With the implementation of established procedures no impacts on cultural resources will occur.

4.4.2.8.2.2 Alternative 1 (Cultural Resources—MCTAB)

Increased Tempo and Frequency of Training—Alternative 1

Increased tempo and frequency of training under Alternative 1 would increase the potential for impacts to occur on cultural resources in sensitive areas. For MCTAB, this would be most apparent within the archaeologically sensitive beach areas where training would be conducted. Training currently uses designated beach zones and transit routes. The same beach zones and transit routes would be used for the increased training. Mitigation measures are in place that would minimize adverse impacts from the increase in training.

4.4.2.8.2.3 Alternative 2 (Cultural Resources—MCTAB)

Increased Tempo and Frequency of Training—Alternative 2

The tempo and frequency of training under Alternative 2 would increase the potential for impacts to occur on cultural resources in sensitive areas. However, training currently uses designated beach zones and transit routes, and mitigation measures are in place that would avoid adverse impacts from the additional tempo and frequency of training under Alternative 2. Alternative 2 will not result in additional impacts.

4.4.2.8.2.4 Alternative 3 (Cultural Resources—MCTAB)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.9 HICKAM AIR FORCE BASE (AFB)

Table 4.4.2.9-1 lists ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 at Hickam AFB. Alternative 3 is the preferred alternative.

Table 4.4.2.9-1. Training and RDT&E Activities at Hickam AFB

Training	Research, Development, Testing, and Evaluation (RDT&E) Activities
• Air Operations • Command and Control • Aircraft Support Operations • Special Warfare Operations (SPECWAROPS)	• Directed Energy (Alternative 2/3)

A review of the 13 resources against training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Hickam AFB. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, cultural resources, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

HRC Air Operations and minor increase in the number of Aircraft Support Operations associated with Hickam AFB would not impact regional air quality. There is no planned construction or alteration associated with the Navy that would affect the cultural resources in the vicinity. There are no current or proposed training and RDT&E activities that could affect land use, land forms, geology, and associated soils development.

Training and RDT&E activities associated with Hickam AFB adhere to policies and regulations governing hazardous materials and hazardous waste, and health and safety, as discussed in Appendix C. Hazardous materials associated with the proposed Directed Energy facility would require separate/additional environmental documentation. There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training and RDT&E at the site would not generate any waste streams that could impact local water quality.

4.4.2.9.1 Airspace—Hickam AFB

4.4.2.9.1.1 No-action Alternative (Airspace—Hickam AFB)

HRC Training—No-action Alternative

Aircraft Support Operations will require coordination with the Air Force and will use existing facilities for fueling and minor maintenance.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace will not be used, and aircraft will use existing approach and departure procedures. Coordination with Honolulu International Airport will be the same as for other military aircraft using the runways.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC and USWEX can include Aircraft Support Operations at Hickam AFB. These Major Exercises include extensive planning and coordination with the FAA. RIMPAC planning conferences are conducted beginning in March of the year prior to each RIMPAC. USWEX training would generally not include Aircraft Support Operations at Hickam AFB. If aircraft support was required it would be coordinated with the FAA well in advance of each 3- or 4-day Major Exercise.

The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.9.1.2 Alternative 1 (Airspace—Hickam AFB)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Aircraft Support Operations would require coordination with the Air Force and would use existing facilities for fueling and minor maintenance. Increased training would result in a minor increase in the number of Aircraft Support Operations.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace would not be used, and aircraft would use existing approach and departure procedures. Coordination with Honolulu International Airport would be the same as for other military aircraft using the runways.

The increase from one Strike Group to two during RIMPAC under Alternative 1 would require a minor increase in Aircraft Support Operations and subsequent coordination between the Navy and FAA. USWEX training would generally not include Aircraft Support Operations at Hickam AFB. If aircraft support was required it would be coordinated with the FAA well in advance of each 3- or 4-day Major Exercise.

The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.9.1.3 Alternative 2 (Airspace—Hickam AFB)

Increased Tempo and Frequency of Training—Alternative 2

An increased tempo and frequency of training would require similar training support as at present. Aircraft Support Operations would require coordination with the Air Force and would use existing facilities for fueling and minor maintenance. No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace would not be used and aircraft would utilize existing approach and departure procedures. Coordination with Honolulu International Airport would be the same as for other military aircraft using the runways.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Training Exercise that would be similar to the requirements for a USWEX and would generally not include Aircraft Support Operations at Hickam AFB. If aircraft support was required it would be coordinated with the FAA well in advance of the Major Exercise.

4.4.2.9.1.4 Alternative 3 (Airspace—Hickam AFB)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.9.2 Biological Resources —Hickam AFB

4.4.2.9.2.1 No-action Alternative (Biological Resources—Hickam AFB)

Navy activities at the site would be performed in accordance with all applicable biological opinions and existing Air Force regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Air Force regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

C2 is achieved through a network of communication devices strategically located at selected DoD installations around the islands with no impacts on biological resources. Training and Major Exercises will continue to follow the Navy guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Hickam AFB procedures, to assist in minimizing impacts on biological resources on the base and in offshore waters.

Vegetation

Vegetation on Hickam AFB consists primarily of managed landscaping. There are no threatened or endangered vegetation species on the base. Training is conducted in existing open areas and facilities.

Wildlife

Navy activities would continue to result in noise and movement of personnel, vehicles, helicopters, and landing craft. However, training events are generally short in duration, and they occur in areas regularly used for such training. Air Operations in support of Major Exercises are a routine occurrence on the base. All participants in training are to adhere to the Navy guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Hickam AFB procedures, to assist in minimizing impacts on biological resources on the base and in offshore waters. Any potential impacts to listed bird species such as the ae`o (Hawaiian stilt) would be addressed through coordination with the USFWS. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. While individual birds may be startled, the training (Air Operations, Aircraft Support Operations, and SPECWAROPS) being currently performed is not likely to significantly impact a population of any of the migratory species, such as the wedge-tailed shearwater, that occur in the Hickam AFB area and thus would be exempt from the MBTA take prohibitions. A Bird Aircraft Strike Hazard (BASH) program is at every Air Force base with a runway in order to prevent as many wildlife strikes to aircraft as possible. Habitat and terrain controls include mowing for specific vegetation heights, brush and tree removal, and dewatering and netting small ponds near runways. Navy activities would be performed in accordance with all applicable Air Force Biological Opinions, rules and regulations, including those addressed under the Air Force BASH Program.

Environmentally Sensitive Habitat

Wetlands on Hickam AFB are avoided during Major Exercises.

4.4.2.9.2.2 Alternative 1 (Biological Resources—Hickam AFB)

Increased Tempo and Frequency of Training Operations and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, they could increase in tempo, but the likelihood of a similar increase in adverse impacts on biological resources is small as discussed below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy guidelines (Table 4.4.2.1.1.1-1), and other applicable Hickam AFB procedures, during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species. No threatened or endangered plant species are known to occur on Hickam AFB.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased tempo of the training would need to include compliance with relevant Air Force and Navy policies and procedures, which would further reduce the potential for effects on birds and other wildlife species.

Environmentally Sensitive Habitat

Wetlands on Hickam AFB would be avoided during increased training.

4.4.2.9.2.3 Alternative 2 (Biological Resources—Hickam AFB)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.9.2.4 Alternative 3 (Biological Resources—Hickam AFB)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.10 WHEELER ARMY AIRFIELD

Table 4.4.2.10-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Wheeler Army Airfield. Alternative 3 is the preferred alternative.

Table 4.4.2.10-1. Training at Wheeler Army Airfield

Training	
• Air Operations	• Aircraft Support Operations
• Command and Control	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Wheeler Army Airfield. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, cultural resources, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

Air Operations and minor increase in the number of Aircraft Support Operations associated with Wheeler Army Airfield would not impact regional air quality. There is no planned construction or alteration associated with the Navy that would affect the cultural resources in the vicinity. There is no current or proposed training that could affect land use, land forms, geology, and associated soils development. Training associated with this site adhere to policies and regulations governing hazardous materials and hazardous waste, and health and safety, as discussed in Appendix C.

There would be no impact on Oahu's socioeconomics, transportation, utilities, or land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training at the site would not generate any waste streams that could impact local water quality.

4.4.2.10.1 Airspace—Wheeler Army Airfield

4.4.2.10.1.1 No-action Alternative (Airspace—Wheeler Army Airfield)

HRC Training—No-action Alternative

Aircraft Support Operations will require coordination with the Army and will use existing facilities for fueling and minor maintenance.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special Use Airspace will not be used, and aircraft will use existing approach and departure procedures.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC and USWEX can include Aircraft Support Operations at Wheeler Army Airfield. These Major Exercises include extensive planning and coordination with the FAA. RIMPAC planning conferences are conducted beginning in March of the year prior to each RIMPAC. USWEX training would generally not include Aircraft Support Operations at

Wheeler Army Airfield. If aircraft support was required it would be coordinated with the FAA well in advance of each 3- or 4-day Major Exercise.

The advance planning and coordination with the FAA regarding aircraft involved in Major Exercises result in minimal impacts on airspace.

4.4.2.10.1.2 Alternative 1 (Airspace—Wheeler Army Airfield)

Increased Tempo and Frequency of Training—Alternative 1

Aircraft Support Operations would require coordination with the Army and would use existing facilities for fueling and minor maintenance. Increased training would result in a minor increase in the number of Aircraft Support Operations.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace would not be used, and aircraft would use existing approach and departure procedures.

4.4.2.10.1.3 Alternative 2 (Airspace—Wheeler Army Airfield)

Increased Tempo and Frequency of Training—Alternative 2

An increased tempo and frequency of training would require similar training support as at present. Aircraft Support Operations would require coordination with the Army and would use existing facilities for fueling and minor maintenance.

No new airspace proposal or any modification to the existing controlled airspace has been identified to accommodate Aircraft Support Operations. Special use airspace would not be used, and aircraft would use existing approach and departure procedures.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Training Exercise that would be similar to the requirements for a USWEX and would generally not include Aircraft Support Operations at Wheeler Army Airfield. If aircraft support was required it would be coordinated with the FAA well in advance of the Major Exercise.

4.4.2.10.1.4 Alternative 3 (Airspace—Wheeler Army Airfield)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.10.2 Biological Resources—Wheeler Army Airfield

4.4.2.10.2.1 No-action Alternative (Biological Resources—Wheeler Army Airfield)

Navy activities at the site would be performed in accordance with all applicable biological opinions and existing Army regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

C2 is achieved through a network of communication devices strategically located at selected DoD installations around the islands with no impacts on biological resources. Training and Major Exercises adhere to the Navy's guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Army procedures, to assist in minimizing impacts on biological resources at the airfield.

Vegetation

Wheeler Army Airfield is a developed area containing mostly nonnative urban vegetation with no known threatened or endangered species. No impacts on vegetation are anticipated from use of existing runways and associated facilities and cleared areas.

Wildlife

Navy activities would continue to result in noise and movement of personnel, vehicles, helicopters, and landing craft. However, training events are short in duration and they occur in areas regularly used for such training. Air Operations in support of Major Exercises are a routine occurrence at the airfield. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. While individual birds may be startled, the training events (C2, Air Operations, Aircraft Support Operations, and SPECWAROPS) being currently performed are not likely to significantly impact a population of any of the migratory species that occur in the Wheeler Army Airfield area, such as the black-crowned night heron, Pacific golden plover, and white-tailed tropicbird, and thus would be exempt from the MBTA take prohibitions.

Environmentally Sensitive Habitat

No critical habitat has been identified on Wheeler Army Airfield.

4.4.2.10.2.2 Alternative 1 (Biological Resources—Wheeler Army Airfield)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number at Wheeler Army Airfield, the tempo of the training may increase, but the likelihood of a similar increase in adverse impacts on biological resources is small, as discussed below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy guidelines (Table 4.4.2.1.1.1-1), and other applicable Army procedures, during training would minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. No threatened or endangered plant species are known to occur on Wheeler Army Airfield.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased training and Major Exercises would comply with relevant Army and Navy policies and procedures, which would further reduce the potential for effects on wildlife.

Environmentally Sensitive Habitat

No critical habitat has been identified at the airfield.

4.4.2.10.2.3 Alternative 2 (Biological Resources—Wheeler Army Airfield)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resource similar to those described above.

4.4.2.10.2.4 Alternative 3 (Biological Resources—Wheeler Army Airfield)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.11 MAKUA MILITARY RESERVATION

Table 4.4.2.11-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Makua Military Reservation. Alternative 3 is the preferred alternative.

Table 4.4.2.11-1. Training at Makua Military Reservation

Training	
• Special Warfare Operations (SPECWAROPS)	• Live Fire Exercise (LFX)

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Makua Military Reservation. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, land use, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at the Makua Military Reservation other than that from localized use of rotary wing aircraft within pre-defined areas. The Aircraft Operations would not change regional air quality. Makua Military Reservation training would not affect the existing airspace structure in the region. Geology and soils impacts would be limited to short-term minor disturbance of beach sand. Movement from the beach would also result in minor, short-term disturbance to soils along pre-defined access routes.

Training associated with Makua Military Reservation adheres to policies and regulations governing hazardous materials and waste, as discussed in Appendix C. Preliminary aerial surveys of the firing range at Makua Military Reservation were inconclusive for depleted uranium (DU). The Army is currently assessing if there is a presence of DU at Makua Military Reservation as well as all Army ranges in Hawaii (U.S. Army, Pacific Public Affairs, 2007). Guidance provided to users of Makua Military Reservation would be followed. There would be no impact on Oahu's socioeconomics, transportation, utilities, and land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Water resources would not be affected by the movement of people and materials along existing roads during training.

4.4.2.11.1 Biological Resources—Makua Military Reservation

4.4.2.11.1.1 No-action Alternative (Biological Resources—Makua Military Reservation)

Navy activities at the site would be performed in accordance with all applicable biological opinions and existing Army regulations. Adherence to established SOPs at the Makua Military Reservation would result in minimal impacts on the physical environment and avoids potential impacts on threatened and endangered species. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Live Fire Exercises (LFX) and SPECWAROPS follow the Navy's guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Army procedures, to assist in minimizing the potential for impacts on biological resources. These activities at Makua Military Reservation were addressed in the 1998 RIMPAC EA (U.S. Department of the Navy, 1998d).

Vegetation

Makua Military Reservation contains 31 endangered plant species. These species are generally confined to remote mountainous areas along the fringe of the range, outside maintained open areas and the impact area. Army procedures restrict training and Major Exercises to areas that are outside of sensitive habitat. An Endangered Species Management Plan has been prepared for the Reservation that establishes a series of preventative and restorative activities appropriate to these resources. Major Exercises follow the preventive measures outlined in the management plan.

In 1999, the U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion concluding that routine military training will not jeopardize the endangered species on Makua Military Reservation if certain conditions are met. These include restrictions to military training, and preparation and implementation of a Wildland Fire Management Plan. The Army is also required to complete an Implementation Plan to stabilize the targeted plant and animal populations. (U.S. Department of the Army, 2005) Major Exercises comply with these restrictions. The *Integrated Wildland Fire Management Plan Oahu and Pohakaloa Training Areas* was completed in 2003 (U.S. Army, Hawaii and 25th Infantry Division [Light], 2003). The Army also completed an Implementation Plan in 2003 to stabilize the targeted plant and animal populations. An Addendum was submitted to the USFWS in 2005 that emphasized management of three population units per plant taxon. (U.S. Department of the Navy, 2002a; U.S. Army Garrison, Hawaii, 2005)

Wildlife

Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. The low probability of one of the training events being capable of significantly impacting a population of the migratory species that occur in the Makua area should exempt the HRC from the take prohibitions.

Potential SPECWAROPS generally include reconnaissance activities and a helicopter raid. Noise from munitions during LFX is considered momentary (intrusive noise), while noise from helicopters or other mobile sources is continuous. Short helicopter hovering periods result in noise levels at Makua Beach of 88 dB. Although these noise levels can cause flushing of birds, the effects are temporary and birds return to the area following completion of training.

The Army funded a study at Schofield Barracks of the effects of artillery noise on the Oahu `elepaio. Noise from 155-mm and 105-mm howitzers, 81-mm and 60-mm mortars, and hand grenades were investigated. Results determined that `elepaio nesting behavior was not significantly affected and the population was not seriously disturbed by artillery training. Nesting attendance and nestling survival rates during training periods were similar to rates in Honouliuli, where there is no military training. (U.S. Department of the Army, 2005)

The only marine mammals that might exist in the region of influence are the Hawaiian monk seal and the humpback whale. Of the five species of sea turtles that occur in Hawaiian waters, only the green turtle and leatherback turtle are likely to be in the region of influence. All participants in training are to adhere to the Navy guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Army procedures, to assist in minimizing impacts on biological resources on the Reservation and in offshore waters. The beach and offshore waters will continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during an increase in Major Exercises. If any are seen, the training event will be delayed until the animals leave the area. Underwater noise effects are discussed in Section 4.1.2.

Environmentally Sensitive Habitat

The USFWS designated critical habitat on Makua Military Reservation in 2001 for the Oahu `elepaio, which is avoided where possible. Critical habitat for endangered plants is located outside the boundary of the reservation.

4.4.2.11.1.2 Alternative 1 (Biological Resources—Makua Military Reservation)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, the tempo may increase, but the likelihood of a similar increase in adverse impacts on biological resources is small, as described below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy guidelines (Table 4.4.2.1.1.1-1) and other applicable Army procedures during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased training would comply with relevant Army and Navy policies and procedures, which would further reduce the effects on wildlife.

Environmentally Sensitive Habitat

Critical habitat areas would continue to be avoided, where possible.

4.4.2.11.1.3 Alternative 2 (Biological Resources—Makua Military Reservation)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training could also increase. Training would take place at existing locations; no expansion of the area would be involved. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.11.1.4 Alternative 3 (Biological Resources—Makua Military Reservation)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.11.2 Cultural Resources—Makua Military Reservation

4.4.2.11.2.1 No-action Alternative (Cultural Resources—Makua Military Reservation)

HRC Training—No-action Alternative

Live Fire Exercises (LFX)

Training at Makua Military Reservation with the potential to affect cultural resources include LFX, which involves the movement of troops through target objectives using a wide range of air/ground weapons. Troop levels range from a few personnel to brigade level (3,000 to 5,000 personnel). At Makua Military Reservation, training occurs within the RIMPAC (Pililaau Range) areas shown in Appendix D.

The traditional and cultural use of Makua Military Reservation is extensive. Approximately 25 percent of the lands at Makua Military Reservation have been surveyed for the presence of cultural sites, and a large number and wide range of site types have been identified. There is a high probability for additional cultural sites in the areas not yet surveyed. Many of the sites are located adjacent to training areas and training restrictions are in place. The management of cultural resources at Makua Military Reservation is guided by a Programmatic Agreement among the Army, the Hawaii SHPO, and the Advisory Council on Historic Preservation (see Section 3.4.2.11.2), and an updated ICRMP for all Army installations in Hawaii is in progress. An Ecosystem Management Plan Report for the protection of these resources has also been developed (U.S. Army Garrison, Hawaii and U.S. Army Corps of Engineers, 1998) that focuses on identification, education, and avoidance of known archaeological sites.

Limited LFX can be conducted at Makua Military Reservation under a court-approved settlement plan of October 2001. Any training proposed for Makua Military Reservation is reviewed by the Army before training is conducted. Extensive planning for training is required and includes coordination meetings 8 weeks and 10 days before the training event, a written plan of maneuver and fire support, and a risk assessment of the training event. SOPs require troops to review training overlays that identify insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided. (U.S. Department of the Navy, Commander, THIRD Fleet, 2004, 2006; U.S. Department of the Navy, 2002a)

In the event cultural materials of any type are unexpectedly encountered during LFX (particularly human remains), all training in the immediate vicinity of the find will cease and the Schofield Barracks Cultural Resources Manager will be notified.

In accordance with the 2000 Programmatic Agreement, access for Native Hawaiians to Makua Military Reservation is granted on a case-by-case basis (see Appendix H).

Major Exercises—No-action Alternative

Any training proposed for Makua Military Reservation is reviewed by the Army before Major Exercises are conducted. Extensive planning for Major Exercises is required, and sensitive biological and cultural resource areas are avoided. (U.S. Department of the Navy, Commander, THIRD Fleet, 2004, 2006; U.S. Department of the Navy, 2002a). In the event cultural materials of any type are unexpectedly encountered during training events, all training in the immediate vicinity of the find will cease and the Schofield Barracks Cultural Resources Manager will be notified.

4.4.2.11.2.2 Alternative 1 (Cultural Resources—Makua Military Reservation)

Increased Tempo and Frequency of Training—Alternative 1

Training under Alternative 1 would increase the potential for impacts on occur to cultural resources in sensitive areas. However, training currently use designated training areas, and mitigation measures are in place that avoid adverse impacts.

4.4.2.11.2.3 Alternative 2 (Cultural Resources—Makua Military Reservation)

Increased Tempo and Frequency of Training—Alternative 2

The tempo and frequency of training under Alternative 2 would increase the potential for impacts on cultural resources in sensitive areas. However, training currently uses designated training areas, and mitigation measures are in place that would avoid adverse impacts. The increased frequency of training over and above Alternative 1 is not expected to cause adverse effects.

4.4.2.11.2.4 Alternative 3 (Cultural Resources—Makua Military Reservation)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.11.3 Health and Safety—Makua Military Reservation

4.4.2.11.3.1 No-action Alternative (Health and Safety—Makua Military Reservation

Under the No-action Alternative, existing training at the Makua Military Reservation will continue and there will be in no adverse impacts on health and safety. The Makua Military Reservation takes every reasonable precaution during planning and execution of training to prevent injury to human life or property.

HRC Training—No-action Alternative

The Navy does not currently conduct routine training at Makua Military Reservation.

Major Exercises—No-action Alternative

LFX and SPECWAROPS typically occur at Makua Military Reservation as part of Major Exercises. Under the No-action Alternative, there will be no impacts on health and safety at the reservation. Every reasonable precaution is taken during the planning and execution of training to prevent injury to human life or damage to property. Specific safety plans have been developed to ensure that each training event is in compliance with applicable policy and requirements, and to ensure that the general public and range personnel and assets are provided an acceptable level of safety. In addition, SOPs have been developed that outline all safety requirements for use of Makua Military Reservation.

4.4.2.11.3.2 Alternative 1 (Health and Safety—Makua Military Reservation

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

An increase in tempo and frequency of training and Major Exercises is not anticipated to adversely impact health and safety at Makua Military Reservation. The total number of training events that affect health and safety would increase by approximately 9 percent above the No-action Alternative. While the number of training events would increase, the types of training would remain the same and existing SOPs would be used.

4.4.2.11.3.3 Alternative 2 (Health and Safety—Makua Military Reservation)

Increased Tempo and Frequency of Training—Alternative 2

An increase in tempo and frequency of training is not anticipated to adversely impact health and safety at Makua Military Reservation. While the number of training events would increase, the types of training would remain the same and existing SOPs would be used.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would perform training events and RDT&E activities in the vicinity of Hawaii. The Major Exercises proposed would be similar to those occurring during Major Exercises, with impacts on health and safety at Makua Military Reservation similar to those described above.

4.4.2.11.3.4 Alternative 3 (Health and Safety—Makua Military Reservation)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.11.4 Noise—Makua Military Reservation

Impacts of noise on human receptors are evaluated based on whether or not a noise event would exceed DoD or OSHA guidelines. Noise effects on wildlife are discussed in Section 4.4.2.11.1, Biological Resources.

4.4.2.11.4.1 No-action Alternative (Noise—Makua Military Reservation)

Under the No-action Alternative, existing training at the U.S. Army's Makua Military Reservation will continue, and there will be no increase to existing noise levels. The Makua Military Reservation maintains a hearing protection program that includes monitoring the hearing of personnel exposed to high noise levels and identifying and posting notification of noise hazard areas. Personnel working in are noise hazard areas are required to use appropriate hearing protection to bring noise levels within established safety levels.

HRC Training—No-action Alternative

The Navy does not currently conduct routine training at Makua Military Reservation.

Major Exercises—No-action Alternative

LFX and SPECWAROPS typically occur at Makua Military Reservation as part of Major Exercises. There will be no increase to existing noise levels during the continuing Major Exercises listed above. The total perceived noise will be the combination of ambient noise and noise from the Major Exercises. Ambient noise sources may include wind, surf, highway traffic, Aircraft Operations, and other local noise-generating land uses. Noise sources from the Major Exercise will include the use of helicopters and small arms munitions.

4.4.2.11.4.2 Alternative 1 (Noise—Makua Military Reservation)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Noise levels associated with increased tempo and frequency of training and Major Exercises would be similar to existing noise levels. The total number of training events that affect noise would increase by approximately 9 percent above the No-action Alternative. Training would take place at existing locations. While the number of training would increase there would be no anticipated increase to the level of noise produced.

4.4.2.11.4.3 Alternative 2 (Noise—Makua Military Reservation)

Increased Tempo and Frequency of Training—Alternative 2

Noise levels associated with increased tempo and frequency of training would be similar to existing noise levels. The total number of training events that affect noise would increase. While the number of training events would increase, there would be no anticipated increase to the level of noise produced.

Additional Major Exercises—Multiple Carrier Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The training proposed would be similar to that occurring during current Major Exercises, with impacts on noise levels similar to those described above.

4.4.2.11.4.4 Alternative 3 (Noise—Makua Military Reservation)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on noise under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.12 KAHUKU TRAINING AREA

Table 4.4.2.12-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Kahuku Training Area. Alternative 3 is the preferred alternative.

Table 4.4.2.12-1. Training at Kahuku Training Area

Training	
• Special Warfare Operations (SPECWAROPS) • Humanitarian Assistance/Non-combatant Evacuation Operations (HAO/NEO)	• Humanitarian Assistance/Disaster Relief Operations (HA/DR)

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Kahuku Training Area. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at the Kahuku Training Area other than that from localized use of rotary wing aircraft within pre-defined areas. The Aircraft Operations would not change regional air quality. Kahuku Training Area training would not affect the existing airspace structure in the region. Geology and soils impacts would be limited to short-term minor disturbance of beach sand. Movement from the beach would also result in minor, short-term disturbance to soils along pre-defined access routes.

Training associated with the Kahuku Training Area adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise as discussed in Appendix C. There would be no impact on Oahu's socioeconomics, transportation, utilities, and land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Water resources would not be affected by the movement of people and materials along existing roads during the training.

4.4.2.12.1 Biological Resources—Kahuku Training Area

4.4.2.12.1.1 No-action Alternative (Biological Resources—Kahuku Training Area)

Navy training at the site would be performed in accordance with all applicable biological opinions and existing Army regulations. Adherence to established SOPs at the Kahuku Training Area would result in minimal impacts on the physical environment and avoids potential impacts on threatened and endangered species. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

The Army's Kahuku Training Area contains 10 species of endangered plants. SPECWAROPS at the range include a reconnaissance and survey mission, and a tactical aircrew recovery event. Potential HA/DR and HAO/NEO events use existing open areas and facilities. Some temporary structures, including tents, may be used. All participants in training are to adhere to the Navy's guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Army procedures, to minimize potential impacts on the endangered vegetation, as well as limit the potential for introduction of invasive plant species.

Wildlife

SPECWAROPS activities generally include reconnaissance activities and a helicopter raid. Although noise levels can cause flushing of individual birds, the effects are temporary. Any potential impacts to listed bird species such as the Oahu `elepaio or `Alauahio (Oahu creeper) would be addressed through coordination with the USFWS. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. The low probability of one of the training events being capable of significantly impacting a population of the migratory species that occur in the Kahuku area, such as the great frigate bird or Pacific golden plover, should exempt the HRC from the take prohibitions.

Environmentally Sensitive Habitat

Training will avoid critical habitat for the Oahu `elepaio and other biologically significant areas in the region of influence.

4.4.2.12.1.2 Alternative 1 (Biological Resources—Kahuku Training Area)

Increased Tempo and frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, their tempo may increase, but the likelihood of a similar increase in adverse impacts on biological resources is small, as discussed below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy guidelines (Table 4.4.2.1.1.1-1), and other applicable Army procedures, during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased training would comply with relevant Army and Navy policies and procedures, which would further reduce the potential for effects on wildlife.

Environmentally Sensitive Habitat

Critical habitat for the Oahu `elepaio and other biologically significant areas would continue to be avoided where possible.

4.4.2.12.1.3 Alternative 2 (Biological Resources—Kahuku Training Area)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.12.1.4 Alternative 3 (Biological Resources—Kahuku Training Area)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.12.2 Cultural Resources—Kahuku Training Area

4.4.2.12.2.1 No-action Alternative (Cultural Resources—Kahuku Training Area)

HRC Training—No-action Alternative

Expeditionary Assault, HAO/NEO, and HA/DR

These three training events (Expeditionary Assault, HAO/NEO, and HA/DR) exhibit similar activities that involve personnel and equipment (e.g., AAVs, SDVs) crossing beach areas or following existing transit routes from the shoreline and dispersing into designated areas for from 1 to 18 days of realistic training. HA/DR events also include the establishment of a safe haven camp or Civil-Military Operations Center, which can use either existing buildings or the erection of tents and portable latrines. At Kahuku Training Area, the insertion point for training is within a landing zone that is one of the more widely used military training areas in Hawaii; the area has been specifically designated for these types of events (see Appendix D).

Surveys of Kahuku Training Area indicate that all archaeological and traditional Hawaiian sites are considered significant (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1998); however, there will be no unmonitored ground-disturbing activities, land clearing, or use of vehicles off existing trails and roads. Training events use an existing training trail and access road that will be graded before the training event (if required). However, in accordance with

SOPs, grading will not exceed the road width or alignment. Training overlays that identify the transit route, camp location, and any nearby restricted areas or sensitive biological and cultural resource areas will be used by all participants. All personnel entering the Kahuku Training Area will adhere to the training guidelines presented in the Ecosystem Management Plan Report (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1998). Therefore, no impacts on cultural resources within the Kahuku Training Area are anticipated.

In the event cultural materials are unexpectedly encountered during the course of Expeditionary Assault, HAO/NEO, or HA/DR events (particularly human remains), all training will cease in the immediate vicinity of the find and the Schofield Barracks Cultural Resources Manager will be notified.

According to NOAA's shipwreck and fishpond location maps, there are numerous shipwrecks (see Figure 3.1.3-2 and 3.4.1.3.2-1), but no known Native Hawaiian fishponds in the vicinity of the HAO/NEO and HA/DR insertion point for Kahuku Training Area. Offshore HAO/NEO activities are performed in waters that are shallow, and most shipwrecks are found in deeper waters.

Major Exercises—No-action Alternative

Elements of Major Exercises (RIMPAC) have been analyzed above. Major Exercises are well planned in advance, use existing trails and roads, and avoid sensitive cultural areas. In the event cultural materials are unexpectedly encountered during the course of Major Exercises, all training will cease in the immediate vicinity of the find and the Schofield Barracks Cultural Resources Manager will be notified. Therefore, no impacts on cultural resources within the Kahuku Training Area are anticipated.

4.4.2.12.2.2 Alternative 1 (Cultural Resources—Kahuku Training Area)

Increased Tempo and Frequency of Training—Alternative 1

Training under Alternative 1 would increase the potential for impacts to occur on cultural resources in sensitive areas. Training currently uses designated training areas, and mitigation measures are in place that would avoid adverse impacts (see above discussions).

4.4.2.12.2.3 Alternative 2 (Cultural Resources—Kahuku Training Area)

Increased Tempo and Frequency of Training—Alternative 2

The tempo and frequency of training under Alternative 2 would increase the potential for impacts to occur on cultural resources in sensitive areas; however, training currently uses designated training areas and mitigation measures are in place that would avoid adverse impacts.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Additional Major Exercises would be similar in nature to those described above and would employ the same mitigation measures. As a result, no impacts are expected.

4.4.2.12.2.4 Alternative 3 (Cultural Resources—Kahuku Training Area)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.13 DILLINGHAM MILITARY RESERVATION

Table 4.4.2.13-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Dillingham Military Reservation. Alternative 3 is the preferred alternative.

Table 4.4.2.13-1. Training at Dillingham Military Reservation

Training
• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Dillingham Military Reservation. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no air emissions generated at the Dillingham Military Reservation other than that from localized use of rotary wing aircraft within pre-defined areas. The Aircraft Operations would not change regional air quality. Dillingham Military Reservation training would not affect the existing airspace structure in the region. Geology and soils impacts would be limited to short-term minor disturbance of beach sand. Movement from the beach would also result in minor, short-term disturbance to soils along pre-defined access routes.

Training associated with the Dillingham Military Reservation adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise as discussed in Appendix C. There would be no impact on Oahu's socioeconomics, transportation, utilities, and land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Water resources would not be affected by the movement of people and materials along existing roads during training.

4.4.2.13.1 Biological Resources—Dillingham Military Reservation

4.4.2.13.1.1 No-action Alternative (Biological Resources—Dillingham Military Reservation)

Navy training at the site would be performed in accordance with all applicable biological opinions and existing Army regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

At the Army's Dillingham Military Reservation, four endangered plant species can be found within the cliff ecological zone. SPECWAROPS activities at the range include a reconnaissance and survey mission, and a tactical aircrew recovery event. All participants in training are to adhere to the Navy's guidelines provided in Table 4.4.2.1.1.1-1, along with applicable Army procedures, to minimize potential impacts on the endangered vegetation, as well as limit the potential for introduction of invasive plant species.

Wildlife

SPECWAROPS activities generally include reconnaissance activities and a helicopter raid. Short helicopter hovering periods could result in noise levels at ground level of 88 dB. Although these noise levels can cause flushing of individual birds, the affects are temporary. Any potential impacts to listed bird species, such as the endangered \`alae ke\`oke\`o (Hawaiian coot), \`alae\`ula (Hawaiian moorhen), koloa maoli (Hawaiian duck), and nene (Hawaiian goose), would be addressed through coordination with the USFWS. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. The low probability of one of the training events being capable of significantly impacting a population of the migratory species that occur in the Dillingham area should exempt the HRC from the take prohibitions.

Dillingham Military Reservation is adjacent to a small segment of beachfront, which is monitored for the presence of Hawaiian monk seals and green turtles. The beach and offshore waters are monitored for the presence of marine mammals and sea turtles 1 hour before and during Major Exercises. If any are seen, the training event is delayed until the animals leave the area. All training participants are briefed on resource protection guidelines (Table 4.4.2.1.1.1-1) for training on Oahu, which minimize the potential for harm to endangered species.

Environmentally Sensitive Habitat

An Army Corps of Engineers jurisdictional wetland on the reservation is outside of the area used for maneuver training.

4.4.2.13.1.2 Alternative 1 (Biological Resources—Dillingham Military Reservation)

Increased Tempo Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). While training events would not increase in number, their tempo may, but the likelihood of a similar increase in adverse impacts on biological resources is small, as described below.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with relevant Navy guidelines (Table 4.4.2.1.1.1-1), and other applicable Army procedures, during training would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased training would comply with relevant Army and Navy policies and procedures, which would further reduce the potential for effects on wildlife. The beach and offshore waters would continue to be monitored for the presence of monk seals and sea turtles 1 hour before and during an increase in Major Exercises. If any are seen, the training event would be delayed until the animals leave the area.

Environmentally Sensitive Habitat

An Army Corps of Engineers jurisdictional wetland on the reservation is outside of the area used for maneuver training.

4.4.2.13.1.3 Alternative 2 (Biological Resources—Dillingham Military Reservation)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003c).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.4.2.13.1.4 Alternative 3 (Biological Resources—Dillingham Military Reservation)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.13.2 Cultural Resources—Dillingham Military Reservation

4.4.2.13.2.1 No-action Alternative (Cultural Resources—Dillingham Military Reservation)

HRC Training and Major Exercises—No-action Alternative

For SPECWAROPS under RIMPAC, Navy and Marine training with the potential to affect cultural resources at Dillingham Military Reservation include helicopter insertions and raids and downed pilot training. Training involves inserting personnel and equipment to conduct combat search and rescue, covert access to military assets, intelligence gathering, staged raids, and return to the host unit. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access using a boat, typically to locate and recover a downed aircrew. (U.S. Department of the Navy, 2002a) Dillingham Military Reservation is also used by the Army for small unit maneuvers of platoon- and squad-sized elements or combat support operations; airmobile operations and paradrop operations; and helicopter night-vision goggle training, which requires the absence of bright man-made sources of light (U.S. Army Garrison, Hawaii, 1996).

As described in Section 3.4.2.13.2, Dillingham Military Reservation has archaeological and traditional Hawaiian resources, including indications of pre-contact use of the coastal dunes for burials. However, all personnel entering the Dillingham Military Reservation will adhere to training guidelines regarding cultural resources. There will be no unmonitored ground-disturbing activities, land clearing, or use of vehicles off existing trails and roads; assembly of "hasty fortifications"; or litter accumulation, as discussed in the Ecosystem Management Plan Report (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1998). As a result, no impacts on cultural resources are anticipated. In the event cultural materials are unexpectedly encountered during SPECWAROPS activities (particularly human remains), training in the vicinity of the find will cease and follow the appropriate military branch protocols. If the find is made by Marine Corps or Navy personnel, the Hawaii SHPO will be immediately notified in accordance with the Programmatic Agreement (see Appendix H). If the find is unexpectedly encountered during Army activities, the Schofield Barracks Cultural Resources Manager will be immediately notified.

4.4.2.13.2.2 Alternative 1 (Cultural Resources—Dillingham Military Reservation)

Increased Tempo and Frequency of Training—Alternative 1

Training under Alternative 1 would increase the potential for impacts on occur to cultural resources in sensitive areas. Training currently uses designated training areas and mitigation measures are in place that would avoid adverse impacts.

4.4.2.13.2.3 Alternative 2 (Cultural Resources—Dillingham Military Reservation)

Increased Tempo and Frequency of Training—Alternative 2

The tempo and frequency of training under Alternative 2 would increase the potential for impacts on occur to cultural resources in sensitive areas. However, training currently uses designated training areas and mitigation measures are in place that would avoid adverse impacts.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Elements of Major Exercises are analyzed in the No-action Alternative. Training currently uses designated training areas and mitigation measures are in place that would avoid adverse impacts.

4.4.2.13.2.4 Alternative 3 (Cultural Resources—Dillingham Military Reservation)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.4.2.14 KEEHI LAGOON

A review of the 13 environmental resources against Salvage Operations training determined that the proposed alternatives would not result in either short- or long-term environmental impacts at Keehi Lagoon. Alternative 3 is the preferred alternative.

Use of Keehi Lagoon does not require control of the airspace above this area. There are no reports of emission from training affecting the air quality for Keehi Lagoon. Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils. Additionally, there are no known significant archaeological sites at Keehi Lagoon. Geology and soils impacts would be limited to short-term minor disturbance of the lagoon bottom. Water resources effects would include minor, temporary increase in turbidity as the Salvage Operations are implemented. There are no air emission issues from HRC training associated with Keehi Lagoon.

Every effort would be made to limit actions that would decrease visibility in order to have effective training for the divers. Training associated with this site adheres to policies and regulations governing hazardous materials and waste, health and safety, and noise, as discussed in Appendix C. There is no impact on native or naturalized vegetation or wildlife within Keehi Lagoon. The proposed training associated with Alternative 1, Alternative 2, or Alternative 3 would not affect socioeconomic characteristics, modes of transportation, or utilities demand on Oahu. There are no prehistoric, historic, or archaeological sites associated with Keehi Lagoon. Additionally, there is no planned construction or alteration associated with the Navy that would affect land use.

4.4.2.15 KAENA POINT

A review of the 13 environmental resources against training determined that the proposed alternatives would not result in either short- or long-term environmental impacts at Kaena Point. Alternative 3 is the preferred alternative.

No air emissions would be generated from training unless use of diesel generators would be required for backup power at Kaena Point. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the Terminal High Altitude Area Defense (THAAD) radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources (including the Laysan albatross eggs being accepted from PMRF), cultural resources, or geology and soils. Training events using the radar do require the use of small amounts of hazardous materials for facility maintenance such as paint repair and oil for the radar unit and generates small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with Air Force, Federal, and State regulations. There is an established safety zone around the radar unit to prevent electromagnetic radiation hazards exposures, which eliminates health and safety issues.

Kaena Point is compatible with existing surrounding land uses, and training are consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program. No noise is generated by training. The site, which employs up to 15 personnel, would not affect local transportation levels of service or utilities. There is no socioeconomic impact from training. Existing or proposed training would not generate any waste streams that could impact local water quality.

4.4.2.16 MT. KAALA

A review of the 13 environmental resources against training determined that the proposed alternatives would not result in either short- or long-term environmental impacts at Mt. Kaala. Alternative 3 is the preferred alternative.

No air emissions would be generated from training at Mt. Kaala unless use of diesel generators would be required for backup power. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils. HRC training at this location would continue to use small amounts of hazardous materials and generate hazardous waste associated with facility maintenance to prevent building corrosion. All hazardous materials used and hazardous waste generated would continue to be handled in accordance with Federal and State regulations.

Mt. Kaala does not represent any public health and safety issues. The site is compatible with existing surrounding land uses and training is consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program. No noise is generated by training. The site, which is only operated by a few personnel, would not affect local transportation levels of service or utilities. There is no socioeconomic impact from use of Mt. Kaala. HRC training would not generate any waste streams that could impact local water quality.

4.4.2.17 WHEELER NETWORK SEGMENT CONTROL/PMRF COMMUNICATION SITES

A review of the 13 environmental resources against training determined that the proposed alternatives would not result in either short- or long-term environmental impacts at Wheeler Network Communications Control. Alternative 3 is the preferred alternative.

No air emissions would be generated from training at Wheeler Network Segment Control/PMRF Communication Sites unless use of diesel generators would be required for backup power. These sites do not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils.

Use of Wheeler Network Segment Control/PMRF Communication Sites does require small amounts of hazardous materials for facility maintenance and generate small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations. There is no electromagnetic radiation generated at the sites; therefore, there are no public health and safety issues. The site is compatible with existing surrounding land uses, and training is consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program.

No noise is generated by training at Wheeler Network Segment Control/PMRF Communication Sites. The sites, which are only manned during training, employ two to four persons. Such a small work force would not affect local transportation levels of service or utilities. There is no socioeconomic impact from the training at the site. HRC training at the site would not generate any waste streams that could impact local water quality.

4.4.2.18 MAUNA KAPU COMMUNICATION SITE

A review of the 13 environmental resources against training determined that the proposed alternatives would not result in either short- or long-term environmental impacts at the Mauna Kapu Communication Site. Alternative 3 is the preferred alternative.

No air emissions would be generated from training at the Mauna Kapa Communication Site unless use of diesel generators would be required for backup power. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils. Use of this site does require small amounts of hazardous materials for facility maintenance and generates small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations.

There is no electromagnetic radiation generated at the Mauna Kapu Communication Site; therefore, there are no public health and safety issues. The site is compatible with existing surrounding land uses, and training is consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program. No noise is generated by training at the site. The site, which is only manned during training, employs two to four persons. Such a small work force would not affect local transportation levels of service or utilities. There is no socioeconomic impact from the use of the site. HRC training at the site would not generate any waste streams that could impact local water quality.

4.4.2.19 MAKUA RADIO/REPEATER/CABLE HEAD

A review of the 13 environmental resources against training determined that the proposed alternatives would not result in either short- or long-term environmental impacts at Makua Radio/Repeater/Cable Head. Alternative 3 is the preferred alternative.

No air emissions would be generated from training at the Makua Radio/Repeater/ Cable Head unless use of diesel generators would be required for backup power. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils. Use of this site does require small amounts of hazardous materials for facility maintenance and generates small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations. There is no electromagnetic radiation generated at the site; therefore, there are no public health and safety issues.

The Makua Radio/Repeater/Cable Head is compatible with existing surrounding land uses, and training is consistent to the maximum extent practicable with the Hawaii Coastal Zone Management Program. No noise is generated by training at the site. The site, which is only manned during training, employs two to four persons. Such a small work force would not affect local transportation levels of service or utilities. There is no socioeconomic impact from the use of the site. HRC training at the site would not generate any waste streams that could impact local water quality.

THIS PAGE INTENTIONALLY LEFT BLANK

4.5 MAUI

4.5.1 MAUI OFFSHORE

Maui Offshore is used for submarine training. Table 4.5.1-1 lists ongoing training and research, development, test, and evaluation (RDT&E) activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 in Maui Offshore. Alternative 3 is the preferred alternative.

Table 4.5.1-1. Training and RDT&E Activities in the Maui Offshore

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Anti-Submarine Warfare (ASW) Tracking Exercise • ASW Torpedo Exercise • Integrated ASW Training	• Portable Undersea Tracking Range (Alternative 1) • Large Area Tracking Range Upgrade (Alternative 1) • Enhanced Electronic Warfare Training (Alternative 1) • Expanded Training Capability for Transient Air Wings (Alternative 1)

A review of the 13 environmental resources against program training and RDT&E activities determined there would be no impacts from training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 for Maui Offshore. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, airspace, cultural resources, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

There would be no emissions from training and RDT&E activities affecting the air quality for the Maui Offshore area. Use of this area does not require control of the airspace. This site has no prehistoric or historic artifacts, archaeological sites (including underwater sites), historic buildings or structures, or traditional resources that could be affected by Hawaii Range Complex (HRC) training and RDT&E activities. Training and RDT&E activities associated with this area would adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise, as discussed in Appendix C. There would be no offshore HRC training or RDT&E activities in Maui Offshore that would adversely affect earth resources (land forms, geology and soils). The socioeconomic characteristics of Maui are not affected by training and RDT&E activities associated with Maui Offshore. HRC training and RDT&E activities would not affect local transportation levels of service or utilities. The area is compatible with existing and surrounding land uses. Water resources would not be affected by the movement of submarines during training.

4.5.1.1 MAUI OFFSHORE

4.5.1.1.1 Biological Resources—Maui Offshore

4.5.1.1.1.1 No-action Alternative (Biological Resources—Maui Offshore)

HRC Training and Major Exercises—No-action Alternative

According to the Hawaiian Islands Humpback Whale National Marine Sanctuary Environmental Impact Statement (EIS) (U.S. Department of Commerce, National Oceanic and Atmospheric Administration and State of Hawaii, Office of Planning, 1997), "… the waters adjacent to Maui, Molokai, and Lanai are important training areas for Navy ships homeported in Pearl Harbor. The channel between Maui, Lanai and Molokai is extensively used for biennial RIMPAC [Rim of the Pacific] Exercises, EOD/MCM [explosive ordnance disposal/mine countermeasures] Exercises, and as well for shallow-water ASW [anti-submarine warfare]… The areas inside the 100-fathom isobath surrounding Maui, Molokai and Lanai, and specifically the channel between these islands, are used for shallow-water ASW operations."

The waters inside the 100-fathom isobath surrounding Maui, Molokai, and Lanai, and specifically the channel between these islands, would continue to be used for RIMPAC Exercises, including EOD and MCM Exercises, as well as shallow-water ASW events.

Submarine events occur throughout much of the HRC. Weapon firing mainly occurs in the Pacific Missile Range Facility (PMRF) Shallow Water Training Range and the training areas within the 100-fathom isobath contour between the islands of Kahoolawe, Maui, Lanai, and Molokai. Most submarine operations occur between approximately 15 fathoms below the water surface and the ocean floor. Multiple in-water runs of MK-48 torpedoes (with no warheads) using one submarine as both target and launch platform occur in the Penguin Bank area.

Endangered humpback whales are normally seen during the winter months, November to May, in the region of influence, with peak concentrations in mid-February to mid-March. The whales seem to prefer areas within the 100-fathom contours such as the Molokai–Lanai–Maui–Kahoolawe channels and Penguin Bank. Humpback whale sightings are mainly concentrated north of Kahoolawe in protected channel areas.

Integrated ASW Training events involving multiple air, surface, and subsurface units of the ASW Tracking Exercise combined, over a period of several days, are called a Major Exercise. No new or unique events take place during integrated training; it is merely the compilation of numerous ASW events as conducted by multiple units over a period of time ranging from 3 to 30 days.

Personnel are aware that they are not to harm or harass whales, Hawaiian monk seals, or sea turtles. Commander Navy Region Hawaii also issues a Navy message annually when the humpback whales return to Hawaiian waters (based on the first sightings) as a means to increase general awareness and emphasize those regulations specific to humpback whales in Hawaii. The Navy has conducted these submarine operations in the Hawaiian Islands for decades, and no harmful effects on these species have been observed to date. As part of the required clearance before a training event, the target area will be inspected visually and determined to be clear. Aircrews are trained to visually scan the surface of the water for anomalies. Due in part to this additional emphasis on visual scanning and the availability of extra crew members to conduct such searches, it is unlikely that whales, monk seals, or sea turtles would be undetected when the aircraft are flying at lower altitudes. If animals are detected, the submarine's path can be adjusted. Submarine events, including those in existing underwater training areas between the islands of Kahoolawe, Maui, Lanai, and Molokai, follow established clearance procedures to ensure the activity will not adversely impact marine mammals and sea turtles. The potential to harm whales, monk seals, or sea turtles from the firing and tracking of non-explosive torpedoes in these training areas, as part of the various Major Exercises, is remote.

4.5.1.1.1.2 Alternative 1 (Biological Resources—Maui Offshore)

Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise, including two Strike Groups conducting training simultaneously in the HRC, and other continuing training (See Table 2.2.2.3-1). The number of tracking and torpedo events would not increase, but the tempo of the events may. Two additional integrated ASW training events would be added as part of Alternative 1. The likelihood of a similar increase in adverse impacts on biological resources would be small because no new or unique events take place; personnel are aware that they are not to harm or harass whales, monk seals, or sea turtles; and the Navy would continue to monitor its events for potential impacts.

HRC Enhancements—Alternative 1

The Portable Undersea Tracking Range would be developed to provide submarine training in areas where the ocean depth is between 300 and 2,000 feet (ft) and at least 3 nautical miles from land (Figure 2.2.3.6.3-1). The underwater range instrumentation hardware could be deployed, and a temporary range created anywhere within the region shown in Figure 2.2.3.6.3-1. The Portable Undersea Tracking Range would also be used in areas around Maui with water depths greater than 300 ft. When training is complete, the Range equipment could be recovered and moved to another location. All of these areas have been used for submarine training since World War II. Other than the temporary disturbance to marine species during instrumentation installation and recovery, no impacts would be expected to occur.

Sources such as the proposed Portable Undersea Tracking Range, underwater communications, and electronic warfare systems that may be deployed in the ocean are beyond the frequency range or intensity level to affect marine animals. Flat areas with no known coral concentration would be selected for the Portable Undersea Tracking Range when possible. In areas that have not been mapped for coral presence, the Navy would develop appropriate habitat data and any necessary Best Management Practices and mitigations in coordination with the National Marine Fisheries Service and U.S. Fish and Wildlife Service (USFWS). The Navy will continue to work with regulatory agencies throughout the planning and development process to minimize the potential for impacts on coral, fish, and marine mammals.

As part of the Joint National Training Capability, PMRF would provide dedicated equipment to enable Mid-Pacific and transiting Strike Groups to participate in either live or virtual training. This capability would allow links between Third Fleet and Seventh Fleet to Mid-Pacific to demonstrate group level Navy Continuous Training Environment. PMRF would be able to participate in major in-port training with at-sea assets. A node would be created in an existing building at PMRF. The node would connect to a sound source in the ocean, such as a transiting submarine in the Maui Offshore area. The sound source would have three alternatives for bandwidth: (1) less than 1 kilohertz (kHz); (2) between 3 kHz and 8 kHz; and (3) greater than 10 kHz. These bandwidths are not anticipated to affect marine mammals or sea turtles. The effects of sound in the water are discussed in Section 4.1.2.

4.5.1.1.1.3 Alternative 2 (Biological Resources—Maui Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training operations would be increased and the frequency of operations could also increase. However, the potential for effects on marine mammals and sea turtles would be minor since personnel are aware that they are not to harm them, clearance procedures are established, and similar to those occurring during current training, as described above.

4.5.1.1.1.4 Alternative 3 (Biological Resources—Maui Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.5.1.2 SHALLOW-WATER MINEFIELD SONAR TRAINING AREA OFFSHORE

A review of the 13 environmental resources against training and RDT&E activities determined that the proposed alternatives would not result in either short- or long-term environmental impacts at the Shallow-water Minefield Sonar Training Area. Alternative 3 is the preferred alternative.

Use of the Shallow-water Sonar Minefield Sonar Training Area does not require control of the airspace above this area. There are no reports of emissions from training or RDT&E activities affecting the air quality in the area. Training and RDT&E activities associated with this site adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise, as discussed in Appendix C. During the preparation of a 1997 Environmental Assessment, exploration of the site indicated no archeological or historic submerged sites or coral reefs in the area.

The Shallow-water Minefield Training Area is located within the Hawaiian Islands Humpback Whale National Marine Sanctuary; however, the inert shapes and mine detection equipment used in training or RDT&E activities at the shallow water training area would be clean and free from residual materials and invasive species from prior use, and no environmental effects on biological resources are anticipated. Since the shapes will rest on the ocean bottom, they would pose no entanglement hazard to marine mammals and sea turtles. A minimum of one inspection per year of the training area and mooring cables/anchor chain is performed.

The Shallow-water Minefield Sonar Training Area is compatible with existing surrounding land uses. There are no earth resources (land forms, geology and soils) that are adversely affected by training or RDT&E activities associated with the site. HRC training and RDT&E activities would not affect local transportation levels of service or utilities. The socioeconomic characteristics of Maui are not affected by training and RDT&E activities associated with this training area. Additionally, water resources would not be affected by the movement of submarines during the training and RDT&E activities.

4.5.2 MAUI ONSHORE

The PMRF capability for Electronic Warfare training would be enhanced to include sites on other islands (e.g., Maui and Hawaii). During Electronic Warfare training, Electronic Warfare emitters transmit signals that replicate hostile radars and weapon systems. Ship and aircraft crews attempt to identify the electronic signals, and react defensively if appropriate. Transmitters could be antennas or mobile vehicles. Where possible, existing towers would be chosen to incorporate new equipment with minimal modifications needed and no substantial impacts on wildlife. The construction of any new towers on Maui would occur at locations selected by personnel familiar with local environmental constraints, including the presence of threatened or endangered species. Additional environmental documentation could be required once specific sites are identified. The placement of new equipment to enhance electronic warfare training capability would be collocated on an existing communication tower or other structure. Any new towers would not be sited in or near wetlands, other known bird concentration areas (e.g., state or Federal refuges, staging areas, rookeries), in known migratory or daily movement flyways, or in habitat of threatened or endangered species. Any required lighting would be shielded in accordance with existing policy. The Navy would continue to consult with USFWS to ensure compliance under Section 7 of the Endangered Species Act.

4.5.2.1 MAUI SPACE SURVEILLANCE SYSTEM

A review of the 13 environmental resources against program training and RDT&E activities determined that the proposed alternatives would not result in either short- or long-term environmental impacts at the Maui Space Surveillance Site. Alternative 3 is the preferred alternative.

The Maui Space Surveillance System is located within 6.2 miles of the Haleakala National Park, which is a prevention of significant deterioration Class I area, as defined by the Clean Air Act. No air emissions would be generated from training and RDT&E activities unless use of diesel generators would be required for backup power; therefore, the proposed alternatives would not affect this special air quality designation. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the Terminal High Altitude Area Defense (THAAD) radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur as a result of proposed training and RDT&E activities, there would be no impact on biological resources, cultural resources, or geology and soils.

The use of hazardous materials and generation of hazardous waste at Maui Space Surveillance System, would be in accordance with applicable regulations. There are established safety zones around electromagnetic radiation hazards, which eliminate health and safety issues. The site is compatible with existing surrounding land uses. No noise is generated by training and RDT&E activities, and the site is operated by up to 60 persons. This small staff would not affect local transportation levels of service or utilities. There is no socioeconomic impact from training and RDT&E activities. Training and RDT&E activities would not generate any waste streams that could impact local water quality.

4.5.2.2 MAUI HIGH PERFORMANCE COMPUTING CENTER

A review of the 13 environmental resources against program activities determined that the proposed alternatives would not result in either short- or long-term environmental impacts at the Maui High Performance Computing Center. Training and RDT&E activities at this site consist of data processing. Alternative 3 is the preferred alternative.

No air emissions would be generated from training and RDT&E activities at the Maui High Performance Computing Center unless use of diesel generators would be required for backup power. The site does not affect the existing airspace structure in the region. Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils.

Use of the Maui High Performance Computing Center does require small amounts of hazardous materials for facility maintenance and generates small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations. There is no electromagnetic radiation generated at the site; therefore, there are no public health and safety issues.

The Maui High Performance Computing Center is compatible with existing surrounding land uses. No noise is generated by training and RDT&E activities at the site. HRC training and RDT&E operations would not affect local transportation levels of service or utilities. There is no socioeconomic impact from use of the site. HRC training and RDT&E activities at the site would not generate any waste streams that could impact local water quality.

4.5.2.3 SANDIA MAUI HALEAKALA FACILITY

A review of the 13 environmental resources against program activities determined that the proposed alternatives would not result in either short- or long-term environmental impacts at the Sandia Maui Haleakala Facility. Alternative 3 is the preferred alternative.

The Sandia Maui Haleakala Facility is located within 6.2 miles of the Haleakala National Park, which is a Prevention of Significant Deterioration Class I area, as defined by the Clean Air Act. No air emissions would be generated from site events unless use of diesel generators would be required for backup power; therefore, the proposed alternatives would not affect this special air quality designation. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils.

Use of the Sandia Maui Haleakala Facility site does require small amounts of hazardous materials for facility maintenance and generates small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations. There is no electromagnetic radiation generated at the site; therefore, there are no public health and safety issues. The site is compatible with existing surrounding land uses.

No noise is generated by training and RDT&E activities at the Sandia Maui Haleakala Facility. HRC training and RDT&E activities would not affect local transportation levels of service or utilities. There is no socioeconomic impact from use of the site. HRC training and RDT&E activities at the site would not generate any waste streams that could impact local water quality.

4.5.2.4 MOLOKAI MOBILE TRANSMITTER SITE

A review of the 13 environmental resources against program activities determined that the proposed alternatives would not result in either short- or long-term environmental impacts at the Molokai Mobile Transmitter Site. Alternative 3 is the preferred alternative.

There are no reports of emissions from training or RDT&E activities affecting the air quality in the area. The site does not affect the existing airspace structure in the region. Telemetry, command and control, and optical sensors are passive systems that do not present the same potential for impacts on wildlife as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). Because no ground disturbance or building modifications would occur, there would be no impact on biological resources, cultural resources, or geology and soils.

Use of the Molokai Mobile Transmitter Site does require small amounts of hazardous materials and generates small amounts of hazardous waste. All hazardous materials used and hazardous waste generated would continue to be managed in accordance with applicable regulations. There are established safety zones, which eliminate health and safety issues. The site is compatible with existing surrounding land uses.

No noise is generated by training and RDT&E activities at the Molokai Mobile Transmitter Site. HRC training and RDT&E activities would not affect local transportation levels of service or utilities. There is no socioeconomic impact from use of the site. HRC training and RDT&E activities at the site would not generate any waste streams that could impact local water quality.

THIS PAGE INTENTIONALLY LEFT BLANK

4.6 HAWAII

4.6.1 HAWAII OFFSHORE

4.6.1.1 KAWAIHAE PIER OFFSHORE

Table 4.6.1.1-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 offshore at Kawaihae Pier. Alternative 3 is the preferred alternative.

Table 4.6.1.1-1. Training at Kawaihae Pier Offshore

Training	
• Expeditionary Assault	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against offshore program training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Kawaihae Pier. The following resources are not addressed because the proposed alternatives have no potential to adversely affect such resources air quality, airspace, cultural resources, geology and soils, hazardous material and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

No air emissions would be generated from Kawaihae Pier offshore training unless use of diesel generators would be required for backup power. Use of Kawaihae Pier does not require control of the airspace above this land area. Kawaihae Pier has no prehistoric and historic artifacts, archaeological sites (including underwater sites), historic buildings or structures, or traditional resources that could be affected by Hawaii Range Complex (HRC) training. Because no ground disturbance or building modifications would occur as a result of proposed training, there would be no impact on geology and soils.

Offshore training associated with Kawaihae Pier adheres to policies and regulations governing hazardous materials and waste, health and safety, and noise, as discussed in Appendix C. There are no concerns with noise as it relates to offshore HRC training at Kawaihae Pier. There would be no impact on socioeconomics, transportation, utilities, and land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. HRC training would not generate any waste streams that could impact local water quality.

4.6.1.1.1 Biological Resources—Kawaihae Pier—Offshore

4.6.1.1.1.1 No-action Alternative (Biological Resources—Kawaihae Pier—Offshore)

The Navy will work with the current land owner for activities that may not be covered under existing consultation or regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

The small beach area located immediately adjacent to the pier contains no vegetation. No threatened or endangered vegetation has been identified in the Kawaihae Harbor area (U.S. Department of the Navy, 2002a).

Expeditionary Assault landing personnel are briefed on existing procedures for entering the harbor and unloading equipment and supplies at the boat ramp. These procedures include inspections by appropriate Federal and/or State agencies of vehicles and equipment from foreign countries to prevent the introduction of invasive or alien species. A recycling wash rack is used to clean foreign country vehicles and equipment prior to back-loading to control the spread of alien species.

Wildlife

The Expeditionary Assault will continue to be conducted in compliance with Executive Order (EO) 13089, *Coral Reef Protection*. Expeditionary Assault landing personnel are briefed on existing procedures for entering the harbor and unloading equipment and supplies at the boat ramp. Before each Expeditionary Assault is conducted, a hydrographic survey is performed to map out the precise transit routes through sandy bottom areas. Within 1 hour of initiation of the Expeditionary Assault landing events, the landing routes and beach areas are determined to be clear of marine mammals and sea turtles. If any are seen, the training event will be delayed until the animals leave the area. During the landing the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The water on this leeward side of the island provides habitat for humpback mother and calf pods and for resting dolphin pods. No threatened or endangered species have been identified within the harbor (U.S. Department of the Navy, 2002a).

During Special Warfare Operations (SPECWAROPS), crews for amphibious inserts follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or Hawaiian monk seals), and sea turtles. Personnel review training overlays that identify the insertion points and any nearby restricted areas; sensitive biological resource areas are avoided.

Hawaiian Islands Humpback Whale National Marine Sanctuary

Although the Kawaihae Pier area is not included within the Hawaiian Islands Humpback Whale National Main Sanctuary (HIHWNMS) located off the northwestern shore of Hawaii, Army and Marine Corps helicopter training events regularly occur over the area within the HIHWNMS boundary. Navy and Army landing craft frequently offload and load supplies and equipment at Kawaihae Pier in support of military training at Pohakuloa Training Area. These training events will continue as approved military actions in the HIHWNMS Environmental Impact Statement/Management Plan.

Potential effects on marine biological resources from mid-frequency active/high-frequency active (MFA/HFA) sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.6.1.1.1.2 Alternative 1 (Biological Resources—Kawaihae Pier—Offshore)

No increases in training and Major Exercises at Kawaihae Pier are expected. Impacts would be the same as those discussed above for the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean No-action Alternative sections.

4.6.1.1.1.3 Alternative 2 (Biological Resources—Kawaihae Pier—Offshore)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training events would be increased and the frequency of events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003d). Potential effects on marine biological resources from MFA/HFA sonar usage are discussed in the applicable Open Ocean Alternative 2 sections.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area for up to 10 days per Major Exercise. The Major Exercises would be similar to those occurring during the Rim of the Pacific (RIMPAC) Exercise and the Undersea Warfare Exercise (USWEX), with the exception of impacts associated with MFA sonar use (Section 4.1.2), impacts on biological resource similar to those described above for the No-action Alternative.

4.6.1.1.1.4 Alternative 3 (Biological Resources—Kawaihae Pier—Offshore)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced research, development, test, and evaluation (RDT&E) activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Potential effects on marine biological resources from MFA/HFA sonar usage determined for Alternative 3 are discussed in the applicable Open Ocean No-action Alternative sections. Potential effects on marine biological resources from non-ASW (sonar usage) training and RDT&E activities determined for Alternative 3 are the same as those analyzed for Alternative 2.

4.6.2 HAWAII ONSHORE

4.6.2.1 POHAKULOA TRAINING AREA

Table 4.6.2.1-1 lists ongoing training and RDT&E activities for the No-action Alternative and proposed training and RDT&E activities for Alternatives 1, 2, and 3 at Pohakuloa Training Area (PTA). Alternative 3 is the preferred alternative.

Table 4.6.2.1-1. Training and RDT&E Activities at PTA

Training	Research, Development, Test, and Evaluation (RDT&E) Activities
• Air-to-Ground Gunnery Exercise (A-G GUNEX) • Bombing Exercises • Special Warfare Operations (SPECWAROPS) • Live Fire Exercise (LFX)	• Large Area Tracking Range Upgrade (Alternative 1) • Enhanced Electronic Warfare Training (Alternative 1) • Expanded Training Capability for Transient Air Wings (Alternative 1)

A review of the 13 resources against program training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for PTA. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, hazardous materials and hazardous waste, geology and soils, land use, socioeconomics, transportation, utilities, and water resources.

The southern portion of the PTA range complex is proposed for Air-to Ground Gunnery Exercises (A-G GUNEX), Bombing Exercises, and Live Fire Exercises (LFXs). This location is within 6.2 miles (mi) of the Hawaii Volcanoes National Park, which is a Prevention of Significant Deterioration Class I area as defined by the Clean Air Act. The proposed alternatives would not affect this special air quality designation because the limited duration of these events would minimize or eliminate the cumulative effects of particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM-10). The Navy would defer to Army procedures for use of any area within the PTA range where depleted uranium (DU) contamination has been found.

No building modifications would occur. Any ground disturbance as a result of training and RDT&E activities would be handled in accordance with existing practices, and no impact on geology and soils is expected.

The use of hazardous materials and generation of hazardous waste at PTA would be in accordance with applicable regulations. PTA is compatible with existing surrounding land uses. HRC training and RDT&E activities would not affect local transportation levels of service or utilities. The socioeconomic characteristics of the area are not affected by training and RDT&E activities associated with this site. Training and RDT&E activities would not generate any hazardous waste streams that could impact local water quality.

4.6.2.1.1 Airspace—PTA

4.6.2.1.1.1 No-action Alternative (Airspace—PTA)

HRC Training—No-action Alternative

HRC training can include LFXs at PTA. These types of training events are confined to the special use airspace R-3103 located above the range associated with PTA. Air activity is controlled and coordinated by PTA Range Control. For training that includes 10 or more aircraft, the Bradshaw Army Airfield manager submits a Notice to Airmen (NOTAM) to the Federal Aviation Administration (FAA) Honolulu Flight Service Station to be published as a Honolulu Local NOTAM and as a Class D NOTAM. The Bradshaw Army Airfield manager provides this information to the airfield Air Traffic Information Service (U.S. Army Garrison, Hawaii, 1996).

The nearest en route airway is located approximately 10 nautical miles north of R-3103. Access to R-3103 would be via Air Traffic Control Assigned Airspace (ATCAA) Pele, shown on Figure 3.6.2.1.1-1. This access route would be above the en route airways and Class D and Class E airspace above Kona Airport. By appropriately containing military activities within the Restricted Airspace and coordinating the use of the ATCAA area, non-participating traffic is advised or separated accordingly, resulting in minimal impacts on airspace from HRC training.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC and USWEX include combinations of ongoing training events. For PTA this includes LFX and SPECWAROPS. These types of training events are confined to the special use airspace R-3103 located above the range associated with PTA. Air activity is controlled and coordinated by PTA Range Control. For training that includes 10 or more aircraft, the Bradshaw Army Airfield manager submits a NOTAM to Honolulu Flight Service Station to be published as a Honolulu Local NOTAM and as a Class D NOTAM. The Bradshaw Army Airfield manager provides this information to the airfield Air Traffic Information Service (U.S. Army Garrison, Hawaii, 1996).

RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. Each USWEX, up to six per year, will include coordination with the FAA well in advance of each 3- or 4-day Major Exercise. The advanced planning and coordination with the FAA regarding scheduling of special use airspace and coordination of Navy training relative to en route airways and jet routes result in minimal impacts on airspace from Major Exercises.

4.6.2.1.1.2 Alternative 1 (Airspace—PTA)

Increased Tempo and Frequency of Training—Alternative 1

Increased training could include additional LFXs at PTA. The total number of training events that affect airspace could increase by approximately 29 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. HRC training would continue to use the existing special use airspace including the R-3103 Restricted Airspace and the Pele ATCAA shown on Figure 3.6.2.1.1-1. By appropriately containing military activities within the Restricted Airspace and coordinating the use of the ATCAA area, non-participating traffic is advised or separated accordingly.

The increase in training under Alternative 1 would require an increase in coordination and scheduling by the Navy, Bradshaw Army Airfield, and the FAA. The increase in training would be readily accommodated within the existing airspace. Consequently, there would be no airspace conflicts.

HRC Enhancements—Alternative 1

HRC enhancements would include a new ground relay station to support the Large Area Tracking Range. The relay station would be added to an existing building. Use of the new ground relay station would not require control of the airspace above this land area.

Major Exercises—Alternative 1

Major Exercises such as RIMPAC and USWEX include combinations of ongoing training events. For PTA this includes LFX and SPECWAROPS. These types of training events are confined to the special use airspace R-3103 located above the range associated with PTA. Air activity is controlled and coordinated by PTA Range Control. For training that includes 10 or more aircraft, the Bradshaw Army Airfield manager submits a NOTAM to Honolulu Flight Service Station to be published as a Honolulu Local NOTAM and as a Class D NOTAM. The Bradshaw Army Airfield manager provides this information to the airfield Air Traffic Information Service (U.S. Army Garrison, Hawaii, 1996).

RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. The increase from one aircraft carrier to two during RIMPAC under Alternative 1 would require a minor increase in coordination and scheduling by the Navy and FAA. Each USWEX, up to six per year, will include coordination with the FAA well in advance of each 3- or 4-day Major Exercise. The advance planning and coordination with the FAA regarding scheduling of special use airspace and coordination of Navy training relative to en route airways and jet routes result in minimal impacts on airspace from Major Exercises.

4.6.2.1.1.3 Alternative 2 (Airspace—PTA)

Increased Tempo and Frequency of Training—Alternative 2

Increased tempo and frequency of training could result in additional LFXs at PTA. The total number of training events that affect airspace could increase by approximately 48 percent above the No-action Alternative. No new airspace proposal or any modification to the existing controlled airspace would be required. The training would continue to use the existing special use airspace including the R-3103 Restricted Airspace and the Pele ATCAA shown on Figure 3.6.2.1.1-1. By appropriately containing military activities within the Restricted Airspace and coordinating the use of the ATCAA area, non-participating traffic is advised or separated accordingly.

The increase in training under Alternative 1 would require an increase in coordination and scheduling by the Navy, Bradshaw Army Airfield, and the FAA. The increase in training would be accommodated within the existing airspace. Consequently, there would be no airspace conflicts.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, Alternative 2 includes a Multiple Strike Group Major Exercise that could include additional LFXs at PTA. The advance planning and coordination with the FAA regarding scheduling of special use airspace, and coordination of Navy training relative to en route airways and jet routes result in minimal impacts on airspace from Major Exercises. The use of three aircraft carriers during a Major Exercise would require an increase in coordination and scheduling by the Navy, Bradshaw Army Airfield, and the FAA. The increased training would be accommodated within the existing airspace.

4.6.2.1.1.4 Alternative 3 (Airspace—PTA)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.1.2 Biological Resources—PTA

4.6.2.1.2.1 No-action Alternative (Biological Resources—PTA)

Navy training and RDT&E activities at the site would be performed in accordance with all applicable biological opinions and existing Army regulations. The Navy will work with the current Department of Defense (DoD) land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

LFXs, which are confined to the Impact Area, are conducted at PTA as part of ongoing training. Strike Warfare for RIMPAC and USWEX includes Bombing and A-G GUNEX, also confined to the Impact Area. A-G GUNEX involve helicopter crews fire guns against stationary land targets for live fire target practice. SPECWAROPS primarily use existing trails and roads. Personnel review training overlays that identify the insertion points and any nearby restricted areas. Although the Impact Area has not been surveyed for biological resources—due to the risks posed by unexploded ordnance—impacts from ordnance and other munitions landing over a long period of use have most likely already degraded the habitat. In addition, numerous ordnance-related fires over the years have tended to favor non-native invasive species over Native Hawaiian species, which generally are not fire-adapted and recover slowly after a fire.

Military activities, other than fire, seem to have had little impact on rare plants. Approximately 25 percent of the installation is covered by lava, with little vegetative development. Dust from training can also negatively impact a threatened or endangered species, as listed in Table 3.6.2.1.2-1, if it is growing close to a road. However, many of the threatened and endangered plants inhabit remote areas of PTA with little or no chance of being impacted by military activity. (Shaw, 1997)

An Integrated Natural Resources Management Plan (INRMP) has been prepared to address protection and management of resources for PTA. Compliance with this plan and the Ecosystem Management Plan during training events and Major Exercises further reduces the potential for effects of training on biological resources and limits the potential for introduction of invasive weed plant species. The risk of impacting threatened or endangered plants can be further minimized by locating training away from areas with these species whenever possible. The effects of continued training on biological resources within the Impact Area will be minor in the context of the overall quantity of ordnance deliveries to this area from various training events.

Air-to-surface missile training as part of strike warfare at PTA is confined to the special use airspace R-3103 associated with Bradshaw Army Airfield and the impact area associated with PTA. Air activity is coordinated by PTA Range Control. The following restrictions from the PTA External Standard Operating Procedures (SOPs) are applicable to all training areas on the installation:

- All off-road driving is prohibited.
- All fenced areas are off-limits.
- All lava tubes and sinkholes are off-limits.
- Digging is only permitted in previously disturbed areas.

Wildlife

The U.S. National Park Service, through an interagency agreement, fenced approximately 6,500 acres to keep feral goats, sheep, and pigs from disturbing native habitat and listed species. The U.S. Department of Agriculture, Wildlife Services staff removes the feral animals. Explosive ordnance disposal specialists assist in these efforts due to safety considerations. (U.S. Army Corps of Engineers, 2001)

For missile and weapons systems, PTA Safety establishes criteria for the safe execution of the test event in the form of Range Safety Approval and Range Safety Operational Plan documents. These plans are required for all weapon and target systems using PTA. The plans include the allowable launch and flight conditions, and flight control methods necessary to contain the missile flight and impacts within the predetermined impact hazard areas. PTA safety criteria also provide for protection of biological and cultural resources. The impact area is in a barren and isolated area with restricted access.

Military readiness activities are exempt from the take prohibitions of the Migratory Bird Treaty Act (MBTA) provided they do not result in a significant adverse effect on the population of a migratory bird species. The low probability of one of the training events being capable of significantly impacting a population of the migratory species that occur in the PTA area should exempt the HRC from the take prohibitions.

Native birds common to PTA, such as honeycreepers (`apapane and Hawaiian `amakihi), can be startled or flushed by intermittent noise associated with training. These effects, however, are temporary and the birds continue to return to the area following completion of training. Any potential impacts to listed bird species, such as the `io (Hawaiian hawk) and nene, which are the only endangered forest birds seen on PTA, would be addressed through coordination with the U.S. Fish and Wildlife Service (USFWS).. Compliance with the PTA INRMP and Ecosystem

Management Plan during training can further reduce the potential for effects on wildlife. The continuance of current training is not likely to adversely affect the long-term well-being, reproduction rates, or survival of these native or listed species.

Section 3.6.2.1.4 describes DU and the recently discovered presence of DU on remote sections of PTA. All Navy activities will follow existing Army SOPs, as well as future plans and regulations concerning DU at PTA.

Environmentally Sensitive Habitat

The USFWS determined that critical habitat for the listed plant species was not necessary since the PTA INRMP and Ecosystem Management Plan encompass management actions that will benefit the listed species for which critical habitat was originally proposed (U.S. Fish and Wildlife Service, 2003c).

The critical habitat established for the endangered palila, a finch-billed honeycreeper, is located outside the areas likely to be affected by the current training.

4.6.2.1.2.2 Alternative 1 (Biological Resources—PTA)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Air-to-Ground Gunnery would increase in number from 16 per year to 18 (See Table 2.2.2.3-1), The likelihood of a similar increase in adverse impacts on biological resources would be small since different areas of PTA's Impact Area would be used for each independent activity, and only two additional Major Exercises are being added per year. Other training at PTA will not increase; LFX will remain at three per year.

Vegetation

Training would continue to take place at existing locations; no expansion of the area would be involved. Compliance with the PTA INRMP and Ecosystem Management Plan during increased training events would minimize the potential for effects on vegetation, as well as limit the potential for introduction of invasive plant species. The risk of impacting threatened or endangered plants could be further minimized by continuing to locate training away from areas with native, threatened, or endangered plant species, whenever possible.

Wildlife

Impacts on wildlife would be similar to those described previously for the No-action Alternative. The increased training events would comply with the PTA INRMP and Ecosystem Management Plan, which could further reduce the potential for effects on wildlife.

Environmentally Sensitive Habitat

The critical habitat established for the endangered palila is located outside the areas likely to be affected by the increased training and Major Exercises.

HRC Enhancements—Alternative 1

To support the Large Area Tracking Range, a new ground relay station would be added to PTA. The relay station would not require new construction, but would be added to an existing building. No impacts on wildlife other than temporary startling by additional personnel involved in the installation are anticipated.

Also under Alternative 1, PTA would receive two Joint Threat Emitters. These transmitters are threat simulators capable of generating radar signals associated with threat systems and consist of a computer controlled multiple emitter and receiver system (one or two command and control units). The proposed transmitters could be antenna or mobile vehicles. When possible, existing towers would be used to incorporate new equipment with minimal modifications. If new towers are needed, additional environmental analysis would be required before such activities could occur. Command and control sensors are passive systems that do not present the same potential for impacts as the radar systems such as the Terminal High Altitude Area Defense (THAAD) radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005).

Adherence to established SOPs at PTA would result in minimal impacts on the physical environment and avoids potential impacts on threatened and endangered species. New training events that are not covered under current regulations at PTA would not be implemented until appropriate coordination has been completed.

4.6.2.1.2.3 Alternative 2 (Biological Resources—PTA)

Increased Tempo and Frequency of Training—Alternative 2

Under this portion of Alternative 2, the tempo of training would be increased and frequency of events could also be increased. Wildlife exhibits a wide variety of responses to noise. Some species are more sensitive to noise disturbances than others. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003d).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area once a year for up to 10 days per Major Exercise. The Major Exercises proposed would occur mainly in the Open Ocean and would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.6.2.1.2.4 Alternative 3 (Biological Resources—PTA)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.1.3 Cultural Resources—PTA

4.6.2.1.3.1 No-action Alternative (Cultural Resources—PTA)

HRC Training and Major Exercises—No-action Alternative

Live Fire Exercises (LFX)

LFXs involve activities within the PTA impact area and along designated, heavily disturbed roads and trails.

Approximately 30 percent of PTA has been surveyed for cultural resources, and approximately 300 archaeological and traditional Hawaiian sites have been identified; some of the sites are eligible for inclusion in the National Register of Historic Places. These surveys of PTA encompass the Keamuku area. Some of the identified sites are located in proximity to existing trails and roads; however, none are located within the impact training area (U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1998; U.S. Department of the Navy, 2002a). Personnel review training overlays that identify insertion points and nearby restricted areas and sensitive biological and cultural resource areas are avoided (U.S. Department of the Navy, 2002a). In the event unexpected cultural materials are encountered (particularly human remains) during LFX, activities in the immediate vicinity of the find will cease and the Schofield Barracks Cultural Resources Manager will be contacted. In addition, if the alignment of trails requires alteration or grading, or other ground disturbing activities are required, coordination with the Schofield Barracks Cultural Resources Manager would be required. Because of the required preplanning of LFX activities and the implementation of the described mitigation measures, no impacts are expected to cultural resources at PTA.

The Army will continue to provide Native Hawaiians with access to traditional religious and cultural properties, in accordance with the American Indian Religious Freedom Act and EO 13007, on a case-by-case basis.

4.6.2.1.3.2 Alternative 1 (Cultural Resources—PTA)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Training and Major Exercises under Alternative 1 could increase the potential for impacts on occur to cultural resources in sensitive areas. For PTA, this would be most apparent along the roads and trails used for LFX, where there are identified archaeological sites. With continued implementation of mitigations specified for the No-action Alternative, no impacts would be anticipated for the increase in tempo and number of training events that make up Alternative 1. If no grading, widening, or other alteration of the roads and trails widths or alignments is required, the increased potential for adverse effects is minimal. However, if alteration to the roads and trails is necessary, coordination with the Schofield Barracks Cultural Resources Manager would be completed prior to the changes (see above analysis under the No-action Alternative for LFX).

HRC Enhancements—Alternative 1

Large Area Tracking Range Upgrade

To support Large Area Tracking Range, a new ground relay station would be added to PTA. The relay station would not require new construction, but would be added to an existing building. A 2002 historic evaluation of the 129 buildings and structures with the cantonments at PTA and Bradshaw Army Airfield identified 107 potential historic buildings. Twenty of the facilities were recommended for retention; however, the report had not been reviewed by the Hawaii State Historic Preservation Officer (Godby, 2007). Once the specific building has been identified for erection of the relay station, coordination with the PTA cultural resources manager will be required to confirm the eligibility of the facility and determine any potential impacts.

4.6.2.1.3.3 Alternative 2 (Cultural Resources—PTA)

Increased Tempo and Frequency of Training—Alternative 2

The tempo and frequency of training over and above Alternative 1 could increase the potential for impacts on cultural resources in sensitive areas. See discussion under Alternative 1. As with Alternative 1, the continued use of mitigations mentioned earlier would minimize potential impacts on cultural resources.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Elements of Major Exercises with the potential to affect cultural resources have been analyzed above for the No-action Alternative and Alternative 1.

4.6.2.1.3.4 Alternative 3 (Cultural Resources—PTA)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.1.4 Health and Safety—PTA

4.6.2.1.4.1 No-action Alternative (Health and Safety—PTA)

Under the No-action Alternative, existing training at PTA will continue and there will be no adverse impacts on health and safety. PTA takes every reasonable precaution during planning and execution of training to prevent injury to human life or property. Section 3.6.2.1.4 describes DU and the recently discovered presence of DU on remote sections of PTA. All Navy activities will follow existing Army SOPs, as well as future plans and regulations concerning DU at PTA.

HRC Training—No-action Alternative

Under the No-action Alternative, LFXs, which are confined to the Impact Area, are conducted at PTA as part of ongoing HRC training. Every reasonable precaution is taken during the planning and execution of training to prevent injury to human life or damage to property. Specific safety plans have been developed to ensure that each training event is in compliance with applicable policy and regulations, and to ensure that the general public and range personnel and assets are provided an acceptable level of safety. The impact area is in an isolated area with restricted access located away from the civilian population. Safety and health precautions are covered in external SOPs and are briefed by the PTA Operations Center.

Major Exercises—No-action Alternative

Strike Warfare Exercises, LFX, and SPECWAROPS routinely occur at PTA. Every reasonable precaution is taken during the planning and execution of training to prevent injury to human life or damage to property. Specific safety plans have been developed to ensure that each training event is in compliance with applicable policy and regulations and to ensure that the general public and range personnel and assets are provided an acceptable level of safety.

For missile and weapons systems, the PTA Safety Office establishes criteria for the safe execution of training in the form of Range Safety Approval and Range Safety Operational Plan documents, which are required for all weapon and target systems using PTA. These include the allowable launch and flight conditions and flight control methods to contain the missile flight and impacts within the predetermined impact hazard areas that have been determined to be clear of nonessential personnel and aircraft.

The impact area is in an isolated area with restricted access located away from the civilian population. Safety and health precautions are covered in external SOPs and are briefed by the PTA Operations Center. Impacts from the continuing Major Exercises at PTA on safety and health are not anticipated.

4.6.2.1.4.2 Alternative 1 (Health and Safety—PTA)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise (including two Strike Groups conducting training simultaneously in the HRC), and other continuing training events; resulting in an increase of approximately 9 percent. While training events would increase in number, it is anticipated that existing SOPs and specific safety plans that have been developed would ensure that the general public and range personnel and assets are provided an acceptable level of safety.

HRC Enhancements—Alternative 1

Under Alternative 1 an upgrade to the existing Large Area Tracking Range would include modifications to existing facilities at the PTA. No construction would be required, and the proposed minor modifications would be to expand training capability. Existing SOPs and specific safety plans have been developed and would ensure that the general public and range personnel and assets are provided an acceptable level of safety.

Also under Alternative 1, PTA would receive two Joint Threat Emitters. These transmitters are threat simulators capable of generating radar signals associated with threat systems and consist of a computer controlled multiple emitter and receiver system (one or two command and control units). The proposed transmitters could be antenna or mobile vehicles. When possible, existing towers would be used to incorporate new equipment with minimal modifications. If new towers are needed, additional environmental analysis would be required before such activities could occur. Command and control sensors are passive systems that do not present the same potential for impacts as the radar systems such as the THAAD radar used on the HRC, even though they may use a radar or other active sensors for tracking and pointing activities (U.S. Department of Defense, 2005). SOPs and specific safety plans have been developed and would ensure that the general public and range personnel and assets are provided an acceptable level of safety.

4.6.2.1.4.3 Alternative 2 (Health and Safety—PTA)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. Although the number of training events would increase, the type of training would remain the same.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during Major Exercises, with potential impacts on health and safety at PTA similar to those described in Section 4.6.2.1.4.1. Existing SOPs and specific safety plans that have been developed would ensure that the general public and range personnel and assets are provided an acceptable level of safety.

4.6.2.1.4.4 Alternative 3 (Health and Safety—PTA)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on health and safety under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.1.5 Noise—PTA

Impacts of noise on human receptors are evaluated based on whether or not a noise event would exceed DoD or Occupational Safety and Health Administration guidelines. Potential noise effects on wildlife are discussed in Section 4.6.2.1.2, Biological Resources.

4.6.2.1.5.1 No-action Alternative (Noise—PTA)

HRC Training—No-action Alternative

Under the No-action Alternative, LFXs and Bombing Exercises, which are confined to the Impact Area, are conducted at PTA as part of ongoing HRC training. PTA maintains a hearing protection program that includes monitoring the hearing of personnel exposed to high noise levels and identifying and posting notification of noise hazard areas. Personnel required to work in noise hazard areas are required to use appropriate hearing protection and to bring noise levels within established safety levels. The impact area is in an isolated area with restricted access located away from the civilian population. Figure 3.6.2.1.5-1 shows existing noise levels from activities at PTA. Existing noise levels, as discussed in Section 3.6.2.1.5, do not impact noise-sensitive land use areas.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC and USWEX include combinations of ongoing training. For PTA this includes LFX and SPECWAROPS. LFX and SPECWAROPS typically occur at PTA as part of Major Exercises. There will be no increase to existing noise levels during the continuing training events listed above. The total perceived noise will be the combination of ambient noise and noise from the Major Exercises. Noise sources from the Major Exercise will include the use of helicopters and small arms munitions.

4.6.2.1.5.2 Alternative 1 (Noise—PTA)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

Alternative 1 would include up to six USWEXs per year, the biennial RIMPAC Exercise (including two Strike Groups conducting training simultaneously in the HRC), and other continuing training events, resulting in an increase of training events by approximately 9 percent. While training events would increase in number, the type of training would be the same. The noise levels produced by proposed Navy training and Major Exercises would not increase the current noise levels at PTA (Figure 3.6.2.1.5-1). The proposed activities would be individual events and would not occur simultaneously.

HRC Enhancements—Alternative 1

Under Alternative 1, an upgrade to the existing Large Area Tracking Range, enhancing Electronic Warfare Training, and expanding training capability for Transient Air Wings would include modifications to existing facilities at the PTA. No construction would be required, and the proposed minor modifications would be to expand training capability. The Large Area Tracking Range upgrade would not produce additional noise levels as the proposed expansion would be contained within existing facilities at PTA.

4.6.2.1.5.3 Alternative 2 (Noise—PTA)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training could also increase. Although the number of training events would increase, the type of training would remain the same and there would be no anticipated increase in the level of noise produced. The noise levels produced by proposed training would not increase the current noise levels at PTA (Figure 3.6.2.1.5-1). The proposed training would be individual events similar to existing training and would not occur simultaneously.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would be added to the Major Exercises occurring in the HRC. These ships would not be homeported in Hawaii, but would be in the area for up to 10 days per Major Exercise. The Major Exercises proposed would be similar to those occurring during RIMPAC and USWEX and would not increase the existing noise levels at PTA.

4.6.2.1.5.4 Alternative 3 (Noise—PTA)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on noise under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.2 BRADSHAW ARMY AIRFIELD

Table 4.6.2.2-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Bradshaw Army Airfield. Alternative 3 is the preferred alternative.

Table 4.6.2.2-1. Training at Bradshaw Army Airfield

Training	
• Special Warfare Operations (SPECWAROPS)	• Command and Control
• Air Operations	• Aircraft Support Operations

A review of the 13 resources against program training under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Bradshaw Army Airfield. Initial analysis indicated that the proposed alternatives would not result in either short- or long-term impacts on air quality, geology and soils, hazardous materials and hazardous waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

No significant air emissions would be generated from localized use of rotary wing aircraft or use of diesel emergency generators at Bradshaw Army Airfield. There would be no ground-disturbing activities or building modifications that could affect geology and soils at Bradshaw Army Airfield. The use of hazardous materials and generation of hazardous waste at this site would be in accordance with applicable regulations (see Appendix C).

Training at Bradshaw Army Airfield would be performed in accordance with all applicable safety regulations (see Appendix C). A review of Table 2.2.2.3-1 indicates that training at Bradshaw Army Airfield has the potential to increase for Command and Control (from one to two events) and Aircraft Support Operations (from one to two events). This increase does not require the Navy to increase the number of personnel “living on” or “traveling to” Bradshaw, nor acquire additional land, or require any new construction, or modification to any current facilities. The proposed increase would not alter current land use patterns on-base or off-base, socioeconomic characteristics, transportation level of service (LOS) for roadway usage or increase utilities demand. Training would not generate any waste streams that could impact local water quality.

4.6.2.2.1 Airspace—Bradshaw Army Airfield

4.6.2.2.1.1 No-action Alternative (Airspace—Bradshaw Army Airfield)

HRC Training—No-action Alternative

HRC training can include localized use of rotary wing aircraft within predefined areas for reconnaissance and survey inserts. Helicopter raids will involve approximately six helicopters over a 2- to 6-hour period; there will be less than six helicopter raids per year. Airspace use within the Bradshaw Army Airfield Class D airspace will be coordinated with the PTA Range Control, minimizing potential impacts on airspace users.

Major Exercises—No-action Alternative

Major Exercises such as RIMPAC include training as described above. Helicopter raids will involve approximately six helicopters over a 2- to 6-hour period. Airspace use within the

Bradshaw Army Airfield Class D airspace will be coordinated with the PTA Range Control. RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. The advanced planning and coordination with the FAA and Bradshaw Army Airfield regarding scheduling of special use airspace and coordination of Navy training relative to en route airways and jet routes result in minimal impacts on airspace from Major Exercises.

4.6.2.2.1.2 Alternative 1 (Airspace—Bradshaw Army Airfield)

Increased Tempo and Frequency of Training—Alternative 1

Increased training could result in minor additional use of rotary wing aircraft within predefined areas for reconnaissance and survey inserts. Helicopter raids will involve approximately six helicopters over a 2- to 6-hour period. Airspace use within the Bradshaw Army Airfield Class D airspace will be coordinated with the PTA Range Control, minimizing potential impacts on airspace users.

Major Exercises—Alternative 1

Major Exercises such as RIMPAC include training as described above. Helicopter raids will involve approximately six helicopters over a 2- to 6-hour period. Airspace use within the Bradshaw Army Airfield Class D airspace will be coordinated with the PTA Range Control. RIMPAC planning conferences, which include coordination with the FAA, are conducted beginning in March of the year prior to each RIMPAC. The advanced planning and coordination with the FAA and Bradshaw Army Airfield regarding scheduling of special use airspace and coordination of Navy training relative to en route airways and jet routes result in minimal impacts on airspace from Major Exercises.

4.6.2.2.1.3 Alternative 2 (Airspace—Bradshaw Army Airfield)

Increased Tempo and Frequency of Training—Alternative 2

Increased tempo and frequency of training could result in minor additional use of rotary wing aircraft within predefined areas for reconnaissance and survey inserts. Helicopter raids will involve approximately six helicopters over a 2- to 6-hour period. Airspace use within the Bradshaw Army Airfield Class D airspace will be coordinated with the PTA Range Control, minimizing potential impacts on airspace users.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

In addition to RIMPAC and USWEX, a Multiple Strike Group Major Exercise could include minor additional use of rotary wing aircraft within predefined areas for reconnaissance and survey inserts. Airspace use within the Bradshaw Army Airfield Class D airspace will be coordinated with the PTA Range Control. Advanced planning and coordination with the FAA and Bradshaw Army Airfield regarding the Multiple Carrier Strike Group and scheduling of special use airspace and coordination of Navy training relative to en route airways and jet routes result in minimal impacts on airspace from Major Exercises.

4.6.2.2.1.4 Alternative 3 (Airspace—Bradshaw Army Airfield)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on airspace under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.2.2 Biological Resources—Bradshaw Army Airfield

4.6.2.2.2.1 No-action Alternative (Biological Resources—Bradshaw Army Airfield)

Navy events at the site would be performed in accordance with all applicable biological opinions and existing Army regulations. The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

HRC Training and Major Exercises—No-action Alternative

Vegetation

Current use of the Bradshaw Army Airfield includes Command and Control, Aircraft Support Operations, and SPECWAROPS (generally helicopter raids and survey and reconnaissance insertions). These training events are limited in scope and are not anticipated to impact the areas beyond the airfield itself. All personnel entering Bradshaw Army Airfield will be briefed on the guidelines set forth in the PTA Ecosystem Management Plan. Adherence to these guidelines will limit the potential for introduction of invasive plant species and reduce any risk of fire or damage due to training.

Wildlife

Since the area has been cleared for the runway, only small mammals and birds are likely to be in the region of influence. Current training is limited in scope and is not anticipated to impact the areas beyond the airfield itself.

Aircraft Support Operations include space for various types or aircraft and equipment for refueling and maintenance. Air Operations are a part of daily and Major Exercises. These types of training events are part of the ongoing activities at Bradshaw and would result in potentially temporarily startling wildlife.

SPECWAROPS activities include special reconnaissance, reconnaissance and surveillance, combat search and rescue, and direct action. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access. The training event involves fewer than 20 troops and has minimal interaction with the environment, since one of the purposes of the training event is to operate undetected. During amphibious inserts the troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological resource areas are avoided by the SPECWAROPS troops. (U.S. Department of the Navy, 2002a)

Although the potential exists for transient threatened or endangered birds to be in the area, such occurrences are considered rare, especially at the airfield. Military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on the population of a migratory bird species. The low probability of one of the training events being capable of significantly impacting a population of the migratory species that occur in the Makua area should exempt the HRC from the take prohibitions. Compliance with the PTA INRMP and Ecosystem Management Plan during training and Major Exercises reduces the potential for adverse effects on wildlife.

Environmentally Sensitive Habitat

Critical habitat for the endangered palila established both north and southeast of Bradshaw Army Airfield will not be affected by training.

4.6.2.2.2.2 Alternative 1 (Biological Resources—Bradshaw Army Airfield)

Increased Tempo and Frequency of Training—Alternative 1

Alternative 1 (See Table 2.2.2.3-1) would not include an increase in training, but the tempo of training events may increase. The likelihood of a similar increase in adverse impacts on biological resources is small since the area has been cleared for the runway and only small mammals and birds are likely to be in the affected areas.

Vegetation

Training would continue to take place in current existing locations; no expansion of the area would be involved. Compliance with the PTA INRMP and Ecosystem Management Plan during increased training should minimize the effects on vegetation, as well as limit the potential for introduction of weed plant species. The risk of impacting threatened or endangered plants could be minimized by continuing to locate training away from areas with native, threatened, or endangered plant species whenever possible.

Wildlife

There is additional suitable habitat nearby for birds such as the endangered `io and nene to use if they temporarily leave the area affected by an increase in training. It is not likely that a bird or any other species of wildlife on Bradshaw Army Airfield would be injured or killed since compliance with the PTA INRMP and Ecosystem Management Plan help to reduce the potential for effects on wildlife. An increase in training is unlikely to adversely affect the long-term well-being, reproduction rates, or survival of these native or listed birds or other forms of wildlife in the area.

Environmentally Sensitive Habitat

The critical habitat established for the endangered palila is located outside the areas likely to be affected by the increased training.

4.6.2.2.2.3 Alternative 2 (Biological Resources—Bradshaw Army Airfield

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003d).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area once a year for up to 10 days per Major Exercise. The Major Exercises proposed would occur mainly in the open ocean and would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resources similar to those described above.

4.6.2.2.2.4 Alternative 3 (Biological Resources—Bradshaw Army Airfield

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.2.3 Cultural Resources—Bradshaw Army Airfield

4.6.2.2.3.1 No-action Alternative (Cultural Resources—Bradshaw Army Airfield)

HRC Training and Major Exercises—No-action Alternative

There are no training or Major Exercises actions with the potential to affect cultural resources at Bradshaw Army Airfield.

4.6.2.2.3.2 Alternative 1 (Cultural Resources—Bradshaw Army Airfield)

Increased Tempo and Frequency of Training—Alternative 1

For actions associated with Alternative 1, there is no training with the potential to affect cultural resources at Bradshaw Army Airfield.

HRC Enhancements—Alternative 1

Large Area Tracking Range Upgrade

Potential impacts on buildings and structures at Bradshaw Army Airfield are the same as described for PTA (see Section 4.6.2.1.3.2).

4.6.2.2.3.3 Alternative 2 (Cultural Resources—Bradshaw Army Airfield)

Increased Tempo and Frequency of Training—Alternative 2

There is no training with the potential to affect cultural resources at Bradshaw Army Airfield.

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

For actions associated with Alternative 2, there are no Major Exercises involving multiple Strike Group training with the potential to affect cultural resources at Bradshaw Army Airfield.

4.6.2.2.3.4 Alternative 3 (Cultural Resources—Bradshaw Army Airfield)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on cultural resources under Alternative 3 would be the same as those described for Alternative 2.

4.6.2.3 KAWAIHAE PIER

Table 4.6.2.3-1 lists ongoing training for the No-action Alternative and proposed training for Alternatives 1, 2, and 3 at Kawaihae Pier. Alternative 3 is the preferred alternative.

Table 4.6.2.3-1. Training at Kawaihae Pier

Training	
• Expeditionary Assault	• Special Warfare Operations (SPECWAROPS)

A review of the 13 resources against training from site activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 was performed for Kawaihae Pier. The following resources are not addressed because the proposed alternatives have no potential to adversely affect such resources: air quality, airspace, cultural resources, geology and soils, hazardous material and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

No air emissions would be generated from Kawaihae Pier training events unless use of diesel generators would be required for backup power. Use of Kawaihae Pier does not require control of the airspace above this land area. Kawaihae Pier has no prehistoric and historic artifacts, archaeological sites, historic buildings or structures, or traditional resources that could be affected by HRC training. Because no ground disturbance or building modifications would occur as a result of proposed training, there would be no impact on geology and soils.

Training associated with this site adhere to policies and regulations governing hazardous materials and waste, health and safety, and noise, as discussed in Appendix C. There are no concerns with noise as it relates to HRC training at Kawaihae Pier. There would be no impact on socioeconomics, transportation, utilities, and land use because the training population is transient, all services (food, transportation, lodging, fuel) are supplied by the military, and training sites remain the same for each alternative. Training would not generate any waste streams that could impact local water quality.

4.6.2.3.1 Biological Resources—Kawaihae Pier

4.6.2.3.1.1 No-action Alternative (Biological Resources—Kawaihae Pier)

HRC Training and Major Exercises—No-action Alternative

Vegetation

Amphibious landings are restricted to specific areas of designated beaches. The small beach area located immediately adjacent to the pier contains no vegetation. No threatened or endangered vegetation has been identified in the Kawaihae Harbor area (U.S. Department of the Navy, 2002a). Vehicles are restricted to existing roads, trails, and other disturbed areas and do not use undisturbed, off-road areas where they might harm vegetation. Expeditionary Assault landing personnel are briefed on existing procedures for entering the harbor and unloading equipment and supplies at the boat ramp. These procedures include inspections by appropriate Federal and/or State agencies of vehicles and equipment from foreign countries to prevent the introduction of invasive or alien species. A recycling wash rack is used to clean foreign country vehicles and equipment prior to back-loading to control the spread of alien species.

Wildlife

No threatened or endangered species have been identified in the Kawaihae Harbor area (U.S. Department of the Navy, 2002a). The potential for adverse effects on biological resources related to offloading and loading vehicles and equipment is minimal. These training events use existing ramps and a small open beach adjacent to the ramps. Reef or coral areas will be avoided. Expeditionary Assault landing personnel are briefed on existing procedures for entering the harbor and unloading equipment and supplies at the boat ramp. These procedures include inspections by appropriate Federal and/or State agencies of vehicles and equipment from foreign countries to prevent the introduction of alien species. A recycling wash rack is used to clean foreign country vehicles and equipment prior to back-loading to control the spread of alien species.

During SPECWAROPS, crews for amphibious inserts follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. Personnel review training overlays that identify the insertion points and any nearby restricted areas; sensitive biological resource areas are avoided.

Environmentally Sensitive Habitat

No critical habitat has been designated at Kawaihae Pier.

4.6.2.3.1.2 Alternative 1 (Biological Resources—Kawaihae Pier)

Increased Tempo and Frequency of Training and Major Exercises—Alternative 1

No increases in training and Major Exercises at Kawaihae Pier are expected. Impacts would be the same as those discussed above for the No-action Alternative.

4.6.2.3.1.3 Alternative 2 (Biological Resources—Kawaihae Pier)

Increased Tempo and Frequency of Training—Alternative 2

Under Alternative 2, the tempo of training would be increased and the frequency of training events could also increase. The intensity and duration of wildlife startle responses decrease with the number and frequency of exposures. The tendency of a bird to flush from a nest declines with habituation to the noise, although the startle response is not completely eliminated (U.S. Fish and Wildlife Service, 2003d).

Additional Major Exercises—Multiple Strike Group Training—Alternative 2

Up to three Strike Groups would visit the area once a year for up to 10 days per Major Exercise. The Major Exercises would occur mainly in the open ocean and would be similar to those occurring during RIMPAC and USWEX, with impacts on biological resource similar to those described above for the No-action Alternative.

4.6.2.3.1.4 Alternative 3 (Biological Resources—Kawaihae Pier)

The difference between Alternative 2 and Alternative 3 is the amount of MFA/HFA sonar usage. Alternative 3 would include all of the training associated with Alternative 2 (see Sections 2.2.4.1 and 2.2.4.3 through 2.2.4.7). As described under Alternative 2, Alternative 3 would provide increased flexibility in training activities by increasing the tempo and frequency of training events (Table 2.2.2.3-1), future and enhanced RDT&E activities (Table 2.2.2.5-1), and the addition of Major Exercises. Alternative 3 would consist of the MFA/HFA sonar usage as analyzed under the No-action Alternative. Effects on biological resources under Alternative 3 would be the same as those described for Alternative 2.

4.7 HAWAIIAN ISLANDS HUMPBACK WHALE NATIONAL MARINE SANCTUARY (HIHWNMS)

Military Activities in Hawaiian Waters

In 1995, the Navy prepared a document entitled "Report on Military Activities in Hawaiian Waters." The National Marine Fisheries Service (NMFS) concluded that Navy activities were "not likely to adversely affect" listed marine species, provided that the following modifications were made to Navy procedures:

1. All mine warfare and mine countermeasures involving the use of explosive charges or live munitions must include safe zones for marine mammals. These zones should be calculated for each training event based on charge type, charge weight, depth of water, and depth of the charge in the water column. Visual surveys by divers in the vicinity of the charge(s) and surveys by small boat(s) should be conducted in order to ensure that safe range minimum distances are appropriate; acoustic monitoring for marine mammals should also be conducted.
2. Shallow water submarine training around Maui, Molokai, Lanai, Kahoolawe, Oahu, and Kauai should be conducted with great care due to the increasingly dense populations of humpback whales during the winter reproductive season.
3. A sensor array capable of detecting vocalizing marine mammals should be put in place.
4. The Navy should consider shifting Prospective Submarine Commanding Officer training outside of the humpback whale season.

Measures Applicable to Hull-Mounted Surface and Submarine Active Sonar

1. Avoid critical habitats, marine sanctuaries, and the Humpback Whale Sanctuary.
2. Surface vessels only: Use observers to visually survey for and avoid operating active sonar when sea turtles and/or marine mammals are observed. Submarines and surface units: Monitor acoustic detection devices for indications of close aboard marine mammals (high bearing rate biological contacts). When a surface combatant or a submarine conducting active sonar training detects a marine mammal close aboard, reduce maximum sonar transmission level to avoid harassment in accordance with the following specific actions.

    a. When marine mammals are detected by any means (aircraft, observer, or aurally) within 600 feet (ft) of the sonar dome, the ship or submarine will limit active transmission levels to at least 4 decibels (dB) below their equipment maximum for sector search modes.

    b. Ship and submarines will continue to limit maximum transmission levels by this 4-dB factor until they determine the marine mammal is no longer within 600 ft of the sonar dome.

    c. Should the marine mammal be detected closing to inside 300 ft of the sonar dome, the principal risk to the mammal changes from acoustic harassment to one of potential physical injury from collision. Accordingly, ships and submarines shall maneuver to avoid collision. Standard whale strike avoidance procedures apply.

d. When seals are detected by any means within 1,050 ft of the sonar dome, the ship or submarine shall limit active transmission levels to at least 4 dB below equipment maximum for sector search mode. Ships or submarines shall continue to limit maximum ping levels by this 4-dB factor until the ships and submarines determine that the seal is no longer within 1,050 ft of the sonar dome.

4.7.1 BIOLOGICAL RESOURCES—HIHWNMS

Appendix C contains as Exhibit C-1, Appendix F of the 1997 HIHWNMS Final Environmental Impact Statement (EIS)/Management Plan, which lists military activities in Hawaii that had been or were being conducted before the effective date of the regulations (final rule published in November 1999). If the military activity is proposed after the official date of the regulations, then the activity is also an allowable activity but subject to prohibited activities provision under 15 CFR §922.184 (that is, distance restrictions on vessel and aircraft approaches to humpback whales, discharge of materials prohibitions, and prohibitions on the taking or possessing of humpback whales) unless the military activities are not subject to consultation (not likely to destroy, cause the loss of, or injure any sanctuary resource). For any military activity that is subsequently modified in a way that causes the activity to be “likely to destroy, cause the loss of, or injure a Sanctuary resource in a <u>manner significantly greater</u> than was considered in previous consultation” then the activity is treated as a new military activity for which consultation may be necessary.

Based on a review of these listed activities, no new activities are being proposed by the Navy in the HRC within the Sanctuary boundaries that were not previously reviewed, and further these activities do not have “a significantly greater” chance of causing destruction or injury to sanctuary resources than was considered in previous consultations. Activities and their potential for impacts on biological resources are discussed below for each applicable island.

4.7.1.1 KAUAI—BIOLOGICAL RESOURCES—HIHWNMS

Few training or research, development, test, and evaluation (RDT&E) activities occur in the area north of Kauai originally included in the Sanctuary. Warning Areas W-186 and W-188 airspace over the Open Ocean is outside the Sanctuary boundary. The Warning Areas are used for missile, bomb, and gunnery training events. Air, surface, and underwater training events are conducted in the surface area of W-186 and W-188. Activities that occur within sanctuary waters would continue to follow all applicable procedures such as using observers to visually survey for and thus avoid humpbacks and other whales.

The HIHWNMS EIS/Management Plan (U.S. Department of Commerce, National Oceanic and Atmospheric Administration and State of Hawaii, Office of Planning, 1997) recognizes that the Pacific Missile Range Facility (PMRF) plays an important role in national defense training. The EIS includes missile launches as one of the DoD activities that currently occur within the sanctuary boundaries. The proposed launches would have impacts within the parameters of ongoing missile programs.

4.7.1.2 OAHU—BIOLOGICAL RESOURCES—HIHWNMS

No current or planned HRC activities are/would be performed within the Sanctuary's boundaries. Transiting military vessels continue to follow all applicable procedures such as using observers to visually survey for and thus avoid humpbacks and other whales.

4.7.1.3 MAUI—BIOLOGICAL RESOURCES—HIHWNMS

The waters inside the 100-fathom isobath surrounding Maui, Molokai, and Lanai, and specifically the channel between these islands, would continue to be used for biennial Rim of the Pacific Exercises, including Explosive Ordnance Disposal and Mine Countermeasures training, as well as shallow-water ASW. Training and RDT&E activities would continue to follow the applicable measures listed above.

4.7.1.4 HAWAII—BIOLOGICAL RESOURCES—HIHWNMS

Although the Kawaihae Pier area is not included within the HIHWMNS located off the northwestern shore of Hawaii, Army, and Marine Corps helicopter training regularly occur over the area within the Sanctuary boundary. Navy and Army landing craft frequently offload and load supplies and equipment at Kawaihae Pier in support of military training at Pohakuloa Training Area. HRC training will continue as approved military actions in the HIHWNMS EIS/Management Plan.

4.8 CONFLICTS WITH FEDERAL, STATE, AND LOCAL LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AREA CONCERNED

Based on an evaluation of consistency with statutory obligations, the Navy's proposed training and RDT&E activities for the HRC do not conflict with the objectives or requirements of Federal, State, regional, or local plans, policies, or legal requirements. The proposed training and RDT&E activities would not alter the use of the sites that currently support missile and rocket testing. Enhancement of the HRC would be in accordance with applicable Federal, State, and local planning plans and policies. The DoD maintains Federal jurisdiction for on-installation land use. Table 4.8-1 provides a summary of environmental compliance requirements that may apply to the proposed training and RDT&E activities.

Table 4.8-1. Summary of Environmental Compliance Requirements

Plans, Policies, and Statutory Requirements	Responsible Agency	Compliance Status
National Environmental Policy Act (NEPA) (42 U.S.C. § 4321, et seq.) Department of the Navy Procedures for Implementing NEPA (OPNAVINST 5090.1B, February 1998)	U.S. Navy	This Environmental Impact Statement and Overseas Environmental Impact Statement (EIS/OEIS) has been prepared in accordance with Council on Environmental Quality regulations (40 Code of Federal Regulations [CFR] § 1500-1508) and Navy NEPA procedures. Public participation and review is being conducted in compliance with the NEPA statute.
Endangered Species Act (16 U.S.C. § 1531) Marine Mammal Protection Act (16 CFR § 1431 et seq.) Magnuson-Stevens Fishery Conservation & Management Act, 16 USC Section 1801-1882	U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS)	Effects on listed species are the subject of consultations with USFWS and NMFS. The Navy prepared an essential fish habitat assessment and concluded no adverse effect.
Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 et seq.; 48 Stat. 401	USFWS	The Act authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with Federal and State agencies to protect fish and wildlife. Effects on fish and wildlife are analyzed in the EIS/OEIS.
Clean Water Act Section 401/402 (§§ 4101-402, 33 U.S.C. § 1251 et seq.) Section 404 (§ 404, 33 U.S.C. § 1251 et seq.)	U.S. Environmental Protection Agency (USEPA) and U.S. Army Corps of Engineers (USACE)	The proposed training and RDT&E activities would not discharge dredged or fill material. Discharges into the water will not result in contaminant concentrations above regulatory standards.
Rivers and Harbors Act (33 U.S.C. § 401 et seq.)	USACE	A Section 10 permit in accordance with the Rivers and Harbors Act may be required.
Clean Air Act (CAA) (42 U.S.C. § 7401 et seq.)	USEPA	The proposed training and RDT&E activities would not compromise the air quality in Hawaii.

Table 4.8-1. Summary of Environmental Compliance Requirements (Continued)

Plans, Policies, and Statutory Requirements	Responsible Agency	Compliance Status
National Marine Sanctuaries Act	National Oceanic and Atmospheric Administration	No new consultation requirement; all activities previously reviewed; not a significantly greater chance of destruction or injury to sanctuary resources
National Historic Preservation Act (NHPA) (16 U.S.C. 470 et seq.)	Advisory Council on Historic Preservation, Hawaii State Historic Preservation Officer	No new consultation requirement; all activities previously reviewed.
Coastal Zone Management Act (CZMA) (16 CFR § 1451, et seq.)	Hawaii Coastal Zone Management Program	The Navy has made a Coastal Consistency Determination in accordance with the CZMA.
Executive Order (EO) 12114 Environmental Effects Abroad of Major Federal Actions	U.S. Navy	EO 12114 requires environmental consideration for actions that may affect the environment outside of U.S. Territorial Waters. This EIS/OEIS satisfies the requirement of EO 12114.
Presidential Proclamation 8031 Establishment of Northwestern Hawaiian Islands Marine National Monument, now called Papahānaumokuākea Marine National Monument	U.S. Navy	Activities and training of the Armed Forces will be carried out in a manner that avoids, to the extent practicable and consistent with operational requirements, adverse impacts on monument resources and qualities; these activities and training are exempt from the proclamation's prohibitions.
EO 13089 Coral Reef Protection	U.S. Navy	Coral reef ecosystems are identified and avoided in accordance with the Department of Defense Coral Reef Protection Implementation Plan.
EO 13112 Invasive Species	U.S. Navy	EO 13112 requires Agencies to identify actions that may affect the status of invasive species and take measures to avoid introduction and spread of these species. This EIS/OEIS satisfies the requirement of EO 13112 with regard to the proposed training and RDT&E activities.
EO 11990 Protection of Wetlands	U.S. Navy	The proposed training and RDT&E activities would not have a significant impact on wetlands.
EO 12962 Recreational Fisheries	U.S. Navy	EO 12962 requires Agencies to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas. The proposed training and RDT&E activities do not have a significant impact on Navy actions in support of this EO.
EO 12898, Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations	U.S. Navy	The proposed training and RDT&E activities would not disproportionately affect minority or low-income populations.
EO 13045, Protection of Children from Environmental Health and Safety Risks	U.S. Navy	The proposed training and RDT&E activities would not disproportionately affect children.

4.9 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

The proposed training and RDT&E activities include increased training and testing events in the HRC. In order to implement the proposed training and RDT&E activities, increased amounts of fossil fuels would be required to power the increased use by ships and aircraft. These fuels are currently in adequate supply from either Navy-owned sources or from commercial distributors. The required electricity demands would be met by the existing electrical generation infrastructure on the Hawaiian Islands.

Anticipated energy requirements of the continued use and enhancement of the HRC would be well within the energy supply capacity of all facilities. Energy requirements would be subject to any established energy conservation practices at each facility. No additional power generation capacity other than the potential use of generators would be required for any of the training and RDT&E activities. In conjunction with EO 13423, *Strengthening Federal Environmental, Energy and Transportation Management,* the use of energy sources has been minimized wherever possible without compromising safety, training, or testing. No additional conservation measures related to direct energy consumption by the proposed training and RDT&E activities are identified.

4.10 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

Resources that are irreversibly or irretrievably committed to a project are those that are used on a long-term or permanent basis. This includes the use of nonrenewable resources such as fuels. Human labor is also considered a nonrenewable resource. Use of these resources is considered irreversible or irretrievable since they would be committed to the proposed training and RDT&E activities and would not be available for other purposes. Furthermore, unavoidable destruction of natural resources as a result of the proposed training and RDT&E events is considered an irreversible or irretrievable commitment of resources if the potential uses of these resources become limited.

The proposed training and RDT&E activities would have an irreversible or irretrievable effect due to the use of nonrenewable energy sources: hydrocarbon fuels for aircraft, vessels, and vehicles. However, the costs of fuel and the climatic consequences of large scale combustion of hydrocarbon fuel are not any less significant for alternative training scenarios. Implementation of the proposed training and RDT&E activities would not result in the destruction of environmental resources so as to cause the potential uses of the environment of the HRC to be limited. The proposed training and RDT&E activities would not adversely affect the biodiversity or cultural integrity within the HRC including the marine, terrestrial, or human environment.

4.11 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The National Environmental Policy Act (NEPA) requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource.

The proposed training and RDT&E activities would result in both short- and long-term environmental effects. The Navy is committed to sustainable range management, including co-use of the HRC with the general public and commercial interests. This commitment to co-use will enhance the long-term productivity of the range areas and surrounding areas.

4.12 FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS (EXECUTIVE ORDER 12898)

An Environmental Justice analysis is included in this document to comply with the intent of Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* Navy, and Department of Defense guidance. The EO states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." In addition, the EO requires that minority and low-income populations be given access to information and opportunities to provide input to decision-making on Federal actions.

As described in Chapter 1.0, scoping is an early and open process for developing the "scope" of issues to be addressed in the EIS and for identifying significant issues related to a proposed action. During scoping, the public helps define and prioritize issues and convey these issues to the agency through both oral and written comments. Four scoping meetings were held on the islands of Maui, Oahu, Hawaii, and Kauai, respectively. The scoping meetings were held in an open house format, presenting informational posters and written information, and making Navy staff and project experts available to answer participants' questions. The public also had an additional opportunity to review the proposed actions during their review of the Draft EIS/OEIS.

The Navy has evaluated training, RDT&E activities and proposed enhancements in the HRC, specifically related to the islands that could potentially be affected by HRC training and RDT&E activities, due to the nature of the activities proposed on and around the islands. Training and RDT&E activities occur in the open ocean, offshore, and within existing Navy, Army, or Marine Corps installations boundaries generally away from population centers. No expansion of the area encompassed within the HRC is planned. In addition, there would be no displacement of persons associated with training, RDT&E activities and proposed HRC enhancements.

The percentage of minority or low-income population in the census area exceeds 50 percent (see Table 4.12-1); and thus the proposed training and RDT&E activities need to comply with EO 12898. Demographics of the population of Kauai and Oahu in 2000 were previously presented in Table 3.3.2.1.10-1 and Table 3.4.2.1.3-1, respectively.

Table 4.12-1. Population and Ethnicity for the State of Hawaii

Geographic Area	Total Population	Race								
		Total	White	Black or African American	American Indian	Asian	Native Hawaiian	Some Other Race	Two or More Races	Hispanic or Latino (of Any Race)
Hawaii	1,211,537	952,194	294,102	22,003	3,535	503,868	113,539	15,147	59,343	87,699
County										
Hawaii	148,677	106,389	46,904	698	666	39,702	16,724	1,695	42,288	14,111
Honolulu	876,156	710,532	186,484	20,619	2,178	403,371	77,680	11,200	74,624	58,729
Kalawao	147	138	38	0	0	25	71	4	9	6
Kauai	58,463	44,525	17,255	177	212	21,042	5,334	505	13,938	4,803
Maui	128,094	99,610	43,421	509	479	39,728	13,730	1,743	28,484	10,050

Source: U.S. Census Bureau, 2000a

According to Council on Environmental Quality environmental justice guidance under NEPA, agencies should consider three factors when determining whether human health effects are disproportionately high and adverse:

- Whether the health effects (bodily impairment, infirmity, illness, or death) are significant, according to NEPA, or above generally accepted norms
- Whether the risk or rate of exposure to an environmental hazard by a minority or low-income population is significant under NEPA and appreciably exceeds or is likely to appreciably exceed that of the general population or appropriate comparison group
- Whether health effects occur in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards

The following factors should be considered when determining whether environmental effects are disproportionately high and adverse:

- Whether there is or will be an impact on the natural or physical environment (ecological, cultural, human health, economic, or social) that significantly, under NEPA, and adversely affects a minority or low-income population that appreciably exceeds or is likely to appreciably exceed that of the general population or appropriate comparison group

- Whether environmental effects are significant, under NEPA, and are or may be having an adverse impact on minority or low-income populations
- Whether environmental effects occur or would occur in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards

The following discussion provides an analysis of environmental justice concerns grouped into the following resource categories: air quality, airspace, biological resources, cultural resources, geology and soils, hazardous materials and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources. In accordance with the requirements of EO 12898, the Navy has determined that proposed training, RDT&E activities and HRC enhancements would not result in disproportionately high and adverse environmental or health impacts on minority or low-income populations. There would be no direct or indirect environmental, cultural, health, or economic impacts specific to any groups from minority or low-income populations nor have any such effects been identified in this EIS/OEIS. Therefore, there would be no impacts related to Environmental Justice under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 as described below.

4.12.1 AIR QUALITY

Environmental justice concerns associated with air quality would occur if the current air quality attainment status would change as a result of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 or if air emissions exceed a health-based standard in a minority or low-income area. Results of analysis conducted for HRC activities determined that there would be no change to the current attainment status and no health-based air quality standards would be exceeded in minority or low-income neighborhoods.

4.12.2 AIRSPACE

Environmental justice concerns associated with airspace would occur if modifications or a need for additional airspace is required as a result of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 or significant (under NEPA) impacts on commercial airspace use were determined in a minority or low-income area. Results of analysis conducted for HRC activities determined that there would be no modifications or need for additional airspace and no significant impacts on commercial airspace use in minority or low-income neighborhoods.

4.12.3 BIOLOGICAL RESOURCES

Environmental justice concerns associated with biological resources would occur if local subsistence food sources (e.g., fish) would be adversely impacted by the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3. Although some fish may be injured or killed, as discussed under the biological resources sections, vegetation and wildlife are not anticipated to be significantly (under NEPA) impacted by current or proposed HRC activities.

4.12.4 CULTURAL RESOURCES

Environmental justice concerns associated with cultural resources would occur if traditional resources or properties to which religious and cultural significance is attached are impacted as a result of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3. Although access to some traditional resource areas may be denied during current or proposed HRC activities for safety reasons, this would only be temporary. The Navy would consult with the State Historic Preservation Officer (SHPO) and the Office of Hawaiian Affairs prior to any construction.

4.12.5 GEOLOGY AND SOILS

Environmental justice concerns associated with impacts on geology and soils would occur from construction-related ground disturbance and the potential for soil contamination. No minority or low-income populations are located within the areas proposed for construction. The potential for minority or low-income populations to come in contact with soil (beach) that could be affected by missile emissions and hazardous materials does exist. However, any spill or terminated flight debris would be quickly remediated to prevent any soil contamination.

4.12.6 HAZARDOUS MATERIALS AND WASTE

Environmental justice concerns associated with hazardous materials and waste as a result of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 would occur if minority or low-income populations were to be exposed. All hazardous materials used and hazardous waste generated would be conducted in accordance with Federal and State regulations. There are no minority or low-income populations residing adjacent to where most of the hazardous materials and waste activities would occur. Any hazardous materials that would result from an early missile flight termination would be cleared from the ground hazard area, and any contamination would be remediated.

4.12.7 HEALTH AND SAFETY

Environmental justice concerns associated with health and safety would occur if the risk or rate of exposure to an environmental hazard by a minority or low-income population is significant under NEPA and appreciably exceeds or is likely to appreciably exceed that of the general population or appropriate comparison group. As addressed in the health and safety sections, there are minimal health and safety risks associated with the No-action Alternative, Alternative 1 Alternative 2, or Alternative 3. Transportation of hazardous materials would follow all applicable Federal and State regulations. Some minority and low-income populations do use the ocean adjacent to the military installations where training and RDT&E activities occur. Navy, Army, and Marine Corps personnel take every reasonable precaution during planning and execution of training and RDT&E activities to prevent injury to human life or property. Specific safety plans have been developed to ensure that each training event is in compliance with applicable policy and regulations, and to ensure that the general public and range personnel and assets are provided an acceptable level of safety.

Missile launches by their very nature involve some degree of risk, and it is for this reason that DoD and PMRF have specific launch and range safety policies and procedures to ensure that any potential risk to the public and government assets (launch support facilities) is minimized. Applicable State and Federal regulations and range safety plans and procedures are followed in transporting and handling potentially explosive ordnance and hazardous materials. Missile components, including any propellant, are transported in Department of Transportation and military designed and approved shipping containers. An explosive safety quantity-distance (ESQD) surrounding the missile launcher is calculated based on the equivalent explosive force of all propellant and pyrotechnic materials contained on the flight vehicle. All potentially hazardous debris resulting from an accident on the launcher will be contained entirely within the ESQD, which will already have been cleared of unprotected personnel. To protect people from injury from either nominal launches or accidents, two primary mitigation measures are in place: flight termination and clearance of specified regions. Clearance areas include the ground hazard area for land areas, Ship Exclusion Zones for ocean areas, and Restricted Airspace and Altitude Reservations for airspace.

Prior to each mission, the PMRF Flight Safety Office performs a comprehensive analysis of the proposed mission, including flight plans, planned impact areas, vehicle response to malfunctions, and effects of flight termination action. A probabilistic analysis is performed with sufficient conservative assumptions incorporated to ensure that the risks from the mission are acceptable. These acceptable risk criteria are designed to ensure that the risk to the public from range activities is lower than the average background risk for other third-party activities (for example, the risk of a person on the ground being injured from an airplane crash).

Range safety would be responsible for ensuring the safe usage of the proposed laser systems on the PMRF range. Range safety would require the proposed high-energy laser program to provide specific information about the proposed usage so that a safety analysis of all types of hazards could be completed and appropriate remedial procedures would be taken before initiation of potentially hazardous laser activities.

4.12.8 LAND USE

The potential impacts on land use from the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 would occur from the addition of new facilities, potential incompatible land uses, and restriction of access to popular beach, fishing, and hunting areas. All of the activities within the HRC occur adjacent to compatible land uses. There are no residential land use areas that would be affected by current or proposed activities. However, minority and low-income populations do use the ocean adjacent to the islands for subsistence fishing, and hunt near some of the support sites. Residents place a high value on traditional fishing and gathering activities and on Hawaiian customs and practices. The availability of an alternate source of food gives residents a sense of self-sufficiency and freedom and reduces dependence on a cash economy. Subsistence activities, therefore, are important in supplementing relatively low family incomes, as well as maintaining the preferred lifestyle of community.

As discussed under the land use sections, access to some of the beaches adjacent to the military installations within the HRC for fishing is allowed and some of these areas would be restricted during hazardous activities. Other areas within the HRC would be available for use. Advance notification is provided of closure times (through a 24-hour hotline at PMRF), so minimal impacts on subsistence fishing are expected. Closure of the southern portion of Polihale State Park on Kauai would occur no more than 30 minutes per launch or up to 15 hours total per year and would only affect the southern end of the park, which in turn would only affect the ability of minority and low-income populations to subsistence fish for short periods during the year.

4.12.9 NOISE

Environmental justice concerns associated with noise would occur if the risk or rate of exposure to a noise level by a minority or low-income population that exceeds DoD or the Occupational Safety and Health Administration (OSHA) safety requirements outside of areas where the public is excluded. Construction related noise on PMRF would be temporary in nature and would only affect a very limited area. Construction related noise would not impact any minority or low-income residential areas on the island.

Launch related noise may be quite high under the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3. However, none of the noise levels would exceed either DoD or OSHA safety requirements outside of the ground hazard area where non-essential personnel and the public are excluded (during launches). Personnel within the ground hazard area would wear hearing protection devices. Noise levels from launches from the southern end of PMRF may startle, awaken, or distract low-income and minority neighborhoods in the town of Kekaha. However, the number of launches from southern PMRF would be infrequent, with most occurring on the northern end of the island. Other noise generating activities within the HRC would occur near the source and are not expected to significantly (under NEPA) impact any minority or low-income areas.

4.12.10 SOCIOECONOMICS

As discussed under the socioeconomic sections, the activities under the No-action Alternative, Alternative 1, Alternative 2, and Alternative 3 would provide an economic benefit to the islands affected by HRC training and RDT&E activities. The opportunities and economic benefit provided help support all industries on the islands and assist both minority and low-income populations. The potential restriction of areas used for commercial fishing and tourist related industries does not affect those industries. Potential impacts on subsistence fishing and gathering activities is addressed above under land use.

4.12.11 TRANSPORTATION

Environmental justice concerns associated with transportation would occur if adverse impacts on the transportation systems used by a minority or low-income population is significant under NEPA and appreciably exceed or are likely to appreciably exceed that of the general population or appropriate comparison group. As addressed in the transportation sections, during activities, the potential for range users would vary from small teams working for 3 to 6 months to as many as 300 individuals visiting for 1 to 2 days to witness and participate in a specific mission. The amount of traffic on the main island highways and potentially other local roadways could be temporarily affected during these training and RDT&E activities. Overall, the effect on roadways would be temporary and the effect on roadways from enhanced RTD&E events would also be temporary and only occur during the time the activity is being conducted.

4.12.12 UTILITIES

The increase on utilities demand would occur during the training and RDT&E activities, which are discrete and intermittent. These increases would be within the available capacity of island utility systems with no effect on minority or low-income populations. The current power supply from Kauai Island Utility Cooperative is sufficient to support the new Range Operations Control

Building and associated building conversions or relocations proposed for PMRF. Domestic waterlines would be added on PMRF to accommodate increases in demand, and the wastewater treatment system would be constructed and connected to the current system.

4.12.13 WATER RESOURCES

Environmental justice concerns associated with water resources would occur if adverse impacts on water quality used by a minority or low-income population are significant under NEPA and appreciably exceed or are likely to appreciably exceed that of the general population or appropriate comparison group. Analysis of launch-related impacts is covered in the Strategic Target System EIS (U.S. Army Strategic Defense Command, 1992), which evaluated the potential impacts of launch emissions, spills of toxic materials, and early flight termination. The analysis concluded that hydrogen chloride emissions would not significantly affect the chemical composition of surface or groundwater; that there would be no significant increase in aluminum oxide in surface waters due to launches; that sampling of surface waters in the vicinity of the launch site showed that hydrogen chloride, potentially deposited during past launches, has not affected surface water quality on PMRF or adjacent areas; and that contamination from spills of toxic materials will be highly unlikely. Subsequent sampling and analysis, prior to and following a 26 February 1993 Strategic Target System target launch, showed little or no evidence that the launch produced any adverse impact on water, soil, or vegetation (U.S. Army Space and Strategic Defense Command, 1993b). As described in Chapter 3.0, sampling for perchlorate was conducted at PMRF in October and November 2006 and the results indicated perchlorate levels were within guidelines. Therefore, HRC RDT&E activities are not expected to affect water resources used by minority or low-income populations.

Based on the estimated total concentrations of munitions constituents dissolved in rainwater migrating from the EOD Land Range on Oahu, their contribution to concentrations of water pollutants in Pearl Harbor will be negligible. These inputs would be periodic, and tidal flushing would further substantially disperse and dilute them. Thus, these intermittent, short-term discharges of very small amounts of munitions constituents into surface waters will have no effect on water resources.

4.13 FEDERAL ACTIONS TO ADDRESS PROTECTION OF CHILDREN FROM ENVIRONMENTAL HEALTH RISKS AND SAFETY RISKS (EXECUTIVE ORDER 13045, AS AMENDED BY EXECUTIVE ORDER 13229)

Since the majority of training and RDT&E activities, as part of continued use and enhancement of the HRC, would be conducted on DoD property and out in the open ocean, this EIS/OEIS has not identified any environmental health and safety risks that may disproportionately affect children.

4.14 HAWAII’S COASTAL ZONE MANAGEMENT PROGRAM

The Navy has requested a review and concurrence from Hawaii’s Coastal Zone Management Program on the Navy’s consistency determination based on an assessment provided in the July 2007 HRC Draft EIS/OEIS and the February 2008 HRC Supplement to the Draft EIS/OEIS. The Navy has determined, based on information provided in those documents and in light of the applicable enforceable policies of Hawaii’s Coastal Zone Management Program, that there are no adverse direct or indirect (cumulative or secondary) effects on coastal uses or resources. Further, the Proposed Action and its Alternatives are consistent, to the maximum extent practicable, with the enforceable policies of Hawaii’s approved Coastal Zone Management Program.

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 Cumulative Impacts

5.0 CUMULATIVE IMPACTS

5.1 REQUIREMENT FOR CUMULATIVE IMPACT ANALYSIS

The National Environmental Policy Act (NEPA) requires an assessment of cumulative impacts arising from the Proposed Action and alternatives. The Council on Environmental Quality (CEQ) regulations define "cumulative effects" as:

". . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 Code of Federal Regulations [CFR] 1508.7).

The contribution of a Proposed Action to the overall impacts in a region of influence is of particular concern. While a single project may have individually minor impacts, when it is considered together with other projects on a regional scale, the effect may be collectively significant. A cumulative impact is the additive effect of all projects in the geographic area.

CEQ provides guidance on cumulative impacts analysis in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). This guidance further identifies cumulative effects as those environmental effects resulting "from spatial and temporal crowding of environmental perturbations. The effects of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the effects of the first perturbation." Noting that environmental impacts result from a diversity of sources and processes, this CEQ guidance observes that "no universally accepted framework for cumulative effects analysis exists," while noting that certain general principles have gained acceptance. One such principal provides that "cumulative effects analysis should be conducted within the context of resource, ecosystem, and community thresholds—levels of stress beyond which the desired condition degrades." Thus, "each resource, ecosystem, and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters." Therefore, cumulative effects analysis normally will encompass geographic boundaries beyond the immediate area of the Proposed Action, and a time frame including past actions and foreseeable future actions, in order to capture these additional effects. Bounding the cumulative effects analysis is a complex undertaking, appropriately limited by practical considerations. Thus, CEQ guidelines observe, "[i]t is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful."

5.2 APPROACH

This Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) will analyze the cumulative environmental effects of the Proposed Action and Alternatives by considering the following criteria:

- The area in which the effects of the proposed project will be felt;
- The impacts that are expected in the area from the proposed project;
- Other actions, past, present and reasonably foreseeable that have had or are expected to have impacts in the same area;
- The impacts or expected impacts from these other actions; and
- -The overall impact that can be expected if the individual impacts are allowed to accumulate.

For the purposes of determining cumulative effects in this chapter, the Navy reviewed environmental documentation regarding known current and past Federal and non-Federal actions associated with the resources analyzed in Chapter 4.0. Additionally, projects in the planning phase were considered, including reasonably foreseeable (rather than speculative) actions that have the potential to interact with the proposed Navy action. The level of information available for different projects varies. The best available science is used in this analysis.

5.3 GEOGRAPHIC BOUNDARIES FOR CUMULATIVE ANALYSIS

Geographic boundaries for analyses of cumulative impacts in this EIS/OEIS vary for different resources and environmental media. For air quality, the potentially affected air quality regions are the appropriate boundaries for assessment of cumulative impacts from releases of pollutants into the atmosphere. For wide-ranging or migratory wildlife, specifically marine mammals and sea turtles, any impacts from the Proposed Action or alternatives might combine with impacts from other sources within the range of the population. Therefore, identification of impacts elsewhere in the range of a potentially affected population is appropriate. For terrestrial biological resources, the Hawaiian Islands is the appropriate geographical area for assessing cumulative impacts. For all other ocean resources, the ocean ecosystem of the central North Pacific Ocean is the appropriate geographic area for analysis of cumulative impacts. The Table 5.3-1 identifies the geographic scope of this cumulative impacts analysis, by resource area.

Table 5.3-1. Geographic Areas for Cumulative Impacts Analysis

Resource	Area for Impacts Analysis
Air Quality	Kauai
Airspace	Central North Pacific Ocean
Marine Biological Resources	Central North Pacific Ocean
Terrestrial Biological Resources	Hawaiian Islands
Cultural Resources	HRC OPAREA, Kauai, Oahu, and Hawaii
Geology and Soils	Kauai, Oahu
Hazardous Materials & Wastes	HRC OPAREA, Kauai, and Oahu
Health and Safety	HRC OPAREA, Kauai, Oahu, and Hawaii
Land Use	Kauai
Noise	HRC OPAREA, Kauai, Oahu, and Hawaii
Socioeconomics	Kauai, Oahu
Transportation	Kauai
Utilities	Kauai
Water Resources	HRC OPAREA, Kauai, and Oahu,

5.4 OTHER PROJECTS AND ACTIVITIES ANALYZED FOR CUMULATIVE IMPACTS

5.4.1 OTHER PROJECTS

Past, present, and reasonably foreseeable actions in the cumulative effects region or region of influence are summarized in Table 5.4.1-1. The following represents a list of past, present, and planned projects with the potential to interact with each of the project alternatives but which are neither dependent on nor part of the Proposed Action.

Table 5.4.1-1. Cumulative Projects List

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
U.S. Fish and Wildlife Service (USFWS) Plant Critical Habitat	Oahu	USFWS	Protection of habitat for federally designated threatened and endangered plants.	Ongoing	Beneficial	Terrestrial
Prescribed Burns at Makua Military Reservation (MMR)	MMR	U.S. Army	Prescribed burns conducted to reduce fuel load at MMR and to facilitate unexploded ordnance (UXO) clearance and surveys for cultural resources.	2002, 2003, and ongoing	Additive	Terrestrial
Stryker Brigade Combat Team Transformation	Oahu and Hawaii	U.S. Army	Multiple construction projects and land acquisitions for converting the 2nd Brigade of the 25th ID(L) into a Stryker Brigade Combat Team.	Unknown; all construction to commence by 2008	Additive	Terrestrial
Prescribed Burns at Army Installations on Oahu (other than MMR)	Oahu	U.S. Army	Prescribed burn to reduce fuel load at ranges. This also facilitates UXO clearance and surveys for cultural resources.	2003 and ongoing	Additive	Terrestrial
Kahuku Windmill and Hook Parcels Land Acquisition	Kahuku Training Area (KTA)	U.S. Army	Purchase adjacent lands for Current Forces training.	2003	Neutral	Terrestrial
Turtle Bay Resort Improvements	KTA	Turtle Bay Resort	Hotel expansion and renovations.	2004	Neutral	Terrestrial
Residential Communities Initiative	Army Bases on Oahu	U.S. Army	The Army plans to turn over approximately 8,300 units of housing on Oahu to a private developer for redevelopment and operation for 50 years.	2004-2054	Neutral	Terrestrial
Farrington Highway Improvements	Mākaha (near MMR)	State of Hawaii	Construct safety and operation improvements for Farrington Highway, including sidewalks, signalized pedestrian crosswalk or bridges, and continuous left turn fences.	Funded through 2004	Additive	Terrestrial
Farrington Highway, Replacement of Mākaha Bridges 3 and 3A	Mākaha (near MMR)	State of Hawaii	Replace two timber bridges in the vicinity of Mākaha Beach Park.	Funded through 2004	Neutral	Terrestrial
Integrated Training Area Management (ITAM)	All Oahu ranges	U.S. Army	The intent of the ITAM program is to systematically provide uniform training land management capability across U.S. Army, Hawaii (USARHAW) and to ensure that the carrying capacity of the training lands is maintained over time.	Ongoing	Beneficial	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Implementation of the Integrated Natural Resources Management Plan (INRMP)	Oahu	U.S. Army	The INRMP "preserves, protects and enhances natural and cultural resources and complies with all applicable laws and regulations, while improving the Army's capability to conduct training and maintain military readiness."	Not all projects funded. Plan covers 2002-2006	Beneficial	Terrestrial
Implementation of the Integrated Cultural Resource Management Plan (ICRMP)	Oahu	U.S. Army	The intent of the ICRMP is to preserve, protect, and enhance cultural resources; it complies with all applicable laws and regulations, while improving the Army's capability to conduct training and maintain military readiness.	Ongoing	Beneficial	Terrestrial
Implementation of Proposed Range and Training Land Program Development Plan Actions	Oahu	U.S. Army	A planning document for managing range facilities and training areas based on Army training doctrine and resource guidance.	Ongoing	Beneficial	Terrestrial
Installation Information Infrastructure Architecture (I3A)	Schofield Barracks Military Reservation (SBMR) - Main Post; Wheeler Army Airfield (WAAF)	U.S. Army	Install fiber optic cables from the cantonment area to the ranges, motor pool, and other facilities within the installation.	2004	Additive	Terrestrial
Drum Road Upgrade	Helemano Military Reservation (HMR) to KTA	U.S. Army	Align, widen, and harden approximately 23 miles (37 kilometers) of the dirt and gravel road that runs from the end of the paved road at HMR to the end of the paved road at KTA. Road upgrade done to accommodate Current Forces training.	2005/2006	Additive	Terrestrial
Residential Development	Wai`anae	Not available (N/A)	Constructed 7 housing units.	2001/2002	Additive	Terrestrial
Residential Development	Wai`anae	N/A	Construct 1,504 housing units.	2002 and beyond	Additive	Terrestrial
Residential Development	Ewa	N/A	Constructed 636 housing units.	2000/2001	Additive	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Residential Development	Ewa	N/A	Constructed 900 housing units.	2001/2002	Additive	Terrestrial
Residential Development	Ewa	N/A	Construct 22,049 housing units.	Unknown	Additive	Terrestrial
Kapolei Parkway	Ewa	Dept. of Transportation Services (DTS)	Construct a new four-lane (six lanes, if needed) boulevard across much of the Ewa plain, from Ko Olina to Ocean Pointe.	Unknown	Additive	Terrestrial
North-South Road	Ewa	State Dept. of Transportation (DOT)	Construct a new four-lane boulevard makai from a future H-1 interchange to near Ewa Villages.	Underway	Additive	Terrestrial
Land Transfer – Dillingham Military Reservation (DMR)	DMR	U.S. Army	Return of the portion of the beach land in front of DMR to the state.	Unknown	Neutral	Terrestrial
Advanced Wastewater Treatment Upgrade	SBMR	U.S. Army	Upgrade current sewage treatment to an advanced treatment and effluent system.	2005	Neutral	Terrestrial Marine
Army Facility Strategy Program	SBMR/WAAF	U.S. Army	Projects include an aviation motor pool complex at WAAF, two physical fitness centers (SBMR, WAAF), a general instruction building, and upgrades to the range at SBMR.	Unknown	Additive	Terrestrial
Hot Cargo Pad	Hickam Air Force Base (HAFB)	U.S. Air Force	Construct facilities to simultaneously load three C-5/ C-17 aircraft.	Unknown	Additive	Terrestrial
Lā`ie Wastewater Collection System Expansion Phase II – Lā`ie	Lā`ie (adjacent to KTA)	Town of Lā`ie	Upgrade the sewage collection system in Lā`ie.	2004	Neutral	Terrestrial Marine
Drydock 2 Waterfront Support Facility	Pearl Harbor (near HAFB)	U.S. Navy	Construct two story metal buildings, renovate latrine, and demolish several buildings.	2003	Neutral	Terrestrial
Kamehameha Highway Bridge Replacements	Kawela Camp Road, Kaukonahua Road (near SBMR)	State of Hawaii	Replace Kawela Stream bridge and Upper Poamoho Stream Bridge.	Funded through 2004	Neutral	Terrestrial Marine

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Kamehameha Highway Traffic Improvements	Kahalu`u to Waimea Bay (near KTA)	State of Hawaii	Construct passing lanes and turning lanes at intersections, modify traffic signals, and install signs, flashers, and other warning devices.	Funded through 2004	Beneficial	Terrestrial
Wai`anae Sustainable Communities Plan	Waianae	Honolulu Dept. of Planning and Permitting	A 20-year land use plan for the Wai`anae planning area.	Ongoing	Neutral	Terrestrial
Central Oahu Sustainable Communities Plan	Central Oahu	Honolulu Dept. of Planning and Permitting	A 25-year plan guiding land use planning for central Oahu.	Ongoing	Neutral	Terrestrial
25th ID(L) & USARHAW Revitalization Program	Oahu	U.S. Army	Construct and renovate water tanks and central ID Lab.	2006-2008	Additive	Terrestrial
Proposal to base eight C-17 aircraft at HAFB and the departure of four C-130 aircraft from HAFB.	HAFB	U.S. Air Force	Basing of eight C-17 aircraft at HAFB; four C-130 aircraft would depart from HAFB.	Unknown	Additive	Terrestrial
Department of Hawaiian Homelands Residential and Agricultural Development	Nānākuli-Wai`anae	Department of Hawaiian Homelands	Development of 16 parcels to provide up to 3,684 single family homes and farm lots.		Additive	Terrestrial
Maluohai Phase III	Kapolei	Unknown	Construct 45 homes.	August 2004	Additive	Terrestrial
Golf Course Development	Ewa, Central Oahu, and Wai`anae	N/A	Develop 171 golf holes on 1,798 acres at nine golf courses.	2002 and beyond	Additive	Terrestrial
Makaha 242-foot Reservoir No. 2	Wai`anae	Board of Water Supply (BWS)	Construct a new water reservoir in Makaha Valley, adjacent to the first reservoir.	Completed	Additive	Terrestrial Marine
Nānākuli 242-foot Reservoir	Wai`anae	BWS	Construct a new reservoir on Puu Haleakala in Nānākuli.	Unknown	Additive	Terrestrial Marine
Wai'anae Regional Park	Wai`anae	Dept. of Design and Construction (DDC)	Expand the existing regional park and add other improvements, such as an ocean recreation center and additional fields.	Underway	Additive	Terrestrial
Wai`anae Wastewater Treatment Plant Modification	Wai`anae	DDC	Wastewater improvements to the existing treatment plant.	Completed	Neutral	Terrestrial Marine

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Wai`anae Coast Emergency Alternate Route	Wai`anae	DTS	Develop a second through-road (for emergencies only) Mauka of Farrington Highway from Makaha to Nānākuli, by constructing new road links between existing sections of public or private road.	Unknown	Additive	Terrestrial
Honouliuli Waste Water Treatment Plant (WWTP) Effluent Reuse	Ewa	DDC	Modify transmission system to distribute 13 million gallons per day (MGD) of reclaimed wastewater, as required by consent decree.	Completed	Neutral	Terrestrial
Honouliuli WWTP Handling Upgrades	Ewa	DDC	Modify solids handling facilities and odor control to improve operations within current 38 MGD capacity.	Underway	Neutral	Terrestrial
Honouliuli WWTP Expansion	Ewa	DDC	Increase the primary liquid treatment capacity (an increase of 13 MGD).	Unknown	Neutral	Terrestrial
Kamokila (Honokai Hale) Community Park	Ewa	DDC	Acquire the land under an existing city park, including land needed for access.	Underway	Neutral	Terrestrial
Ewa Mahiko District Park	Ewa	DDC	Develop a new park at the old mill site in Ewa Villages.	Underway	Neutral	Terrestrial
Honouliuli WWTP site Expansion (Mauka)	Ewa	DDC	Add 27 acres to the existing WWTP site so that ultimate capacity can be raised above 51 MGD.	Underway	Neutral	Terrestrial
Asing Community Park	Ewa	DDC	Develop a new 24-acre park to serve West Loch Estates and Fairways.	Underway	Additive	Terrestrial
Farrington Highway Improvement	Ewa	DDC	Increase the right-of-way and widen highway from two lanes to six lanes along 12 miles from Fort Weaver Road to the proposed North-South Road.	Unknown	Additive	Terrestrial
Oneula Beach Park Expansion	Ewa	DDC	Add six acres in conjunction with the development of the Ocean Pointe community.	Underway	Neutral	Terrestrial
Kalaeloa Regional Park	Ewa	DDC	Develop a new regional park on approximately 456 acres of the former Barbers Point Naval Air Station.	Underway	Neutral	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Makakilo Neighborhood Park	Ewa	DDC	Develop a new neighborhood park in the Makakilo area of the water park.	Underway	Neutral	Terrestrial
Renton Road Improvements (Ewa Town)	Ewa	DTS	Widening the road from two to four lanes within Ewa Villages.	Underway	Additive	Terrestrial
Kaloi Gulch Channel	Ewa	N/A	Drainage improvements in the Varona Village area of Ewa Villages.	Underway	Neutral	Terrestrial
Kalaeloa Desalination Plant	Ewa	BWS	Construct a new, high-technology 15 MGD water production facility in Campbell Industrial Park.	Underway	Neutral	Terrestrial
Ewa Shaft Renovation	Ewa	BWS	Convert an existing private irrigation source into a municipal water production facility.	Underway	Neutral	Terrestrial
Park Row Road	Ewa	DTS	Construct a short extension of Park Row Road makai from Renton Road to the future Kapolei Parkway.	Underway	Neutral	Terrestrial
Residential Development	Central Oahu	N/A	Constructed 644 housing units.	2000/2001	Additive	Terrestrial
Residential Development	Central Oahu	N/A	Constructed 811 housing units.	2001/2002	Additive	Terrestrial
Residential Development	Central Oahu	N/A	Construct 8,710 housing units.	2002 and beyond	Additive	Terrestrial
Pearl Harbor Historic Trail (Middle Loch Park)	Central Oahu	DDC	Aiea and Pearl City communities interested in enhancing a walking trail from Ewa to Ko Olina Resort along old OR&L railroad corridor. Trail is intended to preserve land and open space and offer viewscapes of Pearl Harbor and nearby wetlands.	2001 and beyond	Neutral	Terrestrial
Waipahu Wells III	Central Oahu	BWS	Potable well installation along with 5 pumps to produce 2-3 MGD for the surrounding area.	Underway	Neutral	Terrestrial
Waipio Peninsula Recreation Complex	Central Oahu	DDC	Public soccer complex and park includes soccer fields, stadium, parking lot, and park.	Completed	Neutral	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Central Oahu Regional Park (Waiola Sports Complex)	Central Oahu	DDC	Public sports complex includes a park, baseball fields, and tennis courts.	Underway	Neutral	Terrestrial
Waipahu Wells II Addition (two projects)	Central Oahu	BWS	Construction of pump and reservoir improvements including a 1.5 MGD well.	Underway	Neutral	Terrestrial
Waipahu Wells IV	Central Oahu	BWS	Installation of four 1.5 MGD wells, and GAC treatment facility.	Underway	Neutral	Terrestrial
Haleiwa Drainage Improvements	North Shore	DDC	Upgrades to the existing drainage ditch along Haleiwa Road (mauka side).	Underway	Neutral	Terrestrial
Banzai Rock Beach Support Park	North Shore	DDC	Develop a new parking area (and possibly bath house) mauka of Kamehameha Highway.	Underway	Neutral	Terrestrial
Kaunala Beach Park	North Shore	DDC	Create a new beach park at the Velzyland surf site, including a comfort station and a pavilion.	Underway	Neutral	Terrestrial
Kahawai Beach Support Park (including Sunset Beach Recreation Center)	North Shore	DDC	Create a new 2.6-acre park mauka of Kamehameha Highway near Pupukea Beach Park, to include a recreation center, comfort station, additional parking, and an area for an open market.	Underway	Neutral	Terrestrial
Waimea Valley Park	North Shore	DDC	Purchase the Waimea Falls Park, a private recreational area and botanical garden, in order to preserve the scenic valley and the botanical collection and keep the tourist attraction running.	Land acquisition underway	Beneficial	Terrestrial
Residential Development	Primary Urban Center	N/A	Constructed 74 housing units.	2000/2001	Additive	Terrestrial
Residential Development	Primary Urban Center	N/A	Constructed 91 housing units.	2001/2002	Additive	Terrestrial
Residential Development	Primary Urban Center	N/A	Construct 1,667 housing units.	2002 and beyond	Additive	Terrestrial
Nimitz Highway Reconstructed Sewer (Fort Street Mall to Alakea Street)	Primary Urban Center	N/A	Install 30-inch-diameter, 800-foot long subsurface water line between Fort Street Mall and Alakea Street.	2000/2001	Additive	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Moanalua Road Widening	Primary Urban Center	DDC	Widening one lane of a 1,000-foot-long corridor.	2001 and beyond (no design to date; funding pending)	Additive	Terrestrial
Pele Street Mini-Park	Primary Urban Center	DDC	Small community park.	2004	Neutral	Terrestrial
Residential Development	East Honolulu	N/A	Constructed 204 housing units.	2000/2001	Additive	Terrestrial
Residential Development	East Honolulu	N/A	Constructed 165 housing units.	2001/2002	Additive	Terrestrial
Residential Development	East Honolulu	N/A	Construct 1,177 housing units.	2002 and beyond	Additive	Terrestrial
Waialae Nui Well	East Honolulu	BWS	Construct a new potable well near the Waialae Nui residential subdivision.	Completed	Neutral	Terrestrial
Kalama Valley Community Park	East Honolulu	DDC	Construct new recreation building and related site improvements.	Underway	Additive	Terrestrial
Koko Crater Botanical Garden	East Honolulu	DDC	Construct a new visitor center and related site improvements.	Underway	Additive	Terrestrial
Koko Head Regional Park and Nature Preserve	East Honolulu	DDC	Modifications include education and visitor centers, parking, roadways, comfort stations, an enhanced trail system, and a people mover system.	Underway	Additive	Terrestrial
Aina Haina Nature Preserve	East Honolulu	DDC	Develop a new nature park, complete with a trail system, parking, and related improvements.	Unknown	Additive	Terrestrial
Queen's Beach Park (Wawamalu)	East Honolulu	DDC	Construct a new beach park in the Queen's Beach area, east of the Hawaii Kai Golf Course.	Completed	Neutral	Terrestrial
Hanauma Bay Modification	East Honolulu	DDC	Modifications included parking, food concessions, and information/education centers.	Completed	Neutral	Terrestrial
Kamilo Iki Community Park Modifications	East Honolulu	DDC	Develop new athletic fields and courts at an existing park.	Underway	Neutral	Terrestrial
Ka Iwi Shoreline Park	East Honolulu	DDC	Construct limited park improvements along Ka Iwi Coast, in conjunction with the state.	Land acquisition completed	Neutral	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Wailupe Stream Flood Control	East Honolulu	DDC	Plan to channelize Wailupe Stream in Aina Haina and expand the existing upland drainage basin.	Underway	Additive	Terrestrial Marine
Aina Haina Slide Remediation, Zone B	East Honolulu	DDC	Plan to create a passive park by compacting, regrading, and landscaping to stabilize a slide area.	Underway	Neutral	Terrestrial
Koko Crater Access Road	East Honolulu	DDC	Construct a boulevard to replace and relocate the existing private road into Koko Crater.	Underway	Additive	Terrestrial
Koko Crater Entrance Park	East Honolulu	DDC	Construct a new passive park between Queens Gate and the proposed Koko Villas subdivision.	Underway	Neutral	Terrestrial
Residential Development	Koolaupoko	N/A	Constructed 75 housing units.	2000/2001	Additive	Terrestrial
Residential Development	Koolaupoko	N/A	Constructed 86 housing units.	2001/2002	Additive	Terrestrial
Residential Development	Koolaupoko	N/A	Construct 1,381 housing units.	2002 and beyond	Additive	Terrestrial
Kamehameha Highway Scenic Enhancement	Koolaupoko	DDC	Acquiring and preserving the Waihee Marsh along the shoreline in the Kahaluu area.	Unknown	Beneficial	Terrestrial
Haiku Valley Nature Preserve	Koolaupoko	DDC	Plans to purchase and improve the former US Coast Guard Omega Station and the Haiku Stairs as a park and nature preserve.	Underway	Beneficial	Terrestrial
Waiahole Beach Park	Koolaupoko	DDC	Plans to expand and improve the existing Waiahole Beach Park.	Underway	Neutral	Terrestrial
Waimanalo Well II	Koolaupoko	BWS	Construct a new potable water well mauka of the former Meadow Gold Dairies pasture land.	Unknown	Neutral	Terrestrial
Kahaluu Regional Park	Koolaupoko	DDC	Plans to expand the existing regional park mauka toward the Kahaluu Elementary School and adjacent park.	Underway	Neutral	Terrestrial
Kailua 272 Reservoir	Koolaupoko	BWS	Construct a new reservoir at Kalae O Kaiwa Ridge in Kailua.	Underway	Additive	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Kaneohe Stream Green Belt Park	Koolaupoko	DDC	Plans to establish a greenbelt park along the lower reaches of Kaneohe Stream.	Underway	Neutral	Terrestrial
Kawa Stream Improvements	Koolaupoko	DDC	Channelize Kawa Stream within the Piloiloa Subdivision behind Castle High School in Kaneohe.	Underway	Additive	Terrestrial
Kailua Beach Park Improvements	Koolaupoko	DDC	Construct a new pavilion, canoe halau, relocated comfort station, and various grounds improvements.	Unknown	Neutral	Terrestrial
Waimanalo Treatment and Disposal System	Koolaupoko	DDC	Expand the existing Waimanalo Wastewater Treatment Plant to accommodate increasing demand and to provide service to areas currently using cesspools.	Underway	Neutral	Terrestrial Marine
Kawai Nui Gateway Park	Koolaupoko	DDC	Plans to create a nature walk, dog park, and additional landscaping at various places along the northern and eastern borders of Kawai Nui Marsh.	Underway	Neutral	Terrestrial
Kawai Nui Community Park	Koolaupoko	DDC	Improve an existing park by adding a recreation building, comfort station, and play courts.	Completed	Neutral	Terrestrial
Kailua Park	Koolaupoko	DDC	Develop a new nature park in Maunawili Valley, surrounding and including the existing Luana Hills Golf Course.	Land acquisition underway	Neutral	Terrestrial
Pali Golf Course Improvements	Koolaupoko	DDC	Modifications include replacing the clubhouse and improving all areas of the golf course.	Underway	Neutral	Terrestrial
Kaneohe Bayside Park (Kahua O Waikalua Neighborhood Park)	Koolaupoko	DDC	Create a new park on the site of the soon-to-be-phased-out Kaneohe Sewage Treatment Plant, to include ball fields and open spaces.	Underway	Neutral	Terrestrial
Waikane Nature Preserve	Koolaupoko	DDC	Establish a nature preserve in Waikane Valley, with improvements limited to walking trails.	Underway	Neutral	Terrestrial
Kuou Well III	Koolaupoko	DDC	Construct a new potable water well next to Ho'omaluhia Botanical Garden in Kaneohe.	Completed	Neutral	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Kualoa Regional Park	Koolaupoko	DDC	Upgrade an existing park by constructing a sewage system and improving buildings and roads.	Underway	Neutral	Terrestrial
Kailua Sewage Treatment Plant Modification	Koolaupoko	DDC	Upgrade the existing plant to increase storage capacity and improve odor control.	Underway	Neutral	Terrestrial
Kaneohe Sewage Treatment Plant Modification	Koolaupoko	DDC	Convert the existing treatment plant to a pretreatment facility that has additional capacity to handle wet-weather flows, and demolish the existing structures and tanks so that the land can be used as a park.	Completed	Neutral	Terrestrial
Heeia Kea Park	Koolaupoko	DDC	Create a nature park and passive recreational area within Heeia Kea Valley.	Underway	Neutral	Terrestrial
Kalaeloa Artificial Reef	Ewa	State of Hawaii	Establish an artificial reef site on the seafloor offshore from the Ewa District of the Island of Oahu.	Unknown	Beneficial	Terrestrial
Kaluanui Well Addition	Koolauloa	BWS	Construct a new potable water well within Heeia Kea Valley.	Underway	Beneficial	Terrestrial
Hauula Community Park Building Expansion	Koolauloa	DDC	Expand the existing multi-purpose building and construct related improvements.	Underway	Neutral	Terrestrial
Opana Wells	Koolauloa	BWS	Construct a new potable water well in the Kawela area mauka of the proposed Kuilima Resort.	Completed	Neutral	Terrestrial
Kahuku District Park Improvements	Koolauloa	DDC	Construct a new multi-purpose building, play courts, and related improvements.	Underway	Neutral	Terrestrial
Laie Beach Park (Bluff)	Koolauloa	DDC	Expand the existing beach park and construct related park improvements.	Underway	Neutral	Terrestrial
Hauula Fire Station Relocation	Koolauloa	DDC	Construct a new fire station (possibly including an ambulance facility) outside of the flood plain area.	Underway	Neutral	Terrestrial
Hawaii Superferry		DOT, Harbors Division	Operation of a high-speed ferry between the islands of Oahu, Maui, and Kauai, running in designated close-to-shore water lanes.	2007	Additive	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
ATG Trainer Facility		U.S. Navy	Warehouse structure to house Anti-terrorism Force Protection trainers/simulators.	To Be Determined	Neutral	Terrestrial
Waterfront Upgrade		U.S. Navy	Wharf and supporting facilities to berth Pearl Harbor homeported submarines.	To Be Determined	Additive	Terrestrial
Consolidated fire station	Naval Station area	U.S. Navy	Consolidation of three fire stations into one new station.	To Be Determined	Neutral	Terrestrial
Fire station	West Loch	U.S. Navy	Replacement of existing fire station.	To Be Determined	Neutral	Terrestrial
Compressed air plant	Pearl Harbor Naval Shipyard dry docks, Yankee and Sierra piers	U.S. Navy	Compressed air plant to support submarine overhauls and repairs.	To Be Determined	Additive	Terrestrial
Magazine driveway paving	Driveways to Naval Magazine (NAVMAG) ammunition magazines	U.S. Navy	Pavement of unpaved driveways.	To Be Determined	Additive	Terrestrial
Renovate Facilities for Naval Undersea Warfare Center Detachment Hawaii	Ford Island	U.S. Navy	Renovate five buildings and construct underwater test facility.	Unknown	Additive	Terrestrial
Ship Maintenance Waterfront Facility		U.S. Navy	Building renovations.	To Be Determined	Additive	Terrestrial
P-587 Pacific Fleet Submarine Drive-In	Beckoning Point, Pearl Harbor, HI	Naval Station Pearl Harbor	Construction of a concrete slip to support a drive-in Magnetic Silencing Facility.	FY08 program year	Additive	Terrestrial
P-202 Joint Forces Deployment Staging Area	NS Pearl Harbor, HI	Commander, Navy Region Hawaii; Commander, Navy Installations Command	Creation of a deployment staging area to support deployment of Joint Forces.	FY09 program year	Additive	Terrestrial
P-173 Construct Communication Center, Naval Computer and Telecommunications Area Master Station	Wahiawa	U.S. Navy	Construction of a communication center.	FY08 program year	Neutral	Terrestrial

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
P-004 Construct Conference and Technology Learning Center	Ft. DeRussy	U.S. Navy	Construction of a learning center.	To Be Determined	Neutral	Terrestrial
P-005 Joint Prisoner of War/Missing in Action (POW/MIA) Accounting Command	Hickam AFB	U.S. Navy	Construction of a facility to accommodate the Joint POW/MIA Accounting Command.	To Be Determined	Neutral	Terrestrial
P-578 Construct Fitness Center	NAVSTA Main Base	U.S. Navy	Construction of a fitness center.	To Be Determined	Neutral	Terrestrial
P-182 Construct Missile Magazines, NAVMAG WL	NAVMAG PH, West Loch	U.S. Navy	Construction of five earth-covered box magazines.	To Be Determined	Additive	Terrestrial
P-013 Consolidate Command Support Functions	NCTAMS PAC, Wahiawa	U.S. Navy	Renovation and demolition of buildings in support of consolidation of support functions.	2010	Additive	Terrestrial
P-634 Waterfront Upgrades Bravo 21	Bravo docks 20 and 21	U.S. Navy	Construction of new concrete wharves.	2010	Additive	Terrestrial Marine
P-302 Dry Dock Ship Support Services	Dry docks 1 and 2, Bravo piers 1 and 2	U.S. Navy	Modifications of docks and piers to provide ship support services.	2012	Additive	Terrestrial Marine
P-639 Construct Advanced SEAL Delivery System/SEAL Delivery Vehicle (ASDS/SDV) Operations Wharf	Wharf Victor 2	U.S. Navy	Construction of a new wharf structure.	2013	Additive	Terrestrial Marine
FY09 MCON P-422 Advanced Radar Detection Laboratory (ARDEL)	PMRF	U.S. Navy	Construction of Advanced Radar Facility	2009 and beyond	Additive	Terrestrial
Rim of the Pacific (RIMPAC) Exercise	HRC	U.S. Navy	RIMPAC is a biennial, sea controlled projection fleet exercise that has been conducted since 1968.	2006	Additive	Terrestrial Marine

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Undersea Warfare Exercise (USWEX)	HRC	U.S. Navy	USWEX is an advanced Anti-Submarine Warfare Exercise proposed to be conducted by the U.S. Navy's Carrier Strike Groups and Expeditionary Strike Groups while in transit from the west coast of the United States to the western Pacific Ocean.	2007	Additive	Terrestrial Marine
P-8A Multi-Mission Maritime Aircraft	Hickam AFB	U.S. Navy	Introduction of P-8A Multi-Mission Maritime Aircraft to the Navy Fleet. Proposed action includes transition from existing P-3C aircraft to P-8A Multi-Mission Maritime Aircraft. Hickam AFB has been identified as one of several potential receiving sites. A Notice of Intent to prepare an EIS was published in the *Federal Register* in December 2006.	2011-2019	Additive	Terrestrial
Replacement of F-15 Aircraft with F-22A Aircraft	Hickam AFB	Air Force and Air National Guard	The Air Force and Air National Guard proposes to replace the Hawaii Air National Guard F-15 aircraft with F-22A aircraft at Hickam AFB.	2011	Additive	Terrestrial
Long-range missile tests	HRC Temporary Operating Area, Department of Defense Test Ranges	Missile Defense Agency	Between 2003-2007, 68 different Department of Defense target and interceptor missiles were launched from either Kodiak Launch Complex, Alaska; Vandenberg Air Force Base, California; Pacific Missile Range Facility (PMRF), Hawaii; Ronald Reagan Ballistic Missile Test Site, Marshall Islands, Wake Island, or mobile platforms in to or near the Hawaii Temporary Operating Area. Approximately 628 missile launches occurred during this time period, and the majority of this missile activity was associated with the PMRF fleet training ranges. Current tempo of approximately of 125 launches per year is expected to continue into the future.	Ongoing	Additive	Terrestrial Marine

Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

Table 5.4.1-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completio n Date	Relevance to HRC EIS/OEIS	Relevance to Terrestrial or Marine Environment
Overseas Environmental Assessment (OEA) for MK 48 Advanced Capability Torpedo Service Weapons Tests in Hawaii	Hawaii	U.S. Navy	The Navy's Undersea Weapons Program Office (PMS 404) proposes to conduct three Service Weapons Tests using the MK 48 Advanced Capability (ADCAP) torpedo in 2008. The goal of the MK 48 ADCAP testing is to fire torpedoes with live warheads at a target to test the full function of the weapon systems and to train submarine crews using actual firing sequences. The Draft OEA concluded that that no significant harmful effects on the environment are reasonably foreseeable.	September 2008	Additive	Marine

Source: U.S. Department of the Army, 2005
Note:
Neutral: The project listed would not contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Additive: The project listed would, or is likely to contribute substantially to cumulative effects on resources impacted by the Proposed Action.
Beneficial: The project listed would, or is likely to reduce or offset cumulative effects on resources impacted by the Proposed Action.

5.4.2 OTHER ACTIVITIES

5.4.2.1 COMMERCIAL FISHING

The Hawaii-based longline fishery is the largest commercial fishery in the central Pacific. It is a limited entry fishery with 164 available permits. Approximately 100 vessels have been active in the fisheries for the past 8 to 10 years. Recorded landings from 1994-99 totaled 17.1 million pounds of bigeye tuna, yellowfin tuna, albacore, and swordfish.

Fishing can adversely affect fish habitat and managed species. Potential impacts of commercial fishing include over-fishing of targeted species and by-catch, both of which negatively affect fish stocks. Lost and discarded gear may foul and disrupt bottom habitats. Recreational fishing also has the potential to affect fish habitats because of the large number of participants and the concentrated use of specific habitats (e.g. bottomfishing in the Main Hawaiian Islands).

Removal of fish by fishing can have a profound influence on individual populations. In a recent study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records from 10,000 years ago to the present, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer-term data and information, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems including pollution and anthropogenic climatic change.

Bycatch

Bycatch is the term for the inadvertent capture of non-target species in fishing gear. Besides cetaceans and other marine mammals, sea turtles, seabirds, and non-commercial fish species also are regularly caught and killed unintentionally as bycatch. The World Wildlife Fund convened a summit of the world's leading cetacean experts in January 2002 in Annapolis, Maryland, which was attended by 25 scientists from six continents. The group reached consensus that the single biggest threat facing cetaceans worldwide is death as bycatch in fishing gear. More marine mammals die every year by getting entangled in fishing gear than from any other cause. Researchers estimated a global annual average of nearly 308,000 deaths per year—or nearly 1,000 per day (Read et. al., 2002; 2006). As shown on Figure 5.4.2.1-1, the annual number of marine mammal deaths from fishing bycatch and whaling far exceeds the total of all marine mammals that have died relatively coincident with the use of sonar during North Atlantic Treaty Organization (NATO) and Navy Anti-Submarine Warfare (ASW) training over approximately the past 20 years. This is not meant to suggest that few deaths coincident with the use of sonar lack importance, but is only meant to indicate the relative scale of the potential impacts on marine mammals indicating that the cumulative effect of sonar use is minimal by comparison.

Masking

It should be noted that increases in ambient noise levels might have the potential to mask an animal's ability to detect objects, such as fishing gear, and thus increase their susceptibility to bycatch. Mid-frequency active/high-frequency active (MFA/HFA) sonar transmission, however, involves a very small portion of the frequency spectrum and falls between the central hearing range of the (generally) low-frequency specializing baleen whales and the (generally) high-frequency specializing odontocetes. In addition, the active portion of MFA/HFA sonar is intermittent, brief, and individual units engaged in an exercise are separated by large distances. As a result, MFA/HFA sonar use during Navy training activities will not contribute to an increase in baseline anthropogenic ambient noise levels to any significant degree. Additional discussion of MFA/HFA operation parameters is discussed in Section 5.4.2.3.

Directed Harvest

In addition to mortalities from fisheries bycatch an additional significant effect on marine mammals (see Figure 5.4.2.1-1) is directed harvest (purposeful taking), whether for subsistence, commercial harvest, or scientific research. Impacts from military readiness activities in the Hawaii Range Complex (HRC) are not likely to significantly affect any of the species or stocks of marine mammals or sea turtles subject to directed harvest.

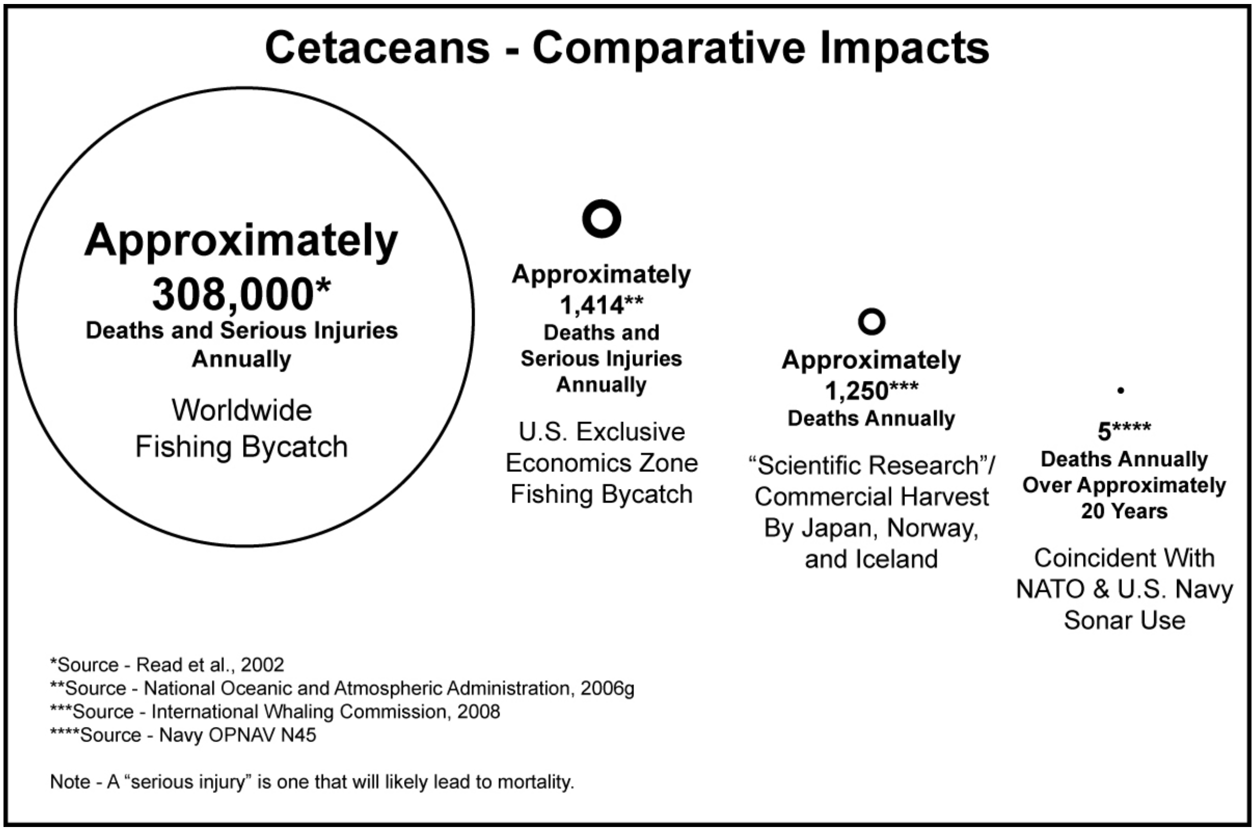


Figure 5.4.2.1-1. Impacts from Fishing and Whaling Compared to Potential Impacts from Sonar Use

5.4.2.2 SHIP STRIKES

Ship strikes, or ship collisions with whales, are a recognized source of whale mortality worldwide. Of the 11 species known to be hit by ships, the most frequently reported is the fin whale. Whale-watching tours are becoming increasingly popular, and ship strikes have risen in recent years. In the Hawaiian Islands, ship strikes of the humpback whale are of particular concern. According to the National Marine Fisheries Service (NMFS) Pacific Islands Region Marine Mammal Response Network Activity Update (dated January 2007), there were nine reported collisions with humpback whales in 2006. Whale watching could also have an effect on whales by distracting them, displacing them from rich food patches, or by dispersing food patches with wake or propeller wash (Katona and Kraus, 1999).

A review of recent reports on ship strikes provides some insight regarding the types of whales, locations and vessels involved, but also reveal significant gaps in the data. The Large Whale Ship Strike Database provides a summary of the 292 worldwide confirmed or possible whale/ship collisions from 1975 through 2002 (Jensen and Silber, 2003). The report notes that the database represents a minimum number of collisions, because the vast majority probably go undetected or unreported.

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks that commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (de Stephanis and Urquiola, 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regionally-based small populations where the significance of low numbers of collisions would be greater, given smaller populations or population segments.

The Hawaii Superferry (which started operations between the islands of Oahu, Maui, and Kauai in late 2007), operates in designated close-to-shore water lanes and changes routes during the winter humpback whale season. Given the vessel's nominally high speed (approximately 35 knots), there is a potential for collisions with marine mammals, in particular humpback whales, due to their density and distribution during the winter. Mitigation requirements imposed by the State of Hawaii for the Superferry include the use of dedicated observers, reduction in speed, and route modifications. Recent litigation has resulted in the requirement to prepare an EIS (under the Hawaii Environmental Policy Act of 1974) to evaluate the effects of the operation of the Superferry on the environment, including humpback whales, infrastructure impacts to local harbor destinations, transport of invasive species and socioeconomic and cultural resources.

5.4.2.3 ANTHROPOGENIC CONTRIBUTORS TO OCEAN NOISE LEVELS

The potential cumulative impact issue associated with MFA/HFA sonar use during a Navy Training exercise is the addition of underwater sound to oceanic ambient noise levels, which in turn could have impacts on marine animals. Anthropogenic sources of ambient noise that are most likely to have contributed to increases in ambient noise are vessel noise from commercial shipping and general vessel traffic, oceanographic research, and naval and other use of sonar.

Ambient noise is environmental background noise. It is generally described as unwanted sound—sound that clutters and masks other sounds of interest (Richardson et al., 1995a). Any potential for cumulative impact should be put into the context of recent changes to ambient sound levels in the world’s oceans as a result of anthropogenic activities. It should be noted, however, that there is a large and variable natural component to the ambient noise level as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp and the vocalizations of marine mammals.

Anthropogenic sources of ambient noise that are most likely to contribute to increases in ambient noise levels are commercial shipping, offshore oil and gas exploration and drilling, and naval and other use of sonar (International Council for the Exploration of the Sea, 2005). Andrew et al. (2002) compared ocean ambient sound from the 1960s with the 1990s for a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 decibels (dB) in the frequency range of 20 to 80 hertz (Hz) and 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period. A possible explanation for the rise in ambient noise is the increase in shipping noise. There are approximately 11,000 supertankers worldwide, each operating 300 days per year, producing constant broadband noise at source levels of 198 dB (Hildebrand, 2004). The most energetic regularly-operated sound sources are seismic air gun arrays from approximately 90 vessels with typically 12 to 48 individual guns per array, firing about every 10 seconds (Hildebrand, 2004). Of the anthropogenic noise sources identified above, only offshore oil and gas exploration and drilling are not reasonably foreseeable within the action area.

5.4.2.3.1 Commercial Shipping

The Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium on “Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology” stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to over 85,000 vessels in 1998 (National Research Council, 2003; Southall, 2005). Between 1950 and 1998, the U.S. flagged fleet declined from approximately 25,000 to less than 15,000 and currently represents only a small portion of the world fleet. Foreign waterborne trade in the United States has increased from 718 to 1,164 million gross metric tons from 1981 to 2001. From 1985 to 1999, world seaborne trade doubled to 5 billion tons and currently includes 90 percent of the total world trade, with container shipping movements representing the largest volume of seaborne trade. It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as significant (or possibly more significant) than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005).

Increases in ambient noise levels have the potential to mask a marine species’ ability to detect approaching vessels, thus increasing their susceptibility to ship strikes.

5.4.2.3.2 Vessel Mechanical Noise Sources

Boats and ships produce sound due to propeller cavitation (or propeller singing) as well as other machinery. Propeller singing has a frequency between 100 and 1,000 Hz (Richardson et al., 1995a). Noise from propulsion machinery enters the water through the hull of the ship. Propulsion machinery sources include rotating shafts, gear reduction transmissions, reciprocating parts, gear teeth, fluid flow turbulence, and mechanical friction. Other sources of noise include fathometers, pumps, non-propulsion engines, generators, ventilators, compressors, flow noise from water dragging on the hull, and bubbles breaking in the wake. Medium and large vessels generate frequencies up to approximately 50 Hz, primarily from propeller blade rate and secondarily from the engine cylinder firing rates and shaft rotation (Richardson et al., 1995a). Propeller cavitation and flow noise can produce frequencies as high as 100 kilohertz (kHz) but generally peak energy occurs between 50 and 150 Hz; and auxiliary machinery (pumps and compressors) may produce frequencies up to several kilohertz (Richardson et al., 1995a). Moreover, most (83 percent) of the acoustic field surrounding large vessels is the result of propeller cavitation (Southall, 2005). Larger ships generally are diesel-powered and have two propellers, which are larger and slower rotating. These propellers typically have four blades, which turn at a rate of approximately 160 rpm and have a frequency of 10 to 11 Hz (Richardson et al., 1995a). It is generally believed that acoustic source levels are not a function of speed for modern diesel vessels across most of their common operations (Heitmeyer et al., 2004). Supply ships often have bow thrusters to help maneuver the ship. A bow thruster may create a harmonic tone with a high fundamental frequency, depending on the rotation rate of the thrusters. One study found nine harmonics, extending up to 1,064 Hz. In another study, the noise increased by 11 dB when the bow thrusters began operating.

Small boats with large outboard engines produce source levels of 175 dB at frequencies up to several hundred hertz (Richardson et al., 1995a; Erbe, 2002). A study was also conducted on the effects of watercraft noise on the acoustic behavior of bottlenose dolphins in Florida (Buckstaff, 2004). The study focused on short-term changes in whistle frequency range, duration, and rate of production. The frequency range and duration of signature whistles did not significantly change due to approaching vessels. However, dolphins whistled more often at the onset of approaching vessels compared to during and after vessel approaches. The whistle rate also increased more at the onset of a vessel approach than when there were no vessels present.

5.4.2.3.3 Whale Watching

Studies on the effects of boat noise and general disturbance resulting from whale-watching vessels have been conducted on pods of killer whales and dolphins (Foote et al., 2004; Bain et al., 2006; Stockin et al., 2008). Foote et al., (2004) found there was a significant increase in call duration for all three killer whale pods studied in the presence of boats from 2001 to 2003. Bain et al. (2006) found the presence of significant effects in both Northern and Southern resident killer whales after decades of intense whale-watching suggest habituation to whale watching is far from complete. Stockin et al., (2008) determined that the presence of whale watch vessels in New Zealand "significantly disrupted" foraging and resting behavior of common dolphins. Bejder et al, (2006) found that dolphin watching vessels could have significant population effects on small, closed, resident or endangered populations of dolphins. "The substantial effect of tour vessels on dolphin abundance in a region of low-level tourism calls into question the presumption that dolphin-watching tourism is benign" (Bejder et al., 2006).

In Hawaii, a study was conducted on the effects of boat noise from whale-watching vessels on the interaction of humpback whales (Au and Green, 2000). Two inflatable boats were equipped with outboard engines. Two were larger coastal boats with twin inboard diesel engines, and the fifth boat was a small water plane area twin hull (SWATH) ship. The study concluded that it is unlikely that the levels of sounds produced by the boats in the study would have any serious effect on the auditory system of humpback whales.

5.4.2.3.4 Commercial and Military Sonar

Active sonar was probably the first wide-scale, intentional use of anthropogenic noise within the oceans. The outbreak of World War I in 1914 was the impetus for the development of a number of military applications of sonar (Urick, 1983); by 1918, both Britain and the United States had built active sonar systems. The years of peace following World War I saw a steady, though extremely slow, advance in applying underwater sound to practical needs. By 1935 several adequate sonar systems had been developed, and by 1938 with the imminence of World War II, quantity production of sonar sets started in the United States (Urick, 1983). The National Research Council (2003) notes that there are both military and commercial sonars: military sonars are used for target detection, localization, and classification. Commercial sonars are typically higher in frequency and lower in power and are used for depth sounding, bottom profiling, fish finding, and detecting obstacles in the water. Commercial sonar use is expected to continue to increase, although it is not believed that the acoustic characteristics will change.

Commercial Sonar Use in Hawaii

Almost all vessels at sea are equipped with active sonar fathometers. Many vessels engaged in commercial or recreational fishing also use active sonar commonly referred to as "fish-finders." Both types of sonar tend to be higher in frequency and lower in power than the hull-mounted MFA sonar used during Navy training; however, there are many more of these sonars, and they are in use much more often and in more locations than Navy sonars.

While oil and gas exploration is not conducted in the Hawaiian Islands, undersea research using active sound sources does occur; sound sources employed include powerful multibeam and sidescan sonars that are generally used for mapping the ocean floor and include both MFA and HFA systems. During mapping surveys, these sonars run continuously, sweeping the large areas of ocean to accurately chart the complex bathymetry present on the ocean floor.

LFA Sonar Use

Although not part of the Proposed Action in this EIS/OEIS, the future use of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) is reasonably foreseeable in or around the HRC study area as it has been proposed in the SURTASS LFA Supplemental EIS. Ongoing litigation over the SURTASS LFA Supplemental EIS may minimize or preclude the use of SURTASS LFA in and around the HRC study area. Nonetheless, LFA is included in this cumulative analysis as described below.

The potential cumulative impact issue associated with SURTASS LFA sonar operations is the addition of underwater sound to oceanic ambient noise levels, which in turn could have impacts on marine animals. Anthropogenic sources of ambient noise that are most likely to contribute to increases in ambient noise levels are commercial shipping, offshore oil and gas exploration and drilling, and naval and other use of sonar (International Council for the Exploration of the Sea, 2005).

SURTASS LFA Sonar Combined with Other Human-Generated Sources of Oceanic Noise

The potential for cumulative impacts and synergistic effects from SURTASS LFA transmissions was analyzed in relation to overall oceanic ambient noise levels, including the potential for LFA sound to add to overall ambient levels of anthropogenic noise. Increases in ambient noise levels have the potential to cause masking, and decrease in distances that underwater sound can be detected by marine animals. These effects have the potential to cause a long-term decrease in a marine mammal's efficiency at foraging, navigating, or communicating (International Council for the Exploration of the Sea, 2005). National Research Council (2003) discussed acoustically-induced stress in marine mammals. National Research Council stated that sounds resulting from one-time exposure are less likely to have population-level effects than sounds that animals are exposed to repeatedly over extended periods of time. The potential for acoustically-induced stress from LFA transmissions is discussed below.

Ambient Noise Levels and Masking

Broadband, continuous low-frequency shipping noise is more likely to affect marine mammals than narrowband, low duty cycle SURTASS LFA sonar. SURTASS LFA sonar bandwidth is limited (approximately 30 Hz), the average maximum pulse length is 60 seconds, signals do not remain at a single frequency for more than 10 seconds, and during an operation the system is off nominally 90 to 92.5 percent of the time. Most mysticete vocalizations are in the low frequency band below 1 kHz. No direct auditory measurements have been made for any mysticete, but it is generally believed that their frequency band of best hearing is below 1,000 Hz, where their calls have the greatest energy (Clark, 1990; Edds-Walton, 2000; Ketten, 2000). However, with the nominal duty cycle of 7.5 to 10 percent, masking would be temporary. For these reasons, any masking effects from SURTASS LFA sonar are expected to be negligible and extremely unlikely.

Odontocetes have a broad acoustic range and hearing thresholds measure between 400 Hz and 100 kHz (Richardson, et al., 1995a; Finneran et al., 2002). It is believed that odontocetes communicate above 1,000 Hz and echolocate above 20 kHz (Würsig and Richardson, 2002). While the upward spread of masking is known to exist, the phenomenon has a limited range in frequency. Yost (2000) showed that magnitude of the masking effect decreases as the difference between signal and masking frequency increase; i.e., the masking effect is lower at 3 times the frequency of the masker than at 2 times the frequency. Gorga et al. (2002) demonstrated that for a 1.2-kHz masking signal, the upward spread of masking was extinguished at frequencies of 6 kHz and higher. Therefore, while the phenomenon of upward spread of masking does exist, it is unlikely that LFA would have any significant effect on the hearing of higher frequency animals. Gorga et al. (2002) also demonstrated that the upward spread of masking is a function of the received level of the masking signal. Therefore, a large increase in the masked bandwidth due to upward masking would only occur at high received levels of the LFA signal.

In a recent analysis for the Policy on Sound and Marine Mammals: An International Workshop sponsored by the Marine Mammal Commission (United States) and the Joint Nature Conservation Committee (United Kingdom) in 2004, Dr. John Hildebrand provided a comparison of anthropogenic underwater sound sources by their annual energy output. On an annual basis, four SURTASS LFA systems are estimated to have a total energy output of 6.8×10^{11} Joules/yr. Seismic air gun arrays were two orders of magnitude greater with an estimated annual output of 3.9×10^{13} Joules/year. MFA and super tankers were both greater at 8.5×10^{12} and 3.7×10^{12} Joules/year, respectively (Hildebrand, 2004). Hildebrand concluded that increases in anthropogenic sources most likely to contribute to increased noise in order of importance are: commercial shipping, offshore oil and gas exploration and drilling, and naval and other uses of sonar. The use of SURTASS LFA sonar is not scheduled to increase past the originally analyzed four systems during the next 5-year regulation under the Marine Mammal Protection Act (MMPA). The percentage of the total anthropogenic acoustic energy budget added by each LFA source is actually closer to 0.5 percent per system (or less), when other man-made sources are considered (Hildebrand, 2004). When combined with the naturally occurring and other man-made sources of noise in the oceans, the intermittent LFA signals barely contribute a measurable portion of the total acoustic energy.

In a recently released report entitled “Ad-Hoc Group on the Impact of Sonar on Cetaceans,” the International Council for the Exploration of the Sea (International Council for the Exploration of the Sea, 2005) concluded that shipping accounts for more than 75 percent of all human sound in the sea, and sonar amounts to no more than 10 percent or so. It further stated that sonar (noise budget) would probably never exceed 10 percent, but that sonar deployment seems likely to increase in the future.

Therefore, the SURTASS LFA Final Supplemental Environmental Impact Statement (SEIS) dated April 2007 concluded that because LFA transmissions would not significantly increase anthropogenic oceanic noise, cumulative impacts and synergistic effects from the proposed four SURTASS LFA sonar systems for masking would not be a reasonably foreseeable significant adverse impact on marine animals.

Stress

Stress can be defined as a threat to homeostasis[1] and is frequently measured with changes in blood chemistry. Smith et al. exposed goldfish (a hearing-specialist fish) to continuous background noise of 160-170 dB RL. There was a "transient spike" in blood cortisol levels within 10 minutes of the onset of noise that was loud enough to cause TTS. However, this cortisol spike did not persist and there was no long-term physiological stress reaction in the animals.

Thomas et al. (1990) exposed captive belugas to recorded industrial noise for 30 minutes at a time, with a total exposure of 4.5 hours over 13 days with a source level of 153 dB. Catecholamine blood levels were checked both before and after noise exposure; however, no significant differences in blood chemistry were observed. Another experiment that measured blood chemistry, but also varied the sound level is described in Romano et al. (2004). In this experiment, a beluga was exposed to varying levels of an impulsive signal produced by a watergun. The levels of three stress-related blood hormones (norepinephrine, epinephrine, and dopamine) were measured after control, low-level sound (171-181 dB sound equivalent level [SEL]) exposure and high-level (184–187 dB SEL) sound exposure. There were no significant differences between low-level sound exposure and control, while the high-level sound exposure did produce elevated levels for all three hormones. Furthermore, regression analysis demonstrated a linear trend for increased hormone level with sound level.

These data support a linear dose-response function (like the LFA risk continuum) for sound exposure and the onset of stress, with only high levels of sound possibly leading to a stress reaction. The extrapolation of the response thresholds from the Romano et al. (2004) experiment (based on watergun signals) to the LFA situation is tenuous because of the differences in the signals, but the relationship between sound level and stress is supported by several studies. There are some recent data (e.g., Evans, 2003) implicating synergistic effects from multiple stressors, including noise. Although there are no data to support synergistic effects, similar impacts might occur with marine mammals, given the multiple stressors that often occur in their environment. This indicates that while stress in marine animals could possibly be caused by operation of the LFA source, it is likely to be constrained to an area much smaller than the zone of audibility, more similar in size to the mitigation zone around the vessel.

National Research Council (2003) discussed acoustically-induced stress in marine mammals and stated that sounds resulting from one-time exposure are less likely to have population-level effects than sounds that animals are exposed to repeatedly over extended periods of time. National Research Council (2003) stated that although techniques are being developed to identify indicators of stress in natural populations, determining the contribution of noise exposure to those stress indicators will be very difficult, but important, to pursue in the future

1 Homeostasis is the property of an open system, especially living organisms, to regulate its internal environment to maintain a stable, constant condition, by means of multiple dynamic equilibrium adjustments, controlled by interrelated regulation mechanisms.

when the techniques are fully refined. There are scientific data gaps regarding the potential for LFA to cause stress in marine animals. Even though an animal's exposure to LFA may be more than one time, the intermittent nature of the LFA signal, its low duty cycle, and the fact that both the vessel and animal are moving mean that there is a very small chance that LFA exposure for individual animals and stocks would be repeated over extended periods of time, such as those caused by shipping noise.

The SURTASS LFA Final SEIS concluded that transmissions would not significantly increase anthropogenic oceanic noise; therefore, cumulative impacts and synergistic effects from stress are not a reasonably foreseeable significant adverse impact on marine animals from exposure to LFA.

Synergistic Effects

The potential for synergistic effects of the operation of SURTASS LFA sonar with overlapping sound fields from other anthropogenic sound sources was initially analyzed based on two LFA sources (U.S. Department of the Navy, 2007). In order for the sound fields to converge, the multiple sources would have to transmit exactly in phase (at the same time), requiring similar signal characteristics, such as time of transmissions, depth, vertical steering angle, waveform, wavetrain, pulse length, pulse repetition rate, and duty cycle. In the very unlikely event that this ever occurred, the analysis demonstrated that the "synergistic" sound field generated would be 75 percent or less of the value obtained by adding the results. Therefore, adding the results conservatively bounds the potential effects of employing multiple LFA sources. In the areas where marine mammals would potentially be affected by significant behavioral changes, they would be far enough away that they would discern each LFA sonar as an individual source. Standard operational employment of two SURTASS LFA sonars calls for the vessels to be nominally at least 185 km (100 nm) apart (U.S. Department of the Navy, 2007). Moreover, LFA sources would not normally operate in proximity to each other and would be unlikely to transmit in phase as noted above. Based on this and the coastal standoff restriction, it is unlikely that LFA sources, under any circumstances, could produce a sound field so complex that marine animals would not know how to escape it if they desired to do so.

Because of the potential for seismic surveys to interfere with the reception of passive signals and return echoes, SURTASS LFA sonar operations are not expected to be close enough to these activities to have any synergistic effects. Because of the differences between the LFA coherent signal and seismic air gun impulsive "shots," there is little chance of producing a "synergistic" sound field. Marine animals would perceive these two sources of underwater sound differently and any addition of received signals would be insignificant. This situation would present itself only rarely, as LFA testing and training operations have not been, and are not expected to be conducted in proximity to any seismic survey activity.

If SURTASS LFA sonar operations were to occur concurrent with other military (including MFA/HFA sonars) and commercial sonar systems, synergistic effects are not probable because of differences between these systems (U.S. Department of the Navy, 2007). For the sound fields to converge, the multiple sources would have to transmit exactly in phase (at the same time), requiring similar signal characteristics, such as time of transmissions, depth, frequency, bandwidth, vertical steering angle, waveform, wavetrain, pulse length, pulse repetition rate, and duty cycle. The potential for this occurring is negligible.

Another area for potential cumulative effects would be those associated with SURTASS LFA to marine mammal populations. To evaluate the effects of SURTASS LFA sonar operations, it is necessary to place it in perspective with other anthropogenic impacts on marine resources.

Bycatch

Increases in ambient noise levels have the potential to mask an animal's ability to detect objects, such as fishing gear, thus increasing their susceptibility to bycatch. Because LFA transmissions are intermittent and would not significantly increase anthropogenic oceanic noise, cumulative impacts and synergistic effects from masking by LFA signals are not a reasonably foreseeable significant adverse impact on marine animals from exposure to LFA.

Ship Strikes

Ship strikes are generally not an issue for SURTASS LFA sonar vessels because of their slow operational speed (3 to 5 knots) and transit speed (10 to 12 knots). However, increases in ambient noise levels have the potential to mask an animal's ability to detect approaching vessels, thus increasing their susceptibility to ship strikes. Because LFA transmissions are intermittent and will not significantly increase anthropogenic oceanic noise, cumulative impacts and synergistic effects from ship strikes due to masking from LFA signals are not a reasonably foreseeable significant adverse impact on marine animals from exposure to LFA.

Authorized Whale Takes

As discussed in the SURTASS LFA Final SEIS, scientific research and subsistence whaling are activities authorized for lethal takes of marine mammals. Based on extensive evaluation in the SURTASS LFA document, the operation of SURTASS LFA sonar with monitoring and mitigation would result in no lethal takes. Therefore, there were no cumulative impacts due to LFA operations.

5.4.2.4 ENVIRONMENTAL CONTAMINATION AND BIOTOXINS

Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect cetaceans (Marine Mammal Commission, 2003). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (Reijnders and Aguilar, 2002). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering whales susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Specific information regarding the potential effects of environmental contamination on marine species in the Hawaiian Islands is not available, and therefore cumulative effects cannot be determined.

5.4.2.5 COASTAL DEVELOPMENT ACTIVITIES

Habitat loss and degradation is now acknowledged to be a significant threat to cetacean populations (Kemp, 1996). The impact of coastal development on whales has not been thoroughly investigated. Habitat alteration has the potential to disrupt the social behavior, food supply, and health of whales. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas, or migratory routes. The most serious threat to cetacean populations from habitat destruction may ultimately prove to be its impact on the lower trophic levels in their food chains (Kemp, 1996).

Likewise, habitat loss and degradation for listed sea turtles (e.g. green and hawksbill turtles) that rest and forage in the nearshore and nest on selected beaches in the Hawaiian Archipelago pose a serious potential threat to their recovery as noted in their Recovery Plans.

5.4.2.6 SCIENTIFIC RESEARCH PERMITS

There are currently 30 scientific research permits and General Authorizations for research issued by the NMFS for cetacean work in the wild in the North Pacific. Of these, 14 specify Hawaiian waters either as one location or the primary location for research. The most invasive research involves tagging or biopsy, while the remainder focus on vessel and aerial surveys and close approach for photo-identification. Species covered by these permits and authorizations include small odontocetes, sperm whales, and large mysticetes. There is one scientific research permit issued to the NMFS Pacific Islands Fisheries Science Center for Hawaiian monk seals that covers tagging, marking, relocation, rehabilitation and stranding response. One permit issued to the Office of Protected Resources, NMFS allows for responses to strandings and entanglements of listed marine mammals. NMFS has also issued General Authorizations for commercial photography of non-listed marine mammals, provided that the activity does not rise to Level A Harassment of the animals. These authorizations are usually issued for no more than 1 or 2 years, depending on the project.

Given the analysis and scrutiny given to permit applications (NEPA, MMPA, and Endangered Species Act [ESA]), it is assumed that any adverse effects are largely transitory (e.g., inadvertent harassment, biopsy effects, etc.). Further, where monitoring of individuals subjected to this level of impact is possible, required reports generally indicate either no significant behavioral changes or short-term changes with relatively quick return to normal behavior. Data to assess population level effects from research are not currently available, and even if data were available it is uncertain that research effects could be separately identified from other adverse effects to cetacean populations in Hawaiian waters.

5.4.2.7 OTHER CONSIDERATIONS

Natural stresses include storms and climate-based environmental shifts, such as algal blooms and hypoxia. Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weakening their immune systems, and making them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal.

Chronic or continuous anthropogenic sound can affect marine mammals by masking important natural sounds, causing physiological effects and stress, habituation, and sensitization (review by Richardson et al., 1995a).

The combination of potential impacts resulting from implementing either of the Proposed Alternatives and other human activities or natural occurrences can affect marine species and their habitats. In general, naturally occurring events such as earthquakes, major storms, the variable presence of prey species, and other natural forces acting on the marine environment, as well as disease processes, contamination, or biotoxins are responsible for increases or decreases in the population and distribution of marine species on a much larger scale than the dispersed, infrequent, and intermittent activity associated with a Navy Training event. However, information regarding the specific impacts these natural occurrences have on marine species is not readily available, and therefore their role in cumulative impacts is not well known.

The effects of global warming on habitats such as coral reefs could be significant. Sea level rise and sea temperature rise can result in coral die offs significantly affecting fish and sea turtle habitat. These potentially adverse impacts are could be so large in scale and area that the dispersed, infrequent, and intermittent activity associated with a Navy Training event would have no significant cumulative effect on fringing coral reefs. Deep sea corals are not likely to be affected by either global warming or Navy training activities.

Potential impacts to Essential Fish Habitat (EFH) are discussed and evaluated in *Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex EIS/OEIS* (U.S. Department of the Navy, 2007b) and a summary for each proposed Navy training activity is provided. Due to the mitigation measures implemented to protect sensitive habitats, and the localized and temporary impacts of the Proposed Action and alternatives, it is concluded that the potential impact of the Proposed Action and alternatives would have no affect on EFH.

5.5 CUMULATIVE IMPACT ANALYSIS

This section addresses the additive effects of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in combination with the projects identified in Section 5.2. Since environmental analyses for some of the projects listed are not complete or do not include quantitative data, cumulative impacts are addressed qualitatively and are described below.

5.5.1 AIR QUALITY

Activities affecting air quality in the region include, but are not limited to, mobile sources such as automobiles and aircraft, and stationary sources such as power generating stations, manufacturing operations and other industries, and volcanic eruptions. Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would result in increases in air emissions within the region of influence. However, the State of Hawaii is generally in compliance with the Federal National Ambient Air Quality Standards and the State Ambient Air Quality Standards. Air pollution levels in Hawaii are generally low due to the small size and isolation of the state. Historic air quality monitoring data do not show any recent upward or downward trends in average air quality conditions in Oahu or Hawaii (U.S. Department of the Army, 2005). Federal ozone standards have not been exceeded in Hawaii during the past decade, despite the cumulative emissions from highway traffic, commercial and military aircraft operations, commercial and industrial facility operations, agriculture operations, and construction projects in both urban and rural areas. Training events that occur in the open ocean have limited effect on air quality due to their distance offshore and meteorological conditions. For events occurring at Pacific Missile Range Facility (PMRF), a Title V Covered Source Permit has been issued and was renewed in 2003 to cover all significant stationary emissions sources on PMRF. Aircraft and missile exhaust emissions are considered mobile sources and are thus exempt from permitting requirements. Minor increases in air emissions may occur as a result of implementation of Alternatives 1, 2, and 3; however, these increases would not violate the Federal or State ambient air quality standards or any other Federal or State air standards, rules, or regulations.

5.5.2 AIRSPACE

The development of military lands prior to and after World War II had the biggest impact on airspace in the Hawaiian Islands. The expansion of military airfields continued as larger and more military aircraft were stationed in Hawaii. Following World War II, the increase in tourism resulted in an expansion of civilian airfields and airports. As with the military, the civilian aircraft increased in numbers and size requiring expansion of the existing airports. This historic development resulted in close monitoring of airspace as the land area is small in Hawaii with limited airspace (U.S. Department of the Army, 2004).

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not incrementally affect airspace within the region of influence because no airspace impacts were identified in the analysis presented in Chapter 4.0. No other projects in the region of influence have been identified that would have the potential for incremental additive cumulative impacts on controlled or uncontrolled airspace, special use airspace, military training routes, en route airways and jet routes, airports/airfields, or air traffic control. Consultation with the Federal Aviation Administration on all matters affecting airspace would eliminate the possibility of indirect adverse impacts and associated cumulative impacts on airspace use in the Hawaiian Islands.

5.5.3 BIOLOGICAL RESOURCES

5.5.3.1 OPEN OCEAN AND OFFSHORE BIOLOGICAL RESOURCES

Marine Plants and Invertebrates

Potential cumulative impacts on marine plants and invertebrates in the HRC include releases of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, and mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives. The presence of persistent organic compounds such as DDT and PCBs are of particular concern. In light of these concerns, Navy activities would have small or negligible potential impacts. There would be no long-term changes to species abundance or diversity, no loss or degradation of sensitive habitats, and no effects to threatened and endangered species. None of the potential impacts would affect the sustainability of resources, the regional ecosystem, or the human community.

Fish

Potential cumulative impacts of Navy activities include release of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives, and, physical and acoustic impacts of vessel activity. The overall effect on fish stocks would be negligible additions to impacts of commercial and recreational fishing in the HRC.

Due to the wide geographic separation of most of the operations, Navy activities would have small or negligible potential impact, and their potential impacts are not additive or synergistic.

Relatively small numbers of fish would be killed by shock waves from mines, inert bombs, and intact missiles and targets hitting the water surface. These and several other types of activities common to many exercises or tests have less-than-significant effects on fish: aircraft, missile, and target overflights; muzzle blast from 5-inch naval guns; releases of munitions constituents; falling debris and small arms rounds; entanglement in military-related debris; and chaff and flares. There would be no long-term changes in species abundance or diversity, no loss or degradation of sensitive habitats, and no significant effects to threatened and endangered species. None of the potential impacts would affect EFH, sustainability of resources, the regional ecosystem, or the human community.

Sea Turtles

Five species of sea turtles, leatherback, loggerhead, olive ridley, hawksbill, and green, may occur in the HRC. Each of these species is globally distributed, and each is listed as threatened or endangered. Refer to Section 3.1.2.3 for more complete information regarding the distribution and conservation status of these sea turtle species.

Incidental take in fishing operations, or bycatch, is one of the most serious threats to sea turtle populations (Table 5.5.3.1-1). In Hawaii, NMFS requires measures (e.g., gear modifications, changes to fishing practices, time/area closures, and incidental take limits) to reduce sea turtle bycatch in the Hawaii-based pelagic longline fisheries. These measures have significantly reduced the level of incidental take of sea turtles in these fisheries. Between 1994 and 1999 observers recorded data on 239 interactions between sea turtles and the Hawaii-based longline fisheries. The reductions in interactions and incidental takes is highlighted in the takes observed from 2003 to 2007.

Table 5.5.3.1-1. Sea Turtles Captured Incidentally in the Hawaii-Based Long Line Fishery 2003–2007

Species	Injured	Dead	Unknown
Leatherback	20	3	0
Loggerhead	45	1	0
Olive Ridley	2	37	0
Green	0	3	0
Hawksbill	0	0	0
Unidentified	1	0	1

Source: Van Fossen, 2008

Sea turtles commonly ingest or become entangled in marine debris (e.g., tar balls, plastic bags, plastic pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts, where debris and their natural food items converge. Marine pollution from coastal runoff, marina and dock construction, dredging, aquaculture, increased underwater noise, and boat traffic can degrade marine habitats used by sea turtles. Sea turtles swimming or feeding at or just beneath the surface of the water are vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death. Increased predation by sharks is also a concern for sea turtles in Hawaii. Disease, specifically fibropapillomatosis, is a threat to green turtles in some areas of the world, in particular Hawaii. In addition, scientists have documented fibropapillomatosis in populations of loggerhead, olive ridley, and flatback turtles. The effects of fibropapillomatosis at the population level are not well understood. How some marine turtle species function within the marine ecosystem is still poorly understood. Global warming could potentially have an extensive impact on all aspects of a turtle's life cycle, as well as impact the abundance and distribution of prey items. Loss or degradation of nesting habitat resulting from erosion control through beach nourishment and armoring, beachfront development, artificial lighting, non-native vegetation, and sea level rise is a serious threat affecting nesting females and hatchlings (National Oceanic and Atmospheric Administration, 2007).

Sea turtles can be found throughout the HRC; two species are known to nest in the Hawaiian Archipelago, the green and hawksbill. All five species migrate through and forage in the offshore and oceanic waters of the HRC. Adult green turtles and hawksbill turtles are more often associated with nearshore habitats where they forage and nest on selected beaches in the Northwestern Hawaiian Islands and the Main Hawaiian Islands. Temporary disturbance incidents associated with HRC activities, such as Mine Neutralization Training, Gunnery Exercise (GUNEX), Sinking Exercise (SINKEX), or Service Weapons Tests could result in an incremental contribution to cumulative impacts on sea turtles. However, the mitigation measures identified in Chapter 6.0 would minimize any potential adverse effects on sea turtles from explosives. Further, since it is not likely that sea turtles can hear MFA/HFA sonar, the Navy believes that this activity would not constitute a significant contribution to cumulative effects on sea turtles from other sources of impact including anthropogenic sound. The impacts of the No-action and Proposed Action Alternatives are not likely to affect the species' or stock's annual rates of recruitment or survival. Therefore, the incremental impacts of the No-action and Proposed Action Alternatives would not present a significant contribution to the effects on sea turtles when added to effects on sea turtles from other past, present, and reasonably foreseeable future actions.

Marine Mammals

Risks to marine mammals emanate primarily from ship strikes, exposure to chemical toxins or biotoxins, exposure to fishing equipment that may result in entanglements, and disruption or depletion of food sources from fishing pressure and other environmental factors. Potential cumulative impacts of Navy activities on marine mammals would result primarily from possible ship strikes, MFA sonar, and use of explosives.

Stressors on marine mammals and marine mammal populations can include both natural and human-influenced causes listed below and described in the following sections:

<u>Natural Stressors</u>

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Social cohesion

<u>Human-Influenced Stressors</u>

- Fisheries interactions/bycatch

- Ship strikes
- Pollution and ingestion
- Noise
- Whale watching

Natural Stressors

Significant natural causes of mortality, die-offs, and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Stranding also is caused by predation by other species such as sharks (Cockcroft et al., 1989; Heithaus, 2001), killer whales (Constantine et al., 1998; Guinet et al. 2000; Pitman et al. 2001), and some species of pinniped (Hiruki et al., 1999; Robinson et al., 1999).

Disease

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, and fungal origin (Visser et al., 1991; Dunn et al., 2001; Harwood, 2002). Gulland and Hall (2005, 2007) provide a summary of individual and population effects of marine mammal diseases.

Marine Neurotoxins

Some single-celled marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can bio-accumulate in the flesh and organs of fish and invertebrates (Geraci et al., 1999; Harwood, 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins (Van Dolah, 2005).

Weather Events and Climate Influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to local marine mammal strandings (Geraci et al., 1999; Walsh et al., 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter 1991). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker et al., 2005).

The effect of large-scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings are difficult to quantify, given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth et al. 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al. 2006), potential starvation if not successful, and corresponding stranding due directly to starvation or succumbing to disease or predation while in a weakened, stressed state (Selzer and Payne 1988; Geraci et al. 1999; Moore, 2005; Learmonth et al. 2006; Weise et al. 2006).

Navigational Error

<u>Geomagnetism</u>

Like some land animals and birds, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and areas of local magnetic anomalies may influence strandings (Bauer et al., 1985; Klinowska 1985; Kirschvink et al. 1986; Klinowska 1986; Walker et al., 1992; Wartzok and Ketten 1999).

<u>Echolocation Disruption in Shallow Water</u>

Some researchers believe stranding may result from reductions in the effectiveness of echolocation in shallow water, especially in the pelagic species of odontocetes who may be less familiar with coastlines (Dudok van Heel, 1966; Chambers and James, 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since live strandings commonly occur along beaches with shallow, sandy gradients (Brabyn and McLean, 1992; Mazzuca et al., 1999; Maldini et al., 2005; Walker et al., 2005). A factor contributing to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy in echolocation signals and reduce the perceptibility of returning echoes of interest.

Social Cohesion

Many pelagic species such as sperm whales, pilot whales, melon-head whales, and false killer whales, and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al., 1999; Conner, 2000; Perrin and Geraci, 2002; National Marine Fisheries Service, 2007).

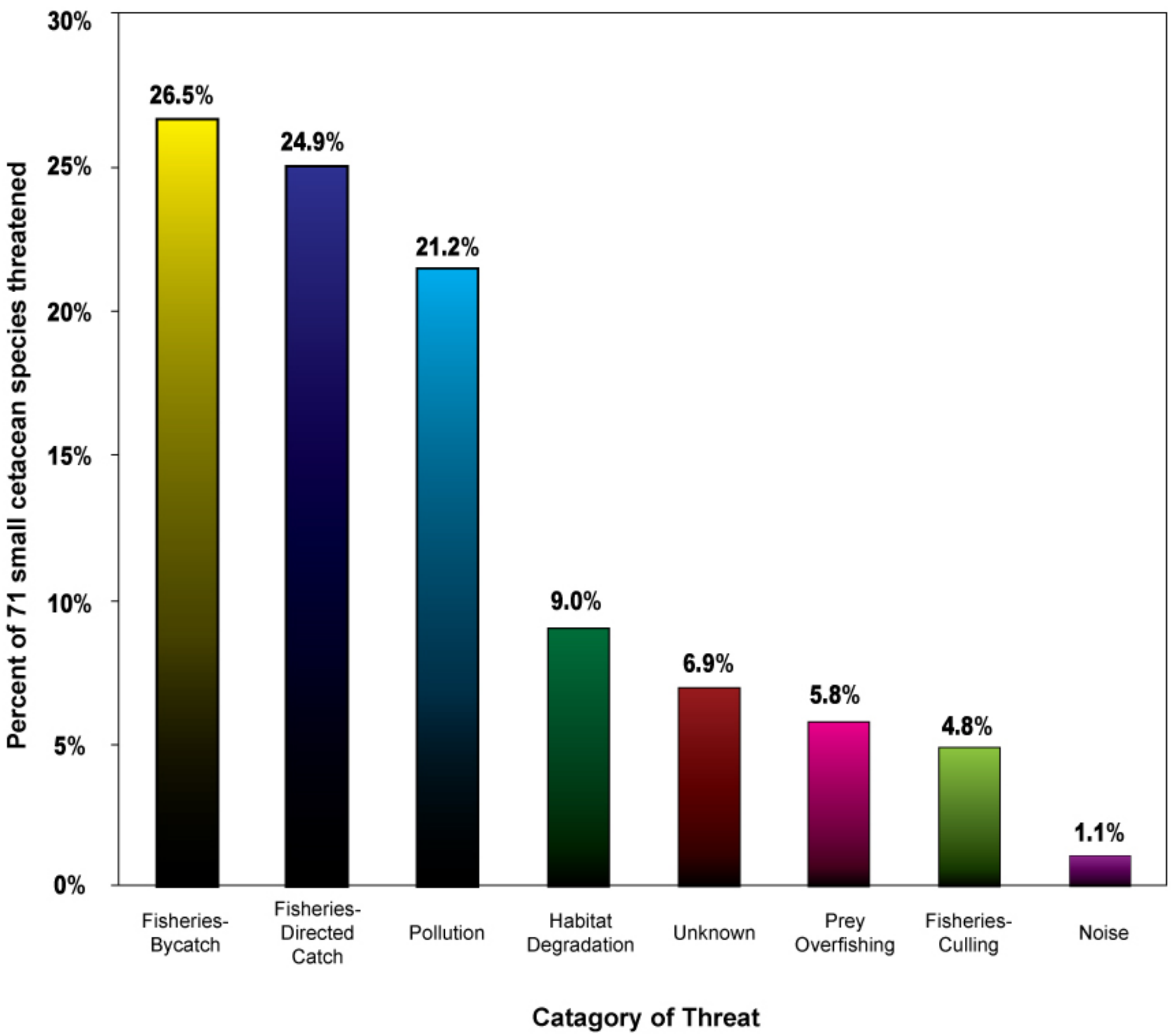
Anthropogenic Stressors

During the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al., 1999; National Marine Fisheries Service, 2007). These activities include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), ship strikes (Laist et al., 2001), and gunshots (Figure 5.5.3.1-1).

Ship Strikes

Many of the migratory species of large whales examined in this EIS/OEIS could be at risk to ship strike from all sources during their migrations within the HRC as well as their destinations outside of the HRC operating area. These species include humpback whales, fin whales, sperm whales, sei whales, Bryde's whales, and minke whales. Commercial shipping and commercial fishing could contribute to ship strike as part of cumulative effects. As noted in Jensen and Silber (2003), certain classes of vessels are likely over-represented in the data, in particular Federal vessels including Navy and Coast Guard ships, which are required to report all strikes of marine mammals. Factors that contribute to this include non-reporting by commercial vessels, failure to recognize ship-strikes by larger ships (e.g., ≥40,000 tons), smaller Navy and

Coast Guard ships, and greater numbers of dedicated observers/watch standers aboard Navy and Coast Guard ships which result in more and better reporting. Over the past decade there have been two ship strikes by Navy vessels in Hawaiian waters, each involving a humpback whale, neither of which appeared injured. One of the vessels was a submarine entering the channel at Pearl Harbor, and the other was a torpedo retrieval boat off of Kekaha, Kauai. In comparison, in 2006 there were nine ship strikes by vessels engaged in whale watching according to the Pacific Islands Region Marine Mammal Response Network.



Source: Culik, 2002

Figure 5.5.3.1-1. Human Threats to World-wide Small Cetacean Populations

Navy vessel traffic is a small fraction (approximately 2 percent) of the overall U.S. commercial and fishing vessel traffic (Jensen and Silber, 2003). While Navy vessel movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the Navy, probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles, or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Note that the majority of ships participating in Navy Training exercises, such as Navy destroyers, have a number of advantages for avoiding ship strike as compared to most commercial merchant vessels.

- The Navy ships have their bridges positioned forward, offering good visibility ahead of the bow.
- Crew size is much larger than merchant ships
- During all ASW, Mine Integrated Warfare (MIW) events and some nearshore ship movements, there are lookouts posted scanning the ocean for anything detectible in the water; anything detected is reported to the Officer of the Deck.
- Navy lookouts receive extensive training including Marine Species Awareness Training designed to provide marine species detection cues and information necessary to detect marine mammals and sea turtles.
- Navy ships are generally much more maneuverable than commercial merchant vessels.

The contribution to cumulative effects by military readiness activities within the HRC with respect to ship strike are expected to be minimal given the relatively small percentage of ship traffic represented by Navy ships and the mitigation measures identified in Chapter 6.0.

Hawaii Superferry

There is a potential for collisions between the Superferry and humpback whales in Hawaiian waters during the winter humpback season. In order to address this and other issues the State of Hawaii imposed operating restrictions on the Superferry by which include routing changes and certified lookouts/observers. A State EIS is being prepared while the ferry continues to operate. Military readiness activities within the HRC are not expected to contribute to cumulative impacts from the Superferry given the routes and training areas Navy ships use, and the mitigation measures identified in Chapter 6.0. The State EIS should also evaluate all other impacts attributable to the Superferry.

Fisheries Interaction: Bycatch, Entanglement, and Directed Catch

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al., 1999; Baird, 2002; Culik, 2002; Carretta et al., 2004; Geraci and Lounsbury, 2005; National Marine Fisheries Service, 2007b). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al., 1999; Nieri et al., 1999; Geraci and Lounsbury, 2005; Read et al., 2006; Zeeberg et al., 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al., 1999; Campagna et al., 2007). (See Figure 5.4.2.1-1).

Bycatch

Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (National Research Council, 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Within U.S. fisheries, between 1990 and 1999 the mean annual bycatch of marine mammals was 6,215 animals. Eighty-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al., 2006). Over the decade there was a 40 percent decline in marine mammal bycatch, primarily due to effective conservation measures that were implemented during this time period.

With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries are the single greatest threat to many marine mammal populations around the world (Read et al., 2006).

For Hawaii, entanglements in fishing gear are a serious concern. According to the NMFS Pacific Islands Region Marine Mammal Response Network Activity Update (dated July 2007), there were reports of 26 distressed marine mammals in Hawaii found entangled in fishing gear for the 6-month period, November to April 2007). Over a 12-month period there were five monk seals found that had been injured by fish hooks. From the NOAA Fisheries observer program to date, there have been three observed interactions with ESA listed whale species and Hawaii-based pelagic longline fisheries. Two of the incidents involved humpback whales, and one involved a sperm whale. Recent Biological Opinions associated with the Fishery Management Plan (FMP) have concluded that the region's pelagic fisheries are not likely to have an adverse effect on the populations of the seven ESA listed whale species in the region. There are documented interactions with several non-ESA listed marine mammals as well, although observer data from the Hawaii-based longline fishery show that interactions with non-ESA listed marine mammals are infrequent. At present, the Hawaii-based pelagic fisheries are classified as Category I fisheries under Section 118 of the MMPA, which defines them to have frequent incidental mortality and serious injury of marine mammals. (National Oceanic Atmospheric Administration Fisheries, 2004)

Section 118 of the MMPA requires that the NMFS implement take reduction plans to reduce interactions between commercial fishing gear and marine mammals, as necessary. NMFS has also assessed the potential risk for marine mammal interactions in the United States and assigned each fishery to a Category (Category I, II, or III) depending on the likelihood of interactions with marine mammals in a particular fishery. Additional information on NMFS' efforts to implement the MMPA and minimize interactions with marine mammals and fisheries can be found on the official NOAA website, "Marine Mammal Protection Act (MMPA) of 1972" (National Oceanic and Atmospheric Administration, 2008a).

Entanglement

Entanglement in active fishing gear is a major cause of death or severe injury among the endangered whales in the action area. Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, or manage to be set free either of their own accord or by fishermen. Many large whales carry off gear after becoming entangled (Read et al., 2006). When a marine mammal swims off with gear attached, the result can be fatal. The gear may become too cumbersome for the animal, or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies. For stranded marine mammals, death is often attributed to such interactions (Baird and Gorgone, 2005). Because marine mammals that die due to fisheries interactions may not wash ashore and not all animals that do wash ashore exhibit clear signs of interactions, data probably underestimate fishery-related mortality and serious injury (National Marine Fisheries Service, 2005b).

Directed Catch

Within the region of influence authorized whale kills from scientific research and subsistence harvest are not known to occur. Therefore, no cumulative effects are expected from military readiness activities within the HRC with respect to authorized directed kills of marine mammals.

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (National Marine Fisheries Service, 2007h). Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al., 2003; Whitehead, 2003). While this has led to mortality, the scale on which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains, and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting, and additional response during disease investigations (National Marine Fisheries Service, 2007b).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure with possible adverse health effects in marine mammals (Borell, 1993; O'Shea and Brownell, 1994; O'Hara and Rice, 1996; O'Hara et al., 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (National Marine Fisheries Service, 2007d). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (Hickie et al., 2007; Krahn et al., 2007; National Marine Fisheries Service, 2007e). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can have toxic effects such as reproductive impairment and immunosuppression (National Marine Fisheries Service, 2007d).

In addition to direct effects, marine mammals are indirectly affected by habitat contamination that degrades prey species availability, or increases disease susceptibility (Geraci et al., 1999).

Navy vessel operation between ports and exercise locations has the potential to release small amounts of pollutant discharges into the water column. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges such as bilgewater and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality or to affect marine mammals.

Anthropogenic Sound

As one of the potential stressors to marine mammal populations, noise and acoustic influences may disrupt marine mammal communication, navigational ability, and social patterns, and may or may not influence stranding. Many marine mammals use sound to communicate, navigate, locate prey, and sense their environment. Both anthropogenic and natural sounds may interfere with these functions, although comprehension of the type and magnitude of any behavioral or physiological responses resulting from man-made sound, and how these responses may contribute to strandings, is rudimentary at best (National Marine Fisheries Service, 2007b). Marine mammals may respond both behaviorally and physiologically to anthropogenic sound exposure, (e.g., Richardson et al., 1995a; Finneran et al., 2000; Finneran et al., 2003; Finneran et al., 2005). However, the range and magnitude of the behavioral response of marine mammals to various sound sources is highly variable (Richardson et al., 1995a) and appears to depend on the species involved, the experience of the animal with the sound source, the motivation of the animal (e.g., feeding, mating), and the context of the exposure.

Marine mammals are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noise that could affect ambient noise arises from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include transportation; dredging; construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonar; explosions; and ocean research activities (Richardson et al., 1995a). Commercial fishing vessels, cruise ships, transport boats, recreational boats, and aircraft, all contribute sound into the ocean (National Research Council, 2003; 2006). Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (National Research Council, 1994, 2000, 2003, 2005; Richardson et al., 1995a; Jasny et al., 2005; McDonald et al., 2006). Much of this increase is due to increased shipping due to ships becoming more numerous and of larger tonnage (National Research Council, 2003; McDonald et al., 2006). Andrew et al. (2002) compared ocean ambient sound from the 1960s with the 1990s for a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 dB in the frequency range of 20 to 80 Hz and 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period.

Navy MFA/HFA Sonar

The Navy's most powerful surface ship sonar is the SQS-53, which has the nominal source level of 235 dB re 1 squared micropascal-second (μPa^2-s) at 1.09 yards (or 1 meter [m]). Generally (based on water conditions) a ping will lose approximately 60 dB after traveling 1,000 yards from the sonar dome, resulting in a received level of 175 dB at 1,000 yards from the sonar dome. The Navy's standard mitigation measures consider the area within 1,000 yards of the bow (the sonar dome) a Safety Zone. The resulting 175 dB sound level at 1,000 yards, where the Navy's mitigation Safety Zone begins, is for comparison, less than source level produced by the vocalization of many marine mammals and less than other sounds marine mammals may be exposed to, such as humpback fluke and flipper slaps at source levels of 183 to 192 dB (Richardson et al., 1995a).

The Navy's standard mitigation measures are designed to prevent direct injury to marine mammals as a result of the sonar's acoustic energy. The Navy currently employs the mitigation measures described in Chapter 6.0. These are designed to prevent direct injury to marine mammals as a result of the sonar's acoustic energy. If any marine mammal is sighted within 1,000 yards of the bow, the sonar power is reduced by 75 percent (6 dB). The average level (195 dB) at which the onset of measurable physiological change to hearing (technically referred to as "temporary threshold shift [TTS]") could be determined occurs approximately 200 yards from a sonar dome transmitting a 1-second, 235 dB ping. The Safety Zone distance of 1,000 yards is more than four times the average distance at which the onset of a measurable and temporary physiological change occurs, and yet a significant power reduction is mandated if a marine mammal comes within this range. Additional measures, detailed in Chapter 6.0 involving exercise planning, to lessen the potential for there to be cumulative impacts or synergistic effect from the use of sonar during training exercises.

A nominal sonar ping is approximately 1 second in duration followed by a period of silence lasting 30 seconds or longer during which the MFA sonar system listens for a return reflection of that ping. An Undersea Warfare (USWEX) event can last for 72 to 96 hours, although the ASW portions of the exercise (modeled as three periods lasting approximately 16 hours each) are a subset of the total exercise timeframe. Within the ASW event where hull-mounted MFA sonar is used, the sonar system produces sound in the water only a small fraction of the time ASW is being conducted or, as in the preceding example, 2 seconds of sound every minute. When compared against naturally occurring and other man-made sources of noise in the oceans, the sonar pings during ASW events are only a brief and intermittent portion of the total acoustic noise.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995a; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions, contribute to a large vessels' noise emissions in the marine environment. Prop-driven vessels also generate noise through cavitation, which accounts much of the noise emitted by a large vessel depending on its travel speed. Military vessels underway or involved in naval operations or exercises, also introduce anthropogenic noise into the marine environment. Noise emitted by large vessels can be characterized as low-frequency, continuous, and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity, and length (Richardson et al., 1995a; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169 - 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds. Given the propagation of low-frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross 1976 in Polefka 2004). Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signature (as compared to a similarly-sized vessel) and thus reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005).

Vessel Mechanical Noise Sources

Mechanical noise on Navy ships, especially those engaged in ASW, is very quiet in comparison to civilian vessels of similar or larger size. Most Navy ships are built to reduce radiated noise so as to assist with the ship's passive ASW and make the ship harder for submarines to detect and classify them passively. This general feature is also enhanced by the use of additional quieting technologies (i.e., gas turbine propulsion) as a means of limiting passive detection by opposing submarines.

Airborne Sound Source

Airborne sound from a low-flying helicopter or airplane may be heard by marine mammals and turtles while at the surface or underwater. Due to the transient nature of sounds from aircraft involved in at-sea operations, such sounds would not likely cause physical effects but have the potential to affect behaviors. Responses by mammals and turtles could include hasty dives or turns, or decreased foraging (Soto et al., 2006); whales may also slap the water with flukes or flippers and swim away from the aircraft track.

Seismic and Explosive Sources

There are no reasonably foreseeable oil and gas exploration activities that would be occurring in the action area and thus no impacts from air guns or explosives to marine mammals are expected. Seismic exploration and nearshore/harbor construction employing explosives may contribute to anthropogenic noise within the action area. Temporary disturbance incidents associated with HRC activities, such as Mine Neutralization Training, GUNEX, SINKEX, or Service Weapons Tests could result in an incremental contribution to cumulative impacts on marine mammals. However, the mitigation measures identified in Chapter 6.0 should eliminate any potential adverse effects to marine mammals from explosives and no cumulative effects are anticipated.

MFA/HFA Sonar

Naval sonars are designed for three primary functions: submarine hunting, mine hunting, and shipping surveillance. There are two classes of sonars employed by the Navy: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (International Council for the Exploration of the Sea, 2005c).

Increases in ambient noise levels might have the potential to mask an animal's ability to detect objects, such as fishing gear, and thus increase their susceptibility to bycatch. MFA sonar transmission, however, involves a very small portion of the frequency spectrum and falls between the central hearing range of the (generally) low-frequency specializing baleen whales and the (generally) high-frequency specializing odontocetes. In addition, the active portion of MFA/HFA sonar is intermittent, brief, and individual units engaged in the exercise are separated by large distances. As a result, MFA/HFA sonar use during Navy training activities will not contribute to an increase in baseline anthropogenic ambient noise levels to any significant degree. Additional discussion of MFA/HFA operational parameters is found in Section 5.4.2.3.

During training exercises, MFA/HFA sonar will add to regional sound levels, but the cumulative effects of potential short-term and intermittent acoustic exposure to marine mammals are not well known. The analysis of potential effects of MFA sonar from training events determined there is a potential for harassment of marine mammals. It is possible that harassment in any form may cause a stress response (Fair and Becker, 2000). Cetaceans can exhibit some of the same stress symptoms as found in terrestrial mammals (Curry, 1999). Disturbance from ship traffic, noise from ships and aircraft, and/or exposure to biotoxins and anthropogenic contaminants may stress animals, weakening their immune systems, and making them more vulnerable to parasites and diseases that normally would not be fatal. Any minimal incremental contribution to cumulative impacts on marine mammals from possible temporary harassment incidents associated with military readiness training within the HRC would not likely be significant. The mitigation measures identified in Chapter 6.0 would be implemented to further minimize any potential adverse effects on marine mammals.

As discussed previously, because MFA/HFA sonar transmissions are brief and intermittent, cumulative impacts from ship strikes due to masking from MFA/HFA sonar signals are not a reasonably foreseeable significant adverse impact on marine animals

Impacts from military readiness activities associated with the HRC, including the use of MFA/HFA sonar, are not likely to affect the identified species or stock of marine mammals through effects on annual rates of recruitment or survival. Therefore, the incremental impacts from these activities would not represent a significant contribution to the cumulative effects on marine mammals or sea turtles when added to other past, present, and reasonably foreseeable future actions.

Cumulative Impacts and Synergistic Effects of LFA/MFA/HFA

MFA/HFA sonars make use of distinct and narrow fractions of the mid-frequency and high-frequency sound spectrum as noted previously. Other Navy systems (i.e., fathometers) are specifically designed to avoid use of these same frequencies, which would otherwise interfere with the MFA/HFA sonars. These HFA sonar systems generally employ weaker power levels at higher frequencies which both result rapid attenuation of the sound levels. There should, therefore, be no cumulative impacts from multiple systems using the same frequency. For the same reason, there should be no synergistic effects from the MFA/HFA systems in use during Navy training. Because of major differences in signal characteristics between LFA sonar, MFA/HFA sonar, and seismic air guns, there is negligible chance of producing a “synergistic” sound field. It is also unlikely that LFA sources, if operated in proximity to each other, would produce a sound field so complex that marine animals would not be able to escape. The potential for sound waves from multiple sources and a marine mammal would converge at the same time to cause harm to the mammal is so unlikely that it is statistically insignificant.

The potential simultaneous use of both LFA sonar and MFA/HFA sonar systems in the HRC would involve transmissions in portions of both the low, mid-, and high frequency sound spectrums. This raises a question regarding the potential for masking from the simultaneous use of these systems. There are, however, large differences between LFA and MFA/HFA sonar systems’ signal characteristics given the time of transmission, depth, vertical steering angle, waveform, wavetrain, pulse length, pulse repetition rate, bandwidth, and duty cycle. As noted above, the portion of the low frequency spectrum that LFA can affect is both small and short in duration. As described previously, MFA sonar transmissions are very brief, in a narrow frequency band, and typically on the order of a 1-second ping with 30 seconds between pings. Similarly, the HFA sources used are lower in power and generally at a single distinct frequency. Therefore, transmissions of LFA and MFA/HFA sonar, if overlapping in time, would do so only temporarily and would each be in narrow, non-overlapping and distinct frequency bands. They would, therefore, not be additive in a masking sense, even if they did overlap in time (they would mask different signals), though in the rare instances where there were overlapping signals from LFA and MFA/HFA sonar they could affect a broader portion of the broadband signals. However, due to the differences in the operational characteristics, especially signal duration, any cumulative masking effects from the simultaneous use of LFA and MFA/HFA systems are expected to be negligible and extremely unlikely.

Summary of Cumulative Impacts Associated with SURTASS LFA

Given the information provided in the SURTASS LFA Final SEIS, the potential for cumulative impacts and synergistic effects from the operations of up to four SURTASS LFA sonars was considered to be small and has been addressed by limitations proposed for employment of the system (i.e., geographical restrictions and monitoring mitigation). Even if considered in combination with other underwater sounds, such as commercial shipping, other operational, research, and exploration activities (e.g., acoustic thermometry, hydrocarbon exploration and production), recreational water activities, naturally-occurring sounds (e.g., storms, lightning strikes, subsea earthquakes, underwater volcanoes, whale vocalizations, etc.) and MFA/HFA sonar, the proposed four SURTASS LFA sonar systems would not add appreciably to the underwater sounds to which fish, sea turtle and marine mammal stocks would be exposed. Moreover, SURTASS LFA sonar will cause no lethal takes of marine mammals (U.S. Department of the Navy 2007d). Therefore, cumulative impacts and synergistic effects of the operation of up to four SURTASS LFA sonar systems in conjunction with the Proposed Action alternatives, in particular MFA/HFA, are not reasonably foreseeable.

Whale Watching

All whale and dolphin watching conducted from vessels in Hawaii are specifically directed at following, closely observing these animals, or placing swimmers/divers to swim with dolphins and whales. Conversely Navy ships attempt to avoid marine mammals and sea turtles when they are observed or detected. While these commercial whale watching activities may have as yet undetected adverse impacts on marine mammals, including population level effects, military readiness activities within the HRC are not expected to contribute to cumulative effects associated with whale watching in Hawaiian waters.

Scientific Research

The effects of scientific research on marine mammals within the HRC are not expected to be significant, and the contribution of military readiness activities within the HRC to cumulative effects of scientific research are expected to be additive but minimal with implementation of the monitoring plan and mitigation measures presented in Chapter 6.0, and scientific research permit application evaluations conducted by NMFS.

Where state, county, and private coastal development may likely affect green and hawksbill turtle foraging and resting habitat, and marine mammal habitats, particularly in the Main Hawaiian Islands, both NEPA and ESA analysis will likely be conducted to evaluate impacts on these species. Based on the mitigation measures presented in Chapter 6.0, military readiness activities within the HRC are not expected to contribute to cumulative effects on sea turtle habitat.

It is worthy of mention that the causes for concern involving whale mortalities generally involve beaked whales at other locations (such as the Bahamas) occurring far from Hawaii, which do not relate to the Hawaiian context (see discussion on the critical nature of "context" presented in Southall et al. (2007)). There have been no known strandings or deaths of any beaked whales associated with the use of sonar in Hawaii. It has also been suggested that marine mammals will not strand in Hawaii, but would die and sink at sea. As discussed in Chapter 4, the claim that a significant number of marine mammal carcasses would be missed is unreasonable, not supported by science, and not supported by the regular occurrence of floating or stranded marine mammals in Hawaii. For the reasons noted above, the Navy does not believe that continuing what has been decades of sonar use in Hawaii will result in any injury to beaked whales or other marine mammals.

Summary of Cumulative Impacts to Open Ocean and Offshore Biological Resources

As discussed above, there should be no cumulative impacts to marine plants, invertebrates, fish, or sea turtles as a result of the Proposed Actions. All Level B harassments of marine mammals are quantified in a cumulative manner given that they are a summation of individual estimated exposures over an annual basis before consideration of the Navy's standard operating procedures, which serve as mitigation measures. It is unlikely there will be any impacts in addition to the behavioral harassments given these standard protective measures. The Navy does not believe that there will be any significant cumulative impacts to marine mammals in the HRC as a result of the Proposed Actions. In total, impacts resulting from the Proposed Actions in the HRC are not expected to result in any significant cumulative impacts to affected Open Ocean and Offshore resources.

5.5.3.2 ONSHORE BIOLOGICAL RESOURCES

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 could affect terrestrial biological resources within the region of influence. Several events contribute cumulatively to habitat degradation, including disturbance to soils and vegetation, spread of invasive non-native species, erosion and sedimentation, and impacts on native plant species. Although individual impacts may be less than significant, collectively they have the potential to be significant over time and space. Some potential effects of invasive species are difficult to foresee (such as leading to a change in fire frequency or intensity); however, it is clear that the potential for damage associated with introduction or spread of invasive plant species is high and increases over time with repeated training missions, especially exercises that cover a very large area, because of the difficulty in effectively monitoring for invasive establishment and achieving timely control. The Navy is addressing these effects with several strategies including (1) implementation of Integrated Natural Resources Management Plans (INRMPs), (2) continued development and implementation of measures to prevent the establishment of invasive plant species by minimizing the potential for introductions of seed or other plant parts (propagules) of exotic species, and (3) finding and eliminating incipient populations before they are able to spread. Key measures include:

- Minimizing the amount of seed or propagules of non-native plant species introduced to the islands through continued efforts to remove seed and soil from all vehicles (including contractor vehicles) coming to the island by pressure washing at the ports of debarcation, and stepped up efforts to ensure that imported construction materials such as sand, gravel, aggregate, or road base material are weed free.

- Regular monitoring and treatment to detect and eliminate establishing exotic species, focusing on areas where equipment and construction materials come ashore and areas within which there is movement of equipment and personnel and soil disturbance which favor the spread and establishment of invasive species (e.g., along roadsides, and disturbed areas).
- Effective measures to foster the reestablishment of native vegetation in areas where non-native vegetation is present.
- Prohibiting living plant materials to be brought to the islands from the mainland (in order to avoid introduction of inappropriate genetic strains of native plants or exotic species, including weeds, insects and invertebrates).

Although there are impacts associated with the implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 on terrestrial biology within the HRC; these impacts would be mitigated to less than significant level. Any construction project or training event would be required to be in compliance with the established INRMP and U.S. Fish and Wildlife Service Biological Opinions. In addition, any project proposed within the HRC affecting threatened or endangered species would have included ESA Section 7 consultation addressing direct, indirect, and cumulative impacts.

5.5.4 CULTURAL RESOURCES

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not result in significant cumulative impacts on cultural resources. The types of impacts typically associated with the alternatives include disturbance of archaeological or Native Hawaiian sites during ground disturbance (construction or troop/equipment movement) or the unanticipated discovery of archaeological materials. In accordance with Section 106 of the National Historic Preservation Act (36 CFR 800), cultural resources mitigation measures as described in the various sections of Chapter 4.0 would be implemented, including avoidance of resources (the preferred mitigation) and/or implementation of specific requirements already outlined in agency planning documents for the affected area (e.g., Integrated Cultural Resource Management Plans, Programmatic Agreements, Memorandums of Agreement). Some actions may also require the development of additional mitigation measures through consultation with the Hawaii State Historic Preservation Office, Council (as appropriate), and local Native Hawaiian organizations. Given the rigorous review process required under Section 106 prior to activities taking place, the measures already in place within agency planning documents to mitigate potential effects, and the diverse range of locations where activities would occur (representing different cultural contexts and site types), the implementation of alternatives presented in this EIS/OEIS, either individually or as a whole, would not result in significant cumulative impacts.

5.5.5 GEOLOGY AND SOILS

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not result in significant impacts on geology and soils within the region of influence. The impacts on geology are very minor and mostly consist of limited temporal and spatial disturbances to underwater sediments or localized soil disturbance in previously disturbed areas on the islands. Erosion is a naturally recurring issue, but it is not heavily exacerbated by military activities. While construction type projects in the region may have localized erosion, overall cumulative effects would be negligible since Best Management Practices for soil disturbing activities are typically implemented during any construction activity.

5.5.6 HAZARDOUS MATERIALS AND WASTE

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not result in cumulative impacts associated with the use of hazardous materials within the region of influence. There are a large number of hazardous materials inherent in the training and RDT&E activities within the HRC. For ordnance items that are used in the water, torpedoes are typically recovered , while the vast majority of non-ordnance items such as sonobuoys are not recovered. Sonobuoys that are not recovered are expended The primary concern with sonobuoys is the metal in the batteries, but studies have shown that with the three types of batteries in use, there is no substantial degradation of marine water quality. There are no hazardous waste disposal sites located on any of the Hawaiian Islands. Hazardous waste is barged to disposal facilities. There are no capacity issues in regards to hazardous waste because it is only sent to a facility that will accept the waste.

The primary impact of cumulative hazardous materials use in the HRC would be to increase the amounts of hazardous constituents that are released to the environment. Hazardous materials settling out of the water column would contribute to contamination of ocean bottom sediments. Relevant activities would include releases of hazardous constituents from fishing vessels, other ocean vessels, wastewater treatment plant outfalls, and non-point source pollution from terrestrial sources. The effects of these activities in the HRC are known only in a very general sense.

Commercial ocean industries, such as fishing and ocean transport, are dispersed over broad areas of the ocean. Discharges of hazardous constituents from non-point source runoff and treatment plant outfalls mostly affect the waters within 3 nm of the coast, whereas most of the Navy activities occur beyond the 12 nm limit of Federal waters. The quantities of contaminants released, however, would be cumulatively insignificant relative to the volume of the water and the area of bottom sediments affected. The use of hazardous materials by the Navy when added to that of other projects, would not significantly impact resources in the HRC.

The primary impact of hazardous materials on Kauai and Oahu would be to contribute contaminants to surface soils and to surface runoff into the ocean. Construction projects and maintenance activities on Kauai and Oahu beyond those included as part of the Proposed Action could also contribute minor amounts of hazardous contaminants to surface soils. The contributions of these other projects would be very minor, however, in comparison to the effects of the training and testing activities. Thus, the cumulative impacts would be substantially the same as the impacts described under each alternative.

5.5.7 HEALTH AND SAFETY

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not affect public health and safety within the region of influence. The major factors influencing this analysis are: (1) the distance of hazardous operations from the islands; (2) the dispersed context of the hazardous operations, such that the intensity of the effects are not additive; (3) the lack of synergistic effects; (4) comprehensive Navy safety procedures in place to ensure that members of the general public are not placed in physical jeopardy due to RDT&E and training at sea; and (5) specific range clearance procedures and practices implemented daily prior to commencement of hazardous operations. Based on these factors, no significant cumulative impacts would occur relative to public health and safety.

5.5.8 LAND USE

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the identified cumulative actions listed in Table 5.4.1-1 would not affect land use within the region of influence because no adverse land use impacts were identified in Chapter 4.0, and most training activities would occur on existing military installations and ranges with no change in use or land use designation. All proposed land uses would be compatible with State of Hawaii planning efforts. PMRF would continue to maintain a strip of coastline for public recreational purposes (except when closed for hazardous operations). Overall, recreational resources would continue to be protected and shoreline access would continue to be unimpeded.

5.5.9 NOISE

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not incrementally affect noise within the region of influence. Noise levels are inherently localized because sound levels decrease relatively quickly with increasing distance from the source. Cumulative impacts would occur when multiple projects affect the same geographic areas simultaneously or when sequential projects extend the duration of noise impacts on a given area over a longer period of time. The noise environment in the Hawaiian Islands has changed over the years with the increase in human activity. The increased level of training proposed under Alternatives 1, 2, or 3 would increase noise levels; however, noise levels from training would be intermittent and similar to other noise levels already experienced in the region of influence. In addition, spatial separation among the cumulative projects listed in Table 5.4.1-1 would minimize or preclude cumulative noise impacts within the region of influence.

As part of the Proposed Action, the Navy is proposing to conduct Field Carrier Landing Practice (FCLP) approximately 16 times per year. For each pilot conducting this activity, the FCLP would include 8 to 10 touch-and-go landings during both daytime and at night (refer to Table 2.2.2.3-1). The landings would take place on existing airport runways at MCBH on Oahu or PMRF airfield on Kauai. Because FCLPs would only occur intermittently in association with transiting Strike Groups participating in Major Exercises and would only occur on existing airport runways, these activities would have only minimal effects on noise levels in the region of influence. For the open ocean, the cumulative impact of these projects in a regional context does not reach a level of significance because of the intermittent nature of the noise events and the lack of sensitive receptors over the large ocean areas involved. Potential cumulative impacts associated with underwater noise and impacts on marine mammals are addressed in Section 5.4.2.

On Oahu, the Honolulu International Airport is a major commercial hub for air traffic throughout the Pacific. Introduction of additional military aircraft (P-8A MMA and F-22) noted in Table

5.4.1-1 would not be expected to have a substantial effect on noise contours, which are dominated by commercial traffic.

5.5.10 SOCIOECONOMICS

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not result in significant socioeconomic impacts within the region of influence. Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 would not produce any significant regional employment, income, housing, or infrastructure impacts. Effects on commercial and recreational fishermen, commercial tour boats, divers, and boaters would be short term in nature and produce some temporary access limitations. Some offshore events, especially if coincident with peak fishing locations and periods or whale migration periods, could cause temporary displacement and potential economic loss to individual fishermen and commercial tour boat operators. However, most offshore events are of short duration and have a small operational footprint. Effects on fishermen and commercial tour boat operators are mitigated by public notification of scheduled activities. In selected instances where safety requires exclusive use of a specific area, commercial fishing vessels, commercial vessels, or private vessels may be asked to relocate to a safer nearby area for the duration of the exercise. These measures should not significantly impact any individual fisherman, overall commercial revenue, or public recreational opportunity in the open ocean area. Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 would not affect minority or low-income populations disproportionately, nor would children be exposed to increased noise levels or safety risks because events mainly occur at sea.

5.5.11 TRANSPORTATION

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the cumulative actions listed in Table 5.4.1-1 would not represent a significant increase in average daily traffic on island roadways or vessel traffic in the open ocean. Within the regional context of the Hawaiian Islands, there are large numbers of ship and boat movements. Ship traffic continues to increase on a yearly basis. However, commercial shipping and Navy ship traffic generally tends to steam to and from its original location. Navy ships conducting training events typically remain in range areas for training and RDT&E. Navy training events do not have a significant impact on other vessel traffic in the Hawaiian waters. In regards to the Hawaii Superferry, given the location of the ferry water lanes, it is not anticipated that the increased vessel traffic from this commuting vessel would contribute to the cumulative effects when assessed in combination with the actions proposed in this EIS/OEIS.

5.5.12 UTILITIES

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the identified cumulative actions listed in Table 5.4.1-1 would not affect utility services within the region of influence because no adverse impacts were identified in Chapter 4.0, and there are no major proposed increases or changes in utility service demand. In addition, implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 would not result in an increase in personnel that would increase utility demand.

5.5.13 WATER RESOURCES

Implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 in conjunction with the identified cumulative actions listed in Table 5.4.1-1 would not result in significant impacts on water quality within the region of influence. For offshore training, the Navy would comply with the *Oil and Hazardous Substance Release and Contingency Plan* (40 CFR 300) developed for Navy activities within the HRC. Water quality impacts associated with implementation of the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 are transitory in nature and would not reach a level of significance even in conjunction with the impacts of the other actions considered in a regional context.

6.0 Mitigation Measures

6.0 MITIGATION MEASURES

Effective training in the proposed Hawaii Range Complex (HRC) areas dictates that ship, submarine, and aircraft participants utilize their sensors and weapon systems to their optimum capabilities as required by the exercise objectives. The Navy recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of training (as outlined in Chapter 4.0). National Environmental Policy Act (NEPA) regulations require that an Environmental Impact Statement (EIS) include analysis of appropriate mitigation measures not already included in the Proposed Action or alternatives (40 Code of Federal Regulations [CFR] § 1502.14 [h]). Each of the alternatives, including the Proposed Action considered in this EIS/Overseas EIS (OEIS), includes mitigation measures intended to reduce the environmental effects of Navy activities as discussed throughout this EIS/OEIS.

This chapter presents the Navy's standard protective measures in detail, outlining steps that would be implemented to protect marine mammals and federally listed species during training events. These protective measures will mitigate impacts resulting from training. It should be noted that protective measures have been standard operating procedures since 2004 for all levels of training from unit-level training through Major Exercises. This chapter also presents a discussion of other measures that have been considered but not adopted because they were determined either: (1) not feasible; (2) to present a safety risk; (3) to provide no known or ambiguous protective benefit; or (4) to have an unacceptable impact on training fidelity.

In addition, in order to issue the Marine Mammal Protection Act (MMPA) authorization required for certain activities, it might be necessary for National Marine Fisheries Service (NMFS) to require additional mitigation or monitoring measures beyond those addressed in the EIS/OEIS. These could include measures considered, but eliminated in the EIS/OEIS, or as yet developed measures. The public will have an opportunity to provide information to NMFS through the MMPA process, both during the comment period following NMFS' Notice of Receipt of the Navy's application for a Letter of Authorization (LOA), and during the comment period following publication of the proposed LOA. NMFS may propose additional mitigation or monitoring measures. Measures not considered in the mitigation and monitoring measures in this EIS/OEIS, but required through the MMPA process, might require evaluation in accordance with the National Environmental Policy Act. In doing so, NMFS may consider "tiering," that is, incorporating this EIS/OEIS during the MMPA process.

6.1 CURRENT MITIGATION MEASURES

Current protective measures employed by the Navy include applicable training of personnel and implementation of activity specific procedures resulting in minimization and/or avoidance of interactions with protected resources.

Navy shipboard lookout(s) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, a marine mammal) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

Navy lookouts undergo extensive training in order to qualify as a watchstander. This training includes on-the-job instruction under the supervision of an experienced watchstander, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects and night observation techniques). In addition to these requirements, many Fleet lookouts periodically undergo a 2-day refresher training course.

The Navy includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Marine Species Awareness Training (MSAT) was updated in 2005, and the additional training materials are now included as required training for Navy lookouts. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species. Marine species awareness and training is reemphasized by the following means:

- **Bridge personnel on ships and submarines**—Personnel utilize marine species awareness training techniques as standard operating procedure, they have available a marine species visual identification aid when marine mammals are sighted, and they receive updates to the current marine species awareness training as appropriate.
- **Aviation units**—Pilots and air crew personnel whose airborne duties during Anti-Submarine Warfare (ASW) operations include searching for submarine periscopes would be trained in marine mammal spotting. These personnel would also be trained on the details of the mitigation measures specific to both their platform and that of the surface combatants with which they are associated.
- **Sonar personnel on ships, submarines, and ASW aircraft**—Both passive and active sonar operators on ships, submarines, and aircraft utilize protective measures relative to their platform. The Navy issues a Letter of Instruction for each Major Exercise which mandates specific actions to be taken if a marine mammal is detected, and these actions are standard operating procedure throughout the exercise.

Implementation of these protective measures is required of all units. The activities undertaken on a Navy vessel or aircraft are highly controlled. The chain of command supervises these activities. Failure to follow orders can result in disciplinary action.

As noted previously, on January 23, 2007, the Deputy Secretary of Defense issued National Defense Exemption (NDE) II exempting all military readiness activities that employ mid-frequency active (MFA) sonar during Major Exercises or within established Department of Defense (DoD) maritime ranges or established operating areas (OPAREAs) from the permitting requirements of MMPA. This exemption covers activities for 2 years from the signing of NDE II. To adhere with NDE II, all exempt military readiness activities employing MFA sonar must follow the required 29 mitigation measures detailed below under three topic headings: Personnel Training (Section 6.1.1); Lookout and Watch Stander Responsibilities (Section 6.1.2); and Operating Procedures (Section 6.1.3). One Operating Procedure involving Safety Zones varies slightly from the NDE II text based on coordination between Navy and NMFS and is captured in its current form in Section 6.1.3. The NDE II language is provided in footnotes. Procedures involving coordination and reporting (the remaining three measures stipulated in the NDEII) are presented in the subsequent section titled Coordination and Reporting since they are not mitigation measures per se.

6.1.1 PERSONNEL TRAINING

All lookouts onboard platforms involved in ASW training events will review the NMFS approved MSAT material prior to MFA sonar use.

All Commanding Officers, Executive Officers, and officers standing watch on the Bridge will have reviewed the MSAT material prior to a training event employing the use of MFA sonar.

Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).

Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not preclude personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.

Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

6.1.2 LOOKOUT AND WATCHSTANDER RESPONSIBILITIES

On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.

In addition to the three personnel on watch noted previously, all surface ships participating in ASW exercises will have at all times during the exercise at least two additional personnel on watch as lookouts.

Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.

On surface vessels equipped with MFA sonar, pedestal mounted “Big Eye” (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).

After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.

Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

6.1.3 OPERATING PROCEDURES

A Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal protective measures.

Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

During MFA sonar operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yards of the sonobuoy.

Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically), the Navy will ensure that MFA transmission levels are limited to at least 6 decibels (dB) below normal operating levels if any detected animals are within 1,000 yards of the sonar dome (the bow)[1].

1 NDE II language provides as follows: When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yards of the sonar dome (the bow), the ship or submarine will limit MFA transmission levels to at least 6 decibels (dB) below normal operating levels.

(i) Ships and submarines will continue to limit maximum MFA transmission levels by this 6-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

(ii) The Navy will ensure that MFA sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level if any detected animals are within 500 yards of the sonar dome. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.[2]

(iii) The Navy will ensure that MFA sonar transmissions will cease if any detected animals are within 200 yards of the sonar dome. MFA sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.[3]

(iv) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the Officer of the Deck concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

(v) If the need for MFA sonar power-down should arise as detailed in “Safety Zones” above, the ship or submarine shall follow the requirements as though they were operating MFA sonar at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 dB the MFA sonar was being operated).

Prior to start up or restart of MFA sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.

MFA sonar levels (generally)—the ship or submarine will operate MFA sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

---

2 NDE II language provides as follows: Should a marine mammal be detected within or closing to inside 500 yards of the sonar dome, MFA sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

3 NDE II language provides as follows: Should the marine mammal be detected within or closing to inside 200 yards of the sonar dome, MFA sonar transmissions will cease. MFA sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW events involving MFA sonar.

Increased vigilance during major ASW training with tactical MFA sonar when critical conditions are present.

Based on lessons learned from strandings in the Bahamas (2000), Madeira (2000), the Canaries (2002), and Spain (2006), beaked whales are of particular concern since they have been associated with MFA sonar operations. The Navy should avoid planning major ASW training with MFA sonar in areas where they will encounter conditions that, in their aggregate, may contribute to a marine mammal stranding event.

The conditions to be considered during exercise planning include:

(i) Areas of at least 1,000-meter (m) depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000 m to 6,000 m occurring across a relatively short horizontal distance (e.g., 5 nautical miles [nm]).

(ii) Cases for which multiple ships or submarines (≥ 3) operating MFA sonar in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10 nm apart).

(iii) An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein events involving multiple ships/subs (≥ 3) employing MFA sonar near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.

(iv) Although not as dominant a condition as bathymetric features, the historical presence of a strong surface duct (i.e., a mixed layer of constant water temperature extending from the sea surface to 100 or more feet).

If the Major Exercise must occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. The Navy will increase vigilance by undertaking the following additional protective measure:

A dedicated aircraft (Navy asset or contracted aircraft) will undertake reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. Where practical, advance survey should occur within about 2 hours prior to MFA sonar use, and periodic surveillance should continue for the duration of the exercise. Any unusual conditions (e.g., presence of sensitive species, groups of species milling out of habitat, any stranded animals) shall be reported to the Officer in Tactical

Command, who should give consideration to delaying, suspending, or altering the exercise.

All safety zone power-down requirements described in Measure 20 apply. The post-exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location and time/duration of the event, and noting results of surveys conducted.

6.1.4 CURRENT MITIGATION MEASURES ASSOCIATED WITH EVENTS USING EER/IEER SONOBUOYS

The following are mitigation measures for use with Extended Echo Ranging/Improved Extended Echo Ranging (EER/IEER) given an explosive source generates the acoustic wave used in this sonobuoy.

1. Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 500 yards at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews are allowed to conduct coordinated area clearances.

2. Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

3. For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yards of observed marine mammal activity, deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yards of the intended post position, co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.

4. When able, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of communication range of these sensors.

5. Aural Detection: If the presence of marine mammals is detected aurally, then that should cue the aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.

6. Visual Detection:
   a. If marine mammals are visually detected within 1,000 yards of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 10 minutes, or are observed to have moved outside the 1,000 yards safety buffer.
   b. Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000 yards safety buffer.

7. Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the “Payload 1 Release” command followed by the “Payload 2 Release” command. Aircrews shall refrain from using the “Scuttle” command when two payloads remain at a given post. Aircrews will ensure that a 1,000 yards safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

8. Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.

9. Ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

10. Mammal monitoring shall continue until out of own-aircraft sensor range.

6.1.5 MFA/HFA SONAR USE ASSOCIATED WITH TRAINING EVENTS IN THE HUMPBACK WHALE CAUTIONARY AREA

Humpback whales migrate to the Hawaiian Islands each winter to rear their calves and mate. Data indicate that, historically, humpback whales have clearly concentrated in high densities in certain areas around the Hawaiian Islands. NMFS has reviewed the Navy’s data on MFA sonar training in these dense humpback whale areas since June 2006 and found it to be rare and infrequent. While past data is no guarantee of future activity, it documents a history of low level MFA sonar activity in dense humpback areas. In order to be successful at operational missions and against the threat of quiet, diesel-electric submarines, the Navy has, for more than 40 years, routinely conducted ASW training in Major Exercises in the waters off the Hawaiian Islands, including the Humpback Whale National Marine Sanctuary. During this period, no reported cases of harmful effects to humpback whales attributed to MFA sonar use have occurred. Coincident with this use of MFA sonar, abundance estimates reflect an annual increase in the humpback whale stock (Mobley, 2001, 2004).

NMFS and the Navy explored ways of affecting the least practicable impact (which includes a consideration of practicality of implementation and impacts to training fidelity) to humpback whales from exposure to MFA sonar. Proficiency in ASW requires that Sailors gain and maintain expert skills and experience in operating MFA sonar in myriad marine environments. Exclusion zones or restricted areas are impracticable and adversely impact MFA sonar training fidelity. The Hawaiian Islands, including areas in which humpback whales concentrate, contain unique bathymetric features the Navy needs to ensure Sailors gain critical skills and experience by training in littoral waters. Sound propagates differently in shallow water. No two shallow water areas are the same. Each shallow water area provides a unique training experience that could be critical to address specific future training requirements. Given the finite littoral areas in the Hawaii Islands area, maintaining the possibility of using all shallow water training areas is required to ensure Sailors receive the necessary training to develop and maintain critical MFA sonar skills. In real world events, crew members will be working in these types of areas and these are the types of areas where the adversary's quiet diesel-electric submarines will be operating. Without the critical ASW training in a variety of different near-shore environments, crews will not have the skills and varied experience needed to successfully operate MFA sonar in these types of waters, negatively affecting vital military readiness.

The Navy recognizes the significance of the Hawaiian Islands for humpback whales. The Navy has designated a humpback whale cautionary area (described below), which consists of a 5-km buffer zone that has been identified as having one of the highest concentrations of humpback whales during the critical winter months. The Navy has agreed that training exercises in the humpback whale cautionary area will require a much higher level of clearance than is normal practice in planning and conducting MFA sonar training. Should national security needs require MFA sonar training and testing in the cautionary area between 15 December and 15 April, it shall be personally authorized by the Commander, U.S. Pacific Fleet (CPF). The CPF shall base such authorization on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for humpback whales and the need to minimize adverse impacts on humpback whales from MFA sonar whenever practicable. Approval at this level for this type of activity is extraordinary. CPF is a four-star Admiral and the highest ranking officer in the U.S. Pacific Fleet. This case-by-case authorization cannot be delegated and represents the Navy's commitment to fully consider and balance mission requirements with environmental stewardship. Further, CPF will provide specific direction on required mitigation prior to operational units transiting to and training in the cautionary area. This process will ensure the decisions to train in this area are made at the highest level in the Pacific Fleet, heighten awareness of humpback whale activities in the cautionary area, and serve to reemphasize that mitigation measures are to be scrupulously followed. The Navy will provide NMFS with advance notification of any such activities.

6.1.5.1 HUMPBACK WHALE CAUTIONARY AREA

The Humpback Whale Cautionary Area is defined as follows: an area extending 5 km from a line drawn from Kaunakakai on the island of Molokai to Kaena Point on the Island of Lanai; and an area extending 5 km from a line drawn from Kaunolu on the Island of Lanai to the most Northeastern point on the Island of Kahoolawe; and within a line drawn from Kanapou Bay on the Island of Kahoolawe to Kanahena Point on the Island of Maui and a line drawn from Cape Halawa on the Island of Molokai to Lipo Point on the Island of Maui, excluding the existing submarine operating area.

6.1.5.2 CAUTIONARY AREA USE, AUTHORIZATION, AND REPORTING

Should national security needs require MFA sonar training and testing in the cautionary area between 15 December and 15 April, it must be personally authorized by the Commander, U.S. Pacific Fleet based on his determination that training and testing in that specific area is required for national security purposes. This authorization shall be documented by the CPF in advance of transiting and training in the cautionary area. Further, CPF will provide specific direction on required mitigation measures prior to operational units transiting to and training in the cautionary area.

The Navy will provide advance notification to NMFS of any such activities.

The Navy will include in its periodic reports for compliance with the MMPA whether or not activities occurred in the area above and any observed effects on humpback whales due to the conduct of these activities.

6.1.6 EVALUATION OF CURRENT MITIGATION MEASURES

The Navy's current mitigation measures reflect the use of the best available science, balanced with the Navy's training needs. To understand the development of these mitigation measures, it is necessary to review the events arising out of the MMPA Incidental Harassment Authorization (IHA) that Navy obtained for Rim of the Pacific (RIMPAC) 2006.

The 2006 RIMPAC IHA was issued on June 27, 2006. It set forth mitigation measures regarding personnel training, use of aviation units to look for marine mammals, use of sonar personnel using passive indicators to check for marine mammals, limits on the sonar levels (generally), coastal exclusion zones, exclusion areas, safety zones, restrictions associated with "choke-points," surface ducting conditions and low visibility, stranding response and reporting protocols. Most of the measures, especially the ones later determined to have been most effective, were already Navy standard operating procedure.

Three days after issuance of the IHA (on June 30, 2006), following consultations with the Department of Commerce and pursuant to Title 16, Section 1371(f) of the United States Code (U.S.C.), the DoD authorized an NDE for a period of 6 months. The NDE exempted military readiness activities from compliance with the requirements of the MMPA involving the use of mid-frequency active (MFA) sonar during major training exercises and on established ranges and operating areas. The Deputy Secretary of Defense required RIMPAC 2006 activities to adhere to the mitigation measures in the 2006 RIMPAC IHA.

Because the RIMPAC 2006 IHA was the first authorization issued by NMFS for MFA sonar use, the mitigation measures required by NMFS in the IHA were purposefully inclusive of all potential mitigation measures without knowledge of either their effectiveness or impact on training fidelity. The IHA recognized the uncertainty associated with the effectiveness of the mandated mitigation measures and therefore required that a report be generated after RIMPAC 2006 that would provide "an assessment of the effectiveness of the mitigation and monitoring measures with recommendations on how to improve them."

In December 2006, the Navy produced the *2006 RIMPAC After-Action Report,* which it subsequently provided to NMFS*.* The assessment consisted of a review of compiled data from operators involved in the exercise, exercise reconstructions, and details of marine mammal detections by exercise participants, shore-based observers, and an aerial marine mammal survey (see Appendix F). The report concluded that certain measures in the IHA should be removed from future consideration because they proved not feasible, presented a safety risk, provided no known or unambiguous protective benefit (having no basis in scientific fact), and/or because they impacted the effectiveness of the required training.

Following the issuance of the *2006 RIMPAC After-Action Report* and consultation between the Navy and NMFS, NDE II was issued. The NDE II included 29 mitigation measures, which incorporated and refined the Navy's standard operating procedures and the measures set forth in the 2006 RIMPAC IHA and NDE I. All of the mandatory mitigation measures contained within NDE II have been utilized in all Navy training in the HRC conducted since January 2007.

After action reports for recent exercises in HRC (see Appendix F) indicate that protective measures have resulted in the minimization of sonar exposure to detected marine mammals. There have been no known instances of marine mammals behaviorally reacting to the use of sonar during these exercises.

The current measures are effective because the typical distances to a received sound energy level associated with temporary threshold shift (TTS) are typically within 200 m of the most powerful active sonar used in the HRC (the AN/SQS 53 MFA sonar); The current safety zone for implementation of power-down and shut-down procedures begins when marine mammals come within 1,000 yards of that sonar.

The Navy has continued to revise mitigation measures based on the best available scientific data, the Navy's training requirements, and evolving regulations. The Navy has previously analyzed and eliminated from further consideration several mitigation measures, many of which were suggested during the public comment period. Potential alternative mitigation or protective measures were assessed based on supporting science, their likely effectiveness in avoiding harm to marine mammals, the extent to which they would adversely impact military readiness activities, including personnel safety, and the practicality of implementation, and impact on the effectiveness of the military readiness activity. These measures, many which were considered previously by the Navy, are discussed in the following section.

6.2 ALTERNATIVE AND/OR ADDITIONAL MITIGATION MEASURES

A number of possible alternative and/or additional mitigation measures have been reviewed in the past in the development of the current measures or have suggested during the public comment period. This section presents those measures and an evaluation based on known science, likely effectiveness, impact to military readiness activities personnel safety, and the practicality of implementation. Alternative measures in addition to those currently in use include the following:

- Using non-Navy personnel onboard Navy vessels to provide surveillance of ASW or other training events to augment Navy lookouts.
- Use non-Navy observers for visual surveillance.
- Survey before, during, and after training events to preclude sonar use.
- Avoid areas seasonally.
- Avoid areas with problematic complex/steep bathymetry and/or seamounts.
- Avoid particular habitats.
- Avoid active sonar use within (1) 12 nautical miles (nm) from shore; (2) 25 kilometers (km) (15.5 miles [mi]) from the 200-m isobath; or (3) 25 nm from shore.

- Use active sonar with output levels as low as possible consistent with mission requirements.
- Use active sonar only when necessary.
- Suspending training at night, periods of low visibility, and in high sea-states when marine mammals are not readily visible.
- Reducing power in strong surface duct conditions.
- Scaling down training to meet core aims.
- Limiting the active sonar event locations.
- Use passive acoustic monitoring to detect and avoid marine mammals.
- Use ramp-up to attempt to clear an exercise area prior to the use of sonar.
- Reduce vessel speed.
- Reporting marine mammal sightings to augment scientific data collection.
- Use of new technology (e.g., unmanned reconnaissance aircraft, underwater gliders, instrumented ranges) to detect marine animals.
- Use of larger shut-down zones.
- Restricting Navy training in “choke-points.”
- Adopt mitigation measures of foreign nation navies.

6.2.1 EVALUATION OF ALTERNATIVE AND/OR ADDITIONAL MITIGATION MEASURES

There is a distinction between effective and feasible monitoring procedures for data collection and measures employed to prevent impacts or otherwise serve as mitigation. The discussion below is in reference to those procedures meant to serve as mitigation measures.

- Using non-Navy personnel onboard Navy vessels to provide surveillance of ASW or other training events to augment Navy lookouts.
  - The protection of marine mammals is provided by a lookout sighting the mammal and prompting immediate action. The premise that Navy personnel cannot or will not do this is unsupportable. Navy lookouts are extensively trained in spotting items at or near the water surface and utilizing chain of command to initiate action. Navy lookouts utilize their skills more frequently than many third party trained marine mammal observers.
  - Use of Navy lookouts is the most effective means to ensure quick and effective communication within the command structure and facilitate implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication via the chain of command. Navy lookouts are trained to report swiftly and decisively using precise terminology to ensure that critical information is passed to the appropriate supervisory personnel.

- Berthing space during Major Exercises, such as USWEX, is very limited. With exercise lengths of 1 to 3 weeks, and given limited at sea transfer, this option would mean that even if berthing is available, a biologist would have to depart with the ship as it leaves port and stay the duration of the exercise. Berthing on non-MFA sonar (i.e., carrier and amphibious assault ships) is more available, but distance from MFA sonar operations would not provide the desired mitigation given the distance to the MFA sources.

- Lengthy and detailed procedures that would be required to facilitate the integration of information from non-Navy observers into the command structure.

- Some training will span one or more 24-hour period with events underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these events given the number of non-Navy observers that would be required onboard for the minimally required, three 8-hour shifts.

- Some surface ships having MFA sonar may have limited berthing capacity. Exercise planning includes careful consideration of this berthing capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the training event. Inclusion of non-Navy observers onboard these ships would require that, in some cases, there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the training objectives.

- Security clearance issues would have to be overcome to allow non-Navy observers onboard event participants.

• Visual surveillance as mitigation using non-Navy observers from non-military aircraft or vessels to survey before, during, and after training events to preclude sonar use in areas where marine mammals may be present.

  - These measures do not result in increased protection to marine species given that the size of the areas, the time it takes to survey, and the movement of marine species preclude real-time mitigation. The areas where training events will mainly occur (the representative areas modeled, see figure 2.2.2.6-1) cover approximately 55,000 square nautical miles within the HRC. Contiguous ASW events may cover many hundreds of square miles in a few hours given the participants are usually not visible to each other (separated by many tens of miles) and are constantly in motion. The number of civilian ships and/or aircraft required to monitor the area around these events would be considerable (in excess of a thousand of square miles). It is, thus, not feasible to survey or monitor the large areas in the time required to ensure these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an event took place. Therefore, surveillance of the "exercise area" would be impracticable as a mitigation measure given that it will not result in precluding marine mammals from being in the "exercise area."

  - Surveillance of an exercise area during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the training area and presenting a concern should aircraft mechanical problems arise.

- Scheduling civilian vessel or aircraft surveillance to coincide with training events would negatively impact training effectiveness, if the exercise was contingent on completion of such surveillance. Exercise event timetables cannot be precisely fixed, but are instead based on the free-flow development of tactical situations to closely mimic real combat action. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would interrupt the necessary spontaneity of the exercise and would negatively impact the effectiveness of the military readiness activity.

- The vast majority of HRC training events involve a Navy aerial asset with crews specifically training to detect objects in the water. The capability of sighting from both surface and aerial platforms provides excellent survey capabilities using Navy training assets participating in the event.

- Avoidance of habitats, periods of seasonal presence, and problematic complex/steep bathymetry including seamounts.
  - Avoidance of marine mammal habitats is not possible given that the full habitat requirements for most of the marine mammals in the Hawaiian Islands are unknown (e.g., with regard to beaked whales see Ferguson et al., 2006). Accordingly, there is no information available on possible alternative exercise locations or environmental factors that would otherwise be less important to marine mammals in the Hawaiian Islands. In addition, these exercise locations were very carefully chosen by exercise planners based on training requirements and the ability of ships, aircraft, and submarines to operate safely. Moving the exercise events to alternative locations would impact the effectiveness of the training and has no known benefit (especially as there is no scientific data available to determine which specific areas should be avoided).
  - Avoidance of the seasonal presence of migrating marine mammals fails to take into account the fact that the Navy's current mitigation measures apply to all detected marine mammals no matter the season. Advance planning to avoid the seasonal presence of migrating marine mammals is not possible given the start of any "season" is variable (dependent on largely unknown environmental factors). To the degree possible, however, Navy already has taken a proactive step in this regard by specifically informing all naval vessels to increase vigilance when the first humpback whales have been sighted around the Hawaiian Islands. Otherwise, limiting training operations to the remaining six months of the year would not only concentrate all annual training and testing activities into a shorter six-month time period, but would also not meet the readiness requirements of the Navy's to deploy trained forces.
  - Avoidance of "seamounts" fail to recognize that there are over 300 seamounts in the HRC (making it impossible to avoid them all and still conduct Major Exercises, fail to define scientific parameters for seamounts critical to marine mammals (such as a critical depth from the surface), and fail to define what would constitute a buffer that would "avoid" these areas. Many seamounts are present in training locations where training takes place to avoid the presence of commercial air traffic. Avoidance of as yet undefined "areas" around seamounts,

also would concentrate activities in areas where other marine mammals may be present whose habitat requirements are not associated with seamounts.

– Avoidance of “steep bathymetry” or “complex bathymetry” fails to define parameters and fail to recognize that all the islands in the Hawaiian chain rise from the ocean floor in a steep bathymetric rise. The purported need for such suggested mitigation measures is based on findings from other areas of the world that do not have direct application to the unique environment present in Hawaii. Such measures also can not be accurately implemented until there is a scientific understanding defining parameters for the measures. Training needs to take place in representative environments (including areas of steep and complex) given that submarines use these environments (such as at Cross Seamount) to avoid detection. Not being allowed to conduct exercises in these areas would unacceptably impact the effectiveness of the training.

- Avoid active sonar use within 12 nautical miles (nm) from shore or in the alternative 25 kilometers (km) (15.5 miles [mi]) from the 200-m isobath.
  - The measure requiring avoidance of MFA sonar within 25 km of the 200-m isobaths was part of the RIMPAC 2006 authorization by NMFS and was based on the assumption that avoidance of the North American continental shelf was a prudent mitigation measure given the presence of beaked whales in the Gulf of Mexico. NMFS modified the measure (a 200-m isobath replacing the continental shelf criteria) for Hawaii because they had received a public comment during rulemaking for a proposed action taking place elsewhere. This measure lacks any scientific basis when applied to the context in Hawaii (i.e. the bathymetry, sound propagation, width of channels).
  - There is no scientific analysis indicating this measure is any more protective in the Pacific and no known basis for the specific metrics (15.5 mi of the 200-m isobath).
  - During RIMPAC 2006, this mitigation measure precluded active ASW training in the littoral region, which significantly impacted realism and training effectiveness (such as for amphibious landings) even though this measure did not apply to the range at the Pacific Missile Range Facility (PMRF) and the planned exercises taking place in the channels between the islands.
  - This procedure had no observable effect on the protection of marine mammals during RIMPAC 2006 and its value is unclear. However, its effect on realistic training is significant.
- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
  - Operators of sonar equipment are trained to be cognizant of the environmental variables affecting sound propagation. In this regard the sonar equipment power levels are always set consistent with mission requirements.
  - Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform’s presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practical when available and when required by the mission.

- Suspending training at night, periods of low visibility and in high sea-states when marine mammals are not readily visible.
  - It is imperative that the Navy train to be able to operate at night, in periods of low visibility, and in high sea-states using the full potential of sonar as a sensor.
  - It would be extremely wasteful for Navy forces at sea to only operate in daylight hours or to wait for weather to clear before undertaking necessary training,

Navy vessels use radar and night vision goggles to detect any object, be it a marine mammal, a periscope of an adversary submarine, trash, debris, or another surface vessel

  - The Navy must train as expected to fight, and adopting this prohibition would eliminate this critical military readiness requirement.

- Reduce power in strong surface ducting conditions:
  - Strong surface ducts are conditions under which ASW training must occur to ensure sailors learn to identify the conditions, how they alter the abilities of MFA sonar systems, and how to deal with strong surface duct effects on MFA sonar systems. The complexity of ASW requires the most realistic training possible for the effectiveness and safety of the sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew's ability.
  - Additionally and most importantly, water conditions in the exercise areas on the time and distance scale necessary to implement this measure are not uniform and can change over the period of a few hours as effects of environmental conditions such as wind, sunlight, cloud cover, and tide changes alter surface duct conditions. In fact, this mitigation measure cannot be accurately and uniformly employed given the many variations in water conditions across a typical HRC exercise area that the determination of "strong surfacing ducting" is continually changing mitigation requirements and so cannot be accurately implemented.
  - Surface ducting alone, does not increase the risk of MFA sonar impacts to marine mammals. While it is true that surface ducting causes sound to travel farther before losing intensity, simple spherical and cylindrical spreading losses result in a received level of no more than 175 dB at 1,000 meters, even in significant surface ducting conditions.
  - There is no scientific evidence that this mitigation measure is effective or that it provides additional protection for marine mammals than the protection provided through "safety zones."

- Scaling down the exercise to meet core aims.
  - Training events are always constrained by the availability of funding, resources, personnel, and equipment with the result being they are always scaled down to meet only the core requirements.

- Limiting the active sonar use to a few specific locations.
  - Areas where events are scheduled to occur are carefully chosen to provide for the safety of events and to allow for the realistic tactical development of the training scenario. Otherwise limiting the training event to a few areas would adversely impact the effectiveness of the training.
  - Limiting the exercise areas would concentrate all sonar use, resulting in unnecessarily prolonged and intensive sound levels vice the more transient exposures predicted by the current planning that makes use of multiple exercise areas.
  - Major Exercises using integrated warfare components require large areas of the littorals and open ocean for realistic and safe training.
- Passive acoustic detection and location of marine mammals.
  - As noted in the preceding section, passive detection capabilities are used to the maximum extent practicable consistent with the mission requirements to alert training participants to the presence of marine mammals in an event location.
  - Implementation of this measure in and of itself is not more protective of the marine mammals because current technology does not allow for the real time detection and location of marine mammals.
  - Requires that marine mammals be vocalizing to be detected to be of any utility
- Using ramp-up to attempt to clear an area prior to the conduct of training events.
  - Ramp-up procedures involving slowly increasing the sound in the water to necessary levels have been utilized in other non-DoD activities. Ramp-up procedures are not a viable alternative for training events, as the ramp-up would alert opponents to the participants' presence and not allow the Navy to train realistically, thus adversely impacting the effectiveness of the military readiness activity.
  - This would constitute additional unnecessary sound introduced into the marine environment, in and of itself constituting harassment.
  - This measure does not account for the movement of the ASW participants over the period of time when ramp up would be implemented.
  - The implicit assumption is that animals would have an avoidance response to the low power sonar and would move away from the sound and exercise area; however, there is no data to indicate this assumption is correct. The Navy is currently gathering data and assessing it regarding the potential usefulness of this procedure as a mitigation measure. However, given there is only limited data to indicate that this is even minimally effective and because ramp-up would have an impact on the effectiveness of the military readiness activity, it was eliminated from further consideration.
- Vessel speed reduction.
  - Vessels engaged in training use extreme caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual

combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations. Training differently than what would be needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities.

- Use of new technology (e.g., unmanned reconnaissance aircraft, underwater gliders, instrumented ranges) to detect and avoid marine animals.
  - Although the Navy does work with many new technologies, they remain unproven, very expensive, and limited in availability. The Navy has been collecting data using the hydrophones in the underwater instrumented range at PMRF to collect passive acoustic data on marine mammals. The Navy is working to develop the capability to detect and localize vocalizing marine mammals using these sensors, but based on the current status of acoustic monitoring science, it is not yet possible to use installed systems as mitigation tools. Similarly, research involving a variety of other methodologies (e.g., underwater gliders, radar, lasers, etc.) is to date (2008) not developed to the point where they are effective or could be used as an actual mitigation tool. As part of the proposed Integrated Comprehensive Monitoring Program, the Navy will continue to coordinate passive monitoring and detection research specific to the proposed use of active sonar.

- Use of larger shut-down zones.

  The current power down and shut down zones are based on scientific investigations specific to MFA sonar for a representative group of marine mammals. It is also based on the source level, frequency, and sound propagation characteristics of MFA sonar. The zones are designed to preclude direct physiological effect from exposure to established marine mammal thresholds. Specifically, the current power-downs at 500 yards and 1,000 yards (457 and 914 meters [m]), as well as the 200 yards (183 m) shut-down safety zones were developed to minimize exposing marine mammals to sound levels that could cause temporary threshold shift (TTS) or permanent threshold shift (PTS). These sound level thresholds were established experimentally and are supported by the scientific community. Implementation of the safety zones discussed above were designed to prevent exposure to sound levels greater than that for onset TTS (195 dB re 1 μPa) for animals detected in the zone. Given that the distance to TTS from a single nominal sonar ping is less than 200 yards, there are additional protective buffers built into the safety zone with power-down of the sonar beginning when marine mammals are within 1,000 yards of the sonar (approximately five times the distance to TTS).

  The safety zone the Navy has developed is also based on a lookouts ability to realistically maintain situational awareness over a large area of the ocean and the lookouts ability to detect marine mammals at that distance during most conditions at sea.

  - It should also be noted that lookouts are responsible for reporting all objects or anomalies sighted in the water regardless of the distance from the vessel. Any sighting is reported to the Officer of the Deck since any object, disturbance, or discoloration in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may require some action be taken.

  - Requirements to implement procedures when marine mammals are present well beyond 1,000 yards require that lookouts sight marine mammals at distances that, in reality, they cannot. These increased distances also greatly increase the area that must be monitored to implement these procedures. For instance, if a power down zone increases from 1,000 to 4,000 yards, the area that must be monitored increases sixteenfold.

- Avoid or limit the use of MFA sonar during ASW training events while conducting transits between islands
  - Conducting ASW training events while transiting between Hawaiian Islands does not present the same conditions as those that resulted in the Bahamas' stranding (see Section 4.1.2.4.10.2). Most importantly, there is no limited egress for marine mammals for events that occur between the Hawaiian Islands.

- Adopt mitigation measures of foreign nation navies
  - Some of these foreign nations' measures (such as predictive modeling) are not applicable to Hawaii given the lack of information upon which to base any modeling. In a similar manner, avoidance of particular seasons or areas of known habitat are not transferrable to the Hawaii context.

  - Other nation's navies do not have the same critical mission to train in ASW as does the Navy. For example, other navies do not possess an integrated Strike Group. As a result, many foreign nations' measures would impact the effectiveness of ASW training to an unacceptable degree. The Navy's ASW training is built around the integrated warfare concept and is based on the Navy's sensor capabilities, the threats faced, the operating environment, and the overall mission.

6.2.1.1 AFTER ACTION REPORTS AND ASSESSMENT

Since RIMPAC 2006, the Navy has completed a number of After Action Reports (AARs). In part, these reports may assess the effectiveness of the preceding mitigation measures.

6.2.1.2 COORDINATION AND REPORTING

There are three procedures in the NDE II (designated by the numbers 27-29 in the NDE II) that are procedures for coordination and reporting of issues involving marine mammals with NMFS as the regulator. These procedures from NDE II are as follows:

The Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live or dead cetacean(s) or floating marine mammals that may occur at any time during or within 24 hours after completion of MFA sonar use associated with ASW training.

The Navy will submit a report to the Office of Protected Resources, NMFS, within 120 days of the completion of a Major Exercise. This report must contain a discussion of the nature of the effects, if observed, based on both modeled results of real-time events and sightings of marine mammals.

If a stranding occurs during an ASW exercise, NMFS and the Navy will coordinate to determine if MFA sonar should be temporarily discontinued while the facts surrounding the stranding are collected.

6.3 CONSERVATION MEASURES

The Navy will continue to fund ongoing marine mammal research in the Hawaiian Islands. Results of conservation efforts by the Navy in other locations will also be used to support efforts in the Hawaiian Islands. The Navy is coordinating monitoring of marine mammals on various established ranges, range complexes, and OPAREAs:

- Implementing a marine species monitoring plan in the Hawaiian Islands range complex.
- Continuing Navy research and contribution to university/external research to improve the state of the science regarding marine species biology and acoustic effects.
- Sharing data with NMFS and via the literature for research and development efforts.

6.4 UNDERWATER DETONATIONS

To ensure protection of marine mammals and sea turtles during underwater detonation training and Mining Operations, the surveillance area must be determined to be clear of marine mammals and sea turtles prior to detonation. Implementation of the following mitigation measures continue to ensure that marine mammals would not be exposed to temporary threshold shift (TTS) of hearing, permanent threshold shift (PTS) or hearing, or injury from physical contact with training mine shapes during Major Exercises.

6.4.1 DEMOLITION AND SHIP MINE COUNTERMEASURES OPERATIONS (UP TO 20 POUNDS)

6.4.1.1 EXCLUSION ZONES

All Mine Warfare and Mine Countermeasures Operations involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects on those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site.

6.4.1.2 PRE-EXERCISE SURVEILLANCE

For Demolition and Ship Mine Countermeasures Operations, pre-exercise surveillance shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The surveillance may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the surveillance area, the exercise shall be paused until the animal voluntarily leaves the area.

6.4.1.3 POST-EXERCISE SURVEILLANCE

Surveillance within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

6.4.1.4 REPORTING

Any evidence of a marine mammal or sea turtle that may have been injured or killed by the action shall be reported immediately to Commander, Pacific Fleet and Commander, Navy Region Hawaii, Environmental Director.

6.4.2 SINKING EXERCISE, GUNNERY EXERCISE, MISSILE EXERCISE AND BOMBING EXERCISE

The selection of sites suitable for Sinking Exercises (SINKEXs) involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations §229.2), and the identification of areas with a low likelihood of encountering ESA listed species. To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating location. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1,000 fathoms (3,000 m) deep and at least 50 nm from land.

In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge.

Although the siting of the location for the exercise is not regulated by a permit, the range clearance procedures used for Gunnery Exercise (GUNEX), Missile Exercise (MISSILEX), and Bombing Exercise (BOMBEX) are the same as those described below for a SINKEX.

6.4.3 UNDERWATER DETONATIONS MITIGATION PROCEDURES

The Navy has developed range clearance procedures to maximize the probability of sighting any ships or protected species in the vicinity of an exercise, which are as follows:

- All weapons firing would be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

Extensive range clearance operations would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.

An exclusion zone with a radius of 1.0 nm would be established around each target. This exclusion zone is based on calculations using a 990-pound (lb) H6 net explosive weight high explosive source detonated 5 feet (ft) below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182 decibels (dB) re: 1 micropascal squared-seconds (μPa^2-s) threshold established for the *WINSTON S. CHURCHILL* (DDG 81) shock trials (U.S. Department of the Navy, 2001b). An additional buffer of 0.5 nm would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, would be surveyed. Together, the zones extend out 2 nm from the target.

A series of surveillance over-flights would be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol would be as follows:

a. Overflights within the exclusion zone would be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.

b. All visual surveillance activities would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.

c. In addition to the overflights, the exclusion zone would be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The Officer Conducting the Exercise (OCE) would be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.

d. On each day of the exercise, aerial surveillance of the exclusion and safety zones would commence 2 hours prior to the first firing.

e. The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.

f. If a protected species observed within the exclusion zone is diving, firing would be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone. This is based on a typical dive time of 30 minutes for traveling listed species of concern. The OCE would determine if the listed species is in danger of being adversely affected by commencement of the exercise.

g. During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any protected species. If protected species are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.

h. Upon sinking of the vessel, a final surveillance of the exclusion zone would be monitored for 2 hours, or until sunset, to verify that no listed species were harmed.

Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise. The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.

In the unlikely event that any listed species are observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to National Oceanic and Atmospheric Administration (NOAA) Fisheries via the Navy's regional environmental coordinator for purposes of identification.

An AAR detailing the exercise's time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event would be submitted to NOAA Fisheries.

6.5 AIRCRAFT OPERATIONS INVOLVING NON-EXPLOSIVE DEVICES

Non-explosive devices such as some sonobuoys, inert bombs, and Mining Operations involve aerial drops of devices that have the potential to hit marine mammals and sea turtles if they are in the immediate vicinity of a floating target. The exclusion zone, therefore, shall be clear of marine mammals and sea turtles around the target location. Pre- and post-surveillance and reporting requirements outlined for underwater detonations shall be implemented during Mining Operations.

6.6 CONDITIONS ASSOCIATED WITH THE BIOLOGICAL OPINION

The Navy will comply with the reasonable and prudent measures and terms and conditions issued by NMFS in their Biological Opinion for HRC training events. In particular, the terms and conditions specify a monitoring program and process for feedback to NMFS following the completion of each exercise event.

6.7 REVIEW OF ENDANGERED SPECIES RECOVERY PLANS

The following sections outline the applicable threats identified in each species Recovery Plan and the mitigation measures adopted by the Navy for the actions covered by this EIS/OEIS. Chapters and page numbers referenced in the following sections refer to the recovery plan being discussed, not the EIS/OEIS.

Recovery plans are developed by the U.S. Fish and Wildlife Service and NMFS to help guide actions that promote the recovery of threatened and endangered species to the point that they may be down-listed and eventually de-listed. Where de-listing may not be reasonably possible given population size or habitat constraints, stopping the decline of the species and establishing a stable population may be interim goals. Recovery plans in general discuss the current status of the species or population, threats to their continued existence, and actions to promote recovery. In many instances one of the primary recovery needs is information on population size and distribution and other basic information such as sex ratios, birth rate/fecundity, recruitment, mortality, hearing sensitivity, and sound production.

Twenty-seven recovery plans for endangered or threatened species have been completed, drafted or are undergoing revision by NMFS. Of these, 10 recovery plans cover species evaluated in this EIS/OEIS: blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), Hawaiian monk seals (*Monachus schauinslandi*), green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*), loggerhead turtles (*Caretta caretta*), olive ridley turtles (*Lepidochelys olivacea*), and leatherback turtles (*Dermochelys coriacea*).

With respect to this EIS/OEIS, a review of the applicable recovery plans found that many plans identified in-water effects such as anthropogenic sound or underwater detonations and ship strikes as possible threats to recovery. In some cases all anthropogenic sources were lumped together, and in others military and civilian sources were broken out separately.

Based on modeling results in this EIS/OEIS, fin whales, sei whales, humpback whales, sperm whales and Hawaiian monk seals might be exposed to acoustic energy that could result in TTS or behavioral modification. Due to the lack of density data for blue whales and North Pacific right whales (*Eubalaena japonicus*)[*] they were not included in the acoustic effects exposure model. There are few sightings for these two species in the Hawaiian Islands area and they are not expected to be exposed to MFA sonar.

For the five species of sea turtles potentially occurring within the HRC, available information suggests that sea turtles are likely not able to hear mid-frequency sounds (2.6 kilohertz [kHz] and 3.3 kHz) in the range produced by active tactical sonars.

∗ There is no current or draft recovery plan for North Pacific right whales.

6.7.1 RECOVERY PLAN FOR THE BLUE WHALE (*BALAENOPTERA MUSCULUS*)—(1998)

Anthropogenic noise was discussed under Habitat Degradation (p.16) and focused on the low-frequency sound transmitted during the Acoustic Thermometry of Ocean Climate (ATOC) experiment conducted in the mid-1990s. Whales observed during the trials were found to be distributed nominally further from the source when it was active than when it was not. No other changes in behavior or distribution were observed. ATOC and the North Pacific Acoustic Laboratory activities are not being considered in this EIS/OEIS.

Under Military Operations Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) and ship shock trials were used to illustrate potential effects. However, neither observed nor potential effects were discussed. Detection of two blue whales in the vicinity of the ship shock trial resulted in the relocation of the trial to an area 9 miles from the whales. Scientific research intended to determine whether exposure to low frequency sounds elicited disturbance reactions from feeding blue or fin whales was conducted in 1997. In 19 focal animal observations (4 blue whales and 15 fin whales), no overt behavioral responses were observed. No changes in whale distribution could be related to LFA; whale distributions closely tracked the distribution of food. One preliminary analysis of whale sounds detections indicated a slight decrease in whale calling activity during LFA, but this was not confirmed by a second analysis. SURTASS LFA is not part of the Proposed Action in this EIS/OEIS.

Military vessel traffic was cited as contributory to the overall issue of vessel traffic and ship strikes.

Mitigation Measures—Except for potential ship strikes none of the threats listed above for blue whales is applicable to training within the HRC. Potential ship strikes would be mitigated by the use of lookouts aboard ASW platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. Based on available sighting data and the mitigation measures outlined in this chapter, it is unlikely that blue whales would be subject to vessel strikes within the HRC, thus fulfilling Recovery Action 4.2, Identify and implement methods to reduce ship collisions with blue whales.

6.7.2 DRAFT RECOVERY PLAN FOR THE FIN WHALE (*BALAENOPTERA PHYSALUS*)—(2006)

Ship Strikes (p. I-25) was a source of mortality for fin whales off the U.S. west coast from 1990 through 2005.

Although recent military activities (G.9 Military Operations, p. I-28) in the North Pacific are not known to have had impacts on fin whales, there was concern that due to "…the large scale and diverse nature of military activities in this ocean basin …there is always potential for disturbing, injuring, or killing these and other whales."

As noted above for blue whales, the issue of SURTASS LFA was also raised for fin whales.

Mitigation Measures—The effect of SURTASS LFA on fin whales is not applicable to training within the HRC. Potential ship strikes would be mitigated by the use of lookouts aboard ASW platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. Based on available sighting data and the mitigation measures outlined Section 6.1, it is unlikely that fin whales would be subject to vessel strikes within the HRC, thus addressing Recovery Action 6.3 - Identify and implement measures to reduce the frequency and severity of ship collisions and gear interactions with fin whales. The use of tactical active sonars within the HRC would be governed by the mitigation measures outlined in Section 6.1, which include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These mitigation measures address Recovery Action 7.2, Implement appropriate measures to reduce the exposure of fin whales to human-generated noise judged to be potentially detrimental.

6.7.3 FINAL RECOVERY PLAN FOR THE HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*)—(1991)

Although not explicitly identified in Section C - Collisions with Ships (p. 26), Navy ships should be included as part of the overall level of vessel traffic in Hawaiian waters which is identified as a potential impact.

In Section D. Acoustic Disturbance, 1. Noise from ships, boats and aircraft, Noise in general was identified as a potential adverse impact on humpback whales. At the time it was speculated that different vessel types and sizes had different acoustic effects depending on their signatures. In addition noise from military airplanes and other exercises were identified as possible sources of disturbance. The following statements from the Plan are provided for historical context (military activities from Barbers Point and Kahoolawe have ceased) but are provided for historical context. “In Hawaii, aerial exercises are executed from Hickam Air Force Base, Kaneohe Marine Corps Air Station, and Barbers Point Naval Air Station on Oahu. The major impact of tactical military aircraft is their use of Kahoolawe Island as a target. Concerns about the effect of military activities on humpback whales were addressed in a consultation between the Navy and NMFS regarding the use of Kahoolawe as a target island in 1979.” Kahoolawe has not been used as a target island since 1990. “Herman et al. (1980) suggested that humpback whales arriving in Hawaiian waters may be disturbed by military aircraft flying low over portions of the Auau Channel between the Islands of Hawaii and Maui. Other ordnance ranges in humpback wintering areas are Kaula Island, Hawaii; Vieques, Puerto Rico; and Farallon de Medinilla, Commonwealth of the Northern Mariana Islands.” While there may have been some impact from the cumulative noise sources of vessels and aircraft the effect seems to have been minimal given the current recovery of the Hawaiian population of humpback whales and their growth in numbers over the past 30 years.

Mitigation Measures—Ship strike was identified as a potential threat, but ship strike mitigation was not explicitly noted in the Plan. For activities covered by this EIS/OEIS, potential ship strikes would be mitigated by the use of lookouts aboard ASW platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. With respect to underwater noise (Recovery Objective 1.31 11 Reduce disturbance from human-produced underwater noise in Hawaiian waters and in other important habitats when humpback whales are present), the use of tactical active sonars within the HRC would be governed by the mitigation measures outlined in Section 6.1. These include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. Consideration of bottom topography, oceanographic conditions, and species habitat preferences will also be considered.

6.7.4 DRAFT RECOVERY PLAN FOR THE SPERM WHALE (*PHYSETER MACROCEPHALUS*)—(2006)

Potential threats identified in Sections G.2. and G.8. discussed anthropogenic sounds and in particular pingers, sonars, and vessel noise (cavitation).

Section G.2. Anthropogenic Noise (p. I-26) "…Sperm whales are known to respond, often dramatically, to unfamiliar noise. Whales exposed to the sounds of pingers used in calibration systems to locate hydrophone arrays temporarily fell silent (Watkins and Schevill, 1975). This response to sounds in the frequency range of 6-13 kHz was interpreted as one of listening, rather than of fear.

The plan further characterizes that, "A stronger response was observed in sperm whales exposed to the intense sonar signaling and ship propeller noise from military activities in the Caribbean Sea during the U.S. invasion of Grenada in 1983. The whales fell silent, changed their activities, scattered, and moved away from the sound sources (Watkins et al., 1985)". To clarify, however, while sperm whales were observed to interrupt their activities by stopping echolocation and leaving the area in the presence of underwater sounds the authors only surmised that the sounds may have originated from submarine sonar given that they saw no vessels (Watkins and Schevill, 1975; Watkins et al., 1985). The authors did not report received levels from these exposures, and also got a similar reaction from artificial noise they generated by banging on their boat hull. It was unclear if the sperm whales were reacting to possible sonar signals or to a potentially new unknown sound in general.

There is currently no evidence of long-term changes in behavior or distribution as a result of occasional exposure to pulsed acoustic stimuli.

6.7.4.1 G.8 MILITARY OPERATIONS (P.I-32)

"…Sperm whales are potentially affected by military operations in a number of ways. They can be struck by vessels and disturbed by sonar and other anthropogenic noise. In addition, their deep diving and large size make sperm whales potential false targets in submarine warfare (or target practice). Evidence suggests that strandings of another deep-diving, pelagic toothed whale, Cuvier's beaked whale (*Ziphius cavirostris*) is related to tests of Navy mid-range sonar and possibly LFA sonar in Greece, the Bahamas, and the Canary Islands (Frantizis, 1998; Anon., 2001; Jepson et al., 2003; U.S. Department of the Navy and U.S. Department of Commerce, 2001; Freitas, 2004; Fernandez, 2004; Fernandez et al., 2005). The extremely loud signals (maximum output 230 decibels re 1 micropascal [μPa]) are in the frequency range of 250-3,000 hertz (Frantzis, 1998), which is well within the likely range of sperm whale hearing.

Similarly, MFA sonar (e.g., U.S. Navy 53C) can produce equally loud sounds at frequencies of 2,000-8,000 hertz (Evans and England 2001), which are also likely to be heard by sperm whales. Clicks produced by sperm whales (and presumably heard by them) are in the range of < 100 hertz to as high as 30 kHz, often with most of the energy in the 2 to 4 kHz range (Watkins 1980). There have been no sperm whale strandings attributed to Navy sonar. However, the large scale and diverse nature of military activities in large ocean basins indicates that there is always potential for disturbing, injuring, or killing these and other whales."

The applicable recovery action is found under Recovery Actions 7.0. Determine and Minimize Any Detrimental Effects of Anthropogenic Noise in the Oceans (p. IV-2).

> 7.1 Support ongoing and additional studies to evaluate the effects of sound on sperm whales.
>
> 7.2 Implement appropriate regulations on sound-production activities which are found to be potentially detrimental to sperm whales, until otherwise demonstrated.

Mitigation Measures—would be implemented as listed in Section 6.1 to mitigate the use of tactical active sonars within the HRC. These include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air-to-Surface Missile Exercises (A-S MISSILEX), an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required. Consideration of bottom topography, oceanographic conditions, and species habitat preferences will also be considered.

These mitigation measures will further the recovery goals of this Plan even though no specific actions were identified in the Plan.

The Navy has and will continue to support research that will help evaluate the effects of sound on sperm whales. The Navy has complied with applicable laws and regulations regarding sound in the oceans to the extent practicable and in compliance with national defense requirements.

6.7.5 RECOVERY PLAN FOR THE HAWAIIAN MONK SEAL (*MONACHUS SCHAUINSLANDI*)—(DRAFT REVISION 2005)

No specific threats to monk seals from activities associated with the HRC were identified in the Hawaiian Monk Seal Recovery Plan.

Mitigation Measures—would be implemented as listed in Section 6.1 to mitigate the use of tactical active sonars within the HRC. These include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and A-S MISSILEX an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required. Consideration of bottom topography, oceanographic conditions, and species habitat preferences will also be considered.

These mitigation measures will assist in furthering the monk seal recovery goals even though these specific actions were not identified in the Hawaiian Monk Seal Recovery Plan.

6.7.6 RECOVERY PLAN FOR THE U.S. PACIFIC POPULATIONS OF THE GREEN TURTLE (*CHELONIA MYDAS*)—(1998)

Construction Blasting (p. 45) was identified as a threat to sea turtles, but not as a current threat in Hawaii. The following narrative did not explicitly identify Navy activities associated with the HRC as having a potential effect.

"Blasting can injure or kill sea turtles in the immediate area. The use of dynamite to construct or maintain harbors, break up reef and rock formations for improved offshore access, etc. can decimate coral reefs, eliminating food and refuge for sea turtles. Some types of dynamiting have minimal impact on marine life, such as placing explosive in pre-drilled holes (drilling and shooting) prior to detonation. This is the standard practice to secure armor rock. (see Recovery – Section 2.2.7)"

In Section 2.2.7 under Recovery, the following actions were identified:

"Prevent the degradation or destruction of reefs by dynamite fishing and construction blasting. Blasting of any nature physically damages reefs and may kill turtles. It must be monitored and/or restricted."

<u>Mitigation Measures</u>—Mitigation measures for sea turtles from underwater demolitions are listed in Section 6.2, Underwater Detonations. In general during underwater explosives training and Mining Operations, the surveillance area must be determined to be clear of marine mammals and sea turtles prior to detonation. For demolition and ship mine countermeasures operations charge size is limited to 20 lb and exclusion zones are established to prevent physical and/or acoustic effects. Pre exercise surveys are conducted by surface vessels, divers, and aircraft (when available) to alert operators of any protected species within the exclusion zone. If a sea turtle or marine mammal is observed, the exercise is postponed until the animal voluntarily leaves the area. Bottom topography is selected to minimize any potential damage to reef structures or other hard substrate that include turtle resting habitat or foraging areas (e.g. patches of sandy bottom substrate away from coral reef structures).

In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and A-S

MISSILEX, an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

The mitigation measures outlined in Section 6.1, include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects on green turtles that may be found within the surveillance areas from MFA/HFA sonar use.

These mitigation measures address Recovery Section 2.2.7 and the Implementation Schedule on p. 83.

6.7.7 RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*)—(1998)

No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in this EIS/OEIS.

Mitigation Measures—Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that hawksbill turtles are observed within the SURVEILLANCE AREA the use of tactical active sonars within the HRC would be governed by the mitigation measures outlined in Section 6.1, which include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects on hawksbill turtles that may be found within the surveillance area.

In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and A-S MISSILEX, an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.7.8 RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE LOGGERHEAD TURTLE (*CARETTA CARETTA*)—(1998)

There is no known nesting of loggerhead turtles in Hawaii according to the Recovery Plan. Nearly all observations of loggerheads now come from incidental catch records associated with pelagic longline fishing originating from Hawaiian ports. No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in this EIS/OEIS.

Mitigation Measures—Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that loggerhead turtles are observed within the surveillance area the use of tactical active sonars within the HRC would be governed by the mitigation measures outlined in Section 6.1, which include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects on loggerhead turtles that may be found within the surveillance area.

In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and A-S MISSILEX, an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.7.9 RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*)—(1998)

No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in this EIS/OEIS.

In the Hawaiian Islands, a single nesting was recorded along Paia Bay, Maui in September 1985; however, there was no successful hatching associated with this event (Balazs and Hau, 1986; National Ocean Service, 2001). Since there are no other known nesting records for the central Pacific Ocean, the above nesting attempt should be considered an anomaly (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998d). Olive ridleys are frequently captured by pelagic longline fishermen in deep, offshore waters of the HRC, especially during spring and summer. Inside the 55-fathom isobath, olive ridley occurrence in the HRC is rare year round.

Mitigation Measures—Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that olive ridley turtles are observed within the surveillance area the use of tactical active sonars within the HRC would be governed by the mitigation measures outlined in Chapter 6.1 which include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects on olive ridley turtles that may be found within the surveillance areas.

In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and A-S MISSILEX, an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.7.10 RECOVERY PLAN FOR U.S. POPULATIONS OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*)—(1998)

No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in this EIS/OEIS.

Satellite-tracking studies, a lack of Hawaiian stranding records, and occasional incidental captures of the species in the Hawaii-based longline fishery indicate that deep, oceanic waters are the most preferred habitats of leatherback turtles in the central Pacific Ocean. As a result, the area of year-round primary occurrence for the leatherback turtle encompasses all HRC waters beyond the 55-fathom isobath. Inshore of the 55-fathom isobath is the area of rare leatherback occurrence. This area is also the same year round. Leatherbacks were not sighted during any of the aerial surveys for which data were collected, all of which took place over waters lying close to the Hawaiian shoreline.

Mitigation Measures—Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that leatherback turtles are observed within the surveillance area, the use of tactical active sonars would be governed by the mitigation measures outlined in Section 6.1, which include the requirement for lookouts, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects on leatherback turtles that may be found within the surveillance areas.

In addition, activities involving explosives or live fire will require lookouts aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and A-S MISSILEX, an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.7.11 ADDITIONAL MARINE MAMMAL RESEARCH SOURCES

There are other potential marine mammal data providers in addition to the Navy that will be investigated for collaboration with this Exercise Marine Monitoring Plan. The goal is to leverage ongoing NMFS permitted studies, academic research and surveys, and new Navy detection technologies that may be of use as data augments to this plan.

Regional and Academic Research Programs

Within the HRC and Southern California (SOCAL), NMFS permitted marine mammal surveys, acoustic monitoring, and animal tagging is being conducted or planned for the next 2 years.

Tagging, for instance, is an important research tool for directly determining marine mammal movement, diving behavior, swim parameters (velocity, direction of travel, foraging depth), as well as potentially recording anthropogenic sound level exposure for an animal. Tagging typically allows for longer-term monitoring of individuals than visual and acoustic monitoring can provide.

In conjunction with other scientists and NMFS, the Navy will explore integrating tagging and additional survey data into HRC monitoring plan if data is available in areas associated with Navy training.

Navy Funded Research and Development Technologies

New research and development technologies in marine mammal research may be considered in the future (late fiscal year [FY] 08 and FY 09), but given the relatively recent nature of some technology, it is unknown at this time what value-added data will be available to supplement monitoring. Information from research and development technologies may, however, generate relevant biological information about marine mammal distribution and by inference impacts, or lack of impacts, from MFA sonar operations. Examples include developing the capability to detect and localize vocalizing marine mammals using the installed range hydrophones. Based on the current status of acoustic monitoring science, it is not yet possible to use installed systems as mitigation tools.

The Navy is also actively engaged in acoustic monitoring research involving a variety of methodologies (e.g., underwater gliders, surface radar detection of marine mammals, etc.); to date, none of the methodologies have been developed to the point where they could be used as an actual mitigation tool. The Navy will continue to coordinate passive monitoring and detection research specific to the proposed use of active sonar. As technology and methodologies become available, their applicability and viability will be evaluated for incorporation into the Navy's monitoring program.

6.8 HAWAII RANGE COMPLEX MONITORING PLAN

The Hawaii Range Complex Monitoring Plan (Monitoring Plan) is being developed in cooperation with NMFS Office of Protected Resources to provide marine mammal and sea turtle monitoring as required under the MMPA and the Endangered Species Act (ESA). When finalized, the Monitoring Plan is expected to contain the framework for research on the effectiveness of the Navy's suite of mitigation measures and analyze behavioral responses of marine mammals to MFA sonar and explosives. The Monitoring Plan is expected to utilize vessel, aerial and shore-based surveys, along with passive acoustics to accomplish its goals.

6.8.1 INTEGRATED COMPREHENSIVE MONITORING PROGRAM

The Navy is currently developing an Integrated Comprehensive Monitoring Program (ICMP) which will provide the overarching structure and coordination for Navy monitoring. The ICMP will, over time, compile analyzed data from all range specific monitoring plans (e.g. HRC monitoring plan) and Navy funded research and development studies. The primary objectives of the ICMP are to:

- To monitor Navy training events, particularly those involving mid-frequency sonar and underwater detonations, for compliance with the terms and conditions of ESA Section 7 consultations or MMPA authorizations;
- To collect data to support estimating the number of individuals exposed to sound levels above current regulatory thresholds;
- To assess the efficacy of the Navy's current marine species mitigation;
- To add to the knowledge base on potential behavioral and physiological effects to marine species from MFA sonar and underwater detonations; and,
- To assess the practicality and effectiveness of a number of mitigation tools and techniques.

The analysis protocols that will be used for the ICMP are still in the development phase at this time (2008). However, data collection methods will be standardized to allow for comparison from range-specific monitoring plans. The sampling scheme for the program will be developed so that the results are scientifically defensible (e.g. statistically significant). A data management system will be developed to assure that standardized, quality data are collected towards meeting of the goals. The ICMP will be evaluated yearly by the Navy to provide a matrix for research progress and goals for the following year. The ICMP reports and the range specific monitoring plan reports will be used by Navy and NMFS for refinement and analysis of the monitoring methods, which can be used in annual LOA applications.

6.9 NAVY-FUNDED RESEARCH

The Navy provides a significant amount of funding and support to marine research. The agency provided 26.4 million dollars in 2008 to universities, research institutions, Federal laboratories, private companies, and independent researchers around the world to study marine mammals. The Navy sponsors 70 percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before ,during and after training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to Navy training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

1. Environmental Consequences of Underwater Sound,
2. Non-Auditory Biological Effects of Sound on Marine Mammals,
3. Effects of Sound on the Marine Environment,
4. Sensors and Models for Marine Environmental Monitoring,
5. Effects of Sound on Hearing of Marine Animals, and
6. Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resources Assessment for the Hawaiian Islands. Furthermore, research cruises by NMFS and by academic institutions have received funding from the Navy. For instance, the Navy funded a marine mammal survey in the Mariana Islands to gather information to support an environmental study in that region given there had been no effort undertaken by NMFS. All of this research helps in understanding the marine environment and aids in determining if there are effects that result from Navy training in the Pacific.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long-term monitoring/studies of marine mammals on various established ranges, range complexes, and OPAREAs. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

6.10 KAUAI

The following sections provide mitigation measures to minimize the potential for impacts on onshore species.

6.10.1 AIRSPACE

Aircraft transiting the Open Ocean Area region of influence on one of the low-altitude airways and/or high-altitude jet routes that will be affected by flight test activities within the PMRF/Main

Base region of influence will be notified of any necessary rerouting before departing their originating airport and will therefore be able to take on additional fuel before takeoff. The establishment of laser range operational procedures, including horizontal and vertical buffers, would minimize potential impacts to aircraft. Coordination with the Federal Aviation Administration (FAA) would occur well in advance of the Major Exercise.

6.10.2 BIOLOGICAL RESOURCES

In accordance with the mitigation measures adopted for PMRF's Enhanced Capability EIS (U.S. Department of the Navy, 1998a), night lighting is shielded to the extent practical to minimize its potential effect on night-flying birds (Newell's shearwater and petrels) and Hawaiian hoary bats.

Measures were suggested in the PMRF Enhanced Capability EIS to further reduce possible environmental impacts. The installation of a portable blast deflector on the launch pad could protect the vegetation on the adjacent sand dunes. The potential for starting a fire would be further reduced by clearing dry vegetation from around the launch pad. Spraying the vegetation adjacent to the launch pad with water just before launch would reduce the risk of ignition. Emergency fire crews would be available during launches to quickly extinguish any fire and minimize its effects. An open (spray) nozzle will be used, when possible, rather than a directed stream when extinguishing fires, to avoid erosion damage to the sand dunes and to prevent possible destruction of cultural resources.

The Kauai Island Utility Cooperative has shielded all streetlights on utility poles along county and state highways to reduce light-attraction impacts. The Cooperative has also placed power line marker balls in areas of concentrated seabird flight paths. These measures could also be used by the Navy for the proposed installation of additional poles and cable between PMRF and Kokee.

If avoidance of activities during bird fallout season is not practicable, monitoring for downed birds near the new towers or antennas would be conducted as appropriate.

The main beam of the Terminal High Altitude Area Defense radar or other ground-based radar system during missile flight tests will not be directed toward the ground and will have a lower limit of 4 to 5 degrees above horizontal, which would preclude electromagnetic radiation impacts to green turtles or monk seals on the beach.

Landing routes and beach areas are surveyed for the presence of sensitive wildlife. If any marine mammals, sea turtles, or nesting seabirds are found to be present on the beach, training is delayed until the animals leave the area.

Mitigation measures to minimize the potential for introductions of seed or other plant parts (propagules) of exotic species include:

- Minimizing the amount of seed or propagules of non-native plant species introduced to the islands through continued efforts to remove seed and soil from all vehicles (including contractor vehicles) coming to the island by pressure washing on the mainland, and stepped up efforts to ensure that imported construction materials such as sand, gravel, aggregate, or road base material are weed free.

- Regular monitoring and treatment to detect and eliminate establishing exotic species, focusing on areas where equipment and construction materials come ashore and areas within which there is movement of equipment and personnel and soil disturbance which favor the spread and establishment of invasive species (e.g., along roadsides, and disturbed areas).
- Effective measures to foster the reestablishment of native vegetation in areas where non-native vegetation is present.
- Prohibiting living plant materials to be brought to the islands from the mainland (in order to avoid introduction of inappropriate genetic strains of native plants or exotic species, including weeds, insects and invertebrates).

Various instructions, as well as exercise-specific orders such as the Exercise RIMPAC Operations Order, advise commanding officers of requirements regarding the protection of Hawaii from the immigration of additional alien or invasive species. Introduction of any plant or animal into Hawaii without permission of the State of Hawaii Department of Agriculture is prohibited. All ship commanding officers and aircraft are required by the Defense Transportation Regulation, DoD 4500.9-R, to conduct inspections of equipment, cargo, supplies and waste prior to entering their first port of entry into the U.S. Office of the Chief of Naval Operations Instruction (OPNAVINST) 6210.2, Quarantine Regulations of the Navy, is intended to prevent the introduction and dissemination, domestically or internationally originated, of diseases affecting humans, plants, and animals; prohibited or illegally taken wildlife; arthropod vectors; and pests of health and agricultural importance. See Appendix C for the specific requirements of OPNAVINST 5090.1B, Chapter 19, and the Exercise RIMPAC Operations Order.

Pacific Missile Range Facility Enhanced Capability Biological Assessment

The following recommendations were established in 1998 after an informal consultation with NMFS on the enhanced capabilities of PMRF (U.S. Department of the Navy, 1998a):

- If whales or monk seals are observed during prelaunch safety clearance activities, the launch should be delayed until monk seals and whales are clear of the launch safety zones.
- Surveys should be conducted of beach areas on PMRF/Main Base and on Niihau for sea turtle nests prior to amphibious landings and other activities that may affect sandy beaches. This will allow locational shifts in the landings to reduce the potential for effects on Hawaiian monk seals and green turtles.
- There is little data on monk seal abundance and distribution at Niihau. PMRF should work with the owners of Niihau Ranch to develop Hawaiian monk seal and green turtle monitoring programs so that appropriate management measures can be implemented by the owners and residents if necessary. Training on census techniques and provision of data forms for participants could be provided by the NMFS. Contingent on approval from the land owners, NMFS could also provide analysis and interpretations of the census and observational data for the owners and residents.

- Studies to investigate the behavioral and physiological responses of large whales and listed sea turtles to high intensity sound of all frequencies should be sponsored and/or funded by the Navy, possibly through the office of Naval Research. This will provide better information on which to evaluate this and future projects.

Pursuant to a previous Section 7 Consultation and Biological Opinion (National Oceanic and Atmospheric Administration, 2007), the Navy agreed to mitigations that reduce or eliminate any potential impacts to humpback whales. No explosive rounds are currently used. Mitigations agreed to include seasonal use during periods when humpback whales are not present, surveying the waters off Kaula to ensure that no whales are present, and limiting the impact area to the southern tip of the island. These mitigation measures are also used for other marine species including Hawaiian monk seals and sea turtles.

6.10.3 CULTURAL RESOURCES

Mitigation measures to reduce and/or eliminate any potential adverse effects on known or unidentified historic properties from ongoing and future missile activities have been developed and are presented in the PMRF Integrated Cultural Resources Management Plan (International Archaeological Resources Institute, Inc., 2005). These include:

- Avoiding training and construction in areas where cultural resources are known to exist
- Monitoring all ground-disturbing activities and construction in medium- and high-sensitivity archaeological areas
- Briefing personnel working in culturally sensitive areas, including providing information on Federal laws protecting cultural resources
- Spraying water on vegetation within the immediate area of the launch vehicle prior to launch. In the event that vegetation ignites as a result of launches, fire suppression personnel are instructed to use an open spray nozzle whenever possible to minimize erosion damage (such as to sand dunes) and prevent destruction of cultural resources.
- If extensive burning of dune vegetation occurs, conducting post-burn archaeological surveys in consultation with the Hawaii State Historic Preservation Office and Navy archaeologist
- Implementing data recovery/research and documentation program if cultural resources are discovered as a result of normal training and base operations activities.

Training and RDT&E activity plans direct that If unanticipated cultural resources are encountered (particularly human remains) during any activity, all activities will cease in the immediate vicinity of the find and procedures outlined in the PMRF ICRMP.

6.10.4 GEOLOGY AND SOILS

New construction would follow standard methods to control erosion during construction. Base personnel would exercise best management practices to reduce soil erosion.

6.10.5 HAZARDOUS MATERIALS AND WASTE

No solid propellant missile launches will occur during rainy conditions, and the launch system will not use a water deluge system for cooling and noise suppression (a deluge system could increase the potential for ground deposition).

The PMRF Fire Department and Spill Response Team are trained in the appropriate procedures to handle materials associated with launches if a mishap occurs. All personnel involved in this training will wear protective clothing and receive specialized training in spill containment and cleanup.

6.10.6 HEALTH AND SAFETY

Mitigation measures to be used during GUNEX, Swimmer Insertion/Extraction, and Expeditionary Assault training events include the use of clearance zones, restricting landings to specific areas of the beach, publication of training overlays that identify the landing routes and any restricted areas, and designating a lookout to watch for other vessels. Every reasonable precaution is taken to prevent injury to human life or property.

The primary issue for and health and safety at PMRF is missile launch safety and emergency response. Appendix K provides details of these procedures. In general to protect both Navy personnel and the general public from injury from either launches or launch accidents, two primary mitigation measures are in place: flight termination and clearance of specified regions. The Range Safety Officer monitors the launch and trajectory of the missile against a planned flight path. If the missile deviates from this flight path, the Range Safety Officer terminates the flight to minimize risk to the public and the environment. Clearance areas include the Ground Hazard Area for land areas, Ship Exclusion Zones for ocean areas, and Restricted Airspace and Altitude Reservations for airspace. In addition, launch times and trajectories are cleared with United States Space Command to prevent impacts upon satellites (both manned and unmanned); this process is called Collision Avoidance.

Missile launches by their very nature involve some degree of risk, and it is for this reason that DoD and PMRF have specific launch and range safety policies and procedures to assure that any potential risk to the public and government assets (launch support facilities) are minimized. Many procedures are in place to mitigate the potential hazards of an accident during the flight of one of these missiles. The PMRF Flight Safety Office prepares a Range Safety Operational Procedure (RSOP) for each mission that involves missiles, supersonic targets, or rockets. The development of the RSOP also considers the hazards from debris of hit-to-kill intercept tests where an interceptor missile impacts a target missile. The Commanding Officer of PMRF approves each RSOP, which includes specific requirements and mission rules. The Flight Safety Office has extensive experience in analyzing the risks posed by such activities. In spite of the developmental nature of missile activities (which leads to a significant probability of mission failure), the United States has an unblemished record of public safety during missile and rocket launches.

To protect people from injury from either nominal launches or accidents, two primary mitigation measures are in place: flight termination and clearance of specified regions. Clearance areas include the ground hazard area for land areas, Ship Exclusion Zones for ocean areas, and Restricted Airspace and Altitude Reservations for airspace. In addition, launch times and trajectories are cleared with United States Space Command (USSPACECOM) to prevent impacts upon satellites (both manned and unmanned); this process is called Collision Avoidance. A flight termination system consists of several components. The ground unit contains a transmitter, which can send simple tones on a mission-specific radio frequency. On the vehicle there is a radio receiver and a termination system. The termination system may either be a non-destructive thrust-termination action or a destruct charge that breaks apart the vehicle. The choice of the system depends on mission, vehicle, and safety constraints. For some missions when the vehicle properties are such that all potential debris from accidents is contained within the hazard area, no flight termination system is needed.

Flight termination is performed by the Missile Flight Safety Officer if a missile malfunctions and leaves a predefined region or violates other predefined mission rules. The acceptable flight region is bounded by Destruct Limits, which are defined to make impact of potentially hazardous debris on populated areas highly unlikely. The Missile Flight Safety Officer terminates flight if the Instantaneous Impact Point of a vehicle crosses a Destruct Limit. The range safety system includes highly-reliable in-flight tracking and command destruction systems. The Missile Flight Safety Officer monitors in real-time missile performance and evaluates flight termination criteria. The flight termination system provides a mechanism to protect the public with very high reliability, even in the unlikely case of a missile malfunction.

The high-energy laser program office would be responsible for providing all necessary documentation to PMRF prior to issuance of the Range Safety Approval. These include:

- Letter of Approval or a Letter of No Concern from the FAA for the use of the laser within Honolulu FAA airspace,
- Letter of Approval or a Letter of No Concern for the use of their laser if it will or has the potential of lasing above the horizon from USSPACECOM as well as clearance from USSPACECOM for each intended laser firing,
- Letter of Approval from the Laser Safety Review Board at Dahlgren for the use for their laser on Navy Ranges (includes a survey and certification of the laser), and Range Safety Laser Data Package.

6.10.7 NOISE

To minimize noise level impacts, personnel or contractors involved in the proposed construction activities would be required to wear hearing protection in areas where noise levels would exceed limits set by the Occupational Safety and Health Administration.

6.10.8 KAULA

Pursuant to a previous Section 7 Consultation and Biological Opinion (National Oceanic and Atmospheric Administration, 2007), the Navy agreed to mitigations that reduce or eliminate any potential impacts to humpback whales. No explosive rounds are currently used. Mitigations agreed to include seasonal use during periods when humpback whales are not present, surveying the waters off Kaula to ensure that no whales are present, and limiting the impact area to the southern tip of the island. These mitigation measures are also used for other marine species including Hawaiian monk seals and sea turtles.

6.10.9 NIIHAU

6.10.9.1 BIOLOGICAL RESOURCES

Special Warfare Operations (SPECWAROPS) training on Niihau uses existing openings, trails, and roads and thus avoid areas that contain threatened or endangered plants. Helicopter landings are in areas designated as suitable and absent of listed biological resources.

Target drones are flown along the east coast of the island away from inhabited areas. There is the potential for a drone to crash and start a brush fire on the island. However, during activities that present the potential for fires, a ground fire-fighting crew and helicopters with water buckets are airborne to minimize any fire hazard.

HRC training will comply with relevant Navy and USFWS policies and procedures (e.g., blow/wash down of vehicles and equipment) during these training events and Major Exercises, which should limit the potential for introduction of invasive plant species.

However, all ocean vessel landings are first checked to ensure the sites are clear of monk seals. Also, training will avoid any beach area with green turtle nests, as they occasionally nest on Niihau beaches.

6.10.9.2 HAZARDOUS MATERIALS AND WASTE

The PMRF Hazardous Material Spill Response Team will be dispatched to the crash site of any mishap to ensure proper removal of all hazardous material/hazardous waste.

6.10.9.3 HEALTH AND SAFETY

During activities that present the potential for fires, a ground fire-fighting crew and helicopters with water buckets are airborne to minimize any fire hazard.

6.11 OAHU

Oahu Army Training Lands (Makua Military Reservation, Kahuku Training Area, Dillingham Military Reservation)

Many critically endangered plants with very low numbers remaining in the wild occur on Army training lands. Large-scale ecosystem protection is mainly done by fencing and invasive plant control in Management Units. Management includes extensive consultation with U.S. Fish and Wildlife Service and ongoing surveys to determine current status. Mitigation measures include:

- Controlling threats
- Improving conditions for recruitment
- Propagation
- Reintroduction
- Development of Implementation Plans that outline required mitigations to offset training risks and to stabilize the targeted plant and animal populations
- Preparation and implementation of a Wildland Fire Management Plan

Table 6.11-1 provides a list of training guidelines that are applicable to all Oahu Training Areas.

6.11.1 PUULOA UNDERWATER RANGE

6.11.1.1 AIRSPACE

The Navy would begin early coordination with regulatory agencies as applicable to reduce environmental impacts and to assist with the development of any required mitigative measures.

6.11.1.2 BIOLOGICAL RESOURCES

Explosive charges, in less than 40 feet of water, would be placed/neutralized only in sandy areas to avoid/minimize potential impacts on coral. Prior to actual detonation, the area is determined to be clear of marine mammals and sea turtles.

During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops.

6.11.1.3 HEALTH AND SAFETY

Demolition activities will be conducted in accordance with Commander, Naval Surface Force (COMNAVSURFPAC), U.S. Pacific Fleet Instruction 3120.8F (U.S. Department of the Navy, 1993), which specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

Table 6.11-1. Training Guidelines for Resource Protection—All Oahu Training Areas

APPLIES TO	
The following list of actions and limitations applies to all Oahu training areas. Additional limitations are imposed in the Sensitive Ecological and Cultural Resource Areas.	
AUTHORITY	
Enforcement of the following rules is under the authority of the Directorate of Plans, Training, Mobilization and Security, Range and Training Support Division.	
REQUIRED ACTIONS	
Access	Before entering a training area, troops must clean all vehicles, equipment, personal gear, shoes, and clothing.
Fire	All fires must be reported immediately. In case of fire, troops will stop training and begin fighting the fire. Troops will continue to fight the fire until released by the Fire Department.
Water	All aviation or other training area fuels or chemicals and other potentially toxic and polluting substances must be handled and stored to avoid spills and fires.
LIMITATIONS FOR SENSITIVE ECOLOGICAL AND CULTURAL RESOURCE AREAS	
Access	No troops may go beyond signs or fences marking the presence of rare or endangered plants and animals or archaeological sites.
Bivouacking	No bivouacking within 3,280 feet of posted signs marking the presence of rare or endangered native plants and animals or restoration projects. No training units larger than platoon size (more than 30 troops) may bivouac outside of reusable bivouac sites provided with portable or fixed latrines. No open fires. No burying or leaving trash. No food preparation. No refueling operations. No cutting, clearing, or disturbing of vegetation. This includes mosses, grasses, shrubs, bushes, and trees.
Maneuvers	No vehicle traffic off existing roads. No use of rocks from rock piles or walls for training purposes. No establishment or new vehicle tracks. No digging, including entrenchment and foxholes, except in areas specifically designated by Range Control. Dillingham Military Reservation and Kahuku Training Area: No pyrotechnic or incendiary training devices except during the wet season (October to April) OR outside areas designed to control fire. No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences. Dillingham Military Reservation and Kahuku Training Area: No use of explosive rounds or tracer ammunition. No road, trail, or firebreak clearing without permission form Range Control. No grading or construction of buildings or other permanent structures without permission from Range Control.

Source: U.S. Department of the Navy, 2002a

6.11.2 NAVAL DEFENSIVE SEA AREA

6.11.2.1 BIOLOGICAL RESOURCES

The Navy requests that multinational participants purge bilge/ballasts tanks in their ships prior to entering U.S. territorial waters.

Prior to the sinking of any vessels or deployment of steel frames for Naval Special Warfare Exercises, environmental documents would be developed and reviewed as appropriate. The Navy would begin early coordination regulatory agencies as applicable to reduce environmental impacts and to assist with the development of any required mitigative measures.

6.11.2.2 HEALTH AND SAFETY

Existing Navy safety protocols will ensure that no non-participants will be in the area during training. The Coast Guard is notified of each planned training event.

6.11.3 PEARL HARBOR

During amphibious inserts, the troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological resource areas are avoided by the SPECWAROPS troops.

6.11.4 FORD ISLAND

Guidance in the Pearl Harbor ICRMP will be followed and coordination with the Navy Region Hawaii's designated cultural resources coordinator would be required.

6.11.5 EXPLOSIVE ORDNANCE DISPOSAL LAND RANGE

The restriction on the maximum net explosive weight of ordnance detonated at the Land Range, 2.5 pounds, will apply to all users of the Land Range.

6.11.6 LIMA LANDING

6.11.6.1 BIOLOGICAL RESOURCES

Prior to actual detonation, the area will be determined to be clear of marine mammals. Training follows the relevant Navy policies and procedures to minimize impacts on biological resources. After training involving underwater detonations, the area will be searched for injured animals.

During amphibious inserts the crews follow established procedures, such as having designated lookouts watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The troops review training overlays that identify the insertion points and any nearby restricted areas. Sensitive biological and cultural resource areas are avoided by the SPECWAROPS troops.

6.11.6.2 HEALTH AND SAFETY

Existing Navy safety protocols for the use of explosives would ensure that no non-participants would be in the area during training. Demolition activities will be conducted in accordance with COMNAVSURFPAC Instruction 3120.8F (U.S. Department of the Navy, 1993), which specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

6.11.7 MARINE CORPS BASE HAWAII

6.11.7.1 AIRSPACE

Coordination with the FAA will occur well in advance of the 3- or 4-day Major Exercise. FAA coordination would include discussions regarding the anticipated number of aircraft including FCLP activities.

6.11.7.2 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Marine Corps regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Any potential impacts to listed bird species, such as the koloa maoli (Hawaiian duck), `alae ke`oke`o (Hawaiian coot), `alae `ula (Hawaiian common moorhen) and ae`o (Hawaiian stilt), would be addressed through coordination/consultation with the USFWS.

The beach and offshore waters would continue to be monitored for the presence of marine mammals and sea turtles 1 hour before and during training. If any are seen, then the training event would be delayed until the animals leave the area.

6.11.7.3 CULTURAL RESOURCES

Training overlays that identify the transit route, camp location, and any nearby restricted areas or sensitive biological and cultural resource areas are used by participants.

Any required road grading will not exceed the existing road width or alignment.

In the event unanticipated cultural remains are identified (particularly human remains), all training will cease in the immediate vicinity and the Hawaii SHPO will be immediately notified in accordance with the Programmatic Agreement.

6.11.8 MARINE CORPS TRAINING AREA/BELLOWS

6.11.8.1 BIOLOGICAL RESOURCES

Any potential impacts to listed bird species would be addressed through coordination/consultation with the USFWS.

To further minimize potential impacts on biological resources, instructions to Service elements engaged in Swimmer Insertion/Extraction, Expeditionary Assault, Humanitarian Assistance/Non-combatant Evacuation Operations (HAO/NEO), Humanitarian Assistance/Disaster Relief Operations (HA/DR), and Mine Countermeasures activities will include:

- Conducting surveys prior to use of amphibious launch vehicles to ensure that humpback whales are not disturbed.
- Establishing buffer zones in locations where green turtles are known to feed so that amphibious training events do not disturb these areas.
- Marking and monitoring green turtle nests discovered on beaches so they are not affected by training.

6.11.8.2 CULTURAL RESOURCES

Measures identified to mitigate impacts to cultural resources from training events include having proper documents in place in advance, crossing streams only at pre-selected locations, restricting vehicle crossings to existing bridges or pre-selected fords with no sensitive resources, and selecting stream crossings to avoid known cultural deposits. In the event unanticipated cultural remains are identified (particularly human remains), all training will cease in the immediate vicinity and the Bellows Air Force Station designated cultural resources coordinator will be notified.

6.11.9 HICKAM AIR FORCE BASE

6.11.9.1 AIRSPACE

Aircraft Support Operations would require coordination with the Air Force.

6.11.9.2 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Air Force regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Any potential impacts to listed bird species such as the ae`o (Hawaiian stilt) would be addressed through coordination with the USFWS.

6.11.10 WHEELER ARMY AIRFIELD

6.11.10.1 AIRSPACE

Aircraft Support Operations will require coordination with the Army and advanced planning and coordination with the FAA.

6.11.10.2 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

6.11.11 MAKUA MILITARY RESERVATION

6.11.11.1 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

6.11.11.2 CULTURAL RESOURCES

Any training proposed for Makua Military Reservation is reviewed by the Army before training is conducted. Extensive planning for training is required and includes coordination meetings 8 weeks and 10 days before the training event, a written plan of maneuver and fire support, and a risk assessment of the training event.

In the event cultural materials of any type are unexpectedly encountered during Live Fire Exercises (LFX) (particularly human remains), all training in the immediate vicinity of the find will cease and the Schofield Barracks Cultural Resources Manager will be notified.

6.11.11.3 HEALTH AND SAFETY

Specific safety plans have been developed to ensure that each training event is in compliance with applicable policy and requirements, and to ensure that the general public and range personnel and assets are provided an acceptable level of safety.

Navy activities would also follow mitigations from the Makua EIS as applicable, including:

- Habitat restoration following a fire. Efforts would be focused on the native forest edges to ensure that the area does not recede after each fire. Revegetation efforts would be implemented in any sensitive habitat destroyed by fire to ensure no net loss of sensitive species or habitat.
- Requiring Soldiers to clean their boots and equipment directly prior to troop marches to eliminate nonnative species.

- Surveying for weeds along roads and landing zones to evaluate the degree of threat and to prioritize control efforts and regularly implementing manual, mechanical, and chemical treatment programs.
- Limiting marches at Ka`ena Point during the Laysan Albatross breeding season (November to July) to at most one march per month and conducting monitoring at the beginning of the wedge-tailed shearwater breeding season (April to June) to determine whether burrows are present along the trail.
- Best Management Practices, such as no lights, cadence, or smoking within the marked areas of the trails
- Continuing to implement land management practices and procedures to reduce erosion impacts on soils from live-fire training.
- Cultural resource avoidance training and site protection, including but not limited to installing fencing or other types of buffering. Provisions in the training PA, including site protection, such as sand bagging, have proven effective in site preservation. In addition, firing points and paths would continue to be aligned to avoid shooting over cultural resources.
- Relocating any targets or training activities that could disturb or damage known cultural resources.
- Continuing to identify Native Hawaiian organizations, groups, families, and individuals that may ascribe traditional religious and cultural importance to areas, landscapes, or historic properties at Makua Military Reservation.

6.11.12 KAHUKU TRAINING AREA

6.11.12.1 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Any potential impacts to listed bird species such as the Oahu `elepaio or `Alauahio (Oahu creeper) would be addressed through coordination with the USFWS.

6.11.12.2 CULTURAL RESOURCES

Training events use an existing training trail and access road that will be graded before the training event (if required). However, in accordance with standard operating procedures, grading will not exceed the road width or alignment. Training overlays that identify the transit route, camp location, and any nearby restricted areas or sensitive biological and cultural resource areas will be used by all participants.

In the event cultural materials are unexpectedly encountered during the course of Expeditionary Assault, HAO/NEO, or HA/DR events (particularly human remains), all training will cease in the immediate vicinity of the find and the Schofield Barracks Cultural Resources Manager will be notified.

6.11.13 DILLINGHAM MILITARY RESERVATION

6.11.13.1 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Any potential impacts to listed bird species, such as the endangered `alae ke`oke`o (Hawaiian coot), `alae`ula (Hawaiian moorhen), koloa maoli (Hawaiian duck), and nene (Hawaiian goose), would be addressed through coordination with the USFWS.

The beach and offshore waters are monitored for the presence of marine mammals and sea turtles 1 hour before and during Major Exercises. If any are seen, the training event is delayed until the animals leave the area.

6.11.13.2 CULTURAL RESOURCES

All personnel entering the Dillingham Military Reservation will adhere to training guidelines regarding cultural resources.

In the event cultural materials are unexpectedly encountered during SPECWAROPS activities (particularly human remains), training in the vicinity of the find will cease and personnel will follow the appropriate military branch protocols. If the find is made by Marine Corps or Navy personnel, the Hawaii SHPO will be immediately notified in accordance with the Programmatic Agreement (see Appendix H). If the find is unexpectedly encountered during Army activities, the Schofield Barracks Cultural Resources Manager will be immediately notified.

6.12 MAUI

Analysis of the program training and research, development, test, and evaluation (RDT&E) activities presented in Section 4.5 indicates there would be no impacts from training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 for Maui Offshore resources.

Submarine events occur in the training areas within the 100-fathom isobath contour between the islands of Kahoolawe, Maui, Lanai, and Molokai and in the Penguin Bank area. The Navy has conducted these submarine operations in the Hawaiian Islands for decades, and no harmful effects on these species have been observed to date.

Personnel are aware that they are not to harm or harass whales, Hawaiian monk seals, or sea turtles. Commander, Navy Region Hawaii issues an annual Navy message when the humpback whales return to Hawaiian waters as a means to emphasize and increase awareness seasonally.

Aircrews participating in events are trained to visually scan the surface of the water for anomalies. Due in part to this additional emphasis on visual scanning and the availability of extra crew members to conduct such searches, it is unlikely that whales, monk seals, or sea turtles would be undetected when the aircraft are flying at lower altitudes. If animals are detected, the submarine's path can be adjusted. Submarine events, including those in existing underwater training areas between the islands of Kahoolawe, Maui, Lanai, and Molokai, follow established clearance procedures to ensure the activity will not adversely impact marine mammals and sea turtles. The potential to harm whales, monk seals, or sea turtles from the firing and tracking of non-explosive torpedoes in these training areas, as part of the various Major Exercises, is remote.

Analysis of the program training and RDT&E activities presented in Section 4.5.2 indicates there would be no impacts from training and RDT&E activities under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3 for Maui Onshore.

6.13 HAWAII

6.13.1 KAWAIHAE PIER

The Navy will work with the current land owner for activities that may not be covered under existing consultation or regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

Expeditionary Assault landing personnel are briefed on existing procedures for entering the harbor and unloading equipment and supplies at the boat ramp. These procedures include inspections by appropriate Federal and/or State agencies of vehicles and equipment from foreign countries to prevent the introduction of invasive or alien species. A recycling wash rack is used to clean foreign country vehicles and equipment prior to back-loading to control the spread of alien species.

Within 1 hour of initiation of the Expeditionary Assault landing events, the landing routes and beach areas are determined to be clear of marine mammals and sea turtles. If any are seen, the training event will be delayed until the animals leave the area. During the landing the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles.

6.13.2 POHAKULOA TRAINING AREA

6.13.2.1 AIRSPACE

For training that includes 10 or more aircraft, the Bradshaw Army Airfield manager submits a Notice to Airmen (NOTAM) to Honolulu Flight Service Station to be published as a Honolulu Local NOTAM and as a Class D NOTAM.
Coordination with the FAA will occur well in advance of each 3- or 4-day Major Exercise

6.13.2.2 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

The following restrictions from the Pohakuloa Training Area (PTA) External Standard Operating Procedures are applicable to all training areas on the installation:

- All off-road driving is prohibited
- All fenced areas are off-limits
- All lava tubes and sinkholes are off-limits
- Digging is only permitted in previously disturbed areas

Potential impacts to listed bird species, such as the `io (Hawaiian hawk) and nene, which are the only endangered forest birds seen on PTA, would be addressed through coordination with the USFWS.

Soldiers will be briefed prior to training about fire prevention, and cultural and natural resource protection. The fire prevention briefing ensures that important information is provided to using individuals that may start wildfires.

According to the *Rare Plants of Pohakuloa Training Area Hawaii* (Shaw, 1997), military activities, other than fire, have little impact on the rare plants on the installation. Occasionally, a rare plant might be crushed by foot or vehicle. Dust created by traffic could negatively impact a rare species if it is growing near a road. Also, only about 4 percent of the installation outside of the impact area had been disturbed by military activities. Most of the disturbance occurs in fixed artillery firing points, bivouac sites, and firing ranges. Many of the rare species inhabit remote areas of Pohakuloa Training Area with little or no chance of being disturbed by military training. Reducing the risk of military impacts on the rare plants can be accomplished easily by locating training away from areas with sensitive species, fencing to enclose sensitive species for protection from ungulates, fire and fuel corridors, fire breaks, additional surveys for threatened and endangered species, and continued sensitive plant propagation efforts.

The following restrictions from the Pohakuloa Training Area External Standard Operating Procedures are applicable to all training areas on the installation:

- All off-road driving is prohibited.
- All fenced areas are off-limits.
- All lava tubes and sinkholes are off-limits.
- Digging is only permitted in previously disturbed areas.

6.13.2.3 CULTURAL RESOURCES

Personnel review training overlays that identify insertion points and nearby restricted areas and sensitive biological and cultural resource areas are avoided. In the event unexpected cultural materials are encountered (particularly human remains) during LFX, activities in the immediate vicinity of the find will cease and the Schofield Barracks Cultural Resources Manager will be contacted. In addition, if the alignment of trails requires alteration or grading, or other ground disturbing activities are required, coordination with the Schofield Barracks Cultural Resources Manager would be required.

The Army will continue to provide Native Hawaiians with access to traditional religious and cultural properties, in accordance with the American Indian Religious Freedom Act and Executive Order 13007, on a case-by-case basis.

6.13.2.4 HEALTH AND SAFETY

Safety and health precautions are covered in external Standard Operating Procedures and are briefed by the PTA Operations Center.

6.13.3 BRADSHAW ARMY AIRFIELD

6.13.3.1 AIRSPACE

The advanced planning and coordination with the FAA and Bradshaw Army Airfield regarding scheduling of special use airspace and coordination of Navy training

6.13.3.2 BIOLOGICAL RESOURCES

The Navy will work with the current DoD land owner for activities that may not be covered under existing consultation or Army regulations. Proposed activities would not be implemented until appropriate coordination and/or consultation with applicable agencies has been completed.

All personnel entering Bradshaw Army Airfield will be briefed on the guidelines set forth in the PTA Ecosystem Management Plan.

6.14 GENERAL OFFSHORE AREAS

The Navy considered whether seasonal, or problematic complex/steep bathymetry or habitat avoidance could be a potential measure based on supporting science, likely effectiveness in avoiding harm to marine mammals, the extent to which it would impact military readiness training and personnel safety, practicality of implementation, and impact on the effectiveness of military readiness training. Measures such as these were not adopted for a variety of reasons. First, habitat requirements for most of the marine mammals in the Hawaiian Islands are unknown or that physical predictor variables that have been used in the Atlantic and Mediterranean Sea do not appear to apply in the Pacific (see Barlow and Gentry, 2004; Ferguson et al., 2006). Thus, there is little information to allow for a possible alternative exercise location in the Hawaiian Islands that is known to be less important to marine mammals. The choices for exercise locations are predicated on training requirements and the ability of ships, aircraft, and submarines to operate safely. This includes avoiding to the maximum extent practicable, shipping and commercial air routes between the islands and locations beyond Hawaii.

Avoiding seamounts in general is impracticable, since there are over 300 potential features that could be considered seamounts in the HRC. This suggested mitigation is based on the untested assumption that seamounts are more important to marine mammals than other parts of the HRC. However, there are no biologically defined criteria for the bathymetric or environmental parameters that would make a seamount critical to marine mammals (such as critical depth from the surface) and fail to define what would constitute a buffer that would constitute “avoiding” these areas. If the Navy were required to avoid all the sea mounts in the Hawaiian waters to some degree, then essentially it would render a large portion of the Hawaii Range Complex OPAREA off-limits to ASW training. This is simply too restrictive and is based only on speculation that seamounts may have a greater density of marine mammals present based on vocalizations. Further, ASW operators need to train with varying conditions so they can deal with using MFA sonar in water density changes based on temperature, salinity, currents, varying weather conditions, and varying profiles of ocean bottoms, which all affect how sound propagates in the water. Areas where there is significant bathymetric change (such as seamounts or undersea ridges) are the same areas where submarines are likely to hide. ASW operators need to be familiar with these areas to understand how to operate and detect potential adversary submarines in those conditions. Recommendations to “avoid steep bathymetry” fail to define the parameters of that “steep” bathymetry, fail to identify why this would be biologically important in the Hawaiian context, and seemingly fail to recognize that all the Hawaiian Islands rise from the ocean floor in what could be considered a steep bathymetric rise.

“Seasonal” restrictions fail to take into account that mitigation measures already in place avoid all detected marine mammals no matter the season. Commander Navy Region Hawaii does issue a Navy message annually when the humpback whales return to Hawaiian waters (based on actual sightings) as a means to increase awareness seasonally. Beyond this, making a restriction based otherwise on a calendar date fails to account for the variation in the arrival and departures of animals seasonally present in Hawaii. A seasonal restriction would not meet Navy training requirements, which are tied to deployments that are often dictated by real world events. Furthermore, forcing all training to occur in the “off” season would result in an increased training intensity rather than having training events distributed over the entire year.

THIS PAGE INTENTIONALLY LEFT BLANK

7.0 List of Preparers

Dedicated to the memory of Tom Peeling

"Hana like e ho`omalu a malama i ka po`ai ola"
Working together to protect and preserve our environment.

7.0 LIST OF PREPARERS

Government Preparers

John Burger, Environmental Coordinator, Pacific Missile Range Facility
M.S., Environmental Science, Rutgers ("The State University of New Jersey"), 1975
B.S., Biology/Chemistry, Emporia State University, 1967 (Emporia, KS, formerly KSTC)
Years of Experience: 31

Connie Chang, Environmental Engineer
Naval Facilities Engineering Command, Pacific
M.S., 1983, Engineering, Purdue University
B.S., 1982, Engineering, University of Hawaii
Years of Experience: 24

Thomas M. Craven, Environmental Protection Specialist
U.S. Army Space and Missile Defense Command
M.S., 1974, Biology, University of Alabama, Tuscaloosa
B.S., 1971, Biology and Math, University of Alabama, Tuscaloosa
Years of Experience: 32

Dennis R. Gallien, Environmental Engineer
U.S. Army Space and Missile Defense Command
B.S., 1979, Industrial Chemistry, University of North Alabama
Years of Experience: 26

David Hasley, Environmental Engineer
U.S. Army Space and Missile Defense Command
B.S., 1984, Mechanical Engineering, University of Texas, Arlington
Years of Experience: 22

Dean W. Leech, CAPT, JAGC
U.S. Navy, Judge Advocate, U.S. Pacific Fleet
J.D., 1988, LL.M (Environmental), 2001
Years of Experience: 20

Rebecca K. Hommon, Counsel (Environmental), Navy Region Hawaii
B.A., 1973, University of New Hampshire
J.D., 1983, Ohio Northern University
Years of Experience: 22

Neil Sheehan, Manager, KAYA Associates, Inc.
Commander, U.S. Pacific Fleet (Contractor)
B.A., 1985, State University of New York at Buffalo
J.D., 1988, University of Dayton School of Law
LL.M, 1998, George Washington University School of Law
Years of Experience: 20

Contractor Preparers

Karen Charley-Barnes, Environmental Scientist, KAYA Associates, Inc.
M.S., 1998, Environmental Science-Policy and Management, Florida A&M University
B.S., 1989, Natural Science and Mathematics, University of Alabama, Birmingham
Years of Experience: 18

Bruce Campbell, Principal Scientist, Parsons Infrastructure & Technology
M.S., 1989, Environmental Management, University of San Francisco
B.S., 1974, Environmental Biology, University of California, Santa Barbara
Years of Experience: 32

Greg Denish, Graphic Artist, KAYA Associates, Inc.
B.A., 2002, Studio Art, Design Emphasis, University of Tennessee
Years of Experience: 5

Conrad Erkelens, Senior Scientist, KAYA Associates, Inc.
M.A., 1993, Anthropology, University of Hawaii
B.A., 1989, Anthropology, University of Hawaii
Years of Experience: 15

Olivia Gist, Geographic Information Systems Analyst, KAYA Associates, Inc.
B.S., 2006, Professional Geography, University of North Alabama
Years of Experience: 2

Kevin Hayes, Engineer, KAYA Associates, Inc.
M.S., 1996, Environmental Engineering, Northeastern University
B.S., 1991, Civil Engineering, University of Massachusetts, Amhurst
Years of Experience: 4

Jonathan Henson, Geographic Information Systems Specialist, KAYA Associates, Inc.
B.S., 2000, Environmental Science, Auburn University
Years of Experience: 8

Lawrence Honma, Senior Marine Scientist, Merkel & Associates, Inc.
M.S., 1994, Marine Science, Moss Landing Marine Laboratories, San Francisco State University
B.S., 1989, Wildlife and Fisheries Biology, University of California, Davis
Years of Experience: 17

Jeral Jones, Geographic Information Systems Specialist, KAYA Associates, Inc.
B.S., 1995, Management Information Systems, University of Alabama in Huntsville
Years of Experience: 13

Rachel Y. Jordan, Senior Environmental Scientist, KAYA Associates, Inc.
B.S., 1972, Biology, Christopher Newport College, Virginia
Years of Experience: 20

Edd V. Joy, Senior Environmental Planner, KAYA Associates, Inc.
B.A., 1974, Geography, California State University, Northridge
Years of Experience: 35

Elizabeth Kellogg, President, Tierra Data Inc.
M.S., 1981, International Agricultural Development with Specialization in Range Management, University of California at Davis
B.S., 1978, Agricultural Science and Management, University of California at Davis
Years of Experience: 21

Krystal Kermott, Environmental Planner, SRS Technologies
B.S., 1999, Biological Sciences, University of California at Santa Barbara
Years of Experience: 4

Erik W.F. Larson, Staff Scientist, ACTA Inc.
A.B., 1993, Earth & Planetary Sciences, Harvard College
A.M., 1996, Earth & Planetary Sciences, Harvard University
Ph.D., 2000, Geophysics, Harvard University
Years of Experience: 7

Amy McEniry, Technical Editor, KAYA Associates, Inc.
B.S., 1988, Biology, University of Alabama in Huntsville
Years of Experience: 19

Tammy Mitnik, Project Manager, SRS
M.S., 2004, Business Administration, American InterContinental University
B.S., 1989, Justice and Public Safety, Auburn University
Years of Experience: 13

Rickie D. Moon, Senior Systems Engineer, Teledyne Solutions, Inc.
M.S., 1997, Environmental Management, Samford University
B.S., 1977, Chemistry and Mathematics, Samford University
Years of Experience: 23

Gene Nitta, Environmental Scientist, Independent Consultant
B.A., 1969, Environmental Biology, University of California, Santa Barbara
Graduate Studies, 1972, Marine Mammal Biology, California State University, San Diego
Years of Experience: 37

Wesley S. Norris, Managing Senior, KAYA Associates, Inc.
B.S., 1976, Geology, Northern Arizona University
Years of Experience: 31

Paige Peyton, Senior Archaeologist, KAYA Associates, Inc.
Ph.D., (in progress), Research in Archaeology and Ancient History, University of Leicester, United Kingdom
M.A., 1990, Anthropology, California State University, San Bernardino
B.A., 1987, Anthropology, California State University, San Bernardino
Years of Experience: 25

William Sims, IT/GIS Manager, KAYA Associates, Inc.
B.S., 1993, Geography, University of North Alabama
Years of Experience: 15

Philip H. Thorson, Senior Research Biologist, SRS Technologies
Ph.D., 1993, Biology, University of California at Santa Cruz
Years of Experience: 27

Karen M. Waller, Senior Program Manager, SRS Technologies
B.S., 1987, Environmental Affairs, Indiana University
Years of Experience: 21

Brian Wauer, Senior Engineer, SRS Technologies
B.S., 1984, Industrial Management, University of Arkansas
B.S., 1983, Administrative Management, University of Arkansas
Years of Experience: 4

Rebecca J. White, Environmental Engineer, KAYA Associates, Inc.
B.S., 2000, Civil/Environmental Engineering, University of Alabama in Huntsville
Years of Experience: 8

Barbara M. Young, Senior Environmental Scientist, KAYA Associates, Inc.
M.A., 1986, Geography, University of Maryland, College Park
B.A., 1978, Geography, Macalester College, St. Paul, MN
Years of Experience: 28

8.0 Glossary of Terms

8.0 GLOSSARY OF TERMS

Access—the right to transit to and from and to make use of an area.

Accretion—growth by gradual external addition.

Activity—an individual scheduled training function or action such as missile launching, bombardment, vehicle driving, or Field Carrier Landing Practice.

Advisory Council on Historic Preservation—a 19-member body appointed, in part, by the President of the United States to advise the President and Congress and to coordinate the actions of Federal agencies on matters relating to historic preservation, to comment on the effects of such actions on historic and archaeological cultural resources, and to perform other duties as required by law (Public Law 89-655; 16 United States Code 470).

Aeronautical Chart—a map used in air navigation containing all or part of the following: topographic features, hazards and obstructions, navigation aids, navigation routes, designated airspace, and airports.

Aesthetic—a pleasing appearance, effect, or quality that allows appreciation of character-defining features, such as of the landscape.

Air Basin—a region within which the air quality is determined by the meteorology and emissions within it with minimal influence on and impact by contiguous regions.

Air Defense Identification Zone—the area of airspace over land or water, extending upward from the surface, within which the ready identification, the location, and the control of aircraft are required in the interest of national security.

Air Route Traffic Control Center (ARTCC)—a facility established to provide air traffic control service to aircraft operating on Instrument Flight Rules flight plans within controlled airspace and principally during the en route phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to aircraft operating under Visual Flight Rules.

Air Traffic Control—a service operated by appropriate authority to promote the safe, orderly, and expeditious flow of air traffic.

Air Traffic Control Assigned Airspace (ATCAA)—Federal Aviation Administration-defined airspace not over an Operating Area (OPAREA) within which specified activities, such as military flight training, are segregated from other Instrument Flight Rules air traffic.

Airfield—usually an active and/or inactive airfield, or infrequently used landing strip, with or without a hard surface, without Federal Aviation Administration-approved instrument approach procedures. An airfield has no control tower and is usually private.

Airport—usually an active airport with hard-surface runways of 3,000 feet or more, with Federal Aviation Administration approved instrument approach procedures regardless of runway length or composition. An airport may or may not have a control tower. Airports may be public or private.

Airspace, Controlled—airspace of defined dimensions within which air traffic control service is provided to Instrument Flight Rules flights and to Visual Flight Rules flights in accordance with the airspace classification. Controlled airspace is divided into five classes, dependent upon location, use, and degree of control: Class A, B, C, D, and E.

Airspace, Special Use—airspace of defined dimensions identified by an area on the surface of the earth wherein activities must be confined because of their nature and/or wherein limitations may be imposed upon non-participating aircraft.

Airspace, Uncontrolled—uncontrolled airspace, or Class G airspace, has no specific definition but generally refers to airspace not otherwise designated and activities below 1,200 feet above ground level. No air traffic control service to either Instrument Flight Rules or Visual Flight Rules aircraft is provided other than possible traffic advisories when the air traffic control workload permits and radio communications can be established.

Airspace—the space lying above the earth or above a certain land or water area (such as the Pacific Ocean); more specifically, the space lying above a nation and coming under its jurisdiction.

Airway—Class E airspace established in the form of a corridor, the centerline of which is defined by radio navigational aids.

Alert Area—a designated airspace in which flights are not restricted but there is concentrated student training or other unusual area activity of significance.

Alkaline—basic, having a pH greater than 7.

Alluvium—a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a maintained slope.

Altitude Reservation—altitude reservation procedures are used as authorization by the Central Altitude Reservation Function, an air traffic service facility, or appropriate air route traffic control center, under certain circumstances, for airspace utilization under prescribed conditions.

Aluminum Oxide (Al_2O_3)—a common chemical component of missile exhaust. Under natural conditions, the chemical is not a source of toxic aluminum; the U.S. Environmental Protection Agency has determined that nonfibrous Al_2O_3, as found in solid rocket motor exhaust, is nontoxic.

Ambient Air Quality Standards—legal limitations on pollutant concentration levels allowed to occur in the ambient air established by the U.S. Environmental Protection Agency or state agencies. Primary ambient air quality standards are designed to protect public health with an adequate margin of safety. Secondary ambient air quality standards are designed to protect public welfare-related values including property, materials, and plant and animal life.

Ambient Air—that portion of the encompassing atmosphere, external to buildings, to which the general public has access.

Amplitude—the maximum departure of the value of a sound wave from the average value.

Annual Average Daily Traffic (AADT)—the total volume passing a point or segment of a highway facility in both directions for 1 year divided by the number of days in the year.

Anthropogenic—human-related.

Aquaculture—the cultivation of the natural produce of water, such as fish or shellfish.

Aquifer—a subsurface formation, group of formations, or part of a formation (e.g., a huge, underground reservoir) that contains sufficient saturated permeable material to conduct groundwater and yield economical quantities of water to wells and springs.

Archaeology—a scientific approach to the study of human ecology, cultural history, prehistory and cultural processes, emphasizing systematic interpretation of material remains.

Archipelago—an expanse of water with many scattered islands; a group of islands.

Area of Potential Effect—the geographic area within which direct and indirect impacts generated by the Proposed Action and alternatives could reasonably be expected to occur and thus cause a change in historic, architectural, archaeological, or cultural qualities possessed by the property.

Artifact—any thing or item that owes its shape, form, or placement to human activity. In archaeological studies, the term is applied to portable objects (e.g., tools and the by-products of their manufacture).

Artisanal—non-industrialized.

Asbestos—a carcinogenic substance formerly used widely as an insulation material by the construction industry; often found in older buildings.

Asbestos-containing Material—any material containing more than 1 percent asbestos.

Atoll—a coral island consisting of a reef surrounding a lagoon.

Attainment Area—an air quality control region that has been designated by the U.S. Environmental Protection Agency and the appropriate state air quality agency as having ambient air quality levels as good as or better than the standards set forth by the National Ambient Air Quality Standards, as defined in the Clean Air Act. A single geographic area may have acceptable levels of one criteria air pollutant, but unacceptable levels of another; thus, an area can be in attainment and non-attainment status simultaneously.

Average Daily Traffic (ADT)—the total volume of traffic passing a given point or segment of a roadway in both directions divided by a set number of days.

A-weighted Sound Level—a number representing the sound level which is frequency-weighted according to a prescribed frequency response established by the American National Standards Institute (ANS1.4-19711) and accounts for the response of the human ear.

Azimuth—a distance in angular degrees in a clockwise direction from the north point.

Backyard Range—a range within a radius of one hour's drive (50-65 miles) of a unit, such that training there can be considered non-deployed for personnel tempo (PERSTEMPO) purposes.

Basement Rock—rock generally with complex structure beneath the dominantly sedimentary rocks.

Bedrock—the solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Benthic Communities—of or having to do with populations of bottom-dwelling flora or fauna of oceans, seas, or the deepest parts of a large body of water.

Benthopelagic—living and feeding near the sea floor as well as in midwaters or near the surface.

Benthos—the sea floor.

Bioaccumulation—building up of a substance, such as PCBs, in the systems of living organisms (and thus, a food web) due to ready solubility in living tissues.

Biological Diversity—the complexity and stability of an ecosystem, described in terms of species richness, species evenness, and the direct interaction between species such as competition and predation.

Biological Resources—a collective term for native or naturalized vegetation, wildlife, and the habitats in which they occur.

Booster—an auxiliary or initial propulsion system that travels with a missile or aircraft and that may not separate from the parent craft when its impulse has been delivered; may consist of one or more units.

Brackish—slightly salty; applicable to waters whose saline content is intermediate between that of streams and sea water.

Calcareous—containing calcium carbonate.

Candidate Species—a species of plant or animal for which there is sufficient information to indicate biological vulnerability and threat, and for which proposing to list as “threatened” or “endangered” is or may be appropriate.

Caprock—a natural overlying rock layer that is usually hard to penetrate.

Carbon Dioxide—a colorless, odorless, incombustible gas which is a product of respiration, combustion, fermentation, decomposition and other processes, and is always present in the atmosphere.

Carbon Monoxide—a colorless, odorless, poisonous gas produced by incomplete fossil-fuel combustion; it is one of the six pollutants for which there is a national ambient standard (see Criteria Pollutants).

Cetacean—an order of aquatic, mostly marine, animals including the whales, dolphins, porpoise, and related forms with large head, fishlike nearly hairless body, and paddle-shaped forelimbs.

Class A Airspace (also Positive Controlled Area)—airspace designated in Federal Aviation Administration Regulation Part 71 within which there is positive control of aircraft.

Coastal Zone—a region beyond the littoral zone occupying the area near the coastline in depths of water less than 538.2 feet. The coastal zone typically extends from the high tide mark on the land to the gently sloping, relatively shallow edge of the continental shelf. The sharp increase in water depth at the edge of the continental shelf separates the coastal zone from the offshore zone. Although comprising less than 10 percent of the ocean’s area, this zone contains 90 percent of all marine species and is the site of most large commercial marine fisheries. This may differ from the way the term “coastal zone” is defined in the State Coastal Zone Management Program (Hawaii Revised Statutes Chapter 205 A).

Community—an ecological collection of different plant and animal populations within a given area or zone.

Component (Cultural Resources)—a location or element within a settlement or subsistence system. Archaeological sites may contain several components that reflect the use of the locality by different groups in different time periods.

Continental Shelf—a shallow submarine plain of varying width forming a border to a continent and typically ending in a steep slope to the oceanic abyss.

Continental Slope—the steep slope that starts at the shelf break about 492 to 656 feet and extends down to the continental rise of the deep ocean floor.

Continental United States (CONUS)—the United States and its territorial waters between Mexico and Canada, but excluding overseas states.

Control Area (CTA)—a controlled airspace extending upwards from a specified limit above the earth.

Controlled Access—area where public access is prohibited or limited due to periodic training or sensitive natural or cultural resources.

Controlled Airspace—airspace of defined dimensions within which air traffic control service is provided to Instrument Flight Rules flights and to Visual Flight Rules flights in accordance with the airspace classification. Controlled airspace is divided into five classes, dependent upon location, use, and degree of control: Class A, B, C, D, and E.

Controlled Firing Area (CFA)—airspace wherein activities are conducted under conditions so controlled as to eliminate hazards to non-participating aircraft and to ensure the safety of persons and property on the ground.

Copepod—a small, shrimp-like crustacean.

Coral Reef—a calcareous organic area composed of solid coral and coral sand.

Cosmology—a branch of metaphysics that deals with the nature, or natural order, of the universe.

Council on Environmental Quality (CEQ)—established by the National Environmental Policy Act, the CEQ consists of three members appointed by the President. A CEQ regulation (Title 40 Code of Federal Regulations 1500-1508, as of July 1, 1986) describes the process for implementing the National Environmental Policy Act, including preparation of environmental assessments and environmental impact statements, and the timing and extent of public participation.

Co-Use—Scheduled uses that safely allow other units to transit the area or conduct activities.

Criteria Pollutants—pollutants identified by the U.S. Environmental Protection Agency (required by the Clean Air Act to set air quality standards for common and widespread pollutants); also established under state ambient air quality standards. There are standards in effect for six criteria pollutants: sulfur dioxide, carbon monoxide, particulate matter, nitrogen dioxide, ozone, and lead.

Cultural Resources—prehistoric and/or historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered of importance to a culture, subculture, or community for scientific, traditional, religious, or any other reason.

Culture—a group of people who share standards of behavior and have common ways of interpreting the circumstances of their lives.

Cumulative Impact—the impact of the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions.

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Current—a horizontal movement of water or air.

C-weighted—utilized to determine effects of high-intensity impulsive sound on human populations, a scale providing unweighted sound levels over a frequency range of maximum human sensitivity.

Danger Area—(1) In air traffic control, an airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times; (2) (DoD only) A specified area above, below, or within which there may be potential danger.

Danger Zone—at the Pacific Missile Range Facility (PMRF), an offshore area to protect submerged cables that is designated in accordance with U.S. Army Corps of Engineers regulations into which entry by any craft is prohibited except with the permission of the Commanding Officer, PMRF. See Code of Federal Regulations, Title 33, Parts 204 to 225a.

Decibel (dB)—the accepted standard unit of measure for sound pressure levels. Due to the extremely large range of measurable sound pressures, decibels are expressed in a logarithmic scale.

Degradation—the process by which a system will no longer deliver acceptable performance.

Demersal—living close to the seafloor.

Direct Effects—immediate consequences of program activities.

Direct Impact—effects resulting solely from program implementation.

District—National Register of Historic Places designation of a geographically defined area (urban or rural) possessing a significant concentration, linkage, or continuity of sites, structures, or objects united by past events (theme) or aesthetically by plan of physical development.

Diurnal—active during the daytime.

Dunes—hills and ridges of sand-size particles (derived predominantly from coral and seashells) drifted and piled by the wind. These dunes are actively shifting or are so recently fixed or stabilized that no soil horizons develop; their surface typically consists of loose sand.

Easement—a right of privilege (agreement) that a person or organization may have over another's property; an interest in land owned by another that entitles the holder of the easement to a specific limited use; a recorded right of use by the United States over property of the State of Hawaii to limit exposure to safety hazards.

Ecosystem—all the living organisms in a given environment with the associated non-living factors.

Effects—a change in an attribute, which can be caused by a variety of events, including those that result from program attributes acting on the resource attribute (direct effect); those that do not result directly from the action or from the attributes of other resources acting on the attribute being studied (indirect effect); those that result from attributes of other programs or other attributes that change because of other programs (cumulative effects); and those that result from natural causes (for example, seasonal change).

Effluent—an outflowing branch of a main stream or lake; waste material (such as smoke, liquid industrial refuse, or sewage) discharged into the environment.

Electromagnetic Radiation (EMR)—waves of energy with both electric and magnetic components at right angles to one another.

Electronic Countermeasures (ECM)—includes both active jamming and passive techniques. Active jamming includes noise jamming to suppress hostile radars and radios, and deception jamming, intended to mislead enemy radars. Passive ECM includes the use of chaff to mask targets with multiple false echoes, as well as the reduction of radar signatures through the use of radar-absorbent materials and other stealth technologies.

En Route Airways—a low-altitude (up to, but not including 5,486.4 meters [18,000 feet] mean sea level) airway based on a center line that extends from one navigational aid or intersection to another navigational aid (or through several navigational aids and intersections) specified for that airway.

En Route Jet Routes—high altitude (above 18,000 feet mean sea level) airway based on a center line that extends from one navigational aid or intersection to another navigational aid (or through several navigational aids and intersections) specified for that airway.

Encroachment—the placement of an unauthorized structure or facility on someone's property or the unauthorized use of property.

Endangered Species—a plant or animal species that is threatened with extinction throughout all or a significant portion of its range.

Endemic—plants or animals that are native to an area or limited to a certain region.

Environmental Justice—an identification of potential disproportionately high and adverse impacts on low-income and/or minority populations that may result from proposed Federal actions (required by Executive Order 12898).

Epibenthic—living on the ocean floor.

Epipelagic—living in the ocean zone from the surface to 109 fathoms (656 feet).

Erosion—the wearing away of a land surface by water, wind, ice, or other geologic agents.

Estuary—a water passage where the tide meets a river current; an arm of the sea at the lower end of a river; characterized by brackish water.

Event—a significant period of time during which training is accomplished. “Event” is a Navy approved employment schedule term.

Exclusive Use—scheduled solely for the assigned unit for safety reasons.

Exotic—not native to an area.

Explosive Ordnance Disposal (EOD)—the process of recovering and neutralizing domestic and foreign conventional, nuclear and chemical/biological ordnance and improvised explosive devices; a procedure in Explosive Ordnance Management.

Explosive Safety Quantity-Distance (ESQD)—the quantity of explosive material and distance separation relationships providing defined types of protection based on levels of risk considered acceptable.

Facilities—physical elements that can include roads, buildings, structures, and utilities. These elements are generally permanent or, if temporary, have been placed in one location for an extended period of time.

Fathom—a unit of length equal to 6 feet; used to measure the depth of water.

Feature—in archaeology, a non-portable portion of an archaeological site, including such facilities as fire pits, storage pits, stone circles, or foundations.

Federal Candidate Species—taxa for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.

Fee Simple Land—land held absolute and clear of any condition or restriction, and where the owner has unconditional power of disposition.

Feral—having escaped from domestication and become wild.

Fleet Area Control and Surveillance Facility (FACSFAC)—Navy facility that provides air traffic control services and controls and manages Navy-controlled off-shore operating areas and instrumented ranges.

Fleet Response Training Plan (FRTP)—the 27-month cycle that replaces the Interdeployment Training Cycle. The FRTP includes four phases prior to deployment: Maintenance, Unit-Level Training, Integrated Training, and Sustainment.

Fleet Response Plan/Fleet Readiness Program (FRP)—the Fleet Response Plan was the Navy’s response to the 2002/2003 international situations in Afghanistan and Iraq. The Fleet Readiness Program was later developed by the Fleet commanders. The FRP is designed to more rapidly develop and then sustain readiness in ships and squadrons so that, in a national crisis or contingency operation, the Navy can quickly surge significant combat power to the scene.

Flight Information Region (FIR)—an airspace of defined dimensions within which flight information service and alerting service are provided. Flight information service is provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights, and alerting service is provided to notify appropriate organizations regarding aircraft in need of search and rescue aid and to assist such organizations as required.

Flight Level—a level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury stated in three digits that represent hundreds of feet. For example, flight level 250 represents a barometric altimeter indication of 25,000 feet; flight level 255 represents an indication of 25,500 feet.

Flight Termination—action taken in certain post-launch situations, such as a missile veering off of its predicted flight corridor; accomplished by stopping the propulsive thrust of a rocket motor via explosive charge. At this point, the missile continues along its current path, falling to earth under gravitational influence.

Floodplain—the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands; includes, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (100-year floodplain).

Free Flight—a joint initiative of the aviation industry and the Federal Aviation Administration to allow aircraft to take advantage of advanced satellite voice and data communication to provide faster and more reliable transmission to enable reductions in vertical, lateral, and longitudinal separation of aircraft, more direct flights and tracts, and faster altitude clearance. It will allow pilots, whenever practicable, to choose their own route and file a flight plan that follows the most efficient and economical route, rather than following the published preferred instrument flight rules routes.

Frequency (as it applies to proposed activities)—the number of training events in a given time period.

Frequency—description of the rate of disturbance, or vibration, measured in cycles per second. Cycles per second are usually referred to as the unit of measure of hertz (Hz). In acoustics, frequency is characterized in general terms as low, mid, or high. The Navy categorizes these as follows:

- **Low-frequency (LF)** sound is below 1,000 Hz.
- **Mid-frequency (MF)** sound is between 1 and 10 kHz.
- **High-frequency (HF)** sound is above 10 kHz.

Frequent User—a unit that conducts training and exercises in the training areas on a regular basis but does not maintain a permanent presence.

Fugitive Dust—any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of the activities of man. Fugitive dust may include emissions from haul roads, wind erosion of exposed soil surfaces, and other activities in which soil is either removed or redistributed.

Great Mahele (1848)—The Hawaiian land distribution act proposed by King Kamehameha III in the 1830s and enacted in 1848.

Ground Hazard Area—the land area contained in an arc within which all debris from a terminated launch will fall. For example, the arc for a Strategic Target System launch is described such that the radius is approximately 10,000 feet to the northeast, 9,100 feet to the east, and 9,000 feet to the south of the launch point. For the Vandal launch, the arc is 6,000 feet.

Groundwater Table—the highest part of the soil or underlying rock material that is wholly saturated with water.

Groundwater—water within the earth that supplies wells and springs; specifically, water in the zone of saturation where all openings in rocks and soil are filled, the upper surface of which forms the water table.

Habitat—the area or type of environment in which a species or ecological community normally occurs.

Hazardous Air Pollutants—other pollutants, in addition to those addressed by the NAAQS, that present the threat of adverse effects on human health or to the environment as covered by Title III of the Clean Air Act. Incorporates, but is not limited to, the pollutants controlled by the National Emissions Standards for Hazardous Air Pollutants program.

Hazardous Material—generally, a substance or mixture of substances capable of either causing or significantly contributing to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; it may pose a threat or a substantial present or potential risk to human health or the environment. Hazardous materials use is regulated by the U.S. Department of Transportation, the Occupational Safety and Health Administration, and the Emergency Right-to-Know Act.

Hazardous Waste—a waste, or combination of wastes, which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may either cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Heiaus—the temple platforms, shrines, and enclosures that Hawaiians constructed for purposes of worship. Built on carefully fitted stones and considered sacred ground, heiaus contained assorted buildings for various religious rites practiced by the various kahuna (sacred priests and priestesses). Most heiaus were damaged in 1819 with the overthrow of the ancient religion and kapu system; however, several have been restored.

Hertz (Hz)—the standard radio equivalent of frequency in cycles per second of an electromagnetic wave. Kilohertz (kHz) is a frequency of 1,000 cycles per second. Megahertz (MHz) is a frequency of 1 million cycles per second.

Historic Properties—under the National Historic Preservation Act, these are properties of national, state, or local significance in American history, architecture, archaeology, engineering, or culture, and worthy of preservation.

Home Lands—as required by the Hawaiian Homes Commission Act (passed by Congress in 1921), areas set aside for the state to lease residential, farm, and pastoral homestead lots for $1 per year to native Hawaiians.

Host—the Facilities Host holds plant account of all Class I (Land) and most Class II (Buildings) property. The Host determines and executes policy for the range/range complex.

Hydraulic Conductivity—the rate in gallons per day water flow through a cross section of one square foot under a unit hydraulic gradient, at the prevailing temperature.

Hydrocarbons—any of a vast family of compounds containing hydrogen and carbon, including fossil fuels.

Hydrochloric Acid—a common chemical component of missile exhaust believed to injure plant leaves and affect wildlife.

Hydrology—the science dealing with the properties, distribution, and circulation of water on the face of the land (surface water) and in the soil and underlying rocks (groundwater).

Hydrophone—an instrument for listening to sound transmitted through water.

Impact Area—the identified area within a range intended to capture or contain ammunition, munitions, or explosives and resulting debris, fragments, and components from various weapon system employments.

Impacts (effects)—an assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured using a qualitative and nominally subjective technique. In this Environmental Impact Statement, as well as in the Council on Environmental Quality regulations, the word impact is used synonymously with the word effect.

Indurated—rendered hard, as in dunes where surface sand is loose, but subsurface areas become increasingly compact (see lithified).

Infrastructure—the system of public works of a country, state, or region, such as utilities or communication systems; physical support systems and basic installations needed to operate a particular area or facility.

Inhibited Red Fuming Nitric Acid (IRFNA)—a liquid hypergolic propellant utilized as an oxidizer (as in the Lance). This reddish-brown acid is highly corrosive, spontaneously reacting with UDMH and certain other organic substances. It also dissolves in water, and care must be taken regarding its induced boiling effects. Its highly toxic, characteristically pungent vapors irritate skin and eyes.

Instrument Flight Rules (IFR)—rules governing the procedures for conducting instrument flight; it is a term used by pilots and controllers to indicate type of flight plan.

Interdeployment Readiness Cycle—the period by which Naval units progress through maintenance/unit-level training, integrated training, and sustainment training stages prior to being deployed with the Fleet.

Intermittent User—a unit that conducts training and exercises in the training areas throughout the year, but not on a regularly scheduled basis, and does not maintain a permanent presence.

International Waters—sea areas beyond 12 nautical miles (nm) of the U.S. shoreline.

Interpretive Trail—a guided or self-guided nature walk, designed to attract interest and communicate an understanding of the environment in which it is located (including, where appropriate, the effects of human activity).

Intertidal Zone—occupies the space between high and low tide, also referred to as the littoral zone; found closest to the coastal fringe and thus only occurring in shallow depths.

Ionizing Radiation—particles or photons that have sufficient energy to produce direct ionization in their passage through a substance. X-rays, gamma rays, and cosmic rays are forms of ionizing radiation.

Isobath—the line on a marine map or chart joining points of equal depth, usually in fathoms below mean sea level.

JATO Bottle—Jet-Assisted Takeoff. These are bottle rockets, generally weighing from about 70 to about 165 pounds, that can be attached to various types of aerial targets or aircraft to assist their takeoffs.

Jet Routes—a route designed to serve aircraft operating from 5,486 meters (18,000 feet) up to and including flight level 450, referred to as J routes with numbering to identify the designated route.

Land/Sea Use—the exclusive or prioritized commitment of a land/sea area, and any targets, systems, and facilities therein, to a continuing purpose that could include a grouping of training events, buffer zone, environmental mitigation, etc. The land/sea area may consist of a range/range complex, grouping of similar facilities, or natural resource-based area with no facilities.

Lead—a heavy metal which can accumulate in the body and cause a variety of negative effects; one of the six pollutants for which there is a national ambient air quality standard (see Criteria Pollutants).

Lead-based Paint—paint on surfaces with lead in excess of 1.0 milligram per square centimeter as measured by X-ray fluorescence detector, or 0.5 percent lead by weight.

Leina-a-ka-uhane—as identified in traditional Hawaiian religious cosmology, a place (generally cliffs or seacoast promontories) from which the spirits of the dead plunge into eternity and are divided into one of three spiritual realms: the realm of the wandering spirits; the realm of the ancestral spirits; or the realm of the endless night.

Leptocephalic—small, elongate, transparent, planktonic.

Level of Service (LOS)—describes operational conditions within a traffic stream and how they are perceived by motorists and/or passengers; a monitor of highway congestion that takes into account the average annual daily traffic, the specified road segment's number of lanes, peak hour volume by direction, and the estimated peak hour capacity by a roadway's functional classification, area type, and signal spacing.

Lithified—the conversion of a newly deposited sediment into an indurated rock.

Littoral—species found in tide pools and near-shore surge channels.

Loam—a loose soil composed of a mixture of clay, silt, sand, and organic matter.

Long-Term Sustainability of Department of Defense Ranges—the ability to indefinitely support national security objectives and the operational readiness of the Armed Forces, while still protecting human health and the environment.

Major Exercise—a period of time during which significant operational employment of live, virtual, and/or constructive forces training is accomplished. A Major Exercise includes multiple training objectives, usually occurring over an extended period of days or weeks.

Maneuver Area—range used for maneuver element training.

Maneuver Element—basic element of a larger force independently capable of maneuver. Normally, a Marine Division recognizes its infantry battalions, tank battalion, and light armored reconnaissance (LAR) battalion as maneuver elements. A rifle (or tank/LAR) battalion would recognize its companies as maneuver elements. A rifle (or tank/LAR) company would recognize its platoons as maneuver elements. Maneuver below the platoon level is not normally possible since fire and movement can be combined only at the platoon level or higher. The Army and National Guard recognize a squad and platoon as maneuver elements.

Maneuver—employment of forces on the battlefield through movement in combination with fire, or fire potential, to achieve a position of advantage with respect to the enemy in order to accomplish the mission.

Marine Corps Ground Unit—Marine Expeditionary Unit Ground Combat Element, or Battalion Landing Team, composed of an infantry battalion of about 1,200 personnel reinforced with artillery, amphibious assault vehicles, light armored reconnaissance assets and other units as the mission and circumstances require. (The analysis will scale units of different size or composition from this Battalion Landing Team standard unit to include a 12-person Special Operations platoon.)

Maritime—of, relating to, or bordering on the sea.

Material Safety Data Sheet—presents information, required under Occupational Safety and Health Act standards, on a chemical's physical properties, health effects, and use precautions.

Medical Evacuation—emergency services, typically aerial, designed to remove the wounded or severely ill to medical facilities.

Mesopelagic—the oceanic zone from 109 to 547 fathoms (656 to 3,280 feet).

Migration—repeated departure and return of individuals and their offspring to and from an area.

Migratory Birds—avians characterized by their practice of passing, usually periodically, from one region or climate to another.

Military Operating Area—airspace below 18,000 feet used to separate or segregate certain non-hazardous military flight activities from Instrument Flight Rules traffic and to identify for Visual Flight Rules traffic where these activities are conducted.

Military Training Route—an airspace corridor established for military flight training at airspeeds in excess of 250 nautical miles/hour.

Minority—minority populations, as reported by the 2000 Census of Population and Housing, includes Black, American Indian, Eskimo or Aleut, Asian or Pacific Islander, Hispanic, or other.

Mitigation—a method or action to reduce or eliminate adverse environmental impacts. Such measures may avoid impacts by not taking a certain action or parts of an action; minimize impacts by limiting the magnitude of an action; rectify impacts by restoration measures; reduce or eliminate impacts over time by preservation or maintenance measures during the action; or compensate for impacts by replacing or providing substitute resources or environments.

Mobile Sources—any movable source that emits any regulated air pollutant.

Mortality—the number of deaths in a given time or place.

Munitions Constituents—any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

National Airspace System—the common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.

National Ambient Air Quality Standards (NAAQS)—as set by the Environmental Protection Agency under Section 109 of the Clean Air Act, nationwide standards for limiting concentrations of certain widespread airborne pollutants to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility and materials (secondary standards). Currently, six pollutants are regulated by primary and secondary NAAQS: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide (see Criteria Pollutants).

National Environmental Policy Act (NEPA)—Public Law 91-190, passed by Congress in 1969. The Act established a national policy designed to encourage consideration of the influences of human activities, such as population growth, high-density urbanization, or industrial development, on the natural environment. The National Environmental Policy Act procedures require that environmental information be made available to the public before decisions are made. Information contained in the National Environmental Policy Act documents must focus on the relevant issues in order to facilitate the decision-making process.

National Register of Historic Places Eligible Property—property that has been determined eligible for the National Register of Historic Places listing by the Secretary of the Interior, or one that has not yet gone through the formal eligibility determination process but which meets the National Register of Historic Places criteria for section review purposes; eligible properties are treated as if they were already listed.

National Register of Historic Places—a register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2 (b) of the Historic Sites Act of 1935 and Section 101 (a)(1) of the National Historic Preservation Act of 1966, as amended.

National Wildlife Refuge—a part of the national network of refuges and wetlands managed by the U.S. Fish and Wildlife Service in order to provide, preserve, and restore lands and waters sufficient in size, diversity and location to meet society's needs for areas where the widest possible spectrum of benefits associated with wildlife and wildlands is enhanced and made available. This includes 504 wildlife refuges nationwide encompassing 92 million acres and ranging in size from one-half acre to thousands of square miles. Dedicated to protecting wildlife and their habitat, U.S. refuges encompass numerous ecosystems and are home to a wide variety of fauna, including large numbers of migratory birds and some 215 threatened or endangered species.

Native Americans—used in a collective sense to refer to individuals, bands, or tribes who trace their ancestry to indigenous populations of North America prior to Euro-American contact.

Native Species—plants or animals living or growing naturally in a given region and often referred to as indigenous.

Native Vegetation—often referred to as indigenous, these are plants living or growing naturally in a given region without agricultural or cultivational efforts.

Navigational Aid—any visual or electronic device, airborne or on the surface, which provides point-to-point guidance information or position data to aircraft in flight.

Neritic—relating to the shallow ocean waters, usually no deeper than 109 fathoms (656 feet).

Nitrogen Dioxide—gas formed primarily from atmospheric nitrogen and oxygen when combustion takes place at high temperatures.

Nitrogen Oxides—gases formed primarily by fuel combustion and which contribute to the formation of acid rain. In the presence of sunlight, hydrocarbons and nitrogen oxides combine to form ozone, a major constituent of photochemical smog.

Nitrogen Tetroxide—a dark brown, fuming liquid or gas with a pungent, acrid odor, utilized in rocket fuels.

Nonattainment Area—an area that has been designated by the U.S. Environmental Protection Agency or the appropriate state air quality agency as exceeding one or more of the national or state ambient air quality standards.

Non-directional Radio Beacon—a radio beacon transmitting non-directional signals whereby the pilot of an aircraft equipped with direction finding equipment can determine the aircraft's bearing to or from the radio beacon and “home” on or track to or from the station.

Non-ionizing Radiation—electromagnetic radiation at wavelengths whose corresponding photon energy is not high enough to ionize an absorbing molecule. All radio frequency, infrared, visible, and near ultraviolet radiation are non-ionizing.

Non-Point Source Pollution—diffuse pollution; that is, from a combination of sources; typically originates from rain and melted snow flowing over the land (runoff). As runoff contacts the land's surface, it picks up many pollutants in its path: sediment, oil and grease, road salt, fertilizers, pesticides, nutrients, toxics, and other contaminants. Runoff also originates from irrigation water used in agriculture and on landscapes. Other types of non-point pollution include changes to the natural flow of water in stream channels or wetlands.

Notice to Airmen (NOTAM)—a notice containing information, not known sufficiently in advance to publicize by other means, the establishment, condition, or change in any component (facility, service, or procedure of, or hazard in the National Airspace System), the timely knowledge of which is essential to personnel concerned with flight operations.

Notice to Mariners (NOTMAR)—a periodic notice regarding changes in aids to navigation, dangers to navigation and other information essential to mariners.

Operating Area (OPAREA)—ocean area not part of a range used by military personnel or equipment for training and weapons system Research, Development, Test & Evaluation (RDT&E).

Operational Range—a range that is under the jurisdiction, custody, or control of the Secretary of Defense and is used for range activities; or although not currently being used for range activities, that is still considered by the Secretary to be a range and has not been put to a new use that is incompatible with range activities.

Ordnance—military supplies including weapons, ammunition, combat vehicles, and maintenance equipment.

OTTO Fuel—a torpedo fuel.

Ozone (O_3)—a highly reactive form of oxygen that is the predominant component of photochemical smog and an irritating agent to the respiratory system. Ozone is not emitted directly into the atmosphere but results from a series of chemical reactions between oxidant precursors (nitrogen oxides and volatile organic compounds) in the presence of sunlight.

Ozone Layer—a naturally occurring layer of ozone 7 to 30 miles above the earth's surface (in the stratosphere) which filters out the sun's harmful ultraviolet radiation. It is not affected by photochemical smog found in the lower atmosphere, nor is there any mixing between ground level ozone and ozone in the upper atmosphere.

Paleontological Resources—fossilized organic remains from past geological periods.

Paleontology—the study of life in the past geologic time, based on fossil plants and animals.

Participant—an individual ship, aircraft, submarine, amphibious vehicle, or ground unit.

Particulate Matter, Fine Respirable—finely divided solids or liquids less than 10 microns in diameter which, when inhaled, remain lodged in the lungs and contribute to adverse health effects.

Particulate Matter, Total Suspended—finely divided solids or liquids ranging from about 0.1 to 50 microns in diameter which comprise the bulk of the particulate matter mass in the atmosphere.

Particulate Matter—particles small enough to be airborne, such as dust or smoke (see Criteria Pollutants).

Payload—any non-nuclear and possibly propulsive object or objects, weighing up to 272.2 kilograms (600 pounds), which are carried on a missile.

Pelagic Zone—commonly referred to as the open ocean.

Pelagic—of the ocean waters.

Peninsula—a portion of land nearly surrounded by water and generally connected with a larger body by an isthmus, although the isthmus is not always well defined.

Per Capita—per unit of population; by or for each person.

Permeability—a quality that enables water to penetrate.

Pesticide—any substance, organic, or inorganic, used to destroy or inhibit the action of plant or animal pests; the term thus includes insecticides, herbicides, fungicides, rodenticides, miticides, fumigants, and repellents. All pesticides are toxic to humans to a greater or lesser degree. Pesticides vary in biodegradability.

pH—a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity.

Photosynthesis—the plant process by which water and carbon dioxide are used to manufacture energy-rich organic compounds in the presence of chlorophyll and energy from sunlight.

Physiography—geography dealing with the exterior physical features and changes of the earth (also known as physical geography).

Phytoplankton—plant-like organisms that drift with the ocean currents, with little ability to move through the water on their own. Predominately one-celled, phytoplankton float in the photic zone (sunlit surface waters of the ocean, which extends to only about 100 meters (330 feet) below the surface), where they obtain sunlight and nutrients, and serve as food for zooplankton and certain larger marine animals.

Pinniped—having finlike feet or flippers, such as a seal or walrus.

Plankton—free-floating, usually minute, organisms of the sea; includes larvae of benthic species.

Pliocene—of, relating to, or being the latest epoch of the Tertiary Period or the corresponding system of rocks; following the Pleistocene and prior to the Miocene.

PM-2.5 and PM-10—standards for measuring the amount of solid or liquid matter suspended in the atmosphere; refers to the amount of particulate matter less than or equal to 2.5 and 10 micrometers in diameter, respectively. The PM-2.5 and PM-10 particles penetrate to the deeper portions of the lungs, affecting sensitive population groups such as children and people with respiratory or cardiac diseases.

Point Source—a distinct and identifiable source, such as a sewer or industrial outfall pipe, from which a pollutant is discharged.

Population Density—the average number of individuals or organisms per unit of space or area.

Potable Water—water that is safe to drink.

Potentially Hazardous Debris—inert debris impacting the earth with a kinetic energy equal to or greater than 11 foot-pounds.

Prehistoric—literally, "before history," or before the advent of written records. In the old world writing first occurred about 5400 years ago (the Sumerians). Generally, in North America and the Pacific region, the prehistoric era ended when European explorers and mariners made written accounts of what they encountered. This time will vary from place to place.

Prohibited Area—designated airspace where aircraft are prohibited, except by special permission. Can also apply to surface craft.

Radar—a radio device or system for locating an object by means of radio waves reflected from the object and received, observed, and analyzed by the receiving part of the device in such a way that characteristics (such as distance and direction) of the object may be determined.

Range—a land or sea area designated and equipped for any or all of the following reasons:

Range Activity—an individual training or test function performed on a range or in an Operating Area. Examples include missile launching, bombardment, and vehicle driving. Individual RDT&E functions are also included in this category.

Range Complex—a geographically integrated set of ranges and associated special use airspace, designated and equipped with a command and control system and supporting infrastructure for freedom of maneuver and practice in munitions firing and live ordnance use against scored and/or tactical targets and/or Electronic Warfare tactical combat training environment.

Range Safety Zone—area around air-to-ground ranges designed to provide safety of flight and personnel safety relative to dropped ordnance and crash sites. Land use restrictions can vary depending on the degree of safety hazard, usually decreasing in magnitude from the weapons impact area (including potential ricochet) to the area of armed over flight and aircraft maneuvering.

Readiness—the ability of forces, units, weapon systems, or equipment to deliver the outputs for which they were designed (includes the ability to deploy and employ without unacceptable delays).

Region of Influence—the geographical region that would be expected to be affected in some way by the Proposed Action and alternatives.

Relative Humidity—the ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature.

Relief—the difference in elevation between the tops of hills and the bottoms of valleys.

Remediation—all necessary actions to investigate and clean up any known or suspected discharge or threatened discharge of contaminants, including without limitation: preliminary assessment, site investigations, remedial investigations, remedial alternative analyses and remedial actions.

Restricted Area—a designated airspace in which flights are prohibited during published periods of use unless permission is obtained from the controlling authority.

Ruderal Vegetation—weedy and commonly introduced flora growing where natural vegetational cover has been interrupted or disturbed by humans.

Runoff—the portion of precipitation on land that ultimately reaches streams, often with dissolved or suspended materials.

Safety Zone—administratively designated/implied areas designated to limit hazards to personnel and the public, and resolve conflicts between events. Can include range safety zones, ESQDs, surface danger zones, special use airspace, Hazard of Electromagnetic Radiation to Ordnance/Hazard of Electromagnetic Radiation to Personnel (HERO/HERP) areas, etc.

Saline—consisting of or containing salt.

Sampling—the selection of a portion of a study area or population, the analysis of which is intended to permit generalization of the entire population. In archaeology, samples are often used to reduce the amount of land area covered in a survey or the number of artifacts analyzed from a site. Statistical sampling is generally preferred since it is possible to specify the bias or probability of error in the results, but judgmental or intuitive samples are sometimes used.

Scoping—a process initiated early during preparation of an Environmental Impact Statement to identify the scope of issues to be addressed, including the significant issues related to the Proposed Action. During scoping, input is solicited from affected agencies as well as the interested public.

Seamount—a peaked, underwater mountain that rises at least 3,281 feet above the ocean floor.

Seawall—a wall or embankment to protect the shore from erosion or to act as a breakwater.

Security Zone—area where public or non-operational support access is prohibited due to training operations of a classified or hazardous nature.

Sensitive Habitats—areas of special importance to regional wildlife populations or protected species that have other important biological characteristics (for example, wintering habitats, nesting areas, and wetlands).

Sensitive Receptor—an organism or population of organisms sensitive to alterations of some environmental factor (such as air quality or sound waves) that undergo specific effects when exposed to such alteration.

Shield Volcano—a broad, gently sloping volcanic cone of flat domicil shape, usually several tens of hundreds of square miles in extent, built chiefly of overlapping and interfingering basaltic lava flows.

Short-Term Public Exposure Guidance Level—an acceptable concentration for unpredicted, single, short-term, emergency exposure of the general public, as published by the National Research Council.

Site—in archaeology, any location where human beings have altered the terrain or have discarded artifacts.

Solid Waste—municipal waste products and construction and demolition materials; includes non-recyclable materials with the exception of yard waste.

Sonar—Sound Navigation and Ranging. Sonar includes any system that uses underwater sound, or acoustics, for observations and communications. The two broad types of sonar are:

- **Passive sonar** detects the sound created by an object (source) in the water. This is a one-way transmission of sound waves traveling through the water from the source to the receiver.
- **Active sonar** detects objects by creating a sound pulse, or ping, that transmits through the water and reflects off the target, returning in the form of an echo. This is a two-way transmission (source to reflector to receiver) and is a form of echolocation.

Sonobuoy—hydrophones, or floating sensors, which acoustically score bomb drops during a training event from the sound where a bomb impacts the surface of the ocean.

Sortie—a single training event or RDT&E activity conducted by one aircraft tin a range or operating area. A single aircraft sortie is one complete flight (i.e., one take-off and one final landing).

Special Use Airspace—consists of several types of airspace used by the military to meet its particular needs. Special use airspace consists of that airspace wherein activities must be confined because of their nature, or wherein limitations are imposed upon aircraft operations that are not a part of these activities, or both. Special use airspace, except for Control Firing Areas, are chartered on instrument flight rules or visual flight rules charts and include hours of operation, altitudes, and the controlling agency.

Species—a taxonomic category ranking immediately below a genus and including closely related, morphologically similar individuals which actually or potentially interbreed.

Specific Absorption Rate—the time rate at which radio frequency energy is absorbed per unit mass of material, usually measured in watts per kilogram (W/kg).

Stakeholder—those people or organizations that are affected by or have the ability to influence the outcome of an issue. In general this includes regulators, the regulated entity, and the public. It also includes those individuals who meet the above criteria and do not have a formal or statutorily defined decision-making role.

State Historic Preservation Officer (SHPO)—the official within each state, authorized by the state at the request of the Secretary of the Interior, to act as liaison for purposes of implementing the National Historic Preservation Act.

State Jurisdictional Waters—sea areas within 3 nm of a state's continental and island shoreline.

Stationary Source—any building, structure, facility, installation, or other fixed source that emits any regulated air pollutant.

Stormwater—runoff produced during storms, generally diverted by rain spouts and stormwater sewerage systems. Stormwater has the potential to be polluted by such sources as yard trimmings and pesticides. A stormwater outfall refers to the mouth of a drain or sewer that channels this runoff.

Subsistence—the traditional harvesting of natural resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade.

Subsistence Economy—a community, usually based on farming and/or fishing, that provides all or most of the basic goods required by its members for survival, usually without any significant surplus for sale.

Subspecies—a geographically defined grouping of local populations which differs taxonomically from similar subdivisions of species.

Substrate—the layer of soil beneath the surface soil; the base upon which an organism lives.

Sulfur Dioxide—a toxic gas that is produced when fossil fuels, such as coal and oil, are burned.

Sustainable Range Management—management of an operational range in a manner that supports national security objectives, maintains the operational readiness of the Armed Forces, and ensures the long-term viability of operational ranges while protecting human health and the environment.

Sustaining the Capability—maintaining necessary skills, readiness and abilities.

Symbiotic—living in or on the host.

System of Systems—all communications, electronic warfare, instrumentation, and systems linkage supporting the range/range complex.

Taking—to harass, harm, pursue, hunt, shout, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Taking can involve harming the habitat of an endangered species.

Talus—rock debris at the base of a cliff.

Targets—earthwork, materials, actual or simulated weapons platforms (tanks, aircraft, electronic warfare systems, vehicles, ships, etc.) comprising tactical target scenarios within the range/range complex impact areas. .

Tempo—as it applies to proposed activities, the intensity. This could include more forces or shorter/longer duration of activities.

Tenant—a unit that has an Inter-Service Support Agreement with the host for use of the training areas and that maintains a permanent presence.

Thermocline—a thin, narrow region in a thermally stratified body of water which separates warmer, oxygen-rich surface water from cold, oxygen-poor deep water and in which temperature decreases rapidly with depth. In tropical latitudes, the thermocline is present as a permanent feature and is located 200 to 1,000 feet below the surface.

Threatened Species—a plant or animal species likely to become endangered in the foreseeable future.

Topography—the configuration of a surface including its relief and the position of its natural and man-made features.

Trade Winds—winds blowing almost constantly in one direction. Especially a wind blowing almost continually from the equator from the northeast in the belt between the northern horse latitudes and the doldrums and from the southeast in the belt between the southern horse latitudes and the doldrums.

Traditional Resources—prehistoric sites and artifacts, historic areas of occupation and events, historic and contemporary sacred areas, material used to produce implements and sacred objects, hunting and gathering areas, and other botanical, biological, and geographical resources of importance to contemporary groups.

Transient—remaining a short time in a particular area.

Troposphere—the atmosphere from ground level to an altitude of 6.2 to 9.3 miles (see stratosphere).

Tsunami—a great sea wave produced by a submarine earthquake or volcanic eruption. Commonly misnamed tidal wave.

Turbid—the condition of being thick, cloudy, or opaque as if with roiled sediment; muddy.

Uncontrolled Airspace—airspace of defined dimensions in which no air traffic control services to either instrument flight rules or visual flight rules aircraft will be provided, other than possible traffic advisories when the air traffic control workload permits and radio communications can be established.

Understory—a vegetal layer growing near the ground and beneath the canopy of a taller layer.

Unique and Sensitive Habitats—areas of special importance to regional wildlife populations or protected species that have other important biological characteristics (for example, wintering habitats, nesting areas, and wetlands).

Unsymmetrical Dimethyl Hydrazine (UDMH)—a liquid hypergolic propellant utilized as a missile fuel (as in the Lance); clear and colorless, UDMH has a sharp ammonia-like or fishy odor, is toxic when inhaled, absorbed through the skin, or taken internally. It is dissolvable in water, but not sensitive to shock or friction; however, when in contact with IRFNA, or any other oxidizing material, spontaneous ignition occurs. In addition, UDMH vapors greater than 2 percent in air can be detonated by electric spark or open flame.

Upland—an area of land of higher elevation.

Upwelling—the replenishing process of upward movement to the surface of marine often nutrient-rich lower waters (a boon to plankton growth), especially along some shores due to the offshore drift of surface water as from the action of winds and the Coriolis force.

U.S. Territorial Waters—sea areas within 12 nm of the U.S. continental and island shoreline.

Viewshed—total area seen within the cone of vision from a single observer position, or vantage point; a collection of viewpoints with optimal linear paths of visibility.

Vista—a distant view through or along an avenue or opening.

Visual Flight Rules (VFR)—rules that govern the procedures for conducting flight under visual conditions; used by pilots and controllers to indicate type of flight plan.

Volatile Organic Compound (VOC)—one of a group of chemicals that react in the atmosphere with nitrogen oxides in the presence of heat and sunlight to form ozone; it does not include methane and other compounds determined by the Environmental Protection Agency to have negligible photochemical reactivity. Examples of volatile organic compounds include gasoline fumes and oil-based paints.

Warning Area—a designated airspace in which flights are not restricted but avoidance is advised during published times of use.

Wastewater—water that has been previously utilized; sewage.

Wetlands—lands or areas that either contain much soil moisture or are inundated by surface or groundwater with a frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include such areas as bogs, marshes, mud and tidal flats, sloughs, river overflows, seeps, springs, or swamps.

Yearly Average Day-Night Sound Level (DNL or L_{dn})—utilized in evaluating long-term environmental impacts from noise, this is an annual mean of the day-night sound level.

Zoning—the division of a municipality (or county) into districts for the purpose of regulating land use, types of buildings, required yards, necessary off-street parking, and other prerequisites to development. Zones are generally shown on a map, and the text of the zoning ordinance specifies requirements for each zoning category.

Zooplankton—animals that drift with the ocean currents, with little ability to move through the water on their own, ranging from one-celled organisms to jellyfish up to 1.8 meters (6 feet) wide. Zooplankton live in both surface and deep waters of the ocean; crustaceans make up about 70 percent. While some float about freely throughout their lives, many spend only the early part of their lives as plankton.

9.0 References

9.0 REFERENCES

Abbott, R., and E. Bing-Sawyer. 2002. *Assessment of Pile-Driving Impacts on the Sacramento Blackfish (Othodon microlepidotus).* Draft report prepared for the California Department of Transportation, District 4. [For Official Use Only]

Abbott R, J. Reyff, and G. Marty, 2005. Monitoring *the effects of conventional pile driving on three species of fish.* Final report prepared by Strategic Environmental Consulting, Inc. for Manson Construction Company, Richmond, California.

Aburto, A., D.J. Rountry, and J.L. Danzer, 1997. "Behavioral response of blue whales to active signals," *Technical Report 1746*. San Diego: Naval Command, Control and Ocean Surveillance Center, RDT&E Division, June.

Advisory Committee on Acoustic Impacts on Marine Mammals, 2006. Report to the Marine Mammal Commission. Marine Mammal Commission; Bethesda, Maryland. February.

Aerospace Corporation, 1998. Impact of the Titan IVB Launch Failure on Ocean Environment.

Aguirre, A.A., and P.L. Lutz, 2004. "Marine turtles as sentinels of ecosystem health: Is fibropapillomatosis an indicator?" *EcoHealth,* 1:275–283.

Air Force Aerospace Medical Research Laboratory, 1990. Armstrong Aerospace Medical Research Laboratory (AAMRL), Air Force Procedure for Predicting Aircraft Noise Around Airbases: Noise Exposure Model (NOISEMAP) Users Manual. Human Systems Division, Air Force Systems Command. Wright-Patterson AFB, OH.

Air Force Center for Environmental Excellence Environmental Services Office, 2003. U.S. Air Force 15th Airlift Wing Installation Restoration Program Final Decision to Support No Further Response Action Planned for AOC EA02 (Radar Shaft) Kokee Air Force Station Kauai, Hawaii, 31 July.

Aki, K., R. Brock, J. Miller, J.R. Mobley, P.J. Rappa, D. Tarnas, M. Yuen, and K. Des Rochers, 1994. A site characterization study for the Hawaiian Islands Humpback Whale National Marine Sanctuary, HAWAU-T-94-001, University of Hawaii Sea Grant Program, 119 pp.

Alexander, J.W., Solangi, M.A., and Riegel, L.S., 1989. "Vertebral osteomyelitis and suspected diskospondylitis in an Atlantic bottlenose dolphin (*Tursiops truncatus*)," *Journal of Wildlife Diseases* 25(1), 118-121.

Alpin, J.A., 1947. "The effect of explosives on marine life," *California Fish and Game,* 33: 23-30.

Amano, M., and M. Yoshioka, 2003. "Sperm whale diving behavior monitored using a suction-cup attached TDR tag," *Marine Ecology Progress Series*, 258:291-295.

Amemiya, T., 1981. "Qualitative response models: a survey," *Journal of Economic Literature*, 19: 1483-1536.

American Dream Realty, 2006. Oahu, Kaneohe Real Estate-Jeff Manson's Team. [Online]. Available: http://www.adrhi.com/kaneoherealestate.asp

American Institute of Aeronautics and Astronautics, 1993. Environmental Monitoring of Space Shuttle Launches at Kennedy Space Center: The First Ten Years. 31st Aerospace Science Meeting and Exhibit, July 11-14, 1993, Reno NV.

Amoser, S., and F. Ladich, 2003. "Diversity in noise-induced temporary hearing loss in otophysine fishes," *Journal of the Acoustical Society of America,* 113(4): 2170-2179, part 1: April.

Amoser, S. and F. Ladich, 2005. "Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats?" *Journal of Experimental Biology,* 208: 3533-3542.

Anderson, L., 1998. *Final report: Cultural Resources Management Plan Report Oahu Training Ranges and Areas, Island of Oahu, Hawaii.* Prepared for the U.S. Army Engineer District, Honolulu, Fort Shafter, Hawai`i. Ogden Environmental and Energy Services Company, Inc., August.

Anderson, L., and S. Williams, 1998. *Historic Preservation Plan for the Kahuku Training Area, O`ahu, Hawai`i.* Prepared for the US Army Engineer District, Honolulu, Fort Shafter, Hawai`i, Ogden Environmental Energy Services Company, Inc., Honolulu.

André, M., M. Terada, and Y. Watanabe, 1997. "Sperm Whale (*Physeter macrocephalus*) Behavioral Response After the Playback of Artificial Sounds," *Reports of the International Whaling Commission*, 47:499-504.

Andrew, R.K., B.M. Howe, J.A. Mercer, and M.A. Dzieciuch, 2002. "Ocean ambient sound: Comparing the 1960's with the 1990's for a receiver off the California coast," *Acoustic Research Letters Online*, 3(2): 65-70. April.

Andrews, K.R., L. Karczmarski, W.W.L. Au, S.H. Rickards, C.A. Vanderlip, and R.J. Toonen, 2006. "Patterns of genetic diversity of the Hawaiian spinner dolphin (*Stenella longirostris*)," *Atoll Research Bulletin*, 543:65-73.

Anon., 2001. "Act Now for Ocean Natives, "Anon.org [Online]. Available: http://www.anon.org/lfas_news.jsp.

Anonymous, 2002. "Baffling boing identified," *Science,* 298:2125. ScienceNow (1209):2.

Anonymous, 2005. "Monk seal snoozes in Kaaawa," *Honolulu Star-Bulletin News*, 6 January [Online]. Available: http://starbulletin.com/2005/01/06/news/briefs.html, [10 June 2005].

Antonelis, G.A. and C.H. Fiscus, 1980. "The pinnipeds of the California Current," *CalCOFI Reports, 21:68-78*.

Aquaculture in Hawaii, 2006. "Aquaculture in Hawai`i," [Online]. Available: http://www.oceanicinstitute.org/_oldsite/aboutus/aquahawaiian.html

Archer, F.I., II, and W.F. Perrin, 1999. "*Stenella coeruleoalba," Mammalian Species,* 603:1-9.

Arruda, J., A. Costidis, S. Cramer, D.R. Ketten, W. McLellan, E.W. Montie, M. Moore, and S. Rommel, 2007. "Odontocete Salvage, Necropsy, Ear Extraction, and Imaging Protocols," edited by N. M. Young (Ocean Research, Conservation and Solutions (ORCAS) and ONR), pp. 1-171.

Arveson, P.T. and D.J. Vendittis, 2000. "Radiated noise characteristics of a modern cargo ship," *Journal of the Acoustic Society of America,* 107(1):118-129.

Astrup, J., 1999. "Ultrasound detection in fish - a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects?" *Comparative Biochemistry and Physiology, Part A,* 124:19-27.

Astrup, J. and Møhl, B., 1993. "Detection of intense ultrasound by the cod *Gadus morhua," Journal of Experimental Biology,* 182: 71-80.

Atema, J., R.R. Fay, A.N. Popper, and W.N. Tavolga eds., 1988. Sensory Biology of Aquatic Animals. New York: Springer Verlag.Au, W.W.L., 1993. "The sonar of dolphins," *Springer-Verlag,* New York, 277 pp.

Au, W.W.L., and M. Green, 2000. "Acoustic interaction of humpback whales and whale-watching boats," *Marine Environment Research*, 49(5):469-481June 2000.

Au, W.L., J. Mobley, W. Burgess, M. Lammers, 2000. "Seasonal and diurnal trends of chorusing humpback whales wintering in waters of western Maui," Marine *Mammal Science*, 16(3):530-544, July.

Au, W.W.L., and D. Herzing, 2003. "Echolocation signals of wild Atlantic spotted dolphin (*Stenella frontalis*)," *Journal of the Acoustical Society of America*, *113(1): 598-604*.

Au, W.W.L., J. Darling, and K. Andrews, 2001. "High-frequency harmonics and source level of humpback whale songs," In Abstract: *Journal of the Acoustical Society of America, 110(5) part 2:2770-Contributed Paper 5aAB3 (9:15)*.

Au, W.W.L., J.K.B. Ford, J.K. Horne, K.A. Newman Allman, 2004. "Echolocation signals of free-ranging killer whales (*Orcinus orca*) and modeling of foraging for Chinook salmon (*Oncorhynchust shawytscha*)," *Journal of the Acoustical Society of America, 115(2):901-909*.

Au, W.W.L., Pack, A.A., Lammers, M.O., Herman, L.M., Deakos, M. and Andrews, K., 2006. "Acoustic properties of humpback whale song," Journal *of the Acoustical Society of America*, 120(2):1103-1110.

Audubon, 2006. "The 2002 Audubon WatchList" [Online]. Available: http://audubon2.org/webapp/watchlist/viewWatchlist.jsp [15 June].

Aviation Supplies and Academics, Inc., 1996. Federal Aviation Regulations and Aeronautical Information Manual, Newcastle, WA.

Bain, D.E., J.C. Smith, R. Williams, and D. Lusseau, 2006. "Effects of vessels on behavior of southern resident killer whales (*Orcinus* spp)". NMFS Contract Report No. AB133F03SE0959 and AB133F04CN0040, March.

Baird, R.W. 2002. "Killer whales of the world: natural history and conservation". *Voyageur Press, Stillwater, MN* 132 pp.

Baird, R.W., 2005a. Personal communication via email between Dr. Robin Baird, Cascadia Research Collective, Olympia, Washington and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, 16 June and 11 July.

Baird, R.W., 2005b. "Sightings of dwarf *(Kogia sima*) and pygmy (*K. breviceps*) sperm whales from the main Hawaiian Islands," *Pacific Science,* 59(3):461-466.

Baird, R.W., and A.M. Gorgone, 2005. "False killer whale dorsal fin disfigurements as a possible indicator of long-line fishery interactions in Hawaiian waters," *Pacific Science,* 59(4):593-601.

Baird, R.W., D. Nelson, J. Lien, and D.W. Nagorsen, 1996. "The status of the pygmy sperm whale, *Kogia breviceps*, in Canada. *Canadian Field-Naturalist,* 110:525-532.

Baird, R.W., A.D. Ligon, and S.K. Hooker, 2000. "Sub-surface and night-time behavior of humpback whales off Maui, Hawaii*: A preliminary report,"* Report prepared for the Hawaii Wildlife Fund, Paia, Hawaii. August.

Baird, R.W., A.M. Gorgone, A.D. Ligon, and S.K. Hooker, 2001. "Mark-recapture abundance estimate of bottlenose dolphins (*Tursiops truncatus*) around Maui and Lanai, Hawaii, during the winter of 2000/2001," Report prepared under Contract #40JGNFO-00262 for the National Marine Fisheries Service, La Jolla, California, August.

Baird, R.W., A.M. Gorgone, and D.L. Webster, 2002. "An examination of movements of bottlenose dolphins between islands in the Hawaiian Island chain," Report for contract 40JGNF11070 for the National Marine Fisheries Service, La Jolla, California, July.

Baird, R.W., D.J. McSweeney, D.L. Webster, A.M. Gorgone, and A.D. Ligon, 2003. "Studies of odontocete population structure in Hawaiian waters: Results of a survey through the main Hawaiian Islands in May and June 2003," Report prepared for the National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, Washington, October.

Baird, R. W., D.J. McSweeney, A.D. Ligon and G.S. Schorr, 2005. "Diving behavior and ecology of Cuvier's (*Ziphius cavirostris*) and Blainville's beaked whales (*Mesoplodon densirostris*) in Hawai`i," Report prepared under Order No. AB133F-04-RQ-0928 to Cascadia Research Collective, Olympia, WA from the Southwest Fisheries Science Center, National Marine Fisheries Service La Jolla, CA 92037 USA, 24 pp.

Baird, R.W., G.S. Schorr, D.L. Webster, S.D. Mahaffy, A.B. Douglas, A.M. Gorgone, and D.J. McSweeney, 2006a. "A survey for odontocete cetaceans off Kaua`i and Ni`ihau, Hawai`i, During October and November 2005: Evidence for population structure and site fidelity," Report to Pacific Islands Fisheries Science Center, NOAA Fisheries [Online]. Available: http://www.cascadiaresearch.org/robin/ Bairdetal2006odontocetesurvey.pdf.

Baird, R.W., D.L. Webster, D.J. McSweeney, A.D. Lignon, G.S. Schorr, and J. Barlow, 2006b. "Diving behaviour of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawai`i," *Canadian Journal of Zoology,* 84:1120-1128.

Baird, R., L. Antoine, C. Bane, J. Barlow, R. LeDuc, D. McSweeney, and D. Webster. 2006c."Killer whales in Hawaiian waters: Information on population identity and feeding habits," *Pacific Science*, 60(4):523-530 Baker, C.S., and L.M. Herman, 1981. "Migration and local movement of humpback whales (*Megaptera novaeangliae*) through Hawaiian waters," *Canadian Journal of Zoology,* 59:460-469.

Baker, J.D., and T.C. Johanos, 2004. "Abundance of the Hawaiian monk seal in the main Hawaiian Islands," *Biological Conservation,* 116:103-110.

Balazs, G.H., 1976. "Green turtle migrations in the Hawaiian archipelago," *Biological Conservation,* 9:125-140.

Balazs, G.H., 1983. "Recovery records of adult green turtles observed or originally tagged at French Frigate Shoals, Northwestern Hawaiian Islands." NOAA Technical Memorandum NMFS. NOAATM-NMFS-SWFC-36:1-42.

Balazs, G.H., 1995. "Status of sea turtles in the central Pacific Ocean," pp. 243-252 In: K.A. Bjorndal, ed. *Biology and Conservation of Sea Turtles*. Rev. ed. Washington, D.C.: Smithsonian Institution Press.

Balazs, G.H., 1998. "Sea turtles," p. 115. In: S.P. Juvik and J.O. Juvik, eds. *Atlas of Hawaii*. Honolulu: University of Hawaii Press.

Balazs, G.H., and M. Chaloupka, 2004. "Thirty-year recovery trend in the once depleted Hawaiian green sea turtle stock," *Biological Conservation,* 117:491–498.

Balazs, G.H. and D.M. Ellis, 1998. "Satellite telemetry of migrant male and female green turtles breeding in the Hawaiian Islands," pp. 281-283. In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez and L. Sarti, eds, *Proceedings of the Eighteenth International Sea Turtle Symposium,* NOAA Technical Memorandum NMFS-SEFSC-436*,* March.

Balazs, G.H., and S. Hau, 1986. "*Lepidochelys olivacea* (Pacific ridley) U.S.A.: Hawaii," *Herpetological Review,* 17:51 6*.*

Balazs, G.H., P. Craig, B.R. Winton, and R.K. Miya, 1994. "Satellite telemetry of green turtles nesting at French Frigate Shoals, Hawaii, and Rose Atoll, American Samoa," pp. 184-187. In: K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar, eds. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Technical Memorandum NMFS-SEFSC-351, March.

Balcomb, K.C, 1987. "The whales of Hawaii, including all species of marine mammals in Hawaiian and adjacent waters," *San Francisco: Marine Mammal Fund*.

Balcomb, K.C., 1989. "Baird's beaked whale *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Berardius arnuxii* Duvernoy, 1851," pp. 261-288. In: S.H. Ridgway and R. Harrison*,* eds. *Handbook of marine mammals, Volume 4: River dolphins and the larger toothed whales*, London: Academic Press.

Ballance, L.T., R.L. Pitman, and P.C. Fiedler, 2006. "Oceanographic influences on seabirds and cetaceans of the eastern tropical Pacific: a review," Progress *in Oceanography*, 69:360-390.

Ballistic Missile Defense System Command, 1977. Environment Assessment Missile Impacts, Illeginni Island, at the Kwajalein Missile Range, Kwajalein Atoll, December.

Banner A, and M. Hyatt, 1973. "Effects of noise on eggs and larvae of two estuarine fishes," *Transactions of the American Fisheries Society*, 102(1):134-136.

Baraff, L.S. and M.T. Weinrich, 1994. "Separation of humpback whale mothers and calves on a feeding ground in early autumn." *Marine Mammal Science*, 9:431-434.

Barlow, J., 1999. "Trackline detection probability for long-diving whales," pp. 209-221. In: G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, eds. *Marine mammal survey and assessment methods*, Brookfield, Vermont: A.A. Balkema.

Barlow, J., 2003. "Cetacean abundance in Hawaiian waters during summer/fall of 2002," *Southwest Fisheries Science Center Administrative Report LJ-03-13*, La Jolla, California: National Marine Fisheries Service, December.

Barlow J., 2006. "Cetacean abundance in Hawaiian waters estimated from a summer/fall survey of 2002," *Marine Mammal Science, 22(2):446-464*.

Barlow, J., and B.L. Taylor, 2005. "Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey," *Marine Mammal Science*, 21(3):429-445.

Barlow, J. and R. Gentry, 2004. Report of the NOAA Workshop on Anthropogenic Sound and Marine Mammals, 19-20 February. pp. 17-18. NOAA-TM-NMFS-SWFSC-361.

Barlow, J. and R. Gisiner, 2006. "Mitigation, monitoring and assessing the effects of anthropogenic sound on beaked whales," *Journal of Cetacean Research And Management, 7(3):239-249.*

Barlow, J., S. Rankin, E. Zele, and J. Appler, 2004. "Marine mammal data collected during the Hawaiian Islands cetacean and ecosystem assessment survey (HICEAS) conducted aboard the NOAA ships McArthur and David Starr Jordan, July–December 2002," NOAA Technical Memorandum NMFS-SWFSC-362, Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, 39 pp. June

Barlow, J. and K.A. Forney. 2007. "Abundance and population density of cetaceans in the California Current ecosystem," Fisheries *Bulletin*, 105:509–526.

Bartholomew, G.A., and N.E. Collias, 1962. "The role of vocalization in the social behavior of the northern elephant seal," *Animal Behaviour*, 10:7-14.

Bartholomew, G.A. and C.L. Hubbs, 1960. "Population growth and seasonal movements of the northern elephant seal, *Mirounga angustirostris* (1)," *Journal Mammalia,* 24:313-324.

Bartol, S.M., J.A. Musick, and M.L. Lenhardt, 1999. "Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*)," *Copeia,* 3:836-840.

Bass, A., M.Marchaterre and R. Baker, 1994. "Vocal-Acoustic Pathways in a Teleost Fish," *Journal of Neuroscience,* 14(7):4025-4039.

Bauer, G., M. Fuller, A. Perry, J.R. Dunn, and J. Zoeger, 1985. "Magnetoreception and biomineralization of magnetite in cetaceans," pp. 489-507.In: Magnetite Biomineralization and Magnetoreception in Organisms: A New Biomagnetism edited by J.L. Kirschvink, D.S. Jones, and B.J. MacFadden (Plenum Press, New York).

Baumgartner, M.F. and B.R. Mate, 2003. "Summertime foraging ecology of North Atlantic right whales," *Marine Ecology Progress Series,* 264:123-135.

Baumgartner, M.F., K.D. Mullin, L.N. May, and T.D. Leming, 2001. "Cetacean habitats in the northern Gulf of Mexico," *Fishery Bulletin,* 99:219-239.

Baxter, L. II, E.E. Hays, G.R. Hampson, and R.H. Backus, 1982. "Mortality of fish subjected to explosive shock as applied to oil well severance on Georges Bank." Woods Hole Oceanographic Institution Report WHO-82-54.

Bazua-Duran and W.W.L. Au, 2002. "The whistles of Hawaiian spinner dolphins," *Journal of the Acoustical Society of America,* 112:3064-3072.

Bazua-Durana, C. and W.W.L. Au. 2004. "Geographic variations in the whistles of spinner dolphins (*Stenella longirostris*) of the Main Hawaiian Islands," *Journal of the Acoustical Society of America,* 116(6):3757-3769.

Beamish, P. and E. Mitchell, 1973. "Short pulse length audio frequency sounds recorded in the presence of a minke whale (*Balaenoptera acutorostrata*)," *Deep-Sea Research,* 20:375-386.

Bejder, L., Samuels, A., Whitehead, H., Gales, N., Mann, J., Connor, R., Heithaus, M., Watson-Capps, J., Flaherty, C and Kruetzen, M. 2006. "Decline in relative abundance of bottlenose dolphins (Tursiops sp) exposed to long-term disturbance." *Conservation Biology*, 20 (6): 1791–1798.

Belt Collins Hawaii, 1994. Assessment of Lead (Pb) and Water Quality in the Nearshore Marine Environments Off the Pacific Missile Range Facility Kauai, Hawaii, 23 July.

Bennett, D.H, C.M. Falter, S.R. Chipps, K. Niemela, and J. Kinney, 1994. "Effects of underwater sound stimulating the intermediate scale measurement system on fish and zooplankton of Lake Pend Oreille, Idaho." Research Report prepared by College of Forestry, Wildlife and Range Sciences, University of Idaho for Office of Naval Research, Arlington Virginia, Contract N00014-92-J-4106.

Benoit-Bird, K.J., 2004. "Prey caloric value and predator energy needs: foraging predictions for wild spinner dolphins," *Marine Biology,* 45:435–444.

Benoit-Bird, K.J., W.W.L. Au, R.E. Brainard, and M.O. Lammers, 2001. "Diel horizontal migration of the Hawaiian mesopelagic boundary community observed acoustically," *Marine Ecology Progress Series,* 217:1-14.

Benoit-Bird, K.J. and W.W.L. Au, 2004. "Diel migration dynamics of an island-associated sound-scattering layer," *Deep-Sea Research I,* 51:707-719.

Benson, L.K. and J.M. Fitzsimons, 2002. "Life history of the Hawaiian fish *Kuhlia sandvicensis* as inferred from daily growth rings of otoliths," Environmental *Biology of Fishes,* 65:131-137.Bernard, H.J., and S.B. Reilly, 1999. "Pilot whales *Globicephala* Lesson, 1828," pp. 245-279. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises,* San Diego: Academic Press.

Best, P.B., D.S. Butterworth, and L.H. Rickett, 1984. "An assessment cruise for the South African inshore stock of Bryde's whales (*Balaenoptera edeni*)," *Reports of the International Whaling Commission,* 34:403-423.

Best, P.B. 1994. "Seasonality of reproduction and the length of gestation in southern right whales *Eubalaena australis*," *Journal of Zoology, London*, 232:175-189.

Bjørge, A., 2002. "How persistent are marine mammal habitats in an ocean of variability?" pp. 63-91. In: P.G.H. Evans and J.A. Raga, eds. *Marine mammals: Biology and conservation,* New York: Kluwer Academic/Plenum Publishers.

Bjorndal, K., 1997. "Foraging ecology and nutrition of sea turtles," pp. 199-231. In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles,* Boca Raton, Florida: CRC Press.

Bjorndal, K.A., A.B. Bolten, and H.R. Martins, 2000. "Somatic growth model of juvenile loggerhead sea turtles *Caretta caretta*: Duration of pelagic stage," *Marine Ecology Progress Series,* 202:265-272.

Blaxter J.H.S., E.J. Denton, J.A.B. Gray, 1981. "The auditory bullae-swimbladder system in late stage herring larvae," *Journal of the Marine Biological Association of the United Kingdom,* 61:315–326.

Booman, C., H. Dalen, H. Heivestad, A. Levsen, T. van der Meeren, and K. Toklum, 1996. "Effekter av luftkanonskyting pa egg, larver og ynell," *Havforskningsinstituttet, Issn* 0071-5638.

Borggaard, D., J. Lien, and P. Stevick, 1999. "Assessing the effects of industrial activity on large cetaceans in Trinity Bay, Newfoundland (1992-1995)," *Aquatic Mammals,* 25:149-161.

Borell, A., 1993. "PCB and DDTs in blubber of cetaceans from the northeastern north Atlantic," Marine *Pollution Bulletin,* 26: 146–151.

Bowen, B.W., F.A. Abreu-Grobois, G.H. Balazs, N. Kamezaki, C.J. Limpus, and R.J. Ferl, 1995. "Trans-Pacific migrations of the loggerhead turtle (*Caretta caretta*) demonstrated with mitochondria DNA markers," *Proceedings of the National Academy of Sciences USA,* 92:3,731-3,734.

Bowen, W.D., C.A. Beck, and D.A. Austin, 2002. "Pinniped ecology," pp. 911-921. In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen*,* eds. *Encyclopedia of marine mammals*, San Diego: Academic Press.

Brabyn, M., and R.V.C. Frew, 1994. "New Zealand herd stranding sites do not relate to geomagnetic topography," *Marine Mammal Science*, 10:195-207.

Brabyn, M.W., and I.G. McLean, 1992. "Oceanography and coastal topography of herd-stranding sites for whales in New Zealand," *Journal of Mammology*, 73, 469-476.

Bradshaw, C.J.A., K. Evans, and M.K A. Hindell. 2005. "Mass Cetacean Strandings—a Plea for Empiricism," Conservation *Biology*, 20:584–586.

Bradshaw, C.J.A., K., Evans, and M.A. Hindell, 2006. "Mass Cetacean Strandings – a Plea for Empiricism," *Conservation Biology*, 20:584-586.

Braun, R.C., 2005. Personal communication via email between Dr. Robert Braun, National Marine Fisheries Service, Pacific Island Fisheries Science Center, Honolulu, Hawaii, and Mr. Conrad Erkelens, U.S. Pacific Fleet, Fleet Environmental Office, Pearl Harbor Hawaii, 1 September.

Broadcast Engineering Services of Bonny Doon, 2007. *Mt. Kahili Electronic Site - KAQA 91.9 FM* [Online]. Available: http://www.well.com/~dmsml/kahili.html.

Brodie, E.C., F.M.D. Gulland, D.J. Greig, M. Hunter, J. Jaakola, J.S. Leger, T.A. Leighfield, and F.M.V. Dolah, 2006. "Domoic acid causes reproductive failure in California sea lions (*Zalophus californianus*)," *Marine Mammal Science*, 22:700–707.

Brownell, Jr., R.L., P.J. Clapham, T. Miyashita, and T. Kasuya, 2001. "Conservation status of North Pacific right whales," *Journal of Cetacean Research and Management, Special Issue*, 2:269-286.

Brownell, R.L., T. Yamada, J.G. Mead, and A.L. van Helden, 2004. Mass strandings of Cuvier's beaked whales in Japan: U.S. Naval acoustic link Paper SC/56/E37 presented to the IWC Scientific Committee (unpublished). 10pp. [Available from the Office of the Journal of Cetacean Research and Management.]

Brownell, R.L., T. Yamada, J.G. Mead, and B.M. Allen, 2006. "Mass strandings of melon-headed Whale *(Peponacephala electra):* a worldwide review,*" Paper* presented to the Scientific Committee of the International Whaling Commission, SC/58/SM8.

Buck, J.R. and P.L. Tyack, 2000. "Response of gray whales to low-frequency sounds," In Abstract: *Journal of the Acoustic Society of America*, 107(5) part 2: 2774.

Buckstaff, K.C., 2004. "Effects of watercraft noise on the acoustic behavior of bottlenose dolphins, *Tursiops truncates*, in Sarasota Bay, Florida," Marine *Mammal Science*, 20(4):709-725

Buerkle, U., 1968. "Relation of pure tone thresholds to background noise level in the Atlantic cod (*Gadus morhua*)," *Journal of the Fisheries Research Board of Canada*, 25: 1155 1160.

Buerkle, U., 1969. "Auditory masking and the critical band in Atlantic cod (*Gadus morhua*)," *Journal of the Fisheries Research Board of Canada*, 26:1113 1119.

Burger, 2006. Comments on the HRC DEIS/OEIS received from John Burger, Pacific Missile Range Facility, regarding hazardous materials and waste at Pacific Missile Range Facility.

Burger, J., 2007a. Comments on the HRC DEIS/OEIS received from John Burger, Pacific Missile Range Facility, regarding albatross egg re-location practices at Pacific Missile Range Facility, January.

Burger, J., 2007b. Personal communication via email: Information received from John Burger, Pacific Missile Range Facility, regarding green sea turtles on Pacific Missile Range Facility, 24 January.

Burger, J., 2007c. Personal communication via email: Information received from John Burger, Pacific Missile Range Facility, regarding invasive species protocols, 30 January.

Burger, J., 2007d. Personal communication via email: Information received from John Burger, Pacific Missile Range Facility, regarding the number of missile launches occurring at PMRF during the past several years, 24 October.

Burger, J., 2007e. Information received from John Burger, Pacific Missile Range Facility, regarding the number of Laysan albatross eggs placed with surrogate parents during the 2007 season, 19 December.

Burger, J. and T. Nizo, 2007. Personal communication via email between John Burger, CIV PMRF, and Thomas Nizo, CIV NAVFAC HI, 30 January.

Burgess, W.C., P.L. Tyack, B.J. Le Boeuf, and D.P. Costa, 1998. "A programmable acoustic recording tag and first results from free-ranging northern elephant seals," *Deep-Sea Research II,* 45:1327-1351.

Burtenshaw, J.C., E.M. Oleson, J.A. Hildebrand, M.A. McDonald, R.K. Andrew, B.M. Howe, and J.A. Mercer, 2004. "Acoustic and satellite remote sensing of blue whale seasonality and habitat in the northeast Pacific," *Deep Sea Research II,* 15:967-986.

Cairns, S.D., 1994. "Scleractinia of the temperate North Pacific," *Smithsonian Contributions to Zoology,* 557:1-150.

Calambokidis, J., G.H. Steiger, J.M. Straley, T.J. Quinn II, L.M. Herman, S. Cerchio, D.R. Salden, M. Yamaguchi, F. Sato, J. Urban R., J.K. Jacobsen, O. Von Ziegesar, K.C. Balcomb, C.M. Gabrielle, M.E. Dahlheim, N. Higahsi, S. Uchida, J.K.B. Ford, Y. Miyamura, P.L. de Guevara P., S.A. Mizroch, L. Schlender, and K. Rasmussen, 1997. "Final Report - Abundance and population structure of humpback whales in the North Pacific basin," Unpublished contract report to the National Marine Fisheries Service, La Jolla, California.

Calambokidis, J., G.H. Steiger, J.M. Straley, L.M. Herman, S. Cerchio, D.R. Salden,., R.J. Urbán, J.K. Jacobson, O, vonZiegesar, K.C. Balcomb, C.M. Gabrielle, M.E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P., Ladrón de Guevara, M. Yamaguchi, F. Sato, S.A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, J. and T.J. Quinn II, 2001. "Movements and population structure of humpback whales in the North Pacific," *Marine. Mammal Science,* 17 (4):769-794.

Calambokidis, J., E. Oleson, M. McDonald, B. Burgess, J. Francis, G. Marshall, M. Bakhtiari, and J. Hildebrand, 2003. "Feeding and vocal behavior of blue whales determined through simultaneous visual-acoustic monitoring and deployment of suction-cap attached tags," p. 27. In *Abstracts: Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003*, Greensboro, North Carolina.

Caldwell, D.K., and M.C. Caldwell, 1989. "Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838): Dwarf sperm whale *Kogia simus* Owen, 1866," pp. 253-260. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals, Volume 4: River dolphins and the larger toothed whales*. London: Academic Press.

California Department of Public Health, 2007. Perchlorate in Drinking Water: California MCL Status. [Online]. Available: http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Perchlorate.aspx.

California Marine Mammal Stranding Network Database, 2006. Southwest Regional Stranding Coordinator National Marine Fisheries Service 501 West Ocean Blvd, Suite 4200 Long Beach, CA 90802-4213562-980-4017 [Online]. Available: http://www.nmfs.noaa.gov/pr/health/networks.htm

Caltrans, 2001. "Pile Installation Demonstration Project, Fisheries Impact Assessment." PIDP EA 012081, Caltrans Contract 04A0148. San Francisco - Oakland Bay Bridge East Span Seismic Safety Project.

Caltrans, 2004. "Fisheries and Hydroacoustic Monitoring Program Compliance Report for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project." Prepared by Strategic Environmental Consulting, Inc. and Illingworth & Rodkin, Inc. June.

Campagna, C., V. Falabella, M. Lewis, 2007. "Entanglement of southern elephant seals in squid fishing gear," *Marine Mammal Science,* 23(2):414-418.

Caribbean Conservation Corporation and Sea Turtle Survival League, 2003. "Flatback Sea Turtle Information & Map," [On-line]. Available: http://www.cccturtle.org/flatback.htm

Carlson, H.W., 1978. "Simplified sonic-boom prediction." NASA TP-1122.

Carr, A., 1987. "New perspectives on the pelagic stage of sea turtle development," *Conservation Biology,* 1:103-121.

Carr, A., 1995. "Notes on the behavioral ecology of sea turtles," pp. 19-26. In: K.A. Bjorndal, ed. *Biology and conservation of sea turtles*, Rev. ed. Washington, D.C.: Smithsonian Institution Press.

Carretta, J.V., J. Barlow, K.A. Forney, M.M. Muto, and J. Baker, 2001. U.S. Pacific marine mammal stock assessments: 2001. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-317

Carretta JV, Forney KA, Muto MM, Barlow J, Baker J, Lowry M. 2004. U.S. Pacific marine mammal stock assessments: 2003. NOAA Technical Memorandum NMFS-SWFSC-358. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M. Lowry, 2005. "U.S. Pacific marine mammal stock assessments: 2004," NOAA Technical Memorandum NMFS-SWFSC-375:1-31 6.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry, 2006. U.S. Pacific Marine Mammal Stock Assessments: 2005. U.S. Department of Commerce, NOAA-TM-NMFS-SWFSC–388.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry, 2007. "U.S. Pacific Marine Mammal Stock Assessments: 2006," (NOAA-TM-NMFS-SWFSC-398, National Marine Fisheries Service, Southwest Fisheries Science Center), pp. 321.

Casper, B.M. and D.A. Mann, 2006. "Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urobatis jamaicensis*)," *Environmental Biology of Fishes*, 76:101–108.

Casper, B.M., P.S. Lobel, and H.Y. Yan, 2003. "The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods," *Environmental Biology of Fishes* 68: 371-379.

Cato, D.H., 1978. "Marine biological choruses observed in tropical waters near Australia," *Journal of the Acoustical Society of America,* 64(3), 736-743*.*

Center for Coastal Monitoring and Assessment, 2006. "Benthic Habitats of the Main Hawaiian Islands—2003," last updated on August 29, 2006, [Online]. Available: http://ccma.nos.noaa.gov/products/biogeography/benthic/htm/uchan.htm.

Centers for Disease Control and Prevention, 2003. Sixteenth Meeting of the Advisory Board on Radiation and Worker Health May 19-20, 2003. Oak Ridge, Tennessee.

Center for Plant Conservation, 2006. "Center for Plant Conservation – National Collection of Endangered Plants," [Online]. Available: http://www.centerforplantconservation.org/ASP/CPC_ViewProfile.asp?CPCNum=4421 [2 August 2006].

Cetacean and Turtle Assessment Program, 1982. "Characterization of marine mammals and turtles in the mid- and North Atlantic areas of the U.S. outer continental shelf," *Final Report to the U.S. Bureau of Land Management, Washington, D.C., from the Graduate School of Oceanography, University of Rhode Island, Kingston,* NTIS PB83-215855.

Chaloupka, M. and G. Balazs, 2005. "Modeling the effect of fibropapilloma disease on the somatic growth dynamics of Hawaiian green sea turtles," *Marine Biology,* 147:1251–1260.

Chaloupka, M.Y., and J.A. Musick, 1997. "Age, growth, and population dynamics," pp. 233-276. In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles,* Boca Raton, Florida: CRC Press.

Chaloupka, T. Work, G. Balazs, S. Murakawa and R. Morris, 2003. "Cause-specific temporal and spatial trends in green sea turtle standings in the Hawaiian Archipelago (1982-2003)". Unpublished.

Chambers, S., and R.N. James, 2005. "Sonar termination as a cause of mass cetacean strandings in Geographe Bay, south-western Australia," In: *Acoustics 2005*, *Acoustics in a Changing Environment* (Busselton, Western Australia).

Chambers, M.D., D.K. Garcelon, and C.A. Schwemm, 2005. "Drift card simulation of larval dispersal from San Nicolas Island, CA during black abalone spawning season." Proceedings of the 6th CA Islands Symposium, Dec. 2003, Ventura, CA, USA.

Chamber of Commerce of Hawaii, Military Affairs Council, 2006. "Hawaii-Based Armed Forces Benefit All of US," (Brochure) January 2006 [Online]. Available: http://www.hawaii.gov/dbedt/info/economic/data_reports/federal/

Chamber of Commerce of Hawaii, Military Affairs Council, 2007. "Profile of Hawaii-Based Armed Forces," (Brochure) January 2007, [Online]. Available: http://www.hawaii.gov/dbedt/info/economic/data_reports/federal/DBEDT_Armed_Forces_2007-01.pdf

Chapman, C.J. 1973. "Field studies of hearing in teleost fish," *Helgoländer wissenschaftliche Meeresuntersuchungen,* 24:371-390.

Chapman, C.J. and A.D. Hawkins, 1969. "The importance of sound in fish behaviour in relation to capture by trawls," *FAO Fisheries Report,* 62(3): 717-729.

Chapman C.J, and A.D. Hawkins, 1973. "A field study of hearing in the cod, *Gadus morhua*," *Journal of Comparative Physiology*, 85:147 167.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, K.M. Fristrup, and C.W. Clark, 2002. "Estimated source levels of fin whale (*Balaenoptera physalus*) vocalizations: Adjustments for surface interference," *Marine Mammal Science,* 18:81-98.

Chave, E.H., and A. Malahoff, 1998. "In deeper waters: Photographic studies of Hawaiian deepsea habitats and life-forms," Honolulu: University of Hawai`i Press.

Chivers, S.J., R.G. LeDuc, and R.W. Baird, 2003. "Hawaiian island populations of false killer whales and short-finned pilot whales revealed by genetic analysis," p. 32. In *Abstracts: Fifteenth Biennial Conference on the Biology of Marine Mammals, 14-1 9* December 2003. Greensboro, North Carolina.

Clapham, P.J. and J.G. Mead, 1999. "*Megaptera novaeangliae,*" *Mammalian Species,* 604:1-9.

Clapham, P. J., S. Leatherwood, I. Szczepaniak, and R.L. Brownell, 1997. "Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919-1926," *Marine Mammal Science,* 13:368-394.

Clapham, P.J., C. Good, S.E. Quinn, R.R. Reeves, J.E. Scarff, and R.L. Brownell, 2004. "Distribution of North Pacific right whales (*Eubalaena japonica*) as shown by 19th and 20th century whaling catch and sighting records," *Journal of Cetacean Research and Management,* 6:1-6.

Clark, C.W. and K.M. Fristrup, 1997. "Whales '95: A combined visual and acoustic survey of blue and fin whales off southern California," *Reports of the International Whaling Commission,* 47:583-600.

Clark, C.W. and P.J. Clapham, 2004. "Acoustic monitoring on a humpback whale (*Megaptera novaeangliae*) feeding ground shows continual singing into late spring," *Proceedings of the Royal Society of London, Part B*, 271:1051-1057.

Clarke, M.R., 1996. "Cephalopods as prey,". III. Cetaceans, *Philosophical Transactions of the Royal Society, B*., 351:1053-1065.

Cleghorn, Paul, 1987. *Prehistoric Cultural Resources and Management Plan for Nihoa and Necker Island, Hawai`i*. Bishop Museum Press, Honolulu, Hawaii. [Online]. Available: http://www2.bishopmuseum.org/noaanwhi/results.asp

Cleghorn, Paul, 1988. The *Settlement and Abandonment of Two Hawaiian Outposts: Nihoa and Necker Islands*. Bishop Museum Occasional Papers, Vol. 28.

Clifton, K., D.O. Cornejo, and R.S. Felger, 1995. "Sea turtles of the Pacific coast of Mexico," pp. 199-209. In: K.A. Bjorndal, ed. *Biology and conservation of sea turtles, revised edition.* Washington, D.C.: Smithsonian Institution Press.

Clyne, H., 1999. Computer simulations of interactions between the North Atlantic Right Whale (*Eubaleana glacialis*) and shipping.

Cockcroft, V.G., G. Cliff, and G.J.B. Ross, 1989. "Shark predation on Indian Ocean bottlenose dolphins *Tursiops truncatus* off Natal, South Africa," South African Journal of Zoology 24, 305-310.

Coker, C.M. and E.H. Hollis, 1950. "Fish mortality caused by a series of heavy explosions in Chesapeake Bay," *Journal of Wildlife Management*, 14(4): 435-445.

Coles, W.C., and J.A. Musick, 2000. "Satellite sea surface temperature analysis and correlation with sea turtle distribution off North Carolina," *Copeia,* 2:551-554.

Collin, S.P., and N.J. Marshall, 2003. Sensory Processing in Aquatic Environments. New York: Springer-Verlag.

Colorado State University, 2002. *Analysis of Fire History and Management Concerns at Pohakuloa Training Area* [Online]. Available: http://www.cemml.colostate.edu/files/tps02-02.pdf [April].

Columbia Gazetteer of North America, 2000. "Kaula," [Online], Available: http://www.bartleby.com/69/1/K02401

Commander, U.S. Fleet Forces Command, 2006. "Fleet Response Plan (FRP) Implementation Message, 231400Z May 03," May.

Commander- in-Chief Pacific Fleet, 2001. *Ehime Maru Environmental Assessment,* 15 June.

Commander, Navy Region Hawaii, 2007. *Survey of Marine and Fishery Resources for An Integrated Natural Resources Management Plan (INRMP) for the Pacific Missile Range Facility (PMRF) Barking Sands (BS),* Kauai, Hawaii – Phase II-2006, October: Revised June 2007.

Commander, Submarine Force U.S. Pacific Fleet, 1997. Environmental Assessment for a Hawaiian Area Shallow-Water Minefield Sonar Training Area, July.

Commerce Business Daily, 2000. *"Utility Systems: conveyance Authority"* [Online], Available: http://frwebgate1.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=357466283058+12+0+0&WAISaction=retrieve [15 September 2006].

Compagno, L.J.V. and J.A. Musick, 2000. *Pseudocharcharias kamoharai*. In: 2004 IUCN red list of threatened species, [Online]. Available: http://www.redlist.org

Conner, R.C., 2000. "Group living in whales and dolphins," pp. 199-218. In: *Cetacean Societies*: In: *Field Studies of Dolphins and Whales*, edited by J. Mann, R. C. Conner, P. L. Tyack, and H. Whitehead (University of Chicago Press, Chicago).

Constantine, R., I. Visser, D. Buurman, R. Buurman, and B. McFadden, 1998. "Killer whale (*Orcinus orca*) predation on dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura, New Zealand," *Marine Mammal Science, 14:324-330*.

Cook, Richard K., 1969. "Subsonic Atmospheric Oscillation," *Proceedings of the Symposium on Acoustic-Gravity Waves in the Atmosphere, Boulder, Colorado, July 16-1* 7, *1968,* ESSA and Advanced Research Projects Agency, Boulder, 1968, pp. 209-213.

Cook, D.S. and E. Spillman, 2000. Military training ranges as a source of environmental contamination. Federal Facilities Environmental Journal. Summer 27-37, 2000.

Cook, M.L.H., R.A. Varela, J.D. Goldstein, S.D. McCulloch, G.D. Bossart, J.J. Finneran, D. Houser, and D.A. Mann, 2006. “Beaked whale auditory evoked potential hearing measurements,” *Journal of Comparative Physiology- A,* 192: 489–495.

Coombs, S. and A.N. Popper, 1979. “Hearing differences among Hawaiian squirrelfish (family Holicentridae) related to differences in the peripheral auditory system.” *Journal of Comparative Physiology- A,* 132:203-207.

Collin, S.P. and N.J. Marshall, eds. 2003. Sensory Processing in Aquatic Environments. New York: Springer-Verlag.

Coral Reef Information System, 2003. “Deep water corals,” [Online]. Available: http://www.coris.noaa.gov/about/deep/deep.html [21 January 2004].

Coral Reef Information System, 2007. Northwestern Hawaiian Islands – Cultural History of the NWHI, Early Settlers; Geography and History; and Archaeology [Online]. Available*:* http://www.coris.noaa.gov/about/eco_essays/nwhi/history.html. [23 January]

Corkeron, P.J. and R.C. Connor, 1999. “Why do baleen whales migrate?,” *Marine Mammal Science,* 15:1228-1245.

Corkeron, P.J., and S.M. Van Parijs, 2001. “Vocalizations of eastern Australian Risso’s dolphins, *Grampus griseus*,” *Canadian Journal of Zoology,* 79:160-164.

Corwin J.T., 1981. “Audition in elasmobranchs,” pp. 81-105. In: *Hearing and Sound Communication in Fishes*, eds. W.N. Tavolga, A.N. Popper, and R.R. Fay, New York: Springer Verlag.

Corwin J.T., 1989. “Functional anatomy of the auditory system in sharks and rays,” *Journal of Experimental Zoology, Supplement*, 2:62-74.

Cottingham, D., 1989. Persistent Marine Debris; Part 1: The Threat, Part 2: The Solution. Mariners Weather Log, National Oceanographic Data Center.

Council on Environmental Quality, 1997. Environmental Justice Guidance Under the National Environmental Policy Act. December [Online]. Available: http://www.whitehouse.gov/CEQ/

County of Kaua`i, Department of Water, 2006. “*Water Quality Report – Covering the period of January 1, 2006 to December 31, 2006*, Kauai Department of Water, Kekaha-Waimea Water System, 2007.

Cowan, J., 1994. *Handbook of Environmental Acoustics*. Van Nostrand Reinhold: New York.

Cox, T.M., T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G.D. Spain, A. Fernandez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hilderbrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. MacLeod, P. Miller, S. Moore, D.C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead,and L. Benner, 2006. "Understanding the impacts of anthropogenic sound on beaked whales," *Journal of Cetacean Research Management,* 7:177-187.

Crocker, D.E., D.P. Costa, B.J. Le Boeuf, P.M. Webb, and D.S. Houser, 2006. "Impacts of El Niño on the foraging behavior of female northern elephant seals," *Marine Ecolology. ProgramSeries* 309.

Croll, D.A., A. Acevedo-Gutiérrez, B.R. Tershy, and J. Urbán-Ramírez, 2001. "The diving behavior of blue and fin whales: Is dive duration shorter than expected based on oxygen stores?," *Comparative Biochemistry and Physiology Part A,* 129:797-809.

Croll, D.A., C.W. Clark, A. Acevedo, B. Tershy, S. Flores, J. Gedamke, and J. Urban, 2002. "Only male fin whales sing loud songs," *Nature,* 417:809.

Crum, L.A., and Y. Mao, 1996. "Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety," *Journal of the Acoustical Society of America,* 99:2898-2907.

Crum, L.A., M.R. Bailey, G. Jingfeng, P.R. Hilmo, S.G. Kargl, and T.J. Matula, 2005. "Monitoring bubble growth in supersaturated blood and tissue ex vivo and the relevance to marine mammal bioeffects," *Acoustic Research Letters Online* 6:214-220.

Cudahy, E., and W.T. Ellison, 2001. "A review of the potential for in vivo tissue damage by exposure to underwater sound." Unpublished report prepared for National Marine Fisheries Service, Office of Protected Resources. Silver Spring, Maryland.

Culik, B.M., S. Koschinski, N. Tregenza, and G.M. Ellis, 2001. "Reactions of harbour porpoises (*Phocoena phocoena*) and herring (*Clupea harengus*) to acoustic alarms," *Marine Ecology Progress Series,* 211:255-260.

Culik, B.M., 2002. "Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats," in United Nations Environment Programme, Convention on Migratory Species (Marine Mammal Action Plan/Regional Seas Reports and Studies No. 177), p. 343. [Online]. Available: http://www.unep.org/regionalseas/News/Review_of_Small_Cetaceans/default.asp

Cummings, W.C., 1985. "Bryde's whale *Balaenoptera edeni* Anderson, 1878," pp. 137-154, In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 3: The sirenians and baleen whales*. San Diego: Academic Press.

Curl, H.C. and K. O'Donnell, 1977. Chemical and Physical Properties of Refined Petroleum Products. NOAA Technical Memorandum ERL MESA-17. NTIS PC A03/MF A01 2001 May 13.

Currents, 2007. "Navy offers sanctuary to migratory birds," [Online]. Available: http://www.p2pays.org/ref/41/40529.pdf

Curry, B.E., 1999. "Stress in mammals: The potential influence of fishery-induced stress on dolphins in the eastern tropical Pacific Ocean," NOAA Technical Memorandum NOAA-TMNMFS-SWFSC-260: 1-121.

D'Amico, A., and W. Verboom, 1998. "Report of the Bioacoustics Panel, NATO/SACLANT," pp. 2-1-2-60.

D'Spain, G.L., A. D'Amico, and D.M. Fromm, 2006. "Properties of the underwater sound fields during some well documented beaked whale mass stranding events," *Journal of Cetacean Research and Management,* 7(3):223-238.

D'Vincent, C.G., R.M. Nilson, and R.E. Hanna, 1985. "Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska," *Scientific Reports of the Whales Research Institute,* 36:41-47.

Dahlheim, M.E., and J.E. Heyning, 1999. "Killer whale *Orcinus orca* (Linnaeus, 1758)," pp. 281-322. In S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises*. San Diego: Academic Press.

Dahlheim, M.E., S. Leatherwood, and W.F. Perrin, 1982. "Distribution of killer whales in the warm temperate and tropical eastern Pacific," *Reports of the International Whaling Commission,* 32:647-653.

Dailey, M., and W.A. Walker, 1978. "Parasitism as a factor (?) in single strandings of southern California cetaceans," *Journal of Parasitology* 64:593-596.

Dailey, M., M. Walsh, D. Odell, and T. Campbell, 1991. "Evidence of prenatal infection in the bottlenose dolphin (*Tursiops truncatus*) with the lungworm *Halocercus lagenorhynch*i (Nematoda: Pseudaliidae)," *Journal of Wildife Diseases* 27:164-165.

Dalen, J. and G.M. Knutsen, 1986. "Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic exploration," pp. 93-102. In: Merklinger, H.M. (Ed.), *Progress in Underwater Acoustics*. Plenum Press, New York.

Dalen J, and A. Raknes, 1985. "Scaring effects on fish from three-dimensional seismic surveys" *Report No. FO 8504*. Institute of Marine Research. Bergen, Norway.

Darling, J. D., and S. Cerchio, 1993. "Movement of a humpback whale (*Megaptera novaeangliae*) between Japan and Hawaii," *Marine Mammal Science,* 1:84-89.

Davenport, J., 1997. "Temperature and the life-history strategies of sea turtles," *Journal of Thermal Biology,* 22:479-488.

Davis, B., 1981. "*Archaeological Reconnaissance Survey of Hawaiian Wind Farm Project Area at Kahuku, O`ahu, Hawai'i," Ms. 060481*. Prepared for Bechtel Power Corporation, Los Angeles, Department of Anthropology, Bernice P. Bishop Museum, Honolulu, Hawaii.

Davis, R.W., G.S. Fargion, N. May, T.D. Leming, M. Baumgartner, W.E. Evans, L.J. Hansen, and K. Mullin, 1998. "Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico," *Marine Mammal Science,* 14:490-507.

Deecke, V. B., J. K. B. Ford, and P. J. B. Slater, 2005. "The vocal behaviour of mammal-eating killer whales: Communicating with costly calls," *Animal Behaviour* , 69:395-405.

Defense Environmental Network and Information eXchange, 1999. "Natural Resources Conservation (FY 1998) Marine Corps Base Hawaii," [Online]. Available: https://www.denix.osd.mil/denix/Public/News/Earthday99/Awards99/MChinrsm/nrawd98.html.

Defense Environmental Network and Information eXchange, 2001. "Natural Resources Conservation (FY99—FY01) Marine Corps Base Hawaii," [Online]. Available: https://www.denix.osd.mil/denix/Public/News/OSD/SecDef01/NRC/nrc_si_hawaii.pdf.

Defense Environmental Network and Information eXchange, 2005. "Introduction and Background," [Online]. Available: https://www.denix.osd.mil/denix/Public/News/OSD/SecDef05/NRC/NRC_Inst_Hawaii.pdf

DeLong, R.L., G.L. Kooyman, W.G. Gilmartin, and T.R. Loughlin, 1984. "Hawaiian monk seal diving behavior," *Acta Zoological Fennica,* 172:129-1 31.

Department of Energy, 1991. *Kauai Test Facility (KTF) Environmental Assessment*, Sandia National Laboratories, March.

Department of Health, 2001. Final Environmental Impact Statement, Outfall Replacement for Wastewater Treatment Plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii, March.

Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. 2003. *Petitioned Public Health Assessment, Soil Pathway Evaluation, Isla de Vieques Bombing Range, Vieques, Puerto Rico*. [Online] Available; http://www.atsdr.cdc.gov/HAC/PHA/isladevieques/idv_toc.html#abb

Department of Labor and Industrial Relations, 2006. "Honolulu MSA Industry Employment Trends", Hawaii Workforce Informer, [Online], Available: http://www.hiwi.org/admin/uploadedPublications/1582_LTproj2002-12-HON.pdf, [31 October].

Department of Planning and Permitting, 2006. *"*Annual Report on The Status of Land Use on Oahu, Fiscal Year 2005*,"* Mufi Hannemann, Mayor, City and County of Honolulu, Henry Eng, FAICP, Director, Department of Planning and Permitting, Honolulu, Hawaii, April 2006. [On-line], Available: http://honoluludpp.org/planning/dpar2/dpar2005.pdf

De Stephanis, R. and E. Urquiola, 2006. 'Collisions between ships and cetaceans in Spain,' Report to the Scientific Committee, *International Whaling Commission* SC/58/BC5.

De Swart, R.L., T.C. Harder, P.S. Ross, H.W. Vos, and A.D.M.E. Osterhaus, 1995. "Morbilliviruses and morbillivirus diseases of marine mammals," *Infectious Agents and Disease*, 4:125-130.

Desilets, Michael E., 2002. Archaeological Monitoring at AOC-18 Landfill, Bellows Air Force Station, Waimanalo, O`ahu, Hawai`i (TMK:4-1-15). T.S. Dye & Colleagues, Archaeologists, Inc. June.

Di Guardo, G., and G. Marruchella, 2005. Sonars, Gas Bubbles, and Cetacean Deaths, "Letters to the Editor," *Veterinary Pathology*, 42:517-518, 2005.

Dierauf, L.A., and F.M.D. Gulland, 2001. "Marine Mammal Unusual Mortality Events," pp. 69-81. In: *Marine Mammal Medicine*, edited by L. A. Dierauf, and F. M. D. Gulland (CRC Press, Boca Raton).

Dietz, R., J. Teilmann, M.-P.H. Jørgensen, and M.V. Jensen, 2002. "Satellite tracking of humpback whales in West Greenland," *National Environmental Research Institute Technical Report 411:1-38*. Copenhagen, Denmark: National Environmental Research Institute.

Dijkgraaf S. 1952. "Uber die Schallwahrnehmung bei Meeresfischen," *Zeitschrift verglishende Phyiologie,* 34:104-122.

Division of Economics, U.S. Fish and Wildlife Service, 2002. "Draft Economic Analysis Of Proposed Critical Habitat Designations For Threatened And Endangered Plants On Kaua`i And Ni`ihau Hawai`i Revised Determination," Draft, April.

Dobson, A.J., 2002. *An introduction to generalized linear models*. Second Edition. Chapman and Hall, CRC Press, Boca Raton, Florida.

Dodd, C.K., 1988. "Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758)," *U.S. Fish and Wildlife Service Biological Report,* 88:1-110.

Dollar, S. and R. Grigg, 2003. "Anthropogenic and natural stresses on selected coral reefs in Hawaii: A multi-decade synthesis of impact and recovery," *Pacific Science*, (in press).

Dolphin, W.F., 1987. "Ventilation and dive patterns of humpback whales, *Megaptera novaeangliae*, on their Alaskan feeding grounds," *Canadian Journal of Zoology, 65:83-90*.

Domingo, M., J. Visa, M. Pumarola, A.J. Marco, L. Ferrer, R. Rabanal, and S. Kennedy, 1992. “Pathologic and immunocytochemical studies of morbillibirus infection in striped dolphins (*Stenella coeruleoalba*),” *Veterinary Pathology*, 29:1-10.

Domjan, M.,1998. *The principles of learning and behavior* (4th ed.). New York: Brooks/Cole.

Donovan, G.P., 1991. “A review of IWC stock boundaries,” *Reports of the International Whaling Commission, Special Issue,* 13:39-68.

Dorne, J.L. C.M., and A.G. Renwick, 2005. “The refinement of uncertainty/safety factors in risk assessment by the incorporation of data on toxicokinetic variability in humans,” *Toxicological Sciences*, 86:20-26.

Dorsey, E.M., 1983. “Exclusive adjoining ranges in individually identified minke whales (*Balaenoptera acutorostrata*) in Washington state,” *Canadian Journal of Zoology,* 61:174-181.

Drolet, R., 2000. *Archaeological Inventory Survey of Area A1, Kahuku Training Area, O`ahu Island, Hawai`i*. Prepared for the US Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawai`i. Scientific Consultant Services/Cultural Resource Management Services (SCS/CRMS), Honolulu, Hawai`i.

Drolet, R., A.K. Yoklavich, and J. Landrum, 1996. Cultural Resources Management Overview Survey Pacific Missile Range Facility, Hawaiian Area Kaua`i, Hawai`i in Conjunction with Department of Defense Legacy Resource Management Program Project No. 70. Prepared for the Department of the Navy, Naval Facilities Engineering Command. Ogden Environmental and Energy Services Co., Inc., Honolulu. [For Official Use Only]

Dudok van Heel, W.H., 1966. “Navigation in cetacea,” pp. 597-606. In: Whales, Dolphins, and Porpoises, edited by K. S. Norris (University of California Press, Berkeley).

Dunn, J.L., J.D. Buck, and T.R. Robeck. 2001. “Bacterial diseases of cetaceans and pinnipeds,” pp. 309-336. In: L.A. Dierauf and F.M.D. Gulland, eds. *CRC Handbook of Marine Mammal Medicine*. CRC Press, Boca Raton, FL.

Dunning, J.B., B.J. Danielson, and H.R. Pulliam, 1992. “Ecological processes that affect populations in complex landscapes,” *Oikos,* 65:169-175.

DuPont, 1980. Blaster’s Handbook-16th edition. Explosives Products Division, E.I. DuPont de Nemours and Company, Wilmington, Delaware. 494 pp.

Dwyer , W.P., W. Fredenberg, and D.A. Erdahl, 1993. “Influence of electroshock and mechanical shock on survival of trout eggs,” *North American Journal of Fisheries Management* , 13:839-843.

Eckert, K.L., 1987. “Environmental unpredictability and leatherback sea turtle (*Demochelys coriacea*) nest loss,” *Herpetologica,* 43:315-323.

Eckert, K.L., 1993. "The biology and population status of marine turtles in the North Pacific Ocean," NOAA Technical Memorandum NMFS-SWFSC-186:1-156.

Eckert, K.L., 1995. "Anthropogenic threats to sea turtles," pp. 611-612. In: K.A. Bjorndal, ed. *Biology and conservation of sea turtles*, Washington, D.C.: Smithsonian Institution Press.

Eckert, K.L., and C. Luginbuhl, 1988. "Death of a giant," *Marine Turtle Newsletter,* 43:2-3.

EDAW, 2005. Electromagnetic Railgun Environmental Assessment Meeting Minutes, PMRF Alternative, May.

Edds, P.L. and J.A.F. Macfarlane, 1987. "Occurrence and general behavior of balaenopterid cetaceans summering in the St. Lawrence Estuary," *Canada Journal of Zoology, 65(6)-1363-1376.*

Edds-Walton, P.L., 2000. "Vocalizations of minke whales *Balaenoptera acutorostrata* in the St. Lawrence Estuary," *12 Bioacoustics,* 11:31-50.

Edds-Walton, P.L. and J.J. Finneran, 2006. "Evaluation of evidence for altered behavior and auditory deficits in fishes due to human-generated noise sources." SPAWAR Technical Report 1939, 50 pp.

Egner, S.A. and D.A. Mann, 2005. Auditory sensitivity of sergeant major damselfish *Abudefduf saxatilis* from post-settlement juvenile to adult. *Marine Ecology Progress Series* 285: 213–222.

Ehrhart, L.M., 1995. "A review of sea turtle reproduction," pp. 29-38, In: K.A. Bjorndal, ed. *Biology and conservation of sea turtles, Rev. ed*. Washington, D.C.: Smithsonian Institution Press.

Ek, H., G. Dave, E. Nilsson, J. Sturve, and G. Birgersson, 2006. "Fate and Effects of 2,4,6-Trinitrotoluene (TNT) from dumped ammunition in a field study with fish and invertebrates," *Archives of Environmental Contamination and Chemistry,* 51:244-252.

Elbert, S.H., 1959. *Selections from Fornander's Hawaiian Antiquities and Folklore*. S. Elbert (editor). The University Press of Hawai`i, Honolulu.

Emory, K.P., 1928. *Archaeology of Nihoa and Necker Islands.* Bernice P. Bishop Museum, Bulletin 53. Tanager Expedition, Publication Number 5. Honolulu, Hawaii.

Engas, A. and S. Lokkeborg, 2002. "Effects of seismic shooting and vessel generated noise on fish behaviour and catch rates," *Bioacoustics*, 12:313-315.

Engas, A., S. Lokkeborg, E. Ona, and A.V. and Soldal, 1996. "Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*)," *Canadian Journal of Fisheries Aquatic Science,* 53: 2238-2249. (2)

Enger, P.S., 1967. "Hearing in herring," *Comparative Biochemistry and Physiology,* 22:527 538.

Enger, P.S., 1981. "Frequency discrimination in teleosts-central or peripheral?" pp. 243-255. In: *Hearing and Sound Communication in Fishes*, eds. W.N. Tavolga, A.N. Popper, and R.R. Fay. New York: Springer-Verlag.

Enterprise Honolulu, 2007. "Military Employment," [Online]. Available: http://www.enterprisehonolulu.com/html/display.cfm?sid=131

Epperly, S.P., J. Braun, A.J. Chester, F.A. Cross, J.V. Merriner, and P.A. Tester, 1995. "Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery," *Bulletin of Marine Science,* 56:547-568.

Erbe, C., 2002. "Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model," Marine Mammal Science, 18(2): 394-418.

Ernst, C.H., R.W. Barbour, and J.E. Lovich, 1994*. Turtles of the United States and Canada,* Washington, D.C.: Smithsonian Institution Press.

Etnoyer, P., D. Canny, B. Mate, L. Morgan, J. Ortega-Otiz and W. Nichols. 2006. "Sea-surface temperature gradients across blue whale and sea turtle foraging trajectories off the Baja California Peninsula, Mexico," *Deep-Sea Research II*, 43: 340-358.

Evans, D.L., 2002. "Report of the Workshop on Acoustic Resonance as a Source of Tissue Trauma in Cetaceans, April 24 & 25, 2002.Silver Spring, MD." National Marine and Fisheries Service, November.

Evans, D.L. and G.R. England, 2001. *Joint Interim Report; Bahamas Marine Mammal Stranding Event of 15-16 March 2000,* National Oceanic and Atmospheric Administration [Online]. Available: http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_bahamas2000.pdf

Evans, P.G.H. and L.A. Miller, 2003. "Proceedings of the Workshop on Active Sonar and Cetaceans, Las Palmas, Gran Canaria, 8 March 2003," *European Cetaceans Society Newsletter 42* (Special Issue)*:*78 pp.

Evans, E.C.I., N.L. Buske, J.G. Grovhoug, E.B. Guinther, P.L. Jokiel, D.T.O. Kam, E.A. Kay, T.J. Peeling, and S.V. Smith, 1974. "A proximate biological survey of Pearl Harbor," as cited In: U.S. Department of the Navy, 1997, *Biodiversity of Marine Communities in Pearl Harbor, Oahu, Hawaii with Observations on Introduced Exotic Species*, August, Bishop Museum Technical Report Number 10 [Online]. Available: http://hbs.bishopmuseum.org/pdf/PHReport.pdf

Evans, K., M.A. Hindell, D. Thiele, 2003. “Body fat and condition in sperm whales, *Physeter macrocephalus*, from southern Australian waters,” *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology,* 134A(4):847-862.

Evans, K., R. Thresher, R.M. Warneke, C.J.A. Bradshaw, M. Pook, D. Thiele, and M. Hindell, M.A., 2005. “Periodic variability in cetacean strandings: links to large-scale climate events,” *Biology Letters,* 1:147-150.

Fahlman, A., A. Olszowka, B. Bostrom and D.R. Jones, 2006. “Deep diving mammal: Dive behavior and circulatory adjustments contribute to bends avoidance,” *Respiratory Physiology and Neurobiology,* 153:66-77.

Fair, P.A., and P.R. Becker, 2000. “Review of stress in marine mammals,” *Journal of Aquatic Ecosystem Stress and Recovery* 7:335-354.

Farris, T., 2004. Hawaiian Melon-headed Whale *(Peponacephala electra)*Mass Stranding Event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31, April 2006.

Fay, R.R., 1988. *Hearing in vertebrates: a psychophysics data book*. Hill-Fay Associates, Winnetka, Illinois. 630 pp.

Fay, R.R., 2005. “Sound source localization by fishes,” pp 36-66. In: *Sound Source Localization*, eds. A.N. Popper and R.R. Fay. New York: Springer Science + Business Media, LLC.

Fay, R.R., Megela-Simmons A. 1999. “The sense of hearing in fishes and amphibians,” pp. 269-318. In: *Comparative Hearing: Fish and Amphibians*, eds. R.R. Fay and A.N. Popper. New York: Springer-Verlag.

Federal Aviation Administration, 1985. *Aviation Noise Effects*. U.S. Department of Transportation, Federal Aviation Administration, Office of Environment and Energy. Washington, D.C.

Federal Aviation Administration, 1996. “Environmental Assessment of the Kodiak Launch Complex, Kodiak Island, Alaska,” June.

Federal Interagency Committee on Noise (FICON), 1992. *Federal Agency Review of Selected Airport Noise Analysis Issues*, August.

Federal Interagency Committee on Urban Noise (FICUN), 1980. *Guidelines for Considering Noise in Land Use Planning and Control.* U.S. Government Printing Office Report #1981-337-066/8071. Washington, D.C.

Fedstats, 2007. Honolulu County, Hawaii. [Online] Available: http://www.fedstats.gov/qf/states/15/15003.html, [February 8, 2007].

Feller, W., 1968. An Introduction to Probability Theory and Its Application, Vol. 1, 3rd ed. New York: Wiley.

Ferguson, M.C., 2005. "Cetacean population density in the eastern Pacific Ocean: Analyzing patterns with predictive spatial models," Ph.D. dissertation, University of California, San Diego.

Ferguson, M.C., and J. Barlow, 2001. "Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-1996," *Southwest Fisheries Science Center Administrative Report LJ-01-04*. La Jolla, California: National Marine Fisheries Service.

Ferguson, Megan C., J. Barlow, S.B. Reilly, and T. Gerrodette, 2006. "Predicting Cuvier's (*Ziphius cavirostris*) and *Mesoplodon* beaked whale population density from habitat characteristics in the eastern tropical Pacific Ocean." *Journal of Cetacean Research Management*, 7(3):287-299.

Fergusson, I., L.A. Compagno, and M. Marks, 2000. *Carcharodon carcharias*. In: 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org

Fernandez, A., 2004. "Pathological findings in stranded beaked whales during the naval military manoeuvres near the Canary Islands," *European Cetacean Society Newsletter,* pp. 37-40.

Fernandez, A., J.F. Edwards, F. Rodriguez, A. Espinosa de los Monteros, P. Herraez, P. Castro, J.R. Jaber, V. Martin, and M. Arbelo, 2005. "Gas and fat embolic syndrome Involving a mass stranding of beaked whales (Family Ziphiidae) exposed to anthropogenic sonar signals," *Veterinary Pathology*, 42:446-457.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway, 2000. "Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions," *Journal of the Acoustical Society of America,* 108:417-431.

Finneran, J.J., D.A. Carder, and S.H. Ridgway, 2001. "Temporary threshold shift (TTS) in bottlenose dolphins (*Tursiops truncatus*) exposed to tonal signals," *Journal of the Acoustical Society of America, 110(5), 2749(A)*, 142nd Meeting of the Acoustical Society of America, Fort Lauderdale, FL, December 2001.

Finneran, J.J., C.E. Schlundt, D.A. Carder, and S.H. Ridgway, 2002a "Auditory filter shapes for the bottlenose dolphin (*Tursiops truncatus*) and the white whale (*Delphinapterus leucas*) derived with notched noise," *Journal of the Acoustical Society of America*, 112:7.

Finneran, J.J., C.E. Schlundt, D.A. Carder, and S.H. Ridgway, 2002b. “Temporary shift in masked hearing thresholds (MTTS) in odontocetes after exposure to single underwater impulses from seismic watergun,” *Journal of Acoustical Society of America,* 111:2929-2940.

Finneran, J.J., D.A. Carder, and S.H. Ridgway, 2003. “Temporary threshold shift measurements in bottlenose dolphins *Tursiops truncatus*, belugas *Delphinapterus leucas*, and California sea lions *Zalophus californianus*, Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, TX, 12-16 May 2003.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and S.H. Ridgway, 2005. “Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones,” *Journal of Acoustical Society of America,* 118:2696-2705.

Finneran, J.J., and C.E. Schlundt, 2004. “Effects of intense pure tones on the behavior of trained odontocetes,” Space and Naval Warfare Systems Center, San Diego, Technical Report 1913, EDO Dynamic Systems, February.

Finneran, J. J., C. E. Schlundt, B. Branstetter, and R. L. Dear. 2007. “Assessing temporary threshold shift in a bottlenose dolphin (*Tursiops truncates*) using multiple simultaneous auditory evoked potentials,” *Journal of the Acoustic Society of America*, 122:1249–1264.

Fishbase, 2008. Froese, R. and D. Pauly. Editors. [Online]. Available: http://www.fishbase.org/search.php.

Fish, J.F. and C.W. Turl, 1976. “Acoustic source levels of four species of small whales,” *Naval Undersea Center Report, NUC-TP 547*

Fish, J.F., and G.C. Offutt, 1972. “Hearing thresholds from toadfish, *Opsanus tau,* measured in the laboratory and field,” *Journal of the Acoustic Society of America*, 51:1318-1321.

Flecther, S., B.J. LeBoeuf, D.P. Costa, P.L. Tyack, and S.B. Blackwell. 1996. “Onboard acoustic recording from diving northern seals,” *Journal of the Acoustical Society of America*, 100(4):2531-2539.

Flewelling, L.J., J.P. Naar, J.P. Abbott, D.G. Baden, N.B. Barros, G.D. Bossart, M.Y. Bottein, D.G. Hammond, E.M. Haubold, C.A. Heil, M.S. Henry, H.M. Jacocks, T.A. Leighfield, R.H. Pierce, T.D. Pitchford, S.A. Rommel, P.S. Scott, K.A. Steidinger, E.W. Truby, F.M.V. Dolah, and J.H. Landsberg, 2005. “Brevetoxicosis: Red tides and marine mammal mortalities,” *Nature,* 435:755-756.

Flores, K.E., and A.G. Kaohi, 1993. *Hawaiian cultural and historical survey of Nohili and Mānā areas, Kona District, Island of Kaua`i, State of Hawai`i.* Unpublished MS on file with USASDC, Environmental Office, Huntsville, Alabama and Hawai`i State Historic Preservation Officer, Honolulu, Hawai`i.

Foote, A.D., R.W. Osborne, and A.R. Hoelzel, 2004. "Environment: Whale-call response to masking boat noise," *Nature Brief Communications*, 428, 29 April.

Forcada, J., 2002. "Distribution," pp. 327-333. In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. *Encyclopedia of marine mammals*. San Diego: Academic Press.

Ford, J.K.B., 2002. "Killer whale *Orcinus orca,"* pp. 669-676. In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. *Encyclopedia of marine mammals*, San Diego: Academic Press.

Fornander, A., 1917. *The Hawaiian Account of the Formation of their Islands and Origin of their Race with the Traditions of their Migrations, etc., as gathered from original sources.* Fornander Collection of Hawaiian Antiquities and Folklore, Memoirs of the Bernice PI Bishop Museum, Volume 4, Part 2, Bishop Museum Press, Honolulu.

Forney, K.A., 2004. "Estimates of cetacean mortality and injury in two U.S. Pacific longline fisheries, 1994- 2002," *Southwest Fisheries Science Center Administrative Report LJ-04-07,* La Jolla, California: National Marine Fisheries Service.

Forney, K.A., St. Aubin, D.J., and Chivers, S.J., 2002. *Chase Encirclement Stress Studies on dolphins involved in eastern tropical Pacific Ocean purse-seine operations during 2001,* Administrative Report No. LJ-02-32, National Marine Fisheries Service, Southwest Fisheries Science Center, California.

Frankel, A.S., C.W. Clark, L.M. Herman, & C.M. Gabriele, 1995. "Spatial distribution, habitat utilization, and social interactions of humpback whales, *Megaptera novaeangliae*, off Hawai'i, determined using acoustic and visual techniques," *Canadian Journal of Zoology,73 :*1134-1146

Frantzis, A., 1998. "Does acoustic testing strand whales?," *Nature*, 392:29.

Frantzis, A., 2004. "The first mass stranding that was associated with the use of active sonar (Kyparissiakos Gulf, Greece, 1996)," In: Proceedings of the workshop. Active sonar and cetaceans. 8 March 2003, Las Palmas, Gran Canaria. *European Cetacean Society Newsletter* 42 (Special Issue):14–20.

Frazer, N.B., 1986. "Survival from egg to adulthood in a declining population of loggerhead turtles, *Caretta caretta," Herpetologica,* 42:47-55.

Frazier, J.G., 2001. "General natural history of marine turtles," pp. 3-174.In: K.L. Eckert and F.A. Abreu-Grobois, eds. Proceedings of the regional meeting: *Marine turtle conservation in the wider Caribbean region: a dialogue for effective regional management,* Santo Domingo, Dominican Republic: WIDECAST, IUCN-MTSG, WWF, and UNEP-CEP.

Freiwald, A., J.H. Fossa, A. Grehan, T. Koslow, and J.M. Roberts, 2004. *Cold-water coral reefs,* Cambridge, U.K.: UNEP-WCMC, 84 pp.

Freitas, L., 2004. The stranding of three Cuvier's beaked whales *Ziphius caviostris* in Madeira archipelago – May 2000. *European Cetacean Society Newsletter 42* (Special Issue):28–32.

Friedlander, A., R. Aeby, R. Brainard, E. Brown, A. Clark, S. Coles, E. Demartini, S. Dollar, S. Goodwin, C. Hunter, P. Jokiel, J. Kenyon, R. Kosaki, J. Maragos, P. Vroom, B. Walsh, I. Williams, and W. Wiltse, 2004. "Status of the coral reefs in the Hawaiian Archipelago, In C. Wilkinson, ed. *Status of coral reefs of the world. Volume 2,* Townsville, Queensland: Australian Institute of Marine Science, pp. 411-430.

Fromm, D., 2004a. "Acoustic Modeling Results of the Haro Strait For 5 May 2003." Naval Research Laboratory, Office of Naval Research, 30 January 2004.

Fromm, D., 2004b. "EEEL Analysis of Shoup Transmissions in the Haro Strait on 5 May 2003," Naval Research Laboratory briefing of 2 September 2004.

Fujimori, L., 2002. "Elephant seal visits Hawaii shores: The young male is the first of its kind to be seen in the islands," *Honolulu Star-Bulletin News*, 18 January.

Fujimori, L., 2005. "Seal steals the show on busy Waikiki Beach," *Honolulu Star-Bulletin News*, 22 January.

Gabriele, C.M., J.M. Straley, S.A. Mizroch, C.S. Baker, A.S. Craig, L.H. Herman, D. Glockner-Ferrari, M.J.Ferrari, S. Cerchio, O. von Ziegesar, J. Darling, D. McSweeney, T.J. Quinn, and J. K. Jacobsen. 2001. "Estimating the mortality rate of humpback whale calves in the central North Pacific Ocean." *Canadian Journal of Zoology*, 79:589-600.

GANDA [Garcia and Associates], 2003. End of field letter for SBCT surveys of Kahuku Training Area. December 2003.

Gannier, A., 2000. "Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated surveys," *Aquatic Mammals,* 26:111-126.

Gannier and Petiau, 2007. "Environmental Variables Affecting the Residence of Spinner Dolphins (*Stenella longirostris*) in a Bay of Tahiti (French Polynesia)," *Aquatic Mammals,* 32: 202-211.

Gannon, D.P., N.B. Barros, D.P. Nowacek, A.J. Read, D.M. Waples, and R.S. Wells, , 2005. "Prey detection by bottlenose dolphins, *Tursiops truncatus*: an experimental test of the passive listening hypothesis," *Animal Behavior,* 69:709-720.

Gaspin, J.B., 1975. "Experimental investigations of the effects of underwater explosions on swimbladder fish, I: 1973 Chesapeake Bay tests." Naval Surface Weapons Center Report NSWC/WOL/TR 75-58.

Gass, S.E., 2003. *Conservation of deep-sea corals in Atlantic Canada,* World Wildlife Fund-Canada (WWF-Canada).

Gausland, I., 2003. “Seismic survey impact on fish and fisheries.” Report prepared by Stavanger for Norwegian Oil Industry Association, March.

Gearin, P.J., M.E. Gosho, J.L. Laake, L. Cooke, R.L. DeLong, and K.M. Hughes, 2000. “Experimental testing of acoustic alarms (Pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the State of Washington,” *Journal of Cetacean Research and Management, 2:1-9*.

Gedamke, J., D.P. Costa, and A. Dunstan, 2001. “Localization and visual verification of a complex minke whale vocalization,” *Journal of the Acoustical Society of America,* 109:3038-3047.

Geraci, J.R., 1989. “Clinical investigation of the 1987-88 mass mortality of bottlenose dolphins along the U.S. central and south Atlantic coast,” (Final report to the National Marine Fisheries Service, U.S. Navy, Office of Naval Research, and Marine Mammal Commission), pp. 1-63.

Geraci, J.R. and V.J. Lounsbury, 1993. *Marine mammals ashore: a field guide for strandings.* Texas A&M University Sea Grant College Program, Publication TAMU-SG-93-601, Galveston, TX., 305 pp.

Geraci, J.R., and D.J. St. Aubin, 1987. “Effects of parasites on marine mammals,” International *Journal of Parasitology* 17:407-414.

Geraci, J.R., and V.J. Lounsbury, 2005. *Marine Mammals Ashore: A Field Guide for Strandings*, Second Edition. National Aquarium in Baltimore, Baltimore, MD.

Geraci, J.R., J. Harwood, and V.J. Lounsbury, 1999. “Marine Mammal Die-Offs – Causes, Investigations, and Issues” *Conservation and Management of Marine Mammals* (ed. J.R. Twiss Jr. and R.R. Reeves), pp. 367-395.

Gillespie, D., and R. Leaper, 2001. “Right whale acoustics: Practical applications in conservations,” Workshop report. Yarmouth Port, Massachusetts: International Fund for Animal Welfare.

Gilmartin, M., and N. Revelante, 1974. “The ‘island mass’ effect on the phytoplankton and primary production of the Hawaiian Islands,” *Journal of Experimental Marine Biology and Ecology,* 16:181-204.

Gilmartin, William G., and J. Forcada, 2002. “Monk Seals,” pp. 756-759.In: *Encyclopedia of Marine Mammals*, eds. Perrin, William F., Bernd Würsig, and J. G. M. Thewissen. Academic Press. San Diego, CA.

Godby, W., 2007. Personal communication between William Godby, Cultural Resources Manager, Pohakuloa Training Area (PTA), and Paige Peyton, Cultural Resources Manager, KAYA Associates, Inc., regarding the status of the architectural survey conducted by Kenneth Hays in 2002. Information acquired during an April 11, 2007 site visit to PTA.

Goertner, J.F., 1982. "Prediction of underwater explosion safe ranges for sea mammals," *NSWC/WOL TR-82-188*. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD, 25 pp.

Goertner, J.F., M.L. Wiley, G.A. Young, and W.W. McDonald, 1994. "Effects of underwater explosions on fish without swimbladders." Naval Surface Warfare Center Report NSWC TR88-114. 113 pp.

Goldbogen, J.A., J. Calambokidis, R.E. Shadwick, E.M. Oleson, M.A. McDonald, and J.A. Hildebrand, 2006. "Kinematics of foraging dives and lunge-feeding in fin whales," *Journal of Experimental Biology,* 209: 1231-1244.

Golden, J., R.P. Ouellette, S. Saari, P. Cheremisinoff, 1980. *Environmental Impact Data Book*, Ann Arbor Science Publishers, Inc., Ann Arbor, MI.

Goldman, K.J. and B. Human, 2000. "*Lamna ditropis,"* In: 2004 *IUCN red list of threatened species* [Online]. Available: http://www.redlist.org

Goldman, K.J. and members of the Shark Specialist Group (as cited on the IUCN website), 2001. "*Alopias vulpinus,"* In: 2004 *IUCN red list of threatened species* [Online]. Available: http://www.redlist.org

Goodman-Lowe, G.D, 1998. "Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the Northwestern Hawaiian Islands during 1991-1994," *Marine Biology, 132:535-546*.

Govoni, J.J., L.R. Settle, M.A. and West, 2003. "Trauma to juvenile pinfish and spot inflicted by submarine detonations," *Journal of Aquatic Animal Health*. 15:111-119.

Grachev, M.A., V.P. Kumarev, L.V. Mamaev, V.L. Zorin, L.V. Baranova, N.N. Denikina, S.I. Belkov, E.A. Petrov, and V.S. Kolesnik, 1989. "Distemper virus in Baikal seals," *Nature* 338:209-210.

Gregory, J. and Clabburn, P.A.T., 2003. "Avoidance behaviour of *Alosa fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river," *Aquatic Living Resources*, 16:313-316.

Greig, D.J., F.M.D. Gulland, and C. Kreuder, 2005. "A decade of live California sea lion (*Zalophus californianus*) strandings along the central California coast: Causes and trends, 1991-2000," Aquatic Mammals 31:11-22.

Grigg, R.W., 1988. "Paleoceanography of coral reefs in the Hawaiian-Emperor chain," *Science,* 240:1737-1743.

Grigg, Richard W., 1993. "Precious Coral Fisheries of Hawaii and the U.S. Pacific Islands. (Fisheries of Hawaii and U.S.-Associated Pacific Islands)," *Marine Fisheries Review* Date: 3/22/1993 [Online]. Available: http://www.encyclopedia.com/doc/1G1-15462284.html.

Grigg, R.W., 1997a. "Hawaii's coral reefs: Status and health in 1997, The International Year of the Reef," pp. 61-72. In: R.W. Grigg and C. Birkeland, eds. *Status of coral reefs in the Pacific*. Sea Grant College Program, School of Ocean and Earth Science and Technology, University of Hawaii.

Grigg, R.W., 1997b. "Paleoceanography of coral reefs in the Hawaiian-Emperor chain – Revisited," pp. 117-121. In: Proceedings of the Eighth Helfman, G.S., B.B. Collette, and D.E. Facey. 1999. *The diversity of fishes. 4th ed*. Malden, Massachusetts: Blackwell Science.

Grovhoug, J.G., 1992. *Evaluation of Sediment Contamination in Pearl Harbor.* Naval Command, Control and Ocean Surveillance Center Technical Report TR-1502. San Diego, CA. 70 pp.

Guinet, C., L.G. Barrett-Lennard, and B. Loyer, 2000. "Co-ordinated attack behavior and prey sharing by killer whales at Crozet Archipelago: strategies for feeding on negatively-buoyant prey," *Marine Mammal Science,* 16:829-834.

Gulland, F.M.D., M. Koski, L.J. Lowenstine, A. Colagross, L. Morgan, and T. Spraker, 1996. "Leptospirosis in California sea lions (*Zalophus califorianus*) stranded along the central California coast, 1981-1994," *Journal of Wildlife Diseases,* 32:572-580.

Gulland, F.M.D. and A.J. Hall, 2005. "The role of infectious disease in influencing status and Trends," pp. 47-61.In: *Marine Mammal Research*, edited by J.E. Reynolds, W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen (John Hopkins University Press, Baltimore).

Gulland, F.M.D., 2006. "Review of the Marine Mammal Unusual Mortality Event Response Program of the National Marine Fisheries Service," (Report to the Office of Protected Resources, NOAA/National Marine Fisheries Service, Silver Springs, MD), p. 32.

Gulland, F.M.D. and A.J. Hall, 2007. "Is marine mammal health deteriorating? Trends in global reporting of marine mammal disease," *EcoHealth* 4:135-150.

Gunther, E.R., 1949. "The habits of fin whales," *Discovery Reports,* 24:115-141.

Halvorsen, M.B., L.E. Wysocki, and A.N. Popper , 2006. "Effects of high-intensity sonar on fish," *Journal of the Acoustical Society of America,* 119:3283.

Han, T., S. Collins, S. Clark, and A. Garland, 1986. *Moe Kau A Ho`Oilo: Hawaiian Mortuary Practices at Keopu, Kona, Hawai`i.* Department of Anthropology, Department Report Series: Report 86-1, Bishop Museum Press, Honolulu.

Hanson, M.T., and R.H. Defran, 1993. "The behavior and feeding ecology of the Pacific coast bottlenose dolphin, *Tursiops truncatus," Aquatic Mammals,* 19:127-142.

Harris, C.M., editor., 1979. *Handbook of Noise Control*. 2nd Edition. McGraw Hill, New York.

Harwood, J., 2002. "Mass Die-offs," pp. 724-726. In *Encyclopedia of Marine Mammals*, edited by W.F. Perrin, B. Würsig, and J.G.M. Thewissen (Academic Press, San Diego).

Hastings, M.C. and A.N. Popper, 2005. "Effects of sound on fish." Technical report for Jones and Stokes to California Department of Transportation, Sacramento, CA. [Online]. Available: http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf

Hastings, M.C., A.N. Popper, J.J. Finneran, and P.J. Lanford, 1996. "Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish (*Astronotus ocellatus*)," *Journal of the Acoustical Society of America,* 99:1759-1766.

Hawaii Coral Reef Assessment and Monitoring Program, 2006. "Coral Reef Assessment and Monitoring Program Long Term Monitoring Study Sites: Kauai," [Online]. Available: http://cramp.hawaii.edu/LT_Monitoring_files/lt_study_sites_Kauai.htm [28 August].

Hawaii Department of Health, 2003. Covered Source Permit Review CSP No. 0110-01-C (USN PMR-Barking Sands) Application for Renewal No. 0110-03, June.

Hawaii Department of Land and Natural Resources, 1981. "Rules regulating wildlife sanctuaries," *Title 13 Department of Land and Natural Resources, Subtitle 5 Forestry and Wildlife Part 2 Wildlife Chapter 125* [Online]. Available: http://www.state.hi.us/dlnr/dofaw/rules/Chap125.pdf

Hawaii Department of Land and Natural Resources, 2002. "Application for an individual incidental take permit pursuant to the Endangered Species Act of 1973 for listed sea turtles in inshore marine fisheries in the main Hawaiian Islands managed by the State of Hawaii," Honolulu: Division of Aquatic Resources.

Hawaii Department of Land and Natural Resources, 2006. "Alulu, Olulu *Brighamia insignis,"* [Online]. Available: http://www.state.hi.us/dlnr/dofaw/cwcs/files/Flora%20fact%20sheets/Bri_ins%20plant%20NTBG_OK.pdf

Hawaii Department of Land and Natural Resources, no date [a]. *Forest Bird and Related Projects*, "Newell's Shearwater Project," [Online]. Available: http://www.dofaw.net/fbrp/projects.php?id=00064 [29 August].

Hawaii Department of Land and Natural Resources, no date [b]. "The Northwestern Hawaiian Islands," [Online]. Available: http://www.hawaii.gov/dlnr/exhibits/nwhi/NWHI_1.htm

Hawaii Department of Land and Natural Resources, no date [c]. "Lo`ulu *Pritchardia aylmer-robinsonii*" [Online]. Available: http://www.state.hi.us/dlnr/dofaw/cwcs/files /Flora%20fact%20sheets/Pri_ayl%20plant%20NTBG_W.pdf.

Hawaii Department of Transportation, 2005. "Highway Division – Station Description: Waialo Rd. ID NO: 130054100101 – 10/19/2005-Kauai-DIR 2-To Kaumualli Hwy," The Traffic Group, Inc.

Hawaii Institute of Marine Biology, 2006. "Coral Reef Assessment and Monitoring Program Hawaii, "[Online]. Available: http://cramp.wcc.hawaii.edu/LT_Montoring_files/lt_study_site_Niihau.htm [28 August].

Hawaii Revised Statutes, 2007. Hawaii Revised Statutes- HRS § 205A-43 – Establishment of shoreline and duties and powers of the department.

Hawaii State Department of Health, Clean Air Branch, 2005. 2005 Annual Summary—Hawaii Air Quality Data. 50 pp.

Hawaii State Historic Preservation Office, 2006. State Historical Preservation Division-Inventory Of Historic Properties. [Online]. Available: http://www.state.hi.us/dlnr/hpd/hpgreeting.html

Hawaii Visitors Bureau, 1993. "Average Daily Visitor Statistics Kaua`i and State of Hawai`i." Online: [Avaiable]http://www.hawaii-county.com/databook_98/Table%207/7.3.pdf

Hawaii, State of, 2004. "Kauai Island Plan," Department of Hawaiian Home Lands, May.

Hawaii, State of, 2005a. *"Kauai County,"* Hawaii Workforce Informer (HIWI), [Online]. Available: http://www.hiwi.org, 2005.

Hawaii, State of, 2005b. The State of Hawaii Data Book 2005.

Hawkins, A.D. and A.D.F. Johnstone, 1978. The hearing of the Atlantic salmon, *Salmo salar*. Journal of Fish Biology 13: 655-673.

Hays G.C., 2002. "Behavioural plasticity in a large marine herbivore: Contrasting patterns of depth utilisation between two green turtle (*Chelonia mydas*) populations," *Marine Biology,* 141:985–990.

Hays, K., 2002. *Architectural Survey and Evaluation of the Cantonment at the Pohakuloa Training Area*, September. 206 pp.

Heezen, B.C., 1957. "Whales entangled in deep sea cables," *Deep Sea Research,* 4:105-115.

Heimlich, S.L., D.K. Mellinger, S.L. Nieukirk, and C.G. Fox, 2005. "Types, distribution, and seasonal occurrence of sounds attributed to Bryde's whales (*Balaenoptera edeni*) recorded in the eastern tropical Pacific, 1999-2001," *Journal of the Acoustical Society of America,* 118:1830-1837.

Heithaus, M.R., 2001. "Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: Attack rate, bite scar frequencies and attack seasonality," *Marine Mammal Science* 17:526-539.

Heitmeyer, R.M., S.C. Wales, and L.A. Pflug, 2004. "Shipping noise predictions: capabilities and limitations," *Marine Technology Society,* 37: 54-65.

Helfman, O.S., B.S. Collette, and D.E. Facey, 1997. *The diversity of fishes.* Malden Massachusetts: Blackwell Science.

Helweg, D.A., A.S. Frankel, J.R. Mobley, and L.H. Herman, 1992. "Humpback whale song: Our current understanding," pp. 459-483. In: J.A. Thomas, R.A. Kastelein and Y.A. Supin (eds.), Marine mammal sensory systems. Plenum, New York, NY, 773 pp.

Herbst, L.H. 1994. "Fibropapillomatosis of marine turtles," *Annual Review of Fish Diseases*. 4:389–425.

Herbst, L.H., E.R. Jacobson, R. Moretti, T. Brown, J.P. Sundberg, and P.A. Klein. 1995. "Experimental transmission of green turtle fibropapillomatosis using cell-free tumor extracts," *Diseases of Aquatic Organisms*, 22:1–12.

Herman, L.M., and R.C. Antinoja, 1977. "Humpback whales in Hawaiian waters: Population and pod characteristics," *Scientific Report of the Whales Research Institute,* 29:59-85.

Herman, L.M., C.S. Baker, P.H. Forestell, and R.C. Antinoja, 1980. "Right whale *Balaena glacialis* sightings near Hawaii: A clue to the wintering grounds?," *Marine Ecology Progress Series,* 2: 271-275.

Heyning, J.E., and J.G. Mead, 1996. "Suction feeding in beaked whales: Morphological and observational evidence," *Contributions in Science, Natural History Museum of Los Angeles County,* 464:1-12.

Heyning, J.E., and T.D. Lewis, 1990. "Fisheries interactions involving baleen whales off southern California," *Report of the International Whaling Commission*, 40:427-431.

Hickie, B.E., R.W. Macdonald, J.K.B. Ford and P.S. Ross, 2007. "Killer whales (*Orcinus orca*) face protracted health risks associated with lifetime exposure to PCBs," *Environmental Science and Technology,41(18):6613-9.*

Higgs, D.M., Plachta, D.T.T., Rollo, A.K., Singheiser, M., Hastings, M.C. & Popper, A.N. 2004. "Development of ultrasound detection in American shad (*Alosa sapidissima*),"*Journal of Experimental Biology,* 207, 155–163.

Higgs, D.M., 2005. "Auditory cues as ecological signals for marine fishes," In: Weissburg MJ, Browman HI (eds) "Sensory biology: linking the internal and external ecologies of marine organisms," *Marine Ecology Program Seried*, 287:278–307.

Hildebrand, J., 2004. Sources of Anthropogenic Sound in the Marine Environment. Report to the Policy on Sound and Marine Mammals: An International Workshop. U.S. Marine Mammal Commission and Joint Nature Conservation Committee, UK. London, England. Online. [Available]: http://www.mmc.gov/sound/internationalwrkshp/pdf/hildebrand.pdf

Hirth, H.F., 1997. "Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758)," *U.S. Fish and Wildlife Service Biological Report,* 97:1-120.

Hiruki, L.M., M.K. Schwartz, and P.L. Boveng, 1999. "Hunting and social behaviour of leopard seals (*Hydrurga leptonyx*) at Seal Island, South Shetland Islands, Antarctica," *Journal of Zoology* 249:97-109.

Hoelzel, A.R., E.M. Dorsey, and S.J. Stern, 1989. "The foraging specializations of individual minke whales," *Animal Behaviour,* 38:786-794.

Hoelzel, A. R., 2003. Marine Mammal Biology: An Evolutionary Approach (Blackwell Publishing, Malden MA).

Hoffman, D.J., B.A. Rattner, G.A. Burton, Jr., and J. Cairns, Jr., 1995. *Handbook of Ecotoxicology*. CRC Press, Inc. Boca Raton, Florida. 755 pp.

Hoffman, J. P. 2004. *Generalized linear models. An applied approach*. Pearson Education, Inc., Boston, Massachusetts. 200 pp.

Hohn, A.A., D.S. Rotstein, C.A. Harms, and B.L. Southall, 2006. "Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005," NOAA Technical Memorandum NMFS-SEFSC-537, 222 pp.

Honolulu Advertiser, 2004. "Kaua`i looks to increase landfill's height". [Online]. Available: http://the.honoluluadvertiser.com/article/2004/jul/28/ln/ln31a.html [15 September 2006].

Honolulu Advertiser 2006. Economic Impact of the Military in Hawaii, [Online]. Available: http://military.honoluluadvertiser.com/mil/2006/4, [26 October].

Honolulu Board of Realtors, 2006a. "Oahu Housing Market Continues to Stabilize", [On-line]. Available: http://www.hicenteral.com/press/pr092006.htm, [25 October].

Honolulu Board of Realtors, 2006b. Kaneohe Real Estate, 2006 [Online]. Available: http://www.realestate-oahu.com/kaneohe-real-estate-home-for-sale.php

Horwood, J., 1987. *The sei whale: Population biology, ecology and management*, London: Croom Helm. 369 pp.

Horwood, J., 1990. *Biology and exploitation of the minke whale,* Boca Raton, FL: CRC Press. 231 pp.

Houghton, J.P. and D.R. Mundy, 1987. "Effects of linear explosive seismic energy releases on fish in Alaska's transition zones." Report 06793-004-020 to Alaska Oil and Gas Association.

Houser, D.S., D.A. Helweg, and P.W.B. Moore, 2001. "A bandpass filter-bank model of auditory sensitivity in the humpback whale," *Aquatic Mammals,* 27:82–91.

Huber, H.R., A.C. Rovetta, L.A. Fry, and S. Johnston, 1991. "Age-specific natality of northern elephant seals at the South Farallon Islands, California," *Journal of Mammalogy*, 72:525-534.

Inouye, D., 2004 (U.S. Senator from Hawaii). Dan Inouye. U.S. Senator from Hawaii. July 16, 2004 [Online]. Available: http://www.senate.gov/~inouye/04pr/20040716.htnml [2 January 2007].

International Archaeological Resources Institute,, 2005. Integrated *Cultural Resources Management Plan for the Pacific Missile Range Facility (PMRF), Island of Kauai, State* Prepared by M.J. Tomonari-Tuggle and A. Yoklavich, Mason Architects, Inc. Prepared for Commander Navy Region Hawaii. April.

International Atomic Energy Agency, 2003. *Features: Depleted Uranium*, [Online]. Available: http://www.iaea.org/NewsCenter/Features/DU/du_qaa.shtml#q3, [25 October 2007].

International Civil Aviation Organization, 1996. *Procedures for Air Navigation Services Rules of the Air and Air Traffic Services* 13th Edition, November.

International Civil Aviation Organization, 1997. *Amendment to the Procedures for Air Navigation Services Rules of the Air and Air Traffic Services* 13th Edition, November.

International Council for the Exploration of the Sea, 2005a. *Report for the Ad-hoc Group on Impacts of Sonar on Cetaceans.* (AGISC) ACE:01 50 pp.

International Council for the Exploration of the Sea (ICES), 2005b. *Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish*—2nd edition. International Council for the Exploration of the Sea. ICES AGISC CM 2005/ACE:06. 61 pp.

International Council for the Exploration of the Sea (ICES), 2005c. *Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations.* International Council for the Exploration of the Sea. 6 pp.

International Whaling Commission, 2001. "Report on the Workshop on the Comprehensive Assessment of Right Whales: A worldwide comparison," *Journal of Cetacean Research and Management, Special Issue,* 2:1-60.

International Whaling Commission), 2005. Classification of the Order Cetacea (whales, dolphins and porpoises). *Journal of Cetacean Research and Management,* 7(1):xi-xii.

International Whaling Commission, 2007. Classification of the Order Cetacea (whales, dolphins and porpoises). *Journal of Cetacean Research and Management*, 9(1):v-xii.

International Whaling Commission, 2008. Scientific Permit Whaling – "Information on scientific permits, review procedure guidelines and current permits in effect." [Online]. Available. http://www.iwcoffice.org/conservation/permits.htm

Itano, D.G., and K.N. Holland, 2000. "Movement and vulnerability of bigeye (*Thunnus obesus*) and yellowfin tuna (*T. albacares*) in relation to FADs and natural aggregation points," *Aquatic Living Resources*, 13:213-223.

Iversen, R.T.B., 1967. "Response of the yellowfin tuna (*Thunnus albacares*) to underwater sound," pp. 105-121. In: W.N. Tavolga (editor), *Marine Bio-Acoustics II*. Pergamon Press, New York.

Iversen, R.T.B., 1969. Auditory thresholds of the scombrid fish *Euthynnus affinis*, with comments on the use of sound in tuna fishing. Proceedings of the FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics, October 1967. *FAO Fisheries Reports* No. 62 Vol. 3. FRm/R62.3.

Jane's, Information Group, 2005. Ammunition Handbook: 5-inch, 54-caliber naval gun ammunition.

Jane's Information Group, 2006. Jane's Air-Launched Weapons: MK-80 Series General Purpose Bombs.

Jansen, G., 1998. "Physiological effects of noise," In: *Handbook of Acoustical Measurements and Noise Control, 3rd Edition,* New York: Acoustical Society of America.

Jaquet, N., S. Dawson, and E. Slooten, 2000. "Seasonal distribution and diving behaviour of male sperm whales off Kaikoura: Foraging implications," *Canadian Journal of Zoology,* 78:407-419.

Jasny, M., J. Reynolds, C. Horowitz, and A. Wetzler, 2005. *Sounding the depths II: The rising toll of sonar, shipping and industrial ocean noise on marine life*. Natural Resources Defense Council Report, New York, New York. 84 pp.

Jefferson, T.A., S. Leatherwood and M.A. Webber. 1994. Marine Mammals of the World. Food and Agriculture Organization of the United Nations and United Nations Environment Programme, Rome.

Jefferson, T.A., S. Leatherwood, and M.A. Webber, 1993. *FAO species identification guide, Marine mammals of the world*. Rome: Food and Agriculture Organization of the United Nations.

Jefferson, T.A., D. Fertl, M. Michael, and T.D. Fagin, 2006. "An unusual encounter with a mixed school of melon-headed whales (*Peponocephala electra*) and rough-toothed dolphins (*Steno bredanensis*) at Rota, Northern Marianas Islands," *Micronesia, 38(2):*239-244.Jerkø, H., I. Turunen-Risel, P.S. Enger P.S., and O. Sand, 1989. "Hearing in the eel (*Anguilla anguilla*)," *Journal of Comparative Physiology* , 165:455-459.

Jensen, J.O.T., and D.F. Alderdice, 1983. "Changes in mechanical shock sensitivity of coho salmon (*Oncorhyncuus kisutch*) eggs during incubation," *Aquaculture,* 32:303-312.

Jensen, J.O.T., and D.F. Alderdice, 1989. "Comparison of mechanical shock sensitivity of eggs of five Pacific salmon (Oncorhyncus) species and steelhead trout (*Salmo gairdneri*)," *Aquaculture,* 78:163-181.

Jensen, A.S. and G.K. Silber, 2003. "Large Whale Ship Strike Database," U.S. Department of Commerce, NOAA Technical Memorandum NMFS-OPR-25.

Jensen, Peter M. and James Head, 1997. *Archaeological Reconnaissance Survey, Naval Magazine Lualualei, NAVMAG-West Loch*. Prepared for Department of the Navy, Pacific Division Naval Facilities Engineering Command.

Jepson, P.D., M. Arbelo, R. Deaville, I.A.P. Patterson, P. Gastro, J.R. Baker, E. Degollada, H.M. Ross, P. Herraez, A.M. Pockett, F.Rodriquez, F.E. Howie, A. Espinosa, R.J. Reid, J.R. Jabert. V.Martin, A.A. Cunningham, and A. Fernandez, 2003. "Gas-bubble lesions in stranded cetaceans," *Nature,* 425:575.

Jepson, P.D., R. Deaville, I.A.P. Patterson, A.M. Pocknell, H.M. Ross, J.R. Baker, F.E. Howie, R.J. Reid, A. Colloff, and A.A. Cunningham, 2005. "Acute and chronic gas bubble lesions in cetaceans stranded in the United Kingdom," *Veterinary Pathology,* 42:291-305.

Jessop, T.S., Knapp, R., Limpus, C.J., Whittier, J.M., 2002. "Dynamic endocrine responses to stress: evidence for energetic constraints and status dependence of breeding in male green turtles," *Generaland Comparative. Endocrinology*, 126:59–67.

Johanos, T. C., and J. D. Baker (eds.), 2005. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2002. United States Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS PIFSC-5, 154 pp.

Johanos TC, B.L. Becker , TJ. Ragen. 1994. "Annual reproductive cycle of the female Hawaiian monk seal (*Monachus schauinslandi*)," *Marine Mammal Science*, 10:13-30

Johnson, M., P.T. Madsen, W.M.X. Zimmer, N. Aguilar de Soto, and P.L. Tyack, 2004. "Beaked whales echolocate on prey," *Proceedings of the Royal Society of London, Part B* 271:S383-S386.

Johnston, R.K., W.J. Wild, K.E. Richter, D. Lapota, P.M. Stang, and T.H. Flor, 1989. *Navy Aquatic Hazardous Waste Sites: The Problem and Possible Solutions.* Naval Ocean Systems Center Technical Report TR-1308. San Diego, CA. 50 pp.

Johnston, D.W., and T.H. Woodley, 1998. "A survey of acoustic harassment device (AHD) use in the Bay of Fundy, NB, Canada," *Aquatic Mammals*, 24: 51–61.

Johnston, Paul F., 2005. Beneath The Seven Seas, Adventures with the Institute of Nautical Archaeology. Revised Edition. Thames & Hudson Ltd., London.

Joint Venture Education Forum, 2005. "*Joint Venture Education Forum, Executive Summary"* [Online]. Available: http://www.pacom.mil/jvef, [26 October].

Jokiel, P.L., E.K. Brown, A. Friedlander, S.K. Rodgers, and W.R. Smith, 2001. "Hawaii coral reef initiative, coral reef assessment and monitoring program (CRAMP) Final Report 1999-2000," Silver Spring, Maryland: National Oceanic and Atmospheric Administration, National Ocean Service, 66 pp.

Jokiel, P.L., E.K. Brown, A. Friedlander, S.K. Rodgers, and W.R. Smith, 2004. "Hawaii coral reef assessment and monitoring program: Spatial patterns and temporal dynamics in reef coral communities," *Pacific Science*, 58:159-174.

Jones, D.M., and D.E. Broadbent, 1998. "Chapter 24-Human performance and noise," pp..21-24. In: C. M. Harris (ed.). *Handbook of acoustical measurements and noise control*. Acoustical Society of America, Woodbury, New York.

Jørgensen, R., N.O. Handegard, H. Gjøsæter, and A. Slotte, 2004. "Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground." *Fisheries Research* 69: 251-261.

Jorgensen, R, K.K. Olsen, I-B Falk-Petersen, and P. Kanapthippilai, 2005. "Investigations of potential effects of low frequency sonar signals on survival, development and behaviour of fish larvae and juveniles," Norwegian College of Fishery Science, University of Tromso, N-9037, Norway.

Kalmijn A.J., 1988. "Hydrodynamic and acoustic field detection," pp. 83-130. In: *Sensory Biology of Aquatic Animals*, eds. A. Atema, R.R. Fay, A.N. Popper, and W.N. Tavolga, New York: Springer-Verlag.

Kalmijn A.J., 1989. "Functional evolution of lateral line and inner ear sensory systems," pp. 187-215. In: The mechanosensory lateral line - Neurobiology and evolution, eds. S. Coombs, P. Görner, and M. Münz, . Berlin: Springer Verlag.

Kamakau, S.M., 1992. *Ruling Chiefs of Hawai*i. Revised Edition. Kamehameha Schools Press, Honolulu, Hawai`i.

Kamezaki, N., K. Matsuzawa, O. Abe, H. Asakawa, T. Fujii, and K. Goto, 2003. "Loggerhead turtles nesting in Japan," pp. 210-217. In: *Loggerhead Sea Turtles* (eds Bolten, A.B. & Witherington, B.E.). Smithsonian Institution Press, Washington, DC. .

Karlsen, H.E., 1992. "Infrasound sensitivity in the plaice (*Pleuronectes plattessa*)," *Journal of Experimental Biology*, 171:173-187.

Kastak, D., and R.J. Schusterman, 1996. "Temporary threshold shift in a harbor seal (*Phoca vitulina*)," *Journal of the Acoustical Society of America*, 100(3):1905-1908.

Kastak, D., and R.J. Schusterman, 1998. "Low-frequency amphibious hearing in pinnipeds: methods, measurements, noise, and ecology," *Journal of the Acoustical Society of America,* 103(4):2216-2228.

Kastak, D., and R.J. Schusterman, 1999. "In-air and underwater hearing sensitivity of a northern elephant seal (*Mirounga angustirostris*)," *Canadian Journal of Zoology,* 77:1751-1758.

Kastak, D., B.L. Southall, R.J. Schusterman, and C.J. Reichmuth, 1999a. "Temporary threshold shift in pinnipeds induced by octave-band noise in water," In Abstract: *Journal of the Acoustical Society of America,* 106,No 4, Pt. 2:2251 (4aUW6).

Kastak, D., R.J. Schusterman, B.L. Southall, and C.J. Reichmuth, 1999b. "Underwater temporary threshold shift induced by octave-band noise in three species of pinniped," *Journal of the Acoustical Society of America,* 106(2):1142-1148.

Kastak D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. "Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration," *Journal of the Acoustical Society of America*, 118:3154–3163.

Kastelein, R., M. Hagedoorn, W.W.L. Au, and D. De Haan, 2003. "Audiogram of a striped dolphin (*Stenella coeruleoalba*)," *Journal of the Acoustical Society of America,* 113:1130-1137.

Kasuya, T., 1975. “Past occurrence of *Globicephala melaena* in the western North Pacific,” *Scientific Reports of the Whales Research Institute Tokyo*, 27:95-110.

Kasuya, T., 2002. “Giant beaked whales *Berardius bairdii* and *B. arnuxii,”* pp. 519-522 In W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. *Encyclopedia of Marine Mammals*. San Diego: Academic Press.

Kasuya, O., T. Miyashita, and F. Kasamatsu, 1988. “Segregation of two forms of short-finned pilot whales off the Pacific coast of Japan,” *Scientific Reports of the Whales Research Institute Tokyo,* 39:77-90.

Kato, H., 2002. “Bryde's whales *Balaenoptera edeni* and *B. brydei,”* pp. 171-177 In W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. *Encyclopedia of Marine Mammals*. San Diego: Academic Press.

Katona, S.K., and S.D. Kraus, 1999. “Efforts to conserve the North Atlantic right whale.” In: *Conservation and Management of Marine Mammals*, eds. J.R. Twiss, Jr. and R.R. Reeves, 311–331. Washington, DC: Smithsonian Institution Press.

Kauai, County of 2005. *Kauai General Plan*, Planning Department, “Preserving Kauai’s Rural Character.” [Online]. Available: http://www.kauai.gov/Portals/0/planning/Ch5.PDF

Kauai Island Utility Cooperative, 2006a. *KIUC Current*, “Kakaha Potential”. October 2006, p. 5, [Online]. Available: http://www.kiuc.coop/pdf/currents/CurrentsOct06.pdf

Kauai Island Utility Cooperative, 2006b. *KIUC Currents*, “Saving Our Shearwaters,” August [Online]. Available: http://www.kiuc.coop/pdf/currents/CurrentsAugust06.pdf

Kaua`i Monk Seal Watch Program, 2003. “Fall 2003 Newsletter,” October, [Online]. Available: http://www.kauaimonkseal.com/News/OCT03NL.htm

Kearns, R.K., and F.C. Boyd, 1965. “The effect of a marine seismic exploration on fish populations in British Columbia coastal waters.” *Candian Journal of Exploration Geophygsics,* Vol 1:83-106 (reprinted in 1965 by CSEG from Canadian Fish Culturist 34, 3-26).

Keeler, J.S., 1976. “Models for noise-induced hearing loss,” pp. 361-381. In: *Effects of Noise on Hearing*, ed. Henderson et al., New York: Raven Press.

Keevin, T.M., G.L. Hempen, and D.J. Schaeffer, 1997. “Use of a bubble curtain to reduce fish mortality during explosive demolition of Locks and Dam 26, Mississippi River,” pp. 197-206. In: *Proceedings of the Twenty-third Annual Conference on Explosives and Blasting Technique,* Las Vegas, Nevada, International Society of Explosive Engineers, Cleveland, Ohio.

Kelleher, J.D., 2002. Explosives Residue: Origin and Distribution. Explosives Residue: Origin and Distribution (Forensic Science Communications). 11 pp. [Online]. Available: http://www.fbi.gov/hq/lab/fsc/backissu/april2002/kelleher.htm 2/

Kelly, J.C. and D.R. Nelson, 1975. "Hearing thresholds of the horn shark, *Heterodontus francisci,*" *Journal of the Acoustical Society of America 58:905–909*.

Kemp, N.J., 1996. "Habitat Loss and Degradation," pp. 263-280 In M.P. Simmonds and J.D. Hutchinson (eds.) *The Conservation of Whales and Dolphins*, John Wiley & Sons Ltd, Chicester.

Kennedy, S., T. Kuiken, P.D. Jepson, R. Deaville, M. Forsyth, T. Barrett, M.W.G.v. Bildt, A.D.M.E. Osterhaus, T. Eybatov, C. Duck, A. Kydyrmanov, I. Mitrofanov, and S. Wilson, 2000. "Mass die-off of Caspian seals caused by canine distemper virus," *Emerging Infectious Diseases,* 6:637-639.

Kennett, J.P., 1982. *Marine geology*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 813 pp.

Kenyon, T.N.,1996. "Ontogenetic changes in the auditory sensitivity of damselfishes (Pomacentridae)," *Jounal of Comparative Physioogyl A*, 179:553–561.

Ketten, D.R., 1992. "The marine mammal ear: Specializations for aquatic audition and echolocation," pp. 717-750. In D. Webster, R. Fay, and A. Popper, eds. *The evolutionary biology of hearing,* Berlin: Springer-Verlag.

Ketten, D.R., 1997. "Structure and functions in whale ears," *Bioacoustics,* 8:103-135.

Ketten, D.R., 1998. "Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts," *NOAA-TM-NMFS-SWFSC-256*, Department of Commerce.

Ketten, D.R., 2004. *Marine Mammal Auditory Systems: A Summary of Audiometric And Anatomical Data And Its Implications For Underwater Acoustic Impacts. Online Report, 24 pp.* [Online]. Available: http://www.solcomhouse.com/auditory.htm

Ketten, D.R., 2005. Models of Beaked Whale Hearing and Responses to Underwater Noise. Environmental Consequences of Underwater Sound(ECOUS) Workshop, Arlington, VA. Final Report N0001140410651, 21 pp.

Ketten, D.R., 2006. Personal Communication: Copy of a letter submitted to Ranger Rick Magazine, National Wildlife Foundation from Dr. Darlene R. Ketten, Senior Scientist Department – Biology-Woods Hole Oceanographic Institution. 3pp.

Kikuchi, W.K., 1987. *Archaeological surface survey of proposed helicopter landing site*: Lehua Landing and Keanahaki, Island of Ni`ihau, February. 7 pp.

Kinsler L.E., A.R. Frey, A.B. Coppens, and J.V. Sanders, 1982. *Fundamentals of acoustics*. 3rd edition, John Wiley and Sons, New York.

Kirschvink, J.L., A.E. Dizon, and J.A. Westphal, 1986. "Evidence from strandings for geomagnetic sensitivity in cetaceans," *Journal of Experimental Biology*, 120:1-24.

Kirschvink, J.L., 1990. "Geomagnetic sensitivity in cetaceans: an update with live stranding records in the United States," pp. 639-649. In: *Sensory Abilities of Cetaceans: Laboratory and Field Evidence* (ed. J.A. Thomas and R.A. Kastelain), New York: Plenum Press.

Kishiro, T., 1996. "Movements of marked Bryde's whales in the western North Pacific," *Reports of the International Whaling Commission,* 46:421-428, 29.

Kiyota, M., N. Baba, and M. Mouri,1992. "Occurrence of an elephant seal in Japan," *Marine Mammal Science,* 8(4):433 (Letter).

Klinowska, M., 1985. "Cetacean stranding sites relate to geomagnetic topography," Aquatic Mammals, 1:27-32.

Klinowska, M. 1986. "Cetacean live stranding dates relate to geomagnetic disturbances," *Aquatic Mammals* 11:109-119.

Knowlton, A.R., F.T. Korsmeyer, J.E. Kerwin, H.Y. Wu, and B. Hynes, 1995. *The hydrodynamic effects of large vessels on right whales.* NMFS Contract No. 40EANFF400534.

Knowlton, A.R. and S.D. Kraus, 2001. "Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean," *Journal of Cetacean Research and Management (Special Issue), 2:193-208*.

Knowlton, A.R., C.W. Clark, and S.D. Kruse, 1991. "Sounds recorded in the presence of sei whales, *Balaenoptera borealis,"* In Abstract: Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, IL, pp. 76.

Knowlton, A.R., M. Marx, H. Pettis, P. Hamilton. and S. D. Kraus,, 2005. Analysis of scarring on North Atlantic right whales (*Eubalaeba glacialis*): Monitoring rates of entanglement interaction: 1980-2002. Final Report to the National Marine Fisheries Service. 20 pp.

Knudsen, F.R., P.S. Enger, and O. Sand, 1992. "Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar L.,*" *Journal of Fish Biology,* 40:523-534.

Knudsen F.R., P.S. Enger, and O. Sand, 1994. "Avoidance responses to low frequency sound in downstream migrating Atlantic salmon smolt, *Salmo salar L," Journal of Fish Biology,* 45:227-233.

Kobayashi, D.R., and J.J. Polovina, 2005. "Evaluation of time-area closures to reduce incidental sea turtle take in the Hawaii-based longline fishery: Generalized additive model (GAM) development and retrospective examination," NOAA Technical Memorandum NMFS-PIFSC-4: 1-39.

Kompanje, E.J.O., 1995. "On the occurrence of spondylosis deformans in white-beaked dolphins *Lagenorhynchus albirostris* (Gray, 1846) stranded on the Dutch coast," *Zooligische Mededekingen Leiden,* 69:231-250.

Kona Blue Water Farms, 2003. *Final environmental assessment for an offshore open ocean fish farm project off Unualoha Point, Kona, Hawaii*, Prepared for Department of Land and Natural Resources by Kona Blue Water Farms, Holualoa, Hawaii.

Kooyman, G.L., D.D. Hammond, and J.P. Schroeder, 1970. "Bronchograms and tracheograms of seals under pressure," *Science,* 169:82-84.

Kooyman, G.L. and F. Trillmich. 1984. "Diving behavior of Galapagos fur seals," pp. 186-195. In: R.L. Gentry and G.L. Kooyman ed*., Fur seals: Maternal strategies on land and at sea*," Princeton University Press, NJ.

Kooyman, G.L. R.W. Davis and J.P. Croxall. 1984. "Diving behavior of Antarctic fur seals," pp. 115-125. In: R.L. Gentry and G.L. Kooyman ed., *Fur seals: Maternal strategies on land and at sea*," Princeton University Press, NJ.

Kopelman, A.H., and S.S. Sadove, 1995. "Ventilatory rate differences between surface-feeding and nonsurface-feeding fin whales (*Balaenoptera physalus*) in the waters off eastern Long Island, New York, U.S.A., 1981-1987," *Marine Mammal Science,* 11:200-208.

Kostyuchenko, L.P., 1973. "Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea." *Hydrobiologia*, 9:45-46.

Krahn, M.M., D.P. Herman, D.P., C.O., Matkin, J.W. Durban, L. Barrett-Lennard, D.G. Burrows, M.E. Dahlheim, N. Black, N., R.G. LeDuc, and P.R. Wade, 2007. "Use of chemical tracers in assessing the dietand foraging regions of eastern North Pacific killer whales," *Marine Environmental Research*, 63, 91–114.

Krausman, P.R., L.K. Harris, C.L. Blasch, K.K.G. Koenen, and J. Francine, 2004. "Effects of military operations on behavior and hearing of endangered Sonoran pronghorn," *Wildlife Monographs*, 1-41.

Krewski, D., C. Brown, and D. Murdoch, 1984. "Determining "safe" levels of exposure: safety factors or mathematical models?" *Toxicological Sciences*, 4:383-394.

Kritzler, H. and Wood, L., 1961. "Provisional Audiogram for the Shark, *Carcharhinus leucas," Science*, 133:1480-14482.

Kruse, S., D.K. Caldwell, and M.C. Caldwell, 1999. “Risso’s dolphin *Grampus griseus* (G. Cuvier, 1812),” pp. 183-212. In S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises,* San Diego: Academic Press.

Kryter, K.D. W.D. Ward, J.D. Miller, and D.H. Eldredge, 1966. “Hazardous exposure to intermittent and steady-state noise,” *Journal of the Acoustical Society of America,* 39:451-464.

Kubota, G., 2004. “Sealing the attention*,” Honolulu Star-Bulletin News, 28 December* [Online]. Available: http://starbulletin.com/2004/12/28/news/wild.html [10 June 2005].

Kvadsheim, PH and E.M. Sevaldsen, 2005. The potential impact of 1 – 8 kHz active sonar on stocks of juvenile fish during sonar exercises. Forsvarets Forskningsinstitutt, PO Box 25, NO-2027, Kjeller, Norway (FFI/Rapport-2005/01027).

Ladich, F., and A.N. Popper, 2004. “Parallel evolution in fish hearing organs,” pp. 95-127. In: Manley, G.A., A.N. Popper, and R.R. Fay (eds), *Evolution of the Vertebrate Auditory System.* Springer Handbook of Auditory Research. Springer-Verlag, New York.

Laist, D.W., A.R. Knowlton, G.M. Mead, A.S. Collet, and M. Podesta, 2001. “Collisions between ships and whales,” *Marine Mammal Science*, 17(1):35-75 (January 2001).

Lafortuna, C.L., M. Jahoda, A. Azzellino, F. Saibene, and A. Colombini, 2003. “Locomotor behaviours and respiratory pattern of the Mediterranean fin whale (*Balaenoptera physalus*),” *European Journal of Applied Physiology, 90:387-395*.

Lagerquist, B.A., K.M. Stafford, and B.R. Mate, 2000. “Dive characteristics of satellite-monitored blue whales (*Balaenoptera musculus*) off the central California coast,” *Marine Mammal Science, 16:375-391*.

Lammers, M.O., 2004. “Occurrence and behavior of Hawaiian spinner dolphins (*Stenella longirostris*) along Oahu's leeward and south shores,” *Aquatic Mammals, 30:237-250*.

Lammers, M.O., W.W.L. Au, and D.L. Herzing. 2003. “The broadband social signaling behavior of spinner and spotted dolphins,” *Journal of the Acoustical Society of America* 114(3):1629-1639.

Land Study Bureau, 1997. *Detailed Land Classification - Island of Kauai, L.S.B. Bulletin No. 9*, University of Hawaii, Honolulu, December.

Langlas, C. Wolforth, T.J. Head, and P. Jensen, 1997. *Archaeological Inventory Survey and Historic and Traditional Cultural Assessment for the Hawai`i Defense Access Road A-AD-6(1) and Saddle Road (SR 200) Project, Districts of South Kōhala, Hāmākua, North Hilo, and South Hilo, Island of Hawaii.* Paul H. Rosendahl Ph.D., Inc., Hilo, Hawaii.

Larkin, R., 1996. "Effects of military noise on wildlife": A Literature Review, Center for Wildlife Ecology, Illinois Natural History Survey January.

Laurinolli, M.H., A.E. Hay, F. Desharnais, and C.T. Taggart, 2003. "Localization of North Atlantic right whale sounds in the Bay of Fundy using a sonobuoy array," *Marine Mammal Science,* 19:708-723.

Learmonth, J.A., C.D. Macleod, M.B. Santos, G.J. Pierce, H.Q.P. Crick, and R.A. Robinson, 2006. "Potential effects of climate change on marine mammals," *Oceanography and Marine Biology: an Annual Review* 44:431-464.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans, 1982. "Whales, dolphins and porpoises of the eastern north Pacific and adjacent Arctic waters. A guide to their identification," NOAA Technical Memorandum Report, National Marine Fisheries Service Circular 444, 245 pp.

Leatherwood, S., T.A. Jefferson, J.C. Norris, W.E. Stevens, L.J. Hansen, and K.D. Mullin, 1993. "Occurrence and sounds of Fraser's dolphin (*Lagenodelphis hosei*) in the Gulf of Mexico," *Texas Journal of Science,* 45:349-354.

Le Boeuf, B.J., and L.F. Petrinovich, 1974. "Elephant seals: Interspecific comparisons of vocal and reproductive behavior," *Mammalia* (Paris) 38: 16–32.

Le Boeuf, B.J., R.J. Whiting, and R.F. Gannt, 1972. "Perinatal behavior of northern elephant seal females and their young," *Behaviour,* 43:121-156.

Le Boeuf, B.J., Y. Naito, A.C. Huntley, and T. Asaga, 1989. "Prolonged, continuous, deep diving by northern elephant seals," *Canadian Journal of Zoology,* 67:2514-2519.

Le Boeuf, B.J., and J. Reiter, 1991. "Biological effects associated with El Nino Southern Oscillation, 1982-83m on northern elephant seals breeding at Ano Nuevo, California," pp. 206-218. In: *Pinnipeds and El Nino: Responses to Environmental Stress*, edited by F. Trillmich, and K. A. Ono (Springer-Verlag, Berlin.

Le Boeuf, B.J., P.A. Morris, S.B. Blackwell, D.E. Crocker, and D.P. Costa, 1996. "Diving behaviour of juvenile northern elephant seals," *Canadian Journal of Zoology,* 74:1632-1644.

Le Boeuf, B.J., D.E. Crocker, D.P. Costa, S.B. Blackwell, P.M. Webb, and D.S. Houser, 2000. "Foraging ecology of northern elephant seals," *Ecological Monographs,* 70:353-382.

LeDuc, R.G., W.L. Perryman, J.W. Gilpatrick, J. Hyde, C. Stinchcomb, J.V. Carretta, and R.L. Brownell, 2001. "A note on recent surveys for right whales in the southeastern Bering Sea," *Journal of Cetacean Research and Management, Special Issue,* 2:287-289, Lee, R. and M. Downing, 1996. "Boom Events Analyzer Recorder: Unmanned Sonic Boom Monitor," *Journal of Aircraft*, 33(1):171-175.

Lee, T., 1993. "Summary of cetacean survey data collected between the years of 1974 and 1985," NOAA Technical Memorandum NMFS-SWFSC-181:I -1 85.

Lenhardt, M.L., 1994. "Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*)," Proceedings, Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, *National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFSC-351,* Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida, pp. 238-241, 32.

Lenhardt, M.L., S. Bellmund, R.A. Byles, S.W. Harkins, and J.A. Musick, 1983. "Marine turtle reception of bone-conducted sound," *Journal of Auditory Research,* 23:119-125.

Leone, D., 2004. "Familiar turtle back on Maui: The green sea turtle dubbed "Maui Girl" became known for her prolific nesting activity," *Honolulu Star-Bulletin News,* 8 June.

Levine, H., L. Bildsten, M. Brenner, C. Calan, S. Flatte´, J. Goodman, J. Gregg, M. Gregg, J. Katz, W. Munk, and P. Weinberger, 2004. "Active Sonar Waveform" *JSR-03-200*. JASON-The MITRE Cooperation, McLean, VA, June.

Liao, T.F., 1994. *Interpreting probability models. Logit, probit, and other generalized linear models*. SAGE Publications, Inc., Newbury Park, California. 88 pp.

Littnan, C.L., B.S. Stewart, P. K. Yochem, and R. Braun, 2006. "Survey of selected pathogens and evaluations of Disease Risk factors for endangered Hawaiian monk seals in the main Hawaiian Islands," *EcoHealth*, 3(4):232-244.

Lombarte ,A., and A.N.Popper , 1994. "Quantitative analyses of postembryonic hair cell addition in the otolithic endorgans of the inner ear of the European hake, *Merluccius merluccius* (Gadiformes, Teleostei)," *Journal of Comparative Neurology*, 345:419-428.

Lombarte, A, H.Y. Yan, A.N. Popper A.N., J.C. Chang, and C. Platt, 1993. "Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamicin," *Hearing Research*, 66:166-174.

Lohmann, K.J., B.E. Witherington, C.M.F. Lohmann, and M. Salmon, 1997. "Orientation, navigation, and natal beach homing in sea turtles," pp. 107-136. In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles*, Boca Raton, Florida: CRC Press.

Lovell, J.M., M.M. Findlay, R.M. Moate, and D.A. Pilgrim, 2005. The polarization of inner ear ciliary bundles from a scorpaeniform fish. Journal of Fish Biology 66: 836–846.

Lotufo, G.R. and M.J. Ludy, 2005. "Comparative toxicokinetics of explosive compounds in Sheepshead minnows," *Archives of Environmental Contamination and Toxicology* 49:206-214.

Løvik, A. and J.M. Hovem, 1979. "An experimental investigation of swimbladder resonance in fishes," *Journal of the Acoustical Society of America*, 66: 850-854.

Luczkovich, J.J., Daniel, H.J., III, Hutchinson, M., Jenkins, T., Johnson, S.E., Pullinger, R.C. & Sprague, M.W. 2000. "Sounds of sex and death in the sea: bottlenose dolphin whistles suppress mating choruses of silver perch," *Bioacoustics,* 10:323–334.

Lusseau, D. Slooten, L. and Currey, R.J.C., 2007. "Unsustainable dolphin-watching tourism in Fiordland, New Zealand". Tourism in Marine Environments, in press. [Online]. Available: http://whitelab.biology.dal.ca/dl/LusseauSlootenCurrey%20TiME%20preprint.pdf

Lutcavage, M.E., and P.L. Lutz, 1997. "Diving physiology," pp. 277-296. In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles,* Boca Raton, Florida: CRC Press.

MacCaughey, V., 1916. "The Seaweeds of Hawaii," *American Journal of Botany*, 3(8):474-479.

MacFarlane, J.A.F., 1981. "Reactions of whales to boat traffic in the area of the confluence of the Saguenay and St. Lawrence rivers, Quebec," Manuscript cited In: Richardson et al. 1995, *Marine mammals and noise,* Chapter 9, pp. 252-275.

MacLeod, C.D., 1999. "A review of beaked whale acoustics, with inferences on potential interactions with military activities," *European Research on Cetaceans,* 13:35-38.

MacLeod, C.D., 2000. "Review of the distribution of *Mesoplodon* species (Order Cetacea, Family Ziphiidae) in the North Atlantic," *Mammal Review,* 30:1-8.

MacLeod, C.D., N. Hauser, and H. Peckham, 2004. "Diversity, relative density and structure of the cetacean community in summer months east of Great Abaco, Bahamas," *Journal of the Marine Biological Association of the United Kingdom,* 84:469-474.

Madsen, P.T., D.A. Carder, W.W.L. Au, P.E. Nachtigall, B. Møhl, and S.H. Ridgway, 2003. "Sound production in neonate sperm whales (L)," *Journal of the Acoustical Society of America 113:2988-2991*.

Madsen, P.T., I. Kerr, and R. Payne, 2004. "Source parameter estimates of echolocation clicks from wild pygmy killer whales (*Feresa attenuata*)," *Journal of the Acoustical Society of America, 116(4)1909-1912*.

Madsen, P.T., M.A. Johnson, P.J. Miller, A.N. Soto, J. Lynch, and P.L. Tyack, 2006. Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. *Journal of the Acoustic Society of America* 120(4):2366-2379.

Maintenance Logs and Records, 2007. Personal communication via email between Greg Hayashi, S CIV NAVFAC HI OPBP6, and Randall Young, CIV NAVFAC PAC, 18 January.

Maldini, D., 2003. "Abundance and distribution patterns of Hawaiian odontocetes: Focus on Oahu," Ph.D dissertation, University of Hawaii, Manoa.

Maldini, D., L. Mazzuca, and S. Atkinson, 2005. "Odontocete stranding patterns in the main Hawaiian Islands (1937-2002): How do they compare with live animal surveys?," *Pacific Science,* 59(1):55-67.

Mallinckrodt Baker, Inc., 2007. *Material Safety Data Sheet Ethylene Glycol* [Online]. Available: http://www.jtbaker.com/msds/englishhtml/E5125.htm

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird, 1983. "Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior." Unpublished. Report from Bolt Beranek and Newman, Inc., Cambridge, Massachusetts, for U.S. Minerals Management Service, Reston, Virginia. Variously paginated. Available from Minerals Management Service, Alaska Outer Continental Shelf Region, 949 East 36th Avenue, Room 110, Anchorage, Alaska 99508-4302, U.S.A.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird, 1984. "Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration." BBN Rep. 5586. Rep. from Bolt Beranek and Newman, Inc., Cambridge, MA, for U.S. Minerals Management Service, Anchorage, Alaska. NTIS PB-218377. Var. p.

Malme, C.I., and P.W. Smith, Jr., 1988. "Analysis of the acoustic environment of pinniped haulout sites in the Alaskan Bering Sea," BBN Tech. Memo No. 1012, BBN Systems and Technology Corp., Cambridge, MA, for LGL Alaska Research Associates, Anchorage, AK. Var. pp.

Malme, C.I., P.R. Miles, G.W. Miller, W.J. Richardson, D.G. Roseneau, D.H. Thomas, and C.R. Green Jr., 1989. Analysis and ranking of the acoustic disturbance potential of petroleum industry activities and other sources of noise in the environment of marine mammals in Alaska. OCS Study MMS 89-0006. Report to U.S. Minerals Management Service, Anchorage, AK.

Maly, K., 1999. "Mauna Kea Science Reserve and Hale Pōhaku Complex: Oral History and Consultation Study, and Archival Literature Research, Ahupua`a of Ka`ohe (Hāmākua District) and Humu`ula (Hilo District), Island of Hawaii," Prepared for Group 70 International, Kumu Pono Associates, Hilo, Hawai`i.

Maly, K. and W. Wulzen, 1997. "Historical Documentary Research," pp. 6-23. In: Wulzen et al., Archaeological Reconnaissance Survey Pacific Missile Range Facility Barking Sands and Makaha Ridge. Land of Waimea, Waimea District, Island of Kauai,. Prepared for Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Paul H. Rosendahl, Ph.D., Inc., Hilo.

Mann, D.A. and P.S. Lobel, 1997. “Propagation of damselfish (Pomacentridae) courtship sounds,” *Journal of the Acoustical Society of America,* 101: 3783–3791,

Mann, D.A., Z. Lu, and A.N. Popper, 1997. “A clupeid fish can detect ultrasound,” *Nature,* 389: 341.

Mann, D.A., Z. Lu, M.C. Hastings, A.N. Popper, 1998. ”Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima)*,” *Journal of the Acoustical Society of America,* 104:562-568.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper, 2001. “Ultrasound detection by clupeiform fishes,” *Journal of the Acoustical Society of America,* 109:3048-3054.

Mann, M.E., Rutherford, S., Wahl, E., Ammann, C., 2005. “Testing the fidelity of methods used in proxy-based reconstructions of past Climate,” *Journal of Climate*, 18“4097-4107.

Maragos, J.E., 1977. “Order Scleractinia - Stony corals,” pp. 158-241 In: D.M. Devaney and L.G. Eldredge, eds. *Reef and shore fauna of Hawaii. Section 1: Protozoa through Ctenophora,* Bishop Museum Special Publication 64(1), Honolulu, Hawaii: Bishop Museum Press.

Maragos, J.E., 1998. “Marine ecosystems,” pp. 111-120. In: S.P. Juvik and J.O. Juvik, eds. *Atlas of Hawai`i, 3d ed*. Honolulu, Hawaii: University of Hawaii Press.

Maragos, J.E., 2000. “Hawaiian Islands (U.S.A.),” pp. 791-812. In: C.R.C. Sheppard, ed. *Seas at the millennium: An environmental evaluation. Volume 2: Regional chapters: The Indian Ocean to the Pacific,* Amsterdam, Netherlands: Pergamon Press.

Marine Mammal Commission, 2003. ‘Workshop on the management of Hawaiian monk seals on beaches in the Main Hawaiian Islands.’ Final report of a workshop held 29-31 October in Koloa, Kauai, Hawaii. Bethesda, Maryland: Marine Mammal Commission.

Márquez-M., R., 1990. *Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date,* Rome: Food and Agriculture Organization of the United Nations. *FAO Fisheries Synopsis* No 125, Volume 11, 4pp.

Marten, K., and S. Psarakos, 1999. “Long-term site fidelity and possible long-term associations of wild spinner dolphins (*Stenella longirostris*) seen off Oahu, Hawaii,” *Marine Mammal Science,* 15:1329-1336.

Mate, B.R., S.L. Nieukirk, and S.D. Kraus, 1997. “Satellite-monitored movements of the northern right whale,” *Journal of Wildlife Management,* 61:1393-1405.

Mate, B.R., R. Gisiner, and J. Mobley, 1998. "Local and migratory movements of Hawaiian humpback whales tracked by satellite telemetry," *Canadian Journal of Zoology,* 76:863–868.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis, 1999. "The Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration," *Marine Mammal Science,* 15:1246-1257.

Matthews, J.N., S. Brown, D. Gillespie, M. Johnson, R. McLanaghan, A. Moscrop, D. Nowacek, R. Leaper, T. Lewis, and P. Tyack, 2001. "Vocalisation rates of the North Atlantic right whale (*Eubalaena glacialis*)," *Journal of Cetacean Research and Management*, 3:271-281.

Mattila, D.K., L.N. Guinee, and C.A. Mayo, 1987. "Humpback whale songs on a North Atlantic feeding ground," *Journal of Mammalogy,* 68:880-883.

Maybaum, H.L., 1989. "Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae*, in Hawaiian waters." M.S. Thesis, University of Hawaii, Manoa, 112 pp.

Maybaum, H.L., 1993. "Responses of humpback whales to sonar sounds," *Journal of the Acoustical Society of America*, 94:1848-1849.

Mazzuca, L., S. Atkinson, B. Keating, and E. Nitta, 1999. "Cetacean mass strandings in the Hawaiian Archipelago, 1957-1998," *Aquatic* Mammals, 25 (2): 105-114.

McAllister, J. Gilbert., 1933. *Archaeology of O`ahu*. Bernice P. Bishop Museum Bulletin 104. Bishop Museum Press, Honolulu, Hawai`i.

McAlpine, D.F., 2002. "Pygmy and dwarf sperm whales *Kogia breviceps* and *K. sima,"* pp. 1007-1009. In: W.F. Perrin, B. Wursig, and J.G.M. Thewissen, eds. *Encyclopedia of Marine Mammals*, San Diego: Academic Press.

McCartney, B.S., and Stubbs, A.R., 1971. "Measurements of the acoustic target strengths of fish in dorsal aspect, including swimbladder resonance," *Journal of Sound and Vibration*, 15:397-420.

McCauley, R.D., M.-N. Jenner, C. Jenner, K.A. McCabe and J. Murdoch, 1998. "The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: preliminary results of observations about a working seismic vessel and experimental exposures," APPEA Journal, 38:692-707.

McCauley, R.D. and D.H. Cato, 2000. "Patterns of fish calling in a nearshore environment in the Great Barrier Reef," In: *Philosophical Transactions of the Royal Society Biological Sciences*, Volume 355, No. 1401/September 20, 2000.

McCauley, R.D., J. Fewtrell and A.N. Popper, 2003. "High intensity anthropogenic sound damages fish ears," *Journal of the Acoustical Society of America,* 113(1):638-642.

McCracken, M.L., 2000. *Estimation of sea turtle take and mortality in the Hawaiian longline fisheries.* SWFSC Administrative Report H-00-06:I-29. 14.

McCulloch, C.E. and S.R. Searle, 2001. *Generalized, linear, and mixed models*. John Wiley and Sons, Inc.; New York, New York. 325 pp.

McCullagh, P. and J.A. Nedler, 1989. *Generalized linear models*. Second Edition. Chapman and Hall; London, United Kingdom. 261 pp.

McDonald, M.A., and C.G. Fox, 1999. "Passive acoustic methods applied to fin whale population density estimation," *Journal of the Acoustical Society of America*, 105:2643-2651.

McDonald, M.A., and S.E. Moore, 2002. "Calls recorded from North Pacific right whales (*Eubalaena japonica*) in the eastern Bering Sea," *Journal of Cetacean Research and Management,* 4:261-266.

McDonald, M.A., J. Calambokidis, A.M. Teranishi, and J.A. Hildebrand, 2001. "The acoustic calls of blue whales off California with gender data," *Journal of the Acoustical Society of America*, 109:1728-1735.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, D. Thiele, D. Glasgow, S.E. Moore, 2005. "Sei whale sounds recorded in the Antarctic," *Journal of the Acoustical Society of America*, 118:3941-3945.

McDonald, M.A., J.A Hildebrand, and S.M. Wiggins. 2006. "Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California," *Journal of the Acoustical Society of America*. 120:711-718.

McEldowney, H., 1979. *Archaeological and Historical Literature Search and Research Design: Lava Flow Control Study.* Bishop Museum Ms. 050879.

McEldowney, H., 1982. Report 1. Ethnographic background of the Mauna Kea summit region. In: cultural resources reconnaissance of the Mauna Kea summit region by H. McEldowney and P. McCoy. Report prepared for Group 70, Honolulu, Hawai`i. Prepared by the Department of Anthropology, Bernice P. Bishop Museum, Honolulu, Hawai`i. [For Official Use Only]

McEwen, B.S. and E.A. Lashley, 2002. *The end of stress as we know it*. Washington, DC: Joseph Henry Press. 239 pp.

McGerty, L., and R.L. Spear, 1997. *An inventory survey with oral histories of a parcel of land on the Plain of Mana, west of Kekaha in the Ahupua`a of Waimea, District of Kona, Island of Kaua`i.* Prepared for Controlled Environment Aquaculture Technology, Inc. Scientific Consultant Services, Inc., Honolulu. [For Official Use Only]

Mclean, F.E. and Shrout, B.L., 1966. *Aircraft design to minimize sonic boom pressure field energy*. NASA 66A33023.

McSweeney, D., K.C. Chu, W.F. Dolphin, and Guinee, 1989. "North Pacific humpback whale songs: a comparison of southeast Alaskan feeding ground songs with Hawaiian wintering ground songs," *Marine Mammal Science,* 5:139-148.

McSweeney, D.J., Baird, R.W. and Mahaffy, S.D., 2007. "Site fidelity, associations and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the island of Hawai'i," *Marine Mammal Science*, 23(3: 666-687.

Mead, J.G., 1989. "Beaked whales of the genus – *Mesoplodon,"* pp. 349-430 In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals*, *Volume 4: River dolphins and the larger toothed whales*. London: Academic Press.

Mead, J.G. and Ch. W. Potter, 1990. "Natural history of bottlenose dolphins along the central Atlantic coast of the United States," pp. 165-195. In: S. Leatherwood and R.R. Reeves (eds.): *The bottlenose dolphin*, Academic Press, Inc., San Diego.

Megyesi, J. and C.R. Griffin, 1996. "Breeding Biology of the Brown Noddy on Tern Island, Hawaii," *Wilson Bulletin., 108(2)*, 1996, pp. 317-334 [Online]. Available: http://elibrary.unm.edu/sora/Wilson/v108n02/p0317-p0334.pdf

Mellinger, D.K., and C.W. Clark, 2003. "Blue whale (*Balaenoptera musculus*) sounds from the North Atlantic," *Journal of the Acoustical Society of America,* 114:1108-1119.

Mellinger, D.K., C.D. Carson, and C.W. Clark, 2000. "Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico," *Marine Mammal Science,* 16:739-756.

Mellinger, D.K., K.M. Stafford, S.E. Moore, L. Munger, and C.G. Fox, 2004. "Detection of North Pacific right whale (*Eubalaena japonica*) calls in the Gulf of Alaska*," Marine Mammal Science,* 20:872-879.

Mesnick, S.L., B.L. Taylor, B. Nachenberg, A. Rosenberg, S. Peterson, J. Hyde, and A.E. Dizon, 1999. "Genetic relatedness within groups and the definition of sperm whale stock boundaries from the coastal waters off California, Oregon and Washington," *Southwest Fisheries Center Administrative Report LJ-99-12:1-10,* La Jolla, California: National Marine Fisheries Service.

Meylan, A., 1995. “Sea turtle migration - evidence from tag returns,” pp. 91-100 In: K.A. Bjorndal, ed. *Biology and conservation of sea turtles*, Rev. ed. Washington, D.C.: Smithsonian Institution Press.

Michel, et al., 2001. Information is as printed In: The National Marine Fishereis Service’s biological opinion regarding the effects of the U.S. Navy’s proposed 2006 RIMPAC Naval exercise, p. 48, June 27, 2006.

Midson, B.,1999. “NURP research helps manage precious coral harvesting so as to preserve foraging sites used by endangered Hawaiian monk seals,”[Online]. Available: http://www.soest.hawaii.edu/ HURL/precious_corals.html [13 June 2005].

Mignucci-Giannoni, A.A., G.M. Toyos-Gonzalez, J. Perez-Padilla, M.A. Rodriguez-Lopez, and J. Overing, 2000. “Mass stranding of pygmy killer whales (*Feresa attenuata*) in the British Virgin Islands,” Journal of. the Marine Biology Associatiom of the United Kingdom 80:759-760.

Miksis J.L., M.D. Grund, D.P. Nowacek, A.R. Solow, R.C. Connor, and P.L. Tyack, 2001. “Cardiac Responses to Acoustic Playback Experiments in the Captive Bottlenose Dolphin, *Tursiops truncatus*,” *Journal of Comparative Psychology*, 115:227-232.

Military Affairs Council, 2006. Advantages to Hawaii- The Chamber of Commerce of Hawaii. Hawaii-Based Armed Forces Benefit All of Us – The Bottom Line, Economic Impact of the Military in Hawaii, January.

Miller, E.H. and D.A. Job, 1992. “Airborne acoustic communication in the Hawaiian monk seal, *Monachus schauinslandi*,” pp. 485-531. In: J.A. Thomas, R.A. Kastelein and A.Y. Supin, eds. *Marine mammal sensory systems,* New York, New York, Plenum Press.

Miller, J.D., 1974. “Effects of noise on people,” *Journal of the Acoustical Society of America,* 56:729–764.

Miller, J.D., 1997. “Reproduction in sea turtles,” pp. 51-81. In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles,* Boca Raton, Florida: CRC Press.

Miller, J.D., C.S. Watson, and W.P. Covell, 1963. “Deafening effects of noise on the cat,” *Acta Oto-Laryngologica Supplement*, 176:1–91.

Miller, P.J.O., N. Biassoni, A. Samuels, and P.L. Tyack, 2000. “Whale songs lengthen in response to sonar,” *Nature,* 405:903.

Miller, P.J.O., M.P. Johnson, and P.L. Tyack, 2004. “Sperm whale behaviour indicates the use of echolocation click buzzes ‘creaks’ in prey capture,” *Proceedings of the Royal Society of London, Part B: 271:2239-2247*.

Mills, J.H., R.M. Gilbert, and W.Y. Adkins, 1979. "Temporary threshold shifts in humans exposed to octave bands of noise for 16 to 24 hours," *Journal of the Acoustical Society of America*, 65:1238–1248.

Missile Defense Agency, 2006. Letter to Mr. Patrick Leonard, Field Supervisor, Pacific Islands Office, U.S. Fish and Wildlife Service from Brian Huizenga, Team Lead Missile Defense Agency, regarding the potential for debris striking the Island of Nihoa to cause fires, December 7.

Mitchell, E., 1975. "Report of the meeting on smaller cetaceans, Montreal, April 1-11, 1974. Subcommittee on small cetaceans," Scientific Committee, International Whaling Commission, *Journal of the Fisheries Research Board of Canada,* 32:889-983.

Miyazaki, N. and W.F. Perrin, 1994. "Rough-toothed dolphin–*Steno bredanensis* (Lesson, 1828)," p. 1-21. In: S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals. Volume 5: The first book of dolphins*, San Diego, California: Academic Press, 416 pp.

Miyazaki, N., and S. Wada, 1978. "Observation of Cetacea during whale marking cruise in the western tropical Pacific, 1976." *Scientific Reports of the Whales Research Institute,* 30:179-195.

Mizroch, S.A., D.W. Rice, D. Zwiefelhofer, J. Waite, and W.L. Perryman, 1999. "Distribution and movements of fin whales (*Balaenoptera physalus*) in the Pacific Ocean," p. 127. In: *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals, 28 November–3 December 1999,* Wailea, Maui.

Moberg, G.P., 2000. "Biological response to stress: implications for animal welfare," pp. 1 – 21. In: G. P. Moberg, and J. A. Mench, editors, *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. Oxford University Press, Oxford, United Kingdom.

Mobley, J.R., 2002. "Information on humpback whale population—Isle Humpbacks could be jockeying for flipper room" *Star Bulletin*, 17 March 2002, [Online]. Available: http://starbulletin.com/2002/03/17/news/story14.html, [29 April 2002].

Mobley, J.R., 2004. *Results of marine mammal surveys on U.S. Navy underwater ranges in Hawaii and Bahamas*. Final Report to Office of Naval Research, 27 pp.

Mobley, J.R., 2005. "Assessing responses of humpback whales to North Pacific Acoustic Laboratory (NPAL) transmissions: Results of 2001–2003 aerial surveys north of Kauai," *Journal of the Acoustical Society of America,* 117:1666-1673.

Mobley, J.R., 2006a. *Results of 2006 RIMPAC Aerial Surveys of Marine Mammals in Kaulakahi and Alenuihaha Channels,* Final Report Submitted to Environmental Division Commander, U.S. Pacific Fleet, 12 pp.

Mobley, J.R., 2006b. *Results of 2006 Aerial Surveys of Humpback Whales North of Kauai,* Quicklook Report Submitted to North Pacific Acoustic Laboratory (NPAL) Program Scripps Institution of Oceanography, 19 pp.

Mobley, Jr., J.R., M. Smultea, T. Norris, and D. Weller, 1996. "Fin whale sighting north of Kauai, Hawaii," *Pacific Science,* 50:230-233.

Mobley, J.R., G.B. Bauer, and L.M. Herman, 1999. "Changes over a ten-year interval in the distribution and relative abundance of humpback whales (*Megaptera novaeangliae*) wintering in Hawaiian waters," *Aquatic Mammals,* 25:63-72.

Mobley, J.R., S.S. Spitz, K.A. Forney, R. Grotefendt, and P.H. Forestell, 2000. "Distribution and abundance of odontocete species in Hawaiian waters: Preliminary results of 1993-98 aerial surveys," *Southwest Fisheries Science Center Administrative Report LJ-00-14C*, La Jolla, California: National Marine Fisheries Service.

Mobley, J.R., S.S. Spitz, and R. Grotefendt, 2001a. *Abundance of humpback whales in Hawaiian waters: Results of 1993-2000 aerial surveys,* Report prepared for the Hawaii Department of Land and Natural Resources and the Hawaiian Islands Humpback Whale National Marine Sanctuary, NOAA, U.S. Department of Commerce.

Mobley, J.R., L.L. Mazzuca, A.S. Craig, M.W. Newcomer, and S.S. Spitz, 2001b. "Killer whales (*Orcinus orca*) sighted west of Niihau, Hawaii," *Pacific Science,* 55:301-303.

Mobley, J.R., S.W. Martin, D. Fromm, and P. Nachtigall. 2007. "Lunar influences as possible causes for simultaneous aggregations of melon-headed whales in Hanalei Bay, Kauai and Sasanhaya Bay, Rota." Abstract for oral presentation at the Seventeenth Biennial Conference on the Biology of Marine Mammals. Cape Town, South Africa, 29 November–3 December 2007.

Møhl, B., M. Wahlberg, P.T. Madesen, A. Heerfordt, and A. Lund, 2003. "The monopulsed nature of sperm whale clicks," *Journal of the Acoustical Society of America, 114*:1143-1154.

Monterey Bay Area Research Institute, 2002. The MBARI Chemical Sensor Program Periodic Table of Elements in the Ocean. [Online]. Available: www.mbari.org/chemsensor/pteo.htm

Moore, S.E., 2005. "Long-term Environmental Change and Marine Mammals," pp. 137-147. In: *Marine Mammal Research: Conservation Beyond Crisis*, edited by J.E. Reynolds, W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen (John Hopkins University Press, Baltimore).

Moore, S.E., J.M. Waite, L.L. Mazzuca, and R.C. Hobbs, 2000. "Mysticete whale abundance and observations of prey associations on the central Bering Sea shelf," *Journal of Cetacean Research and Management,* 2:227-234.

Moore, S. E., W. A. Watkins, M. A. Daher, J. R. Davies, and M. E. Dahlheim, 2002. "Blue whale habitat associations in the Northwest Pacific: Analysis of remotely-sensed data using a Geographic Information System," *Oceanography*, 15(3):20-25.

Moore, M.J. and G.A. Early, 2004. *Cumulative sperm whale bone damage and the bends*. *Science* 306:2215.

Moore, M.J., B. Rubinstein, S.A. Norman, and T. Lipscomb, 2004. "A note on the most northerly record of Gervais' beaked whale from the western North Atlantic Ocean," *Journal of Cetacean Research Management* 6: 279-281.

Morimitsu, T., T. Nagai, M. Ide, H. Kawano, A. Naichuu, M. Koono, and A. Ishii, 1987. "Mass stranding of odontoceti caused by parasitogenic eighth cranial neuropathy," Journal of Wildife Diseases 23, 586-590.

Mossman, V., 2007. Personal communication between Vida Mossman (CTR PMRF) and Karen Barnes on 9 February 2007.

Mrosovsky, N., 1993. World's largest aggregation of sea turtles to be jettisoned. Marine Turtle Newsletter. 63 (Supplement):2-3.

Musick, J.A., and C.J. Limpus, 1997. "Habitat utilization and migration of juvenile sea turtles," pp. 137-163 In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles*, CRC Press, Boca Raton, Florida.

Myrberg, A.A. Jr., 2001. The acoustical biology of elasmobranches. *Environmental Biology of Fishes* 60: 31-45.

Myrberg , A.A., Jr., A. Banner, and J.D. Richard , 1969. "Shark attraction using a video-acoustic system," *Marine Biology* , 2:264.

Myrberg , A.A., Jr., S.J. Ha, S. Walewski, and J.C. Banbury, 1972. "Effectiveness of acoustic signals in attracting epipelagic sharks to an underwater sound source," *Bulletin of Marine Science*, 22:926-949.

Myrberg , A.A., Jr., C.R. Gordon, and A.P. Klimley, 1976. "Attraction of free ranging sharks by low frequency sound, with comments on its biological significance," pp. 205-228. In: *Sound Reception in Fish*, eds. A. Schuijf and A.D. Hawkins, 205-228. Amsterdam: Elsevier.

Myrberg, A.A., Jr. and J.Y. Spires, 1980. "Hearing in damselfishes: an analysis of signal detection among closely related species," *Journal of Comparative Physiology*, 140:135–144.

Nachtigall, P.E., W.W.L. Au, J. Pawloski, and P.W.B. Moore, 1995. "Risso's dolphin (*Grampus griseus*) hearing thresholds in Kaneohe Bay, Hawaii," pp. 49-53. In: *Sensory Systems of Aquatic Mammals* (ed. R. A. Kastelein, J. A. Thomas and P. E. Nachtigall), Woerden, The Netherlands: DeSpil.

Nachtigall, P.E., D.W. Lemonds, and H.L. Roitblat, 2000. "Psychoacoustic studies of dolphins and whales,"pp. 330-363. In: *Hearing by Dolphins and Whales*, W.W.L. Au, A.N. Popper, and R.R. Fay, eds. Springer, New York.

Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au, 2003. "Temporary threshold shift and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncates*)," *Journal of the Acoustical Society of America,* 113:3425-3429.

Nachtigall, P.E., A. Supin, J.L. Pawloski, and W.W.L. Au, 2004. "Temporary threshold shift after noise exposure in bottlenosed dolphin (*Tursiops truncates*) measured using evoked auditory potential," *Marine Mammal Science*, 20:673-687.

Nachtigall, P.E., M.M.L. Yuen, T.A. Mooney, and K.A. Taylor. 2005. "Hearing measurements from a stranded infant Risso's dolphin, *Grampus griseus*," Journal of Experimental Biology, 208:4181-4188.

National Aeronautical Charting Office, 2007. Hawaiian Islands Sectional Aeronautical Chart, Hawaiian Islands Sectional Aeronautical Chart. October.

National Aeronautical and Space Administration, 2002. *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida, and Vandenberg Air Force Base,* California, June.

National Geospatial-Intelligence Agency, 2006."Aeronautical," [Online]. Available: http://www.nga.mil/portal/site/nga01, [August 2006].

National Marine Fisheries Service, 1986. Hawaiian monk seal critical habitat (Final Rule). *Federal Register*, Vol 51, No.83, p. 16047.

National Marine Fisheries Service, 1988. "Critical habitat; Hawaiian monk seal; Endangered Species Act," *Federal Register, Vol,* 53, No. 18, pp. 988-18998, Thursday- [26 May 1988].

National Marine Fisheries Service, 1998*. Recovery plan for the blue whale (Balaenoptera musculus),* Prepared by R.R. Reeves, P.J. Clapham, R.L. Brownell, and G.K. Silber, Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service, 2001a. *Final biological opinion on the U.S. Navy's North Pacific Acoustic Laboratory Sound Source.* Office of Protected Resources, Endangered Species Division, Silver Spring, Maryland.

National Marine Fisheries Service, 2001b. "Interim Findings on the Stranding of Beaked Whales in the Bahamas – December 20,2001" [Online]. Available: http://www.nmfs.noaa.gov/bahamasbeakedwhales.htm [24 January 2007].

National Marine Fisheries Service, 2002a. "Endangered and threatened species: Determination on a petition to revise critical habitat for northern right whales in the Pacific," *Federal Register, Vol* 67, No. 34, pp. 7660-7665, Wednesday, [20 February].

National Marine Fisheries Service, 2002b. *Annual report to Congress on the Status of U.S. Fisheries—2001,* Silver Spring, Maryland: National Marine Fisheries Service, 142 pp.

National Marine Fisheries Service, 2002c. "Fisheries off west coast states and in the western Pacific; Atlantic highly migratory species; Fisheries of the northeastern United States; Implementation of the shark finning prohibition act--Final rule," *Federal Register,* Vol 67, No.28, pp. 6194-6202.

National Marine Fisheries Service, 2002d. *Final Environmental Assessment, Issuance of Scientific Research Permit #1301 to the National Marine Fisheries Service – Honolulu Laboratory.* February

National Marine Fisheries Service, 2003. *Preliminary Report: Multidisciplinary Investigation of Harbor Porpoises (Phocoena phocoena) stranded in Washington State from 2 May-2 June 2003 coinciding with the Mid-Range Sonar Exercises of the USS Shoup,* February 2004.

National Marine Fisheries Service, 2004a. "Interim Report on the Bottlenose Dolphin *(Tursiops truncates)* Unusual Mortality Event Along the Panhandle of Florida, March-April 2004," pp.1-36.

National Marine Fisheries Service, 2004b. "International Sea Turtle Activities, Research and Training for Mitigation of Sea Turtle Interactions with Fisheries." 3pp. Pacific Island Regional Office, NOAA National Marine Fisheries Service. [Online]. Availiable: http://www.fpir.noaa.gov/IFD/ifd_sea_turtles_indonesia.html 2/

National Marine Fisheries Service, 2004c. *Cause of stranding database for marine turtle strandings in the Hawaiian Islands, 1982 – 2003,* Honolulu, Hawaii: National Marine Fisheries Service-Pacific Islands Fisheries Science Center.

National Marine Fisheries Service, 2004d. "Fisheries off west coast states and in the western Pacific; Western Pacific fisheries; Highly migratory species fisheries; Overfishing determination for bigeye tuna," *Federal Register, Vol* 69, No.250, pp. 78397-78398.

National Marine Fisheries Service, 2005a. *Assessment of Acoustic Exposures on Marine Mammals in Conjunction with USS Shoup Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington. 5 May 2003.* National Marine Fisheries, Office of Protected Resources. Silver Spring, MD 20910.

National Marine Fisheries Service, 2005b. "Biological opinion on the continued authorization of the Hawaii-based pelagic, deep-set, tuna longline fishery based on the Fishery Management Plan for Pelagic Fisheries in the Western Pacific Ocean," U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

National Marine Fisheries Service, 2005c. *Pygmy Sperm Whale (Kogia breviceps): Western North Atlantic Stock.* Stock Assessment Report. December, 2005.

National Marine Fisheries Service, 2005d. *Long-Finned Pilot Whale (Globicephala melas): Western North Atlantic Stock.* Stock Assessment Report. December, 2005.

National Marine Fisheries Service, 2005e. *False Killer Whale (Pseudorca crassidens): Northern Gulf of Mexico Stock.* Stock Assessment Report. December, 2005.

National Marine Fisheries Service, 2005f. *Dwarf Sperm Whale (Kogia sima): Western North Atlantic Stock*. Stock Assessment Report. December, 2005.

National Marine Fisheries Service, 2005g. *Harbor Porpoise (Phocoena phocoena): Gulf of Maine/Bay of Fundy Stock.* Stock Assessment Report. December, 2005.

National Marine Fisheries Service, 2005h. *Bottlenose Dolphin (Tursiops truncatus): Gulf of Mexico Bay, Sound, and Estuarine Stocks*. Stock Assessment Report. December, 2005.

National Marine Fisheries Service, 2006a. "Endangered and threatened species: Revision of critical habitat for the northern right whale in the Pacific Ocean. Federal Register 71, No. 129, 38277-38297.

National Marine Fisheries Service, 2006b. Final Rule: for Conducting the Precision Strike Weapon (PSW) Testing and Training by Eglin Air Force Base, *Federal Register*, Vol 71, No 226, pp. 67810-67824.

National Marine Fisheries Service, 2006c. "Notices – Marine Mammals- Notice of Availability of new criteria for designation of marine malls Unusual Mortality Events." Federal Register, Vol 71, No 240, p. 75234. Thursday, 14 December.

National Marine Fisheries Service, 2007a. Comments received on the Preliminary Draft Hawaii Range Complex Environmental Impacts Statement/Overseas Environmental Impact Statement, June.

National Marine Fisheries Service, 2007b. "Marine Mammal Stranding Response Fact Sheet," [Online]. Available: http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_fact_sheet.pdf [29 January 2007].

National Marine Fisheries Service, 2007c. "FAQs about Marine Mammal Strandings," [Online]. Available: http://www.nmfs.noaa.gov/pr/health/faq.htm [30 January 2007.

National Marine Fisheries Service, 2007d. “Marine Mammal Health and Stranding Response Program (MMHSRP),” [Online]. Available: http://www.nmfs.noaa.gov/pr/health/ [30 January 2007].

National Marine Fisheries Service, 2007e. “Recovery Plan for the Hawaiian Monk Seal (*Monachus schauinslandi*) Revision,” National Marine Fisheries Service, Silver Spring, MD., 165 pp. [Online]. Available: http://www.nmfs.noaa.gov/pr/pdfs/recovery/hawaiianmonkseal.pdf.

National Marine Fisheries Service, 2007f. “National Marine Mammal Stranding Program,” [Online]. Available: http://seahorse.nmfs.noaa.gov/msdbs/class/seahorse_public.htm [2 February 2007].

National Marine Fisheries Service, 2007g. National Marine Fisheries Service, Office of Protected Resources. “Hawaii Viewing Guidelines” [Online]. Available: http://www.nmfs.noaa.gov/pr/education/hawaii/guidelines.htm [14 February 2007].

National Marine Fisheries Service, 2007h “Marine Mammal Education Web: What do you know about cetacean strandings?” [Online]. Available: http://www.afsc.noaa.gov/NMML/education/cetaceans/cetaceastrand.htm. Accessed 1/31/07.

National Marine Fisheries Service, 2007i. “National Marine Fisheries Service, Office of Protected Resources. 2005 Multispecies Mass Stranding in North Carolina.” [Online]. Available: http://www.nmfs.noaa.gov/pr/health/mmume/event2005jan.htm [16 February 2007].

National Marine Fisheries Service, 2007j. “Multi-species Unusual Mortality Event in North Carolina Fact Sheet.” [Online]. Available: http://www.nmfs.noaa.gov/pr/pdfs/health/ume_jan_2005_fact_sheet.pdf [16 February 2007].

National Marine Fisheries Service, 2007k. “National Marine Fisheries Service, Office of Protected Resources.” July 2004 mass Stranding of Melon-Headed Whales in Hawai’i [Online]. Available: http:www.nmfs.noaa.gov/pr/health/mmume/event2004jul.html [16 February 2007].

National Marine Fisheries Service, 2007l. “July 2004 Mass Stranding of Melon-Headed Whales in Hawai’i Fact Sheet for Final Report.” [Online]. Available: http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_melonheadedwhales_july2004.pdf [16 February 2007].

National Marine Fisheries Service, 2007n. “2004 Bottlenose Dolphin Unusual Mortality Event Along the Florida Panhandle.” [Online]. Available: http://www.nmfs.noaa.gov/pr/health/mmume/event2004.htm [16 February 2007].

National Marine Fisheries Service, 2007o. "Strandings Newsletter of the Southeast United States Marine Mammal Health and Stranding Network." Winter 2006/Spring 2007. NOAA Technical Memorandum NMFS-SEFSC-545 [Online]. Available: http://www.sefsc.noaa.gov/PDFdocs/SNewsletter112806.pdf [16 February 2007].

National Marine Fisheries Service, 2007p. "Draft Programmatic Environmental Impact Statement for the Marine Mammal Health and Stranding Response Program," (National Marine Fisheries Service, Office of Protected Resources), p. 1006.

National Marine Fisheries Service, 2007q. Listing Endangered and Threatened Wildlife and Designating Critical Habitat; 90-day Finding for a Petition to Reclassify the Loggerhead Turtle in the North Pacific Ocean as a Distinct Population Segment with Endangered Status and to Designate Critical Habitat. Federal Register, Vol 72, No 221, pp. 64585-645874. 16 November 2007.

National Marine Fisheries Service, 2007r. National Marine Fisheries Service, Office of Protected Resources. "Loggerhead Sea Turtle (Caretta Caretta) – 5-Year Review: Summary and Evaluation." [Online]. Available: http://www.nmfs.noaa.gov/pr/pdfs/species/loggerhead_5yearreview.pdf August.

National Marine Fisheries Service, 2008. National Marine Fisheries Office of Protected Resources Memorandum to Chief of Naval Operations, Environmental Readiness. In Review, January.

National Marine Fisheries Service, Pacific Islands Region (NMFS-PIR), 2001. "Final Environmental Impact Statement: Fishery management plan, pelagic fisheries of the western Pacific region." Volumes I and II, Prepared for National Marine Fisheries Service-Pacific Islands Region by URS Corporation, Honolulu, HI under contract to Research Corporation of the University of Hawaii, 1163 pp.

National Marine Fisheries Service, Pacific Islands Regional Office (NMFS-PIR), 2007a. "Pacific Island Region Marine Mammal Response Network-Activity Update, 2006 Marine Mammal Strandings", pp. 9-11, January.

National Marine Fisheries Service, Pacific Islands Regional Office (NMFS-PIR), 2007b. "Pacific Island Region Marine Mammal Response Network-Activity Update. This is the 1st and 2nd quarter 2007 combined issue of the Pacific Islands Regional Marine Mammal Response Network Newsletter, July.

National Marine Fisheries Service Southwest Fisheries Science Center, 1999. "Marine Mammals of the Pacific Region and Hawaii, Unit 23" *Our Living Oceans* [Online]. Available: http://spo.nwr.noaa.gov/unit23.pdf.

National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998a. *Recovery plan for U.S. Pacific populations of the green turtle (Chelonia mydas),* Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998b. *Recovery plan for U.S. Pacific populations of the hawksbill turtle (Eretmochelys imbricata)*, Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998c. *Recovery plan for U.S. Pacific populations of the leatherback turtle (Dermochelys coriacea)*, Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998d. *Recovery plan for U.S. Pacific populations of the olive ridley turtle (Lepidochelys olivacea)*, Silver Spring, Maryland: National Marine Fisheries Service.

National Ocean Service, 2001. Environmental *sensitivity index (ESI) atlas: Hawaii. Volumes 1 and 2*, Seattle, Washington: NOAA.

National Oceanic and Atmospheric Administration, 1979. Formal consultation pursuant to Section 7 of the Endangered Species Act, as amended, regarding the probable impacts of the U.S. Navy use of Kaula and Kahoolawe Target Island on humpback whales that winter in Hawaiian waters. Biological Opinion, September.

National Oceanic and Atmospheric Administration, 2001. "Final Rule for the Shock Trial of the WINSTON S. CHURCHILL (DDG-81), Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Naval Activities" *Federal Register*, Vol 66, No. 87, pp. 22450-22467.

National Oceanic and Atmospheric Administration, 2002a. "Final Rule SURTASS LFA Sonar," *Federal Register*, Department of Commerce; NMFS, *Federal Register,* Vol 67, No. 136, pp. 46712-46789.

National Oceanic and Atmospheric Administration, 2002b. *Report of the workshop on acoustic resonance as a source of tissue trauma in cetaceans.* NOAA Fisheries, Silver Spring, Maryland, April.

National Oceanic and Atmospheric Administration, 2003. "The Cultural Significance of Whales in Hawai`i," Third Printing [Online]. Available: http://hawaiihumpbackwhale.noaa.gov/special_offerings/sp_off/publication_pdfs/Cultural_brochure.pdf.

National Oceanic and Atmospheric Administration, 2004. Endangered Species Act section 7 consultation on proposed regulatory amendments to the FMP for the pelagic fisheries of the western Pacific region. Biological opinion. February 23.

Nation Oceanic and Atmospheric Administration, 2005. “Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Conducting the Precision Strake Weapon (PSW) Testing and Training by Eglin Air Force Base in the Gulf of Mexico,” Federal Register, Vol 70, No 160, pp. 48675-48691, Friday, [August 19, 2005]. [Online]. Available: http://a257.g.akamaitech.net/7/257/2422/01jan20051800/edocket.access.gpo.gov/2005/05-16390.html

National Oceanic and Atmospheric Administration, 2006a. National *Marine Fisheries Service Biological Opinion for RIMPAC, 2006.* July.

National Oceanic and Atmospheric Administration, 2006b. “Northwestern Hawaiian Islands Marine National Monument,” Federal Register, Vol 71, No. 167, pp. 51134-51142 [Online]. Available: http://hawaiireef.noaa.gov/pdfs/nwhinmn_finalregs.pdf

National Oceanic and Atmospheric Administration, 2006c. *Northwestern Hawaiian Islands Proposed National Marine Sanctuary Draft Environmental Impact Statement and Management Plan*, Vol. II of II, Honolulu, Hawaii, April, [Online]. Available: http://www.hawaiireef.noaa.gov/management/mp.html.

National Oceanic and Atmospheric Administration, 2006d. *Public Draft Environmental Assessment National Oceanic and Atmospheric Administration Pacific Region Center*, March.

National Oceanic and Atmospheric Administration, 2006e. “Pacific Islands Region Marine Mammal Response Network Activity Update, April – June 2006”. [Online]. Available: http://www.fpir.noaa.gov/Library/PRD/Marine%20Mammal%20Response/PIR%20hot%20topics%202%20final.pdf.

National Oceanic and Atmospheric Administration, 2006f. “Screening Quick Reference Tables. Screen concentration for inorganic and organic contaminates in various environmental media.” November Online: [Available]: http://response.restoration.noaa.gov/book_shelf/122_squirt_cards.pdf

National Oceanic and Atmospheric Administration, 2006g. Marine Mammals Stock Assessment Reports (SARs) by Region- 1995-2006. [Online]. Available http://www.nmfs.noaa.gov/pr/sars/region.htm

National Oceanic and Atmospheric Administration, 2006h. “Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Conducting the Precision Strake Weapon (PSW) Testing and Training by Eglin Air Force Base in the Gulf of Mexico,” Federal Register, Vol 71, No 226, pp. 67810-67824, Friday, [November 24, 2006]. [Online]. Available: http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/06-9380.htm

National Oceanic and Atmospheric Administration, 2006i. "Small Takes of Marine Mammals Incidental to Specified Activities; Rim of the Pacific Antisubmarine Warfare Exercise Training Events within the Hawaiian Islands Operating Area." Federal Register, Vol 71, No 130, pp. 38709-38738. 7 July.

National Oceanic and Atmospheric Administration, 2007a. "It's Whale Season in Hawai`i," *Announcements,"* 4 April [Online]. Available: http://hawaiihumpbackwhale.noaa.gov/.

National Oceanic and Atmospheric Administration, 2007b. "Taking and Importing Marine Mammals Incidental to the U.S. Navy Operations of Surveillance Towed Array Sensor System Low Frequency Active Sonar." Federal Register, Vol 72, No 161, pp. 46845-46893. 21 August.

National Oceanic and Atmospheric Administration, 2007c. NOAA's National Weather Services Marine Forecasts. [Online]. Available: http://www.weather.gov/os/marine/cwd.htm.

National Oceanic and Atmospheric Administration, 2008. National Oceanic and Atmospheric Administration Fisheries-Office of Protected Resources – Marine Mammal Protection Act (MMPA) 1972. [Online]. Available: http://www.nmfs.noaa.gov/pr/laws/mmpa/.

National Oceanic and Atmospheric Administration Pacific Islands Region, 2007. Personal communication (Email) received from Hans Van Tilburg, Ph.D., Maritime Heritage Coordinator, National Oceanographic and Atmospheric Administration Pacific Islands Region regarding bottom conditions at proposed Mobile Diving and Salvage Unit training vessel, 19 October.

National Oceanic Atmospheric Administration Fisheries, 2004. *Pacific Islands Region ByCatch Reduction Implementation Plan FY04-FY05*, 21 April.

National Park Service, 2004. *Environmental Assessment, Assessment of Effect Reestablishment of the Historic Scene at Pu`ukohola Heiau National Historic Site Hawai'i County, Hawaii,* April [Online]. Available: http://www.nps.gov/puhe/parkmgmt/upload/Environmental_Assessment_April_2004.pdf.

National Park Service, 2006. "USS Arizona Memorial," [Online]. Available: http://www.nps.gov/usar.

National Research Council, 1985. *Oil in the Sea: Inputs, Fates, and Effects*. National Academy Press.

National Research Council, 1990. *Decline of the sea turtles: Causes and prevention*, National Academy Press, Washington D.C.

National Research Council, 1994. *Low-Frequency Sound and Marine Mammals: Current Knowledge and Research Needs*. National Academy Press, Washington, D.C.

National Research Council, 1997. Information is as printed In: The National Marine Fishereis Service's biological opinion regarding the effects of the U.S. Navy's proposed 2006 RIMPAC Naval exercise, p. 48, June 27, 2006.

National Research Council, 2000. *Marine Mammals and Low-Frequency Sound: Progress since 1994*. National Academy Press, Washington, D.C. pp.

National Research Council, 2003. *Ocean noise and marine mammals*, The National Academic Press, Washington D.C. 208 pp.

National Research Council, 2005. *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*. The National Academic Press, Washington D.C. 126 pp.

National Research Council, 2006. *Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options, Committee on Ecosystem Effects of Fishing: Phase II - Assessments of the Extent of Change and the Implications for Policy*, National Academes Press, Washington, D.C.

National Wetlands Inventory, 2007. *Providing Wetland Information to the American People* [Online]. Available: http://www.fws.gov/nwi/ [17 October].

Nature Conservancy of Hawaii and Natural Resources Defense Council, 1992. *The Alien Pest Species Invasion in Hawai`i: Background Study and Recommendations for Interagency Planning*, Review draft 3, Honolulu. [Online]. Available: http://www.hear.org/articles/pdfs/nrdctnch1992.pdf.

Naval Facilities Engineering Command, 2003. *MCBH Kaneohe Bay, Air Installations Compatible Use Zones*, February.

Naval Facilities Engineering Command, 2004. *Partnering Agreement – FY06 MCON* p-410 Consolidated Range Ops Complex, PMRF, Hawaiian Area, Kauai, Hawaii. November.

Naval Facilities Engineering Command, 2006. "Cultural Resources Program Archeological Resources" [Online]. Available: https://portal.navfac.navy.mil/portal/page?_pageid=181,3449819,181_3449838:181_3449863&_dad=portal&_schema=PORTAL.

Naval Facilities Engineering Command Hawaii, 2007. "2007 Annual Water Quality Report-Pacific Missile Range Facility Water System, Mana Well Source." [Online]. Available: http://www.hawaii.navy.mil/Environmental/Water_Quality_Reports/Water%20Qual%20PMRF%202007_4May07.pdf

Naval Facilities Engineering Command, Hawaii Public Affairs, 2005. *Green Power on the Garden Isle*. [Online]. Available: https://portal.navfac.navy.mil/portal/page?_ pageid=181,3991235_dad=portal&_schema=PORTAL.

Naval Institute Guide to Ships and Aircraft of the U.S. Fleet, 2001. Navy EOD 60R-2-2-13; Table 1. Technical Description Documents SW515-A5-MMM-010, SW515-AG-OMP-010, SW516-AA-010.

Naval Ocean Systems Center, 1990. *Environmental Assessment Covering OTTO Fuel II for the Torpedo MK46/MK48 Programs,"* Commander, NOSC, San Diego, CA. 28 November 1990. Letter Ser. 614/94. Naval Surface Weapons Center, Indian Head, Maryland (NSWCIH). February 1983.

Naval Undersea Warfare Center Detachment, 1994. *Final Environmental Assessment for Temporary Hawaiian Area Tracking System,* June.

Naval Undersea Warfare Center Division Newport, Rhode Island, 2007. *Environmental Assessment (EA) for MK 48 Mod 6 Torpedo Exercises in Hawaiian Waters*, July.

Nedler, J.A. and T.W.M. Wedderburn, 1972. "Generalized linear models", *Journal of the Royal Statistical Society*, Series A, 135: 370–384.

Nedwell, J.R., B. Edwards, A.W.H. Turnpenny, and J. Gordon, 2004. "Fish and marine mammal audiograms: A summary of available information," *Subacoustech Limited., Report*, Reference 534R0214.

Nedwell J.R., A.W.H. Turnpenny, J. Gordon, and B. Edwards, 2006. Fish and marine mammal audiograms: a summary of available information on their hearing. *Subacoustech Report to the Department of Trade and Industry Reference:* 534R0210 (307 pp., in preparation).

Nelson, D. R., 1967. "Hearing thresholds, frequency discrimination and acoustic orientation in the lemon shark, *Negaprion brevirostris*, (Poey)," *Bulletin of Marine Science.* 17:741-768.

Nelson, D.R., and R.H. Johnson, 1972. "Acoustic attraction of Pacific reef sharks: effect of pulse intermittency and variability,." *Comparative Biochemistry and Physiology-Part A,* 42:85-95.

Nelson M, M. Garron, R.L Merrick, R.M Pace, and T.V.N. Cole. 2007. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2001-2005. US Department of Commerce, Northeast Fisheries Science Center Reference Document. 07-05. 18 pp.

Nemoto, T., and A. Kawamura, 1977. "Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales," *Reports of the International Whaling Commission, Special Issue,* 1:80-87.

Nestler, J.M., G.R. Ploskey, J. Pickens, J. Menezes, C. Schilt, 1992. "Responses of blueback herring to high-frequency sound and implications for reducing entrainment at hydropower dams," *North American Journal of Fisheries Management.* 12:667–683.

Nestler, J.M., R.A. Goodwin, T.M. Cole, D. Degan, and D. Dennerline, 2002. "Simulating movement patterns of blueback herring in a stratified southern impoundment," *Transactions of the American Fisheries Society,* 131:55–69.

Nicholls B and Racey P.A., 2007. "Bats Avoid Radar Installations: Could Electromagnetic Fields Deter Bats from Colliding with Wind Turbines?" open access freely available online in *PLoS ONE* 2(3): e297. [Online]. Available: www.plosone.org.

Nieri, M., E. Grau, B. Lamarch, and A. Aguilar, 1999. "Mass mortality of Atlantic spotted dolphin (*Stenella frontalis*) caused by a fishing interaction in Mauritania," *Marine Mammal Science*, 15(3):847-854).

Nitta, E.T., and J.R. Henderson, 1993. "A review of interactions between Hawaii's fisheries and protected NMFS species," *Marine Fisheries Review,* 55:83-92.

Norman, S.A., S. Raverty, B. McLellan, A. Pabst, D. Ketten, M. Fleetwood, J.K. Gaydos, B. Norberg, L. Barre, T. Cox, B. Hanson, and S. Jeffries, 2004. "Multidisciplinary investigation of stranded harbor porpoises (*Phocoena phocoena*) in Washington State with an assessment of acoustic trauma as a contributory factor (2 May – 2 June 2003)," U.S. Dep. Commerce, NOAA Technical Memorandum NMFS-NWR-34*,* 120 pp.

Norman, S.A., and Mead, J.G., 2001. "*Mesoplodon europaeus*," Mammalian Species 688:1- 5.

Norris, K.S., and J.H. Prescott, 1961. "Observations on Pacific cetaceans of Californian and Mexican waters," *University of California Publications in Zoology, 63:291-402*.

Norris, K.S., B. Würsig, R.S. Wells, and M. Wursig, 1994. *The Hawaiian spinner dolphin.* Berkeley: University of California Press.

Norris, T.F., M.A. Smultea, A.M. Zoidis, S. Rankin, C. Loftus, C. Oedekoven, J.L. Hayes, and E. Silva, 2005. "A preliminary acoustic-visual survey of cetaceans in deep waters around Niihau, Kauai, and portions of Oahu, Hawaii from aboard the WV Dariabar, February 2005, Final Technical and Cruise Report July 2005," Prepared for Geo-Marine, Inc., Plano, Texas, and NAVFAC Pacific, Pearl Harbor, Hawaii, by Cetos Research Organization, Bar Harbor, Maine. Contract #2057sa05-F.

North Atlantic Treaty Organization, no date. Part II: *SACLANTCEN marine mammal and human divers risk mitigation rules -planning*. Chapter 2, 9 pp.

Northrop, J., W.C. Cummings, and M.F. Morrison, 1971. "Underwater 20-Hz signals recorded near Midway Island," *Journal of the Acoustical Society of America*, 49:1909-1910.

Northwest and Alaska Fisheries Center, 1978. "Northern elephant seal appears on one of the Northwestern Hawaiian Islands."

Northwestern Hawaiian Islands Multi-Agency Education Project, 2006. "Expeditions," [Online]. Available: http://www.hawaiianatolls.org/research/index.php

Nowacek, D.P., M.P. Johnson, and P.L. Tyack, 2004. "North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli," *Proceedings of the Royal Society of London, Part B.,* 271:227-231.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack, 2007. "Responses of cetaceans to anthropogenic noise." *Mammal Review*, 37(2):81-115.

Nuclear Regulatory Commission, 1997. *Proceedings of a dose-modeling workshop*. November 13–14, 1997. Washington, D.C.

Occupational Safety and Health Administration, 1996a. "Occupational noise exposure in OSHA safety and health standards; miscellaneous minor and technical amendments. 29 CFR 1910.95". *Federal Register*, Vol 61, No. 46, pp. 9227--9236,

Occupational Safety and Health Administration 1996b. "Occupational Exposure to 1,3-Butadiene; Final Rule." . *Federal Register*, Vol 61, No. 214, pp. 56746-56795, [Online]. Available: http://frwebgate1.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=486577342323+0+0+0&WAISaction=retrieve

Occupational Safety and Health Administration 2006. "Occupational Exposure to Hexavalent Chromium", *Federal Register*, Vol 71, No. 39, pp. 10099-10385, [Online]. Available: http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?position=all&page=10100&dbname=2006_register

Odell, D.K.,1987. A *Review of the Southeastern United States Marine Mammal Stranding Network: 1978-1987.* NOAA Technical Report NMFS 98. Marine Mammal Strandings in the United States. Proceedings of the Second Marine Mammal Stranding Workshop Miami, Florida December 3-5, 1987.

Odell, D.K., and K.M. McClune, 1999. "False killer whale *Pseudorca crassidens* (Owen, 1846)," pp. 213-243. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises,* San Diego: Academic Press.

Office of Naval Research, 1999a. *LWAD 99-3 OEA Overseas Environmental Assessment (OEA) for the Littoral Warfare Advanced Development (LWAD) 99-3 Sea Test*, ONR Code 32, 22 July.

Office of Naval Research, 1999b. LWAD 99-2 OEA. *Overseas Environmental Assessment (OEA) for the Littoral Warfare Advanced Development (LWAD) 99-2 Sea Test*. ONR Code 32, 15 April.

Office of Naval Research, 2001. *Final Environmental Impact Statement for the North Pacific Acoustic Laboratory*, Volume I, May.

Offshore Island Restoration Committee, undated. "Hawaiian Islands-Kaula Rock, Niihau," [Online]. Available: http://www.botany.hawaii.edu/gradstud/eijzenga/OIRC/kaula.htm [18 July 2006].

Ogden Environmental, 1997. *Airborne Noise Modeling for the Point Mugu Sea Range Environmental Impact Statement.* Modeling conducted by Ogden Environmental and Energy Services, Inc., Colorado Springs, CO.

O'Hara, T.M., and C. Rice, 1996. "Polychlorinated biphenyls," pp. 71–86. *In: Noninfectious diseases of wildlife,* 2nd edition, A. Fairbrother, L. Locke, and G. Hoff (eds.). Iowa State University Press, Ames, Iowa,.

O'Hara T.M., Krahn, M., Boyd, D., Becker, P. and Philo, M., 1999. "Organochlorine Contaminant Levels in Eskimo Harvested Bowhead Whales of Arctic Alaska," *Journal of Wildlife Diseases,* 35(4):741–752. Wildlife Disease Association,

Ohizumi, H., T. Matsuishi, and H. Kishino, 2002. "Winter sightings of humpback and Bryde's whales in tropical waters of the western and central and North Pacific," *Aquatic Mammals*, 28:73-77.

Ohizumi, H., T. Isoda, T. Kishiro, and H. Kato, 2003. "Feeding habits of Baird's beaked whale *Berardius bairdii*, in the western North Pacific and Sea of Okhotsk off Japan," *Fisheries Science,* 69:11-20.

Okamura, H., K. Matsuoka, T. Hakamada, M. Okazaki, and T. Miyashita, 2001. "Spatial and temporal structure of the western North Pacific minke whale distribution inferred from JARPN sightings data," *Journal of Cetacean Research and Management*, 3:193-200.

O'Keeffe, D. J. and G. A. Young, 1984. *Handbook on the environmental effects of underwater explosions*. Naval Surface Weapons Center, Dahlgren, Virginia 22448. Report No. NSWC TR 83-240.

Oleson, E., J. Barlow, C. Clark, J. Gordon, S. Rankin, and J. Hildebrand, 2003. "Low frequency calls of Bryde's whales," *Marine Mammal Science,* 19:407-419.

Oleson, E.M., J. Calambokidis, J. Barlow, and J. Hildebrand, 2007. "Blue Whale Visual And Acoustic Encounter Rates In The Southern California Bight," *Marine Mammal Science*, 23(3): 574–597. .

Omura, H., S. Ohsumi, T. Nemoto, K. Nasu, and T. Kasuya, 1969. "Black right whales in the North Pacific," *Scientific Reports of the Whales Research Institute,* 21:l-78.

Osborne, R., 2003a. “Historical Information on Porpoise Strandings in San Juan County Relative to the May 5th Navy Sonar Incident”. *The Whale Museum News & Events*. [Online], Available: http://www.whale-museum.org/museum/press/archives/hist_strand.html

Osborne, R., 2003b. Statement of R. Osborne of 28 May 2003 provided to NMFS.

O’Shea, T. and Brownell, R.L. 1994. “Organochlorine and metal contaminants in baleen whales: A review and evaluation of conservation implications.” *Science of the Total Environment* 154: 179–200.

Östman, J.S.O., 1994. “Social organization and social behavior of Hawaiian spinner dolphins (*Stenella longirostris*),” Ph.D dissertation, University of California at Santa Cruz.

Östman-Lind, J., A.D. Driscoll-Lind, and S.H. Rickards, 2004. “Delphinid abundance, distribution and habitat use off the western coast of the island of Hawaii,” *Southwest Fisheries Science Center Administrative Report LJ-04-02C*. La Jolla, California: National Marine Fisheries Service.

Oxman, D.S., R. Barnett-Johnson, M.E. Smith, A.B. Coffin, D.D. Miller, R. Josephson, A.N. Popper, 2007. “The effect of vaterite deposition on otolith morphology, sound reception and inner ear sensory epithelia in hatchery-reared chinook salmon (*Oncorhynchus tshawytscha*),” *Canadian Journal of Fisheries and Aquatic Sciences,* 64:1469-1478.

Pace, R.M. and G.K. Silber, 2005. Simple analyses of ship and large whale collisions: Does speed kill?” Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, December 2005.

Pacific Business News, 2002. *”*Co-op closes Kauai Electric purchase*”,* [Online], Available: http://pacific.bizjournals.com/pacific/stories/2002/10/28/daily84.html [15 September 2006].

Pacific Missile Range Facility, 1999. "Wildlife Flourishing at PMRF," Release #24-99, [Online]. Available: http://www.pmrf.navy.mil/pr_seals.html, [26 April 2002].

Pacific Missile Range Facility, 2000. *Mountaintop Surveillance Sensor Test Integration Center Facility, Kauai, Hawaii, Final Environmental Assessment,* May.

Pacific Missile Range Facility, 2001. *Integrated Natural Resources Management Plan*, Pacific Missile Range Facility, Hawaii, Final, October.

Pacific Missile Range Facility, 2006a. “Barking Sands Botanical Survey Report,” May.

Pacific Missile Range Facility, 2006b. “Pacific Missile Range Bird Surveys, “ Results conducted on 13-17 February and 14-20 April.

Pacific Missile Range Facility, 2006c. "Herpetological and Mammal Surveys at Pacific Missile Range Facility," February and April.

Pacific Missile Range Facility, 2006d. "The Status of *Wilkesia hobdyi* (Asteraceae) U.S. Navy Pacific Missile Range Facility Makaha Ridge, Kokjee, Kauai, Hawaii, Prepared for Helber Haster & Fee, Planners, by K.R. Wood/Research Biologist, 17-21 April.

Pacific Missile Range Facility, 2006e. "Kokee Botanical Survey Report," May.

Pacific Missile Range Facility, Barking Sands, Hawaii, 1991. *Fleet Mission Planning Guide, FMPG-91,* 1 April.

Palacios, D.M., and B.R. Mate, 1996. "Attack by false killer whales (*Pseudorca crassidens*) on sperm whales (*Physeter macrocephalus*) in the Galapagos Islands," *Marine Mammal Science,* 12:582-587.

Palka, D. and M. Johnson (eds), 2007. *Cooperative Research to Study Dive Patterns of Sperm Whales in the Atlantic Ocean*. Minerals Management Service, New Orleans, LA. OCS Study MMS2007-033. 49 pp.

Palmer, K.V.W., 1927. "The Veneridae of Eastern America: Cenozoic and Recent," *Palaeontologica Americana,* 1:209–522.

Pampel, F.C., 2000. *Logistic regression. A primer*. SAGE Publications, Inc., Newbury Park, California.

Panigada, S., M. Zanardelli, S. Canese, and M. Jahoda, 1999. "Deep diving performances of Mediterranean fin whales," p. 144. In: *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 1999,* Wailea, Maui.

Papastamatiou, Y.P, B.M. Wetherbee, C.G. Lowe, and G.L Crow, 2006. "Distribution and diet of four species of carcharhinid shark in the Hawaiian Islands; evidence for resource partitioning and competitive exclusion," *Marine Ecology Progress Series, 320; 239-251,* published 29 August [Online]. Available: http://www.hawaii.edu/HIMB/sharklab/Papastamatiou_MEPS06.pdf

Parente, C.L., J.P. Araujo, and M.E. Araujo, 2007. "Diversity of cetaceans as tool in monitoring environmental impacts of seismic surveys." *Biota Neotrop*ica 7(1):1-7.

Parks, S.E., D.R. Ketten, J. Trehey O'Malley, and J. Arruda, 2004. "Hearing in the North Atlantic right whale: Anatomical predictions," *Journal of the Acoustical Society of America*, 115:2442.

Parks, S.E., D.R. Ketten, J.T. O'Malley, and J. Arruda. 2007. Anatomical predictions of hearing in the North Atlantic Right whale. *The Anatomical Record,* 290:734-744.

Parks, S.E., C.W. Clark, and P.L. Tyack. 2007. "Short- and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication," *Journal of the Acoustical Society of America,* 122: 3725–3731.

Parrish, F.A., M.P. Craig, T.J. Regan, G.J. Marshall and B.M. Buhleier, 2000. "Identifying diurnal foraging habitat of endangered Hawaiian monk seals using a seal-mounted video camera," *Marine Mammal Science,* 16:392-412.

Parrish, F.A., K. Abernathy, G.J. Marshall, and B.M. Buhleier, 2002. "Hawaiian monk seals (*Monachus schauinslandi*) foraging in deep-water coral beds," *Marine Mammal Science,* 16(2): 392-412.

Parrish, F.A., G.J. Marshall, C.L. Littnan, M. Heithaus, S. Canja, B. Becker, R. Braun, and G.A. Antonelis, 2005. "Foraging of juvenile monk seals at French Frigate Shoals, Hawaii," *Marine Mammal Science*, 21:93-107.

Paterson, R.A., 1984. "*Spondylitis deformans* in a Bryde's whale (*Balaenoptera edeni* Anderson) stranded on the southern coast of Queensland," Journal of Wildife Diseases 20, 250-252.

Payne, K., P. Tyack, and R. Payne, 1983. "Progressive changes in the songs of humpback whales (*Megaptera novaengliae*): A detailed analysis of two seasons in Hawaii," pp. 9-57. In: R. Payne, ed. *Communication and behavior in whales*, Washington, D.C.: American Association for the Advancement of Science.

Pearson, W.H., J.R. Skalski, and C.I. Malme , 1987. "Effects of sounds from a geophysical survey device on fishing success." Report prepared by Battelle/Marine Research Laboratory for the Marine Minerals Service, United States Department of the Interior under Contract Number 14-12-0001-30273. June.

Pearson, W.H., Skalski, J. R., and Malme, C.I., 1992. "Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes* ssp)," Canadian Journal Fisheries. and Aquatic. Science, 49:1343-1356.

Perrin, W.F., and R.L. Brownell, 2002. "Minke whales *Balaenoptera acutorostrata* and *B. bonaerensis,"* pp. 750-754. In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. *Encyclopedia of marine mammals*, San Diego: Academic Press.

Perrin, W.F. and J.W. Gilpatrick, 1994. "Spinner dolphin, *Stenella longirostris* (Gray, 1828)," pp. 99-128. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals, Volume 5. The first book of dolphins,* San Diego, Academic Press.

Perrin, W.F., and A.A. Hohn, 1994. "Pantropical spotted dolphin, *Stenella attenuate,"* pp. 71-98. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 5: The first book of dolphins*. San Diego: Academic Press.

Perrin, W.F., C.E. Wilson, and F.I. Archer, 1994a. "Striped dolphin – *Stenella coeruleoalba* (Meyen, 1833)," pp. 129-159In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 5: The first book of dolphins.* Academic Press, San Diego, CA.

Perrin W.F., S. Leatherwood, and A. Collet, 1994b. "Fraser's dolphin - *Lagenodelphis hosei* Fraser, 1956," pp. 225-240. In: S.H. Ridgway and R. Harrison, eds. *Handbook of Marine Mammals Volume 5: The first book of dolphins*, Academic Pres, London.

Perrin, W.F., and Geraci, J.R., 2002. "Stranding," pp. 1192-1197.In: *Encyclopedia of Marine Mammals*, edited by W.F. Perrin, B. Wursig, and J.G.M. Thewissen (Academic Press, San Diego),.

Perry, S.L., D.P. DeMaster, and G.K. Silber, 1999. "The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973," *Marine Fisheries Review,* 61:1-74.

Perryman, W.L., and T.C. Foster, 1980. "Preliminary report on predation by small whales, mainly the false killer whale, *Pseudorca crassidens*, on dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific," *Southwest Fisheries Science Center Administrative Report LJ-80-05*, La Jolla, California: National Marine Fisheries Service.

Perryman, W.L., D.W.K. Au, S. Leatherwood, and T.A. Jefferson, 1994. "Melon-headed whale. *Peponocephala electra* (Gray, 1846)," pp. 363-386. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 5: The first book of dolphins*, San Diego: Academic Press.

Philips, J.D., P.E. Nachtigall, W.W.L. Au, J.L. Pawloski, and H.L. Roitblat, 2003. "Echolocation in the Risso's dolphin, *Grampus griseus," Journal of the Acoustical Society of America,* 113:605-616.

Pianradosi, C.A. and E. D. Thalmann, 2004. "Whales, sonar, and decompression sickness," *Nature,* 1428 (5 April 2004).

Pickering, A.D. 1981. Stress and Fishes. New York: Academic Press.

Pilia`au Range Complex and Makua Military Reservation, 2006, Summary of Archeological Sites. [Online]. Available: http://www.25idl.army.mil/makua/History.asp?HistDispID=14.

Pitman, R.L., L.T. Ballance, S.L. Mesnick, and S.J. Chivers, 2001. "Killer whale predation on sperm whales: Observations and implications," Marine Mammal Science 17:494-507.

Pivorunas, A., 1979. "The feeding mechanisms of baleen whales," *American Scientist,* 67:432-440.

Plachta, D.T.T. and A.N. Popper, 2003. "Evasive responses of American shad (*Alosa sapidissima*) to ultrasonic stimuli," *Acoustic Research Letters Online 4: 25-30, 2003* [Online]. Available: http://scitation.aip.org/getpdf/servlet/GetPDFServlet?filetype=pdf&id=ARLOFJ000004000002000025000001&idtype=cvips&prog=normal.

Plachta, D.T.T., J. Song , M.B. Halvorsen, and A.N. Popper, 2004. "Neuronal encoding of ultrasonic sound by a fish," *Journal of Neurophysiology*, 91:2590-2597.

Plastic Process Equipment, 2007. *Material Safety Data Sheet Propylene Gycol Industrial*, Lyondell [Online]. Available: http://www.ppe.com/msds/Propylene%20Glycol.pdf.

Podestà, M., A. D'amico, G. Pavan, A. Drougas, A. Komnenou, and N. Portunato, 2006. "A review of Cuvier's beaked whale strandings in the Mediterranean Sea," *Journal of Cetacean Research and Management*, 7:251–261.

Polefka, S., 2004. "Anthropogenic Noise and the Channel Islands National Marine Sanctuary How Noise Affects Sanctuary Resources, and What We Can Do About It," September. [Online]. Available: http://channelislands.noaa.gov/sac/pdf/7-12-04.pdf

Polovina, J.J., D.R. Kobayashi, D.M. Parker, M.P. Seki, and G.H. Balazs, 2000. "Turtles on the edge: Movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997-1998," *Fisheries Oceanography,* 9:71-82.

Polovina, J.J., G.H. Balazs, E.A. Howell, D.M. Parker, M.P. Seki, and P.H. Dutton, 2004. "Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean," *Fisheries Oceanography,* 13:36-51.

Poole, M.M., 1995. "Aspects of the behavioral ecology of spinner dolphins (*Stenella longirostris*) in the nearshore waters of Moorea, French Polynesia,: Ph.D. dissertation., University of California, Santa Cruz.

Pooley, S.G., 1993. "Hawaii Marine Fisheries: Some history, long-term trends, and recent development," *Marine Fisheries Review 55(2):7-19* [Online]. Available: http://www.encyclopedia.com/doc/1G1-15462276.html.

Popper, A.N., 1976. "Ultrastructure of the auditory regions in the inner ear of the lake whitefish," *Science* 192:1020 1023.

Popper, A.N., 1977. "A scanning electron microscopic study of the sacculus and lagena in the ears of fifteen species of teleost fishes," *Journal of Morphology*, 153:397 418.

Popper, A.N.,1980. "Scanning electron microscopic study of the sacculus and lagena in several deep-sea fishes," *American Journal of Anatomy*, 157:115-136.

Popper, A.N., 1981. “Comparative scanning electron microscopic investigations of the sensory epithelia in the teleost,” *Journal of Comparative Neurology*, 200:357-374.

Popper, A.N., 2000. “Hair cell heterogeneity and ultrasonic hearing: recent advances in understanding fish hearing,” *Philosophical Transactions of the Royal Society of Biological Sciences, 29:*355:1277-80.

Popper, A.N., 2003. “Effects of anthropogenic sound on fishes,” *Fisheries,* 28:24-31.

Popper, A.N. and T.J. Carlson, 1998. “Application of sound and other stimuli to control fish behavior,” *Transactions of the American Fisheries Society,* 127(5):673-707.

Popper, A.N., and B. Hoxter, 1984. “Growth of a fish ear: 1. “Quantitative analysis of sensory hair cell and ganglion cell proliferation,” *Hearing Research*, 15:133 142.

Popper, A.N., and B. Hoxter, 1987. “Sensory and nonsensory ciliated cells in the ear of the sea lamprey, Petromyzon marinus,” Brain, Behavior and Evolution, 30:43-61.

Popper, A.N. and R.R. Fay, 1977. “Structure and function of the elasmobranch auditory system,” *American Zoologist,* 17:443-452.

Popper, A.N. and C. Platt, 1993. “Inner ear and lateral line,” pp. 99-136In:: *The Physiology of Fishes*, First Edition, edited by Evans DH. Boca Raton, FL: CRC Press, Inc., 1993.

Popper, A.N. and Z. Lu, 2000. “Structure-function relationships in fish otolith organs,” *Fisheries Research.* 46: 15-25.

Popper A.N., R.R. Fay, C. Platt, and O. Sand, 2003. “Sound detection mechanisms and capabilities of teleost fishes,” pp.3-38. In Sensory Processing in Aquatic Environments, eds. S.P. Collin and N.J. Marshall, New York: Springer-Verlag.

Popper, A.N., J. Fewtrell, M.E. Smith, and R.D. McCauley, 2004. “Anthropogenic sound: Effects on the behavior and physiology of fishes,” *Marine Technology Society Journal.*, 37(4): 35-40.

Popper, A.N., M.E. Smith, P.A. Cott, B.W. Hanna, A.O. MacGillivray, M.E. Austin, and D.A. Mann. 2005. “Effects of exposure to seismic airgun use on hearing of three fish species,” *Journal of the Acoustical Society of America*, 117(6): 3958-3971.

Popper, A.N. and W.N. Tavolga, 1981. “Structure and function of the ear in the marine catfish, *Arius felis*,” *Journal of Comparative Physiology* , 144: 27-34.

Popper, A.N., M.B. Halvorsen, E. Kane, D.D. Miller, M.E. Smith, P. Stein, and L.E. Wysocki. 2007. “The effects of high-intensity, low-frequency active sonar on rainbow trout,” *Journal of the Acoustical Society of America*, 122:623-635.

Popper, A.N., and C.R. Schilt , 2008. "Hearing and acoustic behavior (basic and applied)," In: *Fish Bioacoustics*, eds. J.F. Webb, R.R. Fay, and A.N. Popper. New York: Springer Science + Business Media, LLC.

Presidential Document, 2000. "Executive Order 13178—Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve," *Federal Register*, 65(236):76901- 76910. [Online]. Available: http://www.denix.osd.mil/denix/Public/Legislation/EO/note77.html [1 January 2007].

Presidential Document, 2006.. "Proclamation 8031 of June 15, 2006. Establishment of the Northwestern Hawaiian Islands Marine National Monument," *Federal Register*, 71(122):36441-36475.

Quackenbush, S.L., T.M. Work, G.H. Balazs, R.N. Casey, J. Rovnak, A. Chaves, L. du Toit, J. D. Baines, C.R. Parrish, P.R. Bowser, and J.W. Casey, 1998. "Three closely related herpes viruses are associated with fibropapillomatosis in marine turtles," *Virology,* 246:392–399.

Quaranta, A., P. Portalatini, and D. Henderson, 1998. "Temporary and permanent threshold shift: An overview," *Scandinavian Audiology,* 27:75–86.

Ragen, T.J., and M.A. Finn, 1996. The Hawaiian monk seal on Nihoa and Necker Islands, 1993," pp. 90-94. In: T.C. Johanos and T.J. Ragen, eds. *The Hawaiian monk seal in the Northwestern Hawaiian Islands, 1993,* NOAA Technical Memorandum NMFS-SWFSC 227

Ragen, T.J., and D.M. Lavigne, 1999. "The Hawaiian monk seal: Biology of an endangered species," pp. 224-245. In: J.R. Twiss, Jr. and R.R. Reeves, eds. *Conservation and Management of Marine Mammals,* Washington, D.C.: Smithsonian Institution Press.

Ramcharitar, J. and Popper, A.N., 2004. "Masked auditory thresholds of sciaenid fishes: a comparative study," *Journal of the Acoustical Society of America*, 116:1687-1691.

Ramcharitar, Higgs, D.M. and Popper, 2001. "Sciaenid inner ears: A study in diversity." *Brain, Behavior and Evolution*, 58:152-162. Ramcharitar, J.U., X. Deng, D. Ketten, and A.N. Popper, 2004. "Form and function in the unique inner ear of a teleost fish: The silver perch (*Bairdiella chrysoura*)," *Journal of Comparative Neurolology, 475:531-539*.

Ramcharitar, J., D. Higgs, and A.N. Popper, 2006a. "Audition in sciaenid fishes with different swim bladder-inner ear configurations," *Journal of the Acoustical Society of America*, 119:439-443.

Ramcharitar, J., and D. Gannon, and A.N. Popper A., 2006b. "Bioacoustics of fishes of the Family Sciaenidae (croakers and drums)," *Transactions of the American Fisheries Society,* 135:1409–1431.

Rand Corporation. 2005. Unexploded Ordnance Cleanup Costs: Implications of Alternative Protocols. Published by the *Rand Corporation*, 70 pp.

Randall, J.E., 1995. "Zoogeographic analysis of the inshore Hawaiian fish fauna," pp. 193-203. In: J.E. Maragos, M.N.S. Peterson, L.G. Eldredge, J.E. Bardach and HF. Takeuchi, eds. *Marine and coastal biodiversity in the tropical island Pacific region, Volume 1. Species systematics and information management priorities*, Honolulu. Hawaii: East-West Center.

Randall, J.E., 1998. "Zoogeography of shore fishes of the Indo-Pacific region," *Zoological Studies,* 37:227-268.

Range Commanders Council, Range Safety Group, 2002. "Standard 321-02," *Common Risk Criteria for National Test Ranges, Subtitle: Inert Debris,* June.

Rankin, J.J., 1953. "First record of the rare beaked whale, Mesoplodon europaeus, Gervais, from the West Indies," Nature 172:873-874.

Rankin, S., and J. Barlow, 2003. "Discovery of the minke whale "boing" vocalization, and implications for the seasonal distribution of the North Pacific minke whale," p. 134. In: *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14–19 December 2003*, Greensboro, North Carolina.

Rankin, S. and J. Barlow, 2005. "Source of the North Pacific "boing" sound attributed to minke whales," *Journal of the Acoustical Society of America,* 118(5):3346-3351.

Raytheon, 2007. "The Standard Missile Family," [Online]. Available: http://www.raytheon.com/products/standard_missile/

Read, A.J., P. Drinker, and S. Northridge, 2002. *By-Catches of Marine Mammals in U.S. Fisheries and a First Attempt to Estimate the Magnitude of Global Marine Mammal By-Catch*, World Wildlife Fund Conference Report, January 2002, Annapolis, MD.

Read, A.J., P. Drinker, and S. Northridge, 2006. "Bycatch of Marine Mammals in U.S. and Global Fisheries," *Conservation Biology*, 20:63-169.

Redfern, J.V., M.C. Ferguson, E.A. Becker, K.D. Hyrenbach, C. Good, J. Barlow, K. Kaschner, M.F. Baumgartner, K.A. Forney, L.T. Ballance, P. Fauchald, P. Halpin, T. Hamazaki, A.J. Pershing, S.S. Qian, A. Read, S.B. Reilly, L. Torres, and F. Werner. 2006. "Techniques for cetacean-habitat modeling: A review," *Marine Ecology Progress Series,* 310:271-295.

Rechtman, R., A. Yoklavich, and M. Binder, 1998. *Cultural Resources Management Plan, Pacific Missile Range Facility, Barking Sands, Kauai,* Prepared for the Department of the Navy, Naval Facilities Engineering Command, Paul H. Rosendahl, Ph.D., Inc., Hilo. [For Official Use Only]

Reeves R.R., G.K. Silber, P.M. Payne , 1998. Draft Recovery Plan for the Fin Whale *Balaenoptera physalus* and Sei Whale *Balaenoptera borealis.* Draft Report prepared for the Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Silver Spring, Maryland. Report updated in June 2006.

Reeves, R.R., B.D. Smith, E.A. Crespo, and G. Notarbartolo di Sciara, 2003. *2002-2010 conservation plan for the world's cetaceans: Dolphins, whales, and porpoises*, Gland, Switzerland: IUCN- The World Conservation Union, 147 pp.

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell, 2002. *National Audubon Society guide to marine mammals of the world,* New York: Alfred A. Knopf. 527 pp.

Reeves, R.R., S. Leatherwood, G.S. Stone, and L.G. Eldredge, 1999. *Marine mammals in the area served by the South Pacific Regional Environment Programme (SPREP),* Apia, Samoa: South Pacific Regional Environment Programme.

Reeves, R.R., W.F. Perrin, B.L. Taylor, C.S. Baker, and S.L. Mesnick, 2004. "Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management, April 30 - May 2, 2004," La Jolla, California, NOAA Technical Memorandum NMFS-SWFSC 363:l- 94.

Reijnders, P.J.H., and A. Aguilar, 2002. "Pollution and marine mammals," pp. 948-957. In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds*. Encyclopedia of marine mammals,* San Diego: Academic Press.

Reilly, S., and V.G. Thayer, 1990. "Blue whale (*Balaenoptera musculus*) distribution in the eastern tropical Pacific," *Marine Mammal Science,* 6:265-277.

Remage-Healey, L. and A.H. Bass, 2006. "From social behavior to neural circuitry: steroid hormones rapidly modulate advertisement calling via a vocal pattern generator," *Hormones Behavior,* 50:432-441.

Rendell, L., and H. Whitehead, 2004. "Do sperm whales share coda vocalizations? Insights into coda usage from acoustic size measurement," *Animal Behaviour,* 67:865-874.

Renner, R.H. and J.M. Short, 1980. *Chemical Products of Underwater Explosions.* Naval Surface Weapons Center, Dahlgren, VA. NSWC/WOL. TR 78-87, February.

Resendiz, A., B. Resendiz, W.J. Nichols, J.A. Seminoff, and N. Kamezaki, 1998. "First confirmed east-west transpacific movement of a loggerhead sea turtle, *Caretta caretta*, released in Baja California, Mexico," *Pacific Science,* 52:151-153.

Resnick, D., and G. Niwayama, 2002. "Ankylosing spondylitis," pp. 1023-1081. In: Diagnosis of bone and joint disorders, edited by D. Resnick (W.B. Saunders Co., Philadelphia),.

Resture, J., 2002. "Welcome, Nihoa Island" [Online]. Available: http://www.janeresture.com/nihoa/ [23 April 2002].

Resture, J., 2004. "Welcome, Necker Island" [Online]. Available: http://www.janeresture.com/necker/index.htm.

Resture, J., 2006. "Welcome, Kaula Island" [Online]. Available: http://www.janeresture.com/kaula/index.htm.

Rice, D.W., 1960. "Distribution of the bottle-nosed dolphin in the Leeward Hawaiian Islands," *Journal of Mammalogy,* 41 :407-408.

Rice, D.W. 1977. "*Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific,." Reports of the International Whaling Commission. Special Issue*, 1:92–97.

Rice, D.W., 1998. "Marine mammals of the world: Systematics and distribution," *Society for Marine Mammalogy Special Publication,* 4:1-231.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thompson, 1995a. *Marine mammals and noise,* funded by Minerals Management Service, Office of Naval Research, LGL, Ltd., Greeneride Sciences, Inc., and BBN Systems and Technologies under MMS Contract 14-12-0001-30673. San Diego: Academic Press, Inc.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thompson, 1995b. p. 163. In: *Marine mammals and noise,* funded by Minerals Management Service, Office of Naval Research, LGL, Ltd., Greeneride Sciences, Inc., and BBN Systems and Technologies under MMS Contract 14-12-0001-30673. San Diego: Academic Press, Inc.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thompson, 1995c. pp. 205-240. In: *Marine mammals and noise,* funded by Minerals Management Service, Office of Naval Research, LGL, Ltd., Greeneride Sciences, Inc., and BBN Systems and Technologies under MMS Contract 14-12-0001-30673. San Diego: Academic Press, Inc.

Ridgway, S.H., and M.D. Dailey, 1972. "Cerebral and cerebellar involvement of trematode parasites in dolphins and their possible role in stranding," Journal of Wildlife Diseases. 8:33-43.

Ridgway, S.H., 2000. "The auditory central nervous system," pp. 273-293. In: W.W.L. Au, A.N. Popper, and R.R. Fay, eds. *Hearing by whales and dolphins,* New York: Springer-Verlag.

Ridgway, S.H., and D.A. Carder, 2001. "Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales," *Aquatic Mammals,* 27:267-276.

Ridgway, S.H., and R. Howard, 1979. "Dolphin lung collapse and intramuscular circulation during free diving: evidence from nitrogen washout," *Science,* 206:1182–1183.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin and J.H. Anderson, 1969a. "Hearing in the giant sea turtles," *Journal of the Acoustical Society of America,* 59, Suppl. 1. S46.

Ridgway, S.H., B.L. Scronce, and J. Kanwisher, 1969b. "Respiration and deep diving in the bottlenose porpoise," *Science,* 166:1651-1654.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C. E. Schlundt, and W.R. Elsberry, 1997. *Behavioral Responses and Temporary Shift in Masked Hearing Threshold of Bottlenose Dolphins, Tursiops truncatus, to 1-second Tones of 141 to 201 dB re 1 μPa.* Technical Report 1751, Revision 1, Naval Command, Control and Ocean Surveillance Center NCCOSC, RDT&E DIV D3503, 49620 Beluga Road, San Diego, CA 92152. September.

Rivers, J.A., 1997. "Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California,: *Marine Mammal Science,* 13:186-195.

Roberts, S., and M. Hirshfield, 2003. "Deep sea corals: Out of sight, but no longer out of mind," *Frontiers in Ecology & the Environment*, 2(3): 123–130 .18 pp.

Robertson, K.M., and S.J. Chivers, 1997. "Prey occurrence in pantropical spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific," *Fishery Bulletin,* 95:334-348.

Robinson, S., L. Wynen, and S. Goldsworthy, 1999. "Predation by a Hooker's sea lion (*Phocarctos hookeri*) on a small population of fur seals (*Arctocephalus* spp.) at Macquarie Island," Marine Mammal Science, 15:888-893.

Rogers, A.D., 1994. "The biology of seamounts," pp. 306-350. In: J.H. Blaxter, and A.J. Southward, eds. *Advances in marine biology,* 30: 305-354, San Diego: Academic Press.

Rogers P.H., M. Cox. 1988. "Underwater sound as a biological stimulus," pp. 131-149. In: Sensory Biology of Aquatic Animals, eds. A. Atema, R.R. Fay, A.N. Popper, and W.N. Tavolga, New York: Springer-Verlag.

Romano, T.A., J.A. Olschowka, S.Y. Felten, V. Quaranta, S.H. Ridgway, and D.L. Felten, 2002. "*Immune response, stress, and environment: Implications for cetaceans,"* pp. 253-279. In: *Molecular and Cell Biology of Marine Mammals*, C.J. Pfeiffer (ed). Krieger Publishing Co., Inc. .

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran, 2004. "Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure*," Canadian Journal of Fisheries and Aquatic Science*, 61:1124-1134.

Rommel, S.A., A.M. Costidis, A. Fernández, P.D. Jepson, D.A. Pabst , W.A. Mclellan, D.S. Houser, T.W. Cranford, A.L. Van Helden, D.M. Allen, and N.B. Barros. 2006. "Elements of beaked whale anatomy and diving physiology and some hypothetical causes of sonar-related stranding**,"** *Journal Cetacean of Research and Management,* 7:189–209.

Rosen, G. and G.R. Lotufo, 2005. "Toxicity and fate of two munitions constituents in spiked sediment exposures with the marine amphipod *Eohaustorius estuarius*," Environmental Toxicology and Chemistry 24(11): 2887-2897.

Rosen, G. and G.R. Lotufo, 2007a. "Toxicity of explosive compounds to the marine mussel *Mytilus galloprovincialis*, in aqueous exposures," *Ecotoxicology and Environmental Safety,* 68(2): 228-236.

Rosen, G. and G.R. Lotufo, 2007b. "Bioaccumulation of explosive compounds in the marine mussel *Mytilus galloprovincialis," Ecotoxicology and Environmental Safety,* 68(2): 237-245.

Rosenbaum, H.C., R.L. Brownell, M.W. Brown, C. Schaeff, V. Portway, B.N. Whiate, S. Malik, L.A. Pastene, N.J. Patenaude, C.S. Baker, M. Goto, P.B. Best, P.J. Clapham, P. Hamilton, M. Moore, R. Payne, V. Rowntree, C.T. Tynan, J.L. Bannister, and R. DeSalle, 2000. "World-wide genetic differentiation of *Eubalaena*: Questioning the number of right whale species," *Molecular Ecology, 9:1793-1802*.

Rosendahl, P.H., 1977. *Archaeological Inventory and Evaluation Report for Installation Environmental Impact Statement.* Parts 1 and 2. Report prepared by Department of Anthropology, Bernice P. Bishop Museum, Honolulu for U.S. Army Engineer Division, Pacific Ocean, Honolulu, on file at USACE, Pacific Ocean Division, Fort Shafter.

Rosendahl, P., 2000. *Pearl Harbor Naval Complex Cultural Resources Management Plan*. Contributing authors, Mason Architects, Inc. and Maptech, Inc., August. [For Official Use Only]

Ross, D., 1976. *Mechanics of Underwater Noise*. Pergamon Press, New York, 375pp.

Ross, G.J.B., and S. Leatherwood, 1994. "Pygmy killer whale.*Feresa attenuata* Gray, 1874," pp. 387-404. In: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals. Volume 5: The first book of dolphins*, San Diego: Academic Press.

Ross, Q.E., D.J. Dunning, J.K. Menezes, M.J. Kenna Jr., and G. Tiller, 1996. " Reducing impingement of alewives with high-frequency sound at a power plant intake on Lake Ontario," *North American Journal of Fisheries Management,* 16: 548-559.

Ross, Q.E., D.J. Dunning, R. Thorne, J.K. Menezes, G.W. Tiller, and J.K. Watson, 1993. "Response of alewives to high-frequency sound at a power plant intake on Lake Ontario," *North American Journal of Fisheries Management*,13:291-303.

Rowntree, V., J. Darling, G. Silber, and M. Ferrari, 1980. "Rare sighting of a right whale (*Eubalaena glacialis*) in Hawaii," *Canadian Journal of Zoology,* 58:309-312.

Safina, C., 1996. *Xiphias gladius*. In: 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org

Salden, D.R., and J. Mickelsen, 1999. "Rare sighting of a North Pacific right whale (*Eubalaena glacialis*) in Hawaii," *Pacific Science,* 53:341-345.

Salden, D.R., L.M. Herman, M. Yamaguchi, and F. Sato, 1999. "Multiple visits of individual humpback whales (*Megaptera novaeangliae*) between the Hawaiian and Japanese winter grounds," *Canadian Journal of Zoology,* 77:504-508.

Sand, O., Enger PS, Karlsen HE, Knudsen FR, Kvernstuen T. 2000. "Avoidance responses to infrasound in downstream migrating European silver eels, *Anguilla Anguilla*," *Environmental Biology of Fishes,* 47:327-336.

Sand ,O., Karlsen HE. 1986. "Detection of infrasound by the Atlantic cod," *Journal of Experimental Biology*, 125:197-204.

Sand , O., Karlsen HE. 2000. "Detection of infrasound and linear acceleration in fish," *Philosophical Transactions of the Royal Society of London B*, 355:1295-1298.

Sandia National Laboratories, 2006. *Annual Site Environmental Report for Tonopah Test Range, Nevada and Kauai Test Facility, Hawaii*, Sandia National Laboratories, September.

Santulli, A., A. Modica, C. Messina, L. Ceffa, A. Curatolo, G. Rivas, G. Fabi, and V. D'Amelio, V. 1999. "Biochemical response of European Sea Bass (*Dicentrarchus labrax* L.) to the stress induced by offshore experimental seismic prospecting," Marine Pollution Bulletin: 38 (12): 1105-1114.

Sanvito, S., and F. Galimberti, 2003. "Source level of male vocalizations in the genus *Mirounga*: Repeatability and correlates," *Bioacoustics,* 14:47-57.

Sapolsky, R.M., 2005. "The influence of social hierarchy on primate health," *Science,* 308: 648-652.

Saunders, J.C., J.H. Mills, and J.D. Miller, 1977. "Threshold shift in the chinchilla from daily exposure to noise for six hours," *Journal of the Acoustical Society of America*, 61:558–570.

Sawyers, K.N., 1968. "Underwater sound pressure from sonic booms," *Journal of the Acoustical Society of America*, 44:523-524.

Scarff, J.E., 1986. "Historic and present distribution of the right whale (*Eubalaena glacialis*) in the eastern North Pacific south of 50°N and east of 180°W," *Reports of the International Whaling Commission, Special Issue 10:43-63*.

Scarff, J.E., 1991. "Historic distribution and abundance of the right whale (*Eubalaena glacialis*) in the north Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury whale charts," *Reports of the International Whaling Commission,* 41:467-489.

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg, and P.J. Clapham, 1992. "Behavior of individually-identified sei whales *Balaenoptera borealis* during an episodic influx into the southern Gulf of Maine in 1986," *Fishery Bulletin,* 90:749-755.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway, 2000. "Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterous leucas*, after exposure to intense tones," *Journal of the Acoustical Society of America,* 107:3496-3508.

Schoenherr, J.R., 1991. "Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon," *Canadian Journal of Zoology,* 69:583-594.

Scholik, A.R. and H.Y. Yan, 2001. "Effects of underwater noise on auditory sensitivity of a cyprinidfish," *Hearing Research,* 152:1-2:17-24.

Scholik, A.R. and H.Y. Yan, 2002. "The effects of noise on the auditory sensitivity of the bluegill sunfish, *Leptomis macrochirus*. *Comparative Biochemistry", Physiology, A Molecular Integration and Physiology,* 133: 43-52. 34.

Schotten, M., W.W.L. Au, M.O. Lammers, and R. Aubauer, 2004. "Echolocation recordings and localization of wild spinner dolphins (*Stenella longirostris*) and pantropical spotted dolphins (S. *attenuata*) using a four-hydrophone array," pp. 393-400. In: J.A. Thomas, C.F. Moss and M. Vater, eds. *Echolocation in bats and dolphins*, Chicago, Illinois: University of Chicago Press.

Schreck, C.B., 1981. "Stress and compensation in teleostean fishes: response to social and physical factors". pp.295-321. In: *Stress and Fish* (ed. A. D. Pickering), London: Academic Press.

Schreck, C.B.**,** 2000. "Accumulation and long-term effects of stress in fish." pp. 147-158. In: *The Biology of Animal Stress – Basic Principles and Implications for Animal Welfare* (ed. G. P. Moberg and J. A. Mench), New York: CABI Publishing.

Schreer, J.F., K.M. Kovacs, and R.J.O. Hines, 2001. "Comparative diving patterns of pinnipeds and seabirds," *Ecological Monographs,* 71:137-162.

Schwartz, M., A. Hohn, A. Bernard, S. Chivers, and K. Peltier, 1992. "Stomach contents of beach cast cetaceans collected along the San Diego County coast of California, 1972-1991, *Southwest Fisheries Science Center Administrative Report LJ-92-18*, La Jolla, California: National Marine Fisheries Service.

Schwarz, A.L. and G.L. Greer, 1984. "Responses of Pacific herring, *Clupea harengus pallasi*, to some underwater sounds," *Canadian Journal of Fisheries and Aquatic. Science,* 41:1183-1192.

Science Lab.com, 2007. *Material Safety Data Sheet Ethylene Glycol* [Online]. Available: http://www.sciencelab.com/xMSDS-Ethylene_glycol-9927167.

Scott, M.D., and K.L. Cattanach, 1998. "Diel patterns in aggregations of pelagic dolphins and tuna in the eastern Pacific," *Marine Mammal Science,* 14:401-428.

Scott, M.D., A.A. Hohn, A.J. Westgate, J.R. Nicolas, B.R. Whitaker, and W.B. Campbell, 2001. "A note on the release and tracking of a rehabilitated pygmy sperm whale (*Kogia breviceps*)," *Journal of Cetacean Research and Management*, 3:87-94.

Seitz, W. and K. Kagimoto, 2007. *Hawaii Island Hawksbill Turtle Recovery Project-2007 Annual Report.* University of Hawaii at Manoa, Pacific Cooperative Studies Unit.

Selzer, L. A., and P.M. Payne, 1988. "The distribution of white-sided dolphins (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States," *Marine Mammal Science* 4:141-153.

Seminoff, J.A., 2004. "Marine Turtle Specialist Group Review: 2004 Global Status Assessment, Green Turtle (*Chelonia mydas*)," The World Conservation Union (IUCN), Species Survival Commission Red List Programme, Marine Turtle Specialist Group, [Online]. Available: http://www.iucnmtsg.org/red_list/cm/MTSG_Chelonia_mydas_ assessment_expanded-format.pdf [June 26, 2005].

Seminoff, J.A., W.J. Nichols, A. Resendiz, and L. Brooks, 2003. "Occurrence of hawksbill turtles, *Eretmochelys imbricata* (Reptilia: Cheloniidae), near the Baja California Peninsula, Mexico," *Pacific Science,* 57:9-16.

Sergeant, D.E., 1982. "Some biological correlates of environmental conditions around Newfoundland during 1970-1979: harp seals, blue whales and fulmar petrels," North Atlantic Fisheries Organization [NAFO] Scientific Council Studies, pp. 107-110.

Sevaldsen, E.M., and Kvadsheim, P.H., 2004. *Active sonar and the marine environment*. Norwegian Defense Research Establishment, Horten, Norway. http://www.mil.no/multimedia/archive/00052/_Active_sonar_and_th_52526a.pdf, 8 pp.

Severns, M., and P. Fiene-Severns, 2002. *Diving Hawaii and Midway*, Singapore: Periplus Editions (HK) Ltd. 250 pp.

Seyle, H., 1950. "Stress and the general adaptation syndrome," *British Medical Journal*, 1383-1392.

Shallenberger, E.W., 1981. *The status of Hawaiian cetaceans,* Report prepared under Contract #MM7AC028 for the Marine Mammal Commission, Washington, D.C.

Shane, S.H., 1994. "Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91," *Bulletin of the Southern California Academy of Sciences,* 93:13-29.

Shane, S.H., and D. McSweeney, 1990. "Using photo-identification to study pilot whale social organization," *Reports of the International Whaling Commission, Special Issue,* 12:259-263.

Shark Specialist Group, 2000. *Carcharhinus limbatus*. In: 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org

Shaw, R., 1997. *Rare Plants of Pohakuloa Training Area Hawaii,* Center for Ecological Management of Military Lands, Department of Forest Sciences, Colorado State University.

Shelden, K.E.W., S.E. Moore, J.M. Waite, P.R. Wade, and D.J. Rugh, 2005. "Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska," *Mammal Review,* 35:129-1 55.

Shineldecker, C.L., 1992. *Handbook of Environmental Contaminants: A Guide for Site Assessment*. Lewis Publishers, Inc. Chelsea, Michigan. 367 pp.

Shipley, C., B.S. Stewart, and J. Bass, 1992. "Seismic communication in northern elephant seals," pp. 553-562. In: J.A. Thomas, R.A. Kastelein, and A.Y. Supin, eds. *Marine mammal sensory systems*, New York: Plenum Press.

Sierra Club, 2006. "Boots on the Ground, Birds in the Nest," *Sierra Club Insider* [Online]. Available: http://www.sierraclub.org/insider/insider2006-03-21.asp.

Sierra Club, undated. "Department of Defense Range Tours, A Look at How Military Training Operations Impact Natural Resources and Endangered Species by the Sierra Club's Senior Washington DC Lands Director, Maribeth Oakes," [Online]. Available: http://www.sierraclub.org/wildlife/species/range_tour/

Silber, G.K., 1986. "The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*)," *Canadian Journal of Zoology,* 64:2075-2080.

Simão, S.M., and S.C. Moreira., 2005. "Vocalizations of a female humpback whale in Arraial do Cabo (RJ, Brazil)," *Marine Mammal Science,* 21:150-153.

Simpson, J.H., P.B. Tett, M.L. Argote-Espinoza, A. Edwards, K.J. Jones, and G. Savidge, 1982. "Mixing and phytoplankton growth around an island in a stratified sea," *Continental Shelf Research,* 1:15-31.

Simmonds, M.P. and J.D. Hutchinson, 1996. *The Conservation of Whales and Dolphins-Science and Practice*. Edited by M.P. Simmonds and J.D. Hutchinson. John Wiley & Sons.

Simmonds, M.P. and L.F. Lopez-Jurado, 1991. Whales and the military. Nature 351:448.

Simmonds, M.P., and S.J. Mayer, 1997. "An evaluation of environmental and other factors in some recent marine mammal mortalities in Europe: implications for conservation and management," *Environmental Reviews* 5(2):89-98.

Sisneros J.A., 2007. "Saccular potentials of the vocal plainfin midshipman fish, *Porichthys notatus*," *Journal of Comparative Physiology A,* 193:413-424.

Sisneros. J.A. and A.H. Bass, 2003. "Seasonal plasticity of peripheral auditory frequency sensitivity," *Journal of Neuroscience* 23(3): 1049-1058.

Skalski, J.R., W.H. Pearson, and C.I. Malme, 1992. "Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp)," *Canadian Journal of Fisheries and Aquatic Science,* 49:1357-1365.

Skillman, R.A., and G.H. Balazs, 1992. "Leatherback turtle captured by ingestion of squid bait on swordfish longline," *Fishery Bulletin,* 90:807-808.

Skillman, R.A., and P. Kleiber, 1998. "Estimation of sea turtle take and mortality in the Hawaii-based long line fishery, 1994-96," NOAA Technical Memorandum NMFS-SWFSC-257: 1-52.

Skov, H., T. Gunnlaugsson, W.P. Budgell, J. Horne, L. Nøttestad, E. Olsen, H. Søiland, G. Víkingsson and G. Waring. 2007. "Small-scale spatial variability of sperm and sei whales in relation to oceanographic and topographic features along the Mid-Atlantic Ridge," Deep Sea Research Part II: Topical Studies in *Oceanography,* 55(1-2):254-268.

Slotte, A., K. Kansen, J. Dalen, E. and Ona, 2004. "Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast," *Fisheries Research,* 67:143-150. (3)

Smale, M.J., 2000. *Carcharhinus longimanus*. In: 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org

Smith, G.W.. 1990. Ground surveys for sea turtle nesting sites in Belize, 1990. Annual Report to the U.S. Fish and Wildlife Service, 24 pp.

Smith, S.H., K.J.P. Deslarzes, and R. Brock, 2006. Characterization of Fish and Benthic Communities of Pearl Harbor and Pearl Harbor Entrance Channel, Hawaii. Final Report-December 2006, Contract Number: N62470-02-D-997; Task Order Number: 0069. Funded by: Department of Defense Legal Resource Management Program, Project Number 03-183 – Naval Facilities Engineering Command.

Smith, M.E., A.S. Kane, and A.N. Popper, 2004a. "Noise-induced stress response and hearing loss in goldfish (*Carassius auritus*)," *Journal of Experimental Biology 207:3591-602*.

Smith, M.E., A.S. Kane, and A.N. Popper, 2004b. "Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water?" *Journal of Experimental Biology*, 207:3591-602.

Smith, P. W., Jr.. 1974. "Averaged sound transmission in range-dependent channels," *Journal of the Acoustic Society of America*, 55:1197-1204.

Snover, M. 2005. "Population trends and viability analyses for Pacific Marine Turtles," U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Pacific Islands Fishery Science Center Internal Report IR-05-008*. Honolulu, Hawaii.

Solis, P., 2004. *Laser Safety Survey Report for the Pacific Missile Range Facility Open Ocean Range*, Naval Surface Warfare Center, Corona Division, July 1, 2004. [For Official Use Only]

Song, J., A. Mathieu, R.F. Soper, and A.N. Popper, 2006. "Structure of the inner ear of bluefin tuna *Thunnus thynnus," Journal of Fish Biology, 68: 1767–1781*.

Soto, N.A., M. Johnson, P.T. Madsen, P.L. Tyack, A. Bocconcelli, J.F. Borsani, 2006. "Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (*Ziphius cavirostris*)," *Marine Mammal Science*, 22(3): 690-699.

Southall, B.L., 2005. *Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium: Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology, 18-19 May 2004*. Released 27 April 2005.

Southall, B., 2006. Declaration of Brandon L. Southall, Ph.D. Natural Resources Defense Council v Donald C. Winter (RIMPAC), June 30, 2006.

Southall, B.L., R. Braun, F.M.D. Gulland, A.D. Heard, R.W. Baird, S.M. Wilkin, and T.K. Rowles, 2006. "Hawaiian melon-headed whale (*Peponacephala electra*) mass stranding event of July 3-4, 2004," NOAA Technical Memorandum NMFS-OPR-31, 73 pp.

Southall, B., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Green, Jr., D. Kastak, D. Ketten, J. Miller, P. Nachtigall, W.J. Richardson, J. Thomas and P. Tyack, 2007. "Marine Mammals Noise Criteria: Initial Scientific Recommendations," *Aquatic Mammals,* 33(4):411-521

Spitz, W.U., 1993. Spitz and Fisher's Medicolegal Investigation of Death; Guidelines for the Application of Pathology to Crime Investigation. 3rd ed., Springfield: Charles C. Thomas pub., pp. 1-829.Spotila, J.R., M.P. O'Connor, and F.V. Paladino, 1997. "Thermal biology," pp. 297-314. In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles,* Boca Raton, Florida: CRC Press.

Stacey, P.J., and R.W. Baird, 1991. "Status of the false killer whale, *Pseudorca crassidens*, in Canada,". *Canadian Field-Naturalist,* 105:189-197.

Stafford, K.M., 2003. "Two types of blue whale calls recorded in the Gulf of Alaska," *Marine Mammal Science*," 19:682-693.

Stafford, K.M., S.L. Nieukirk, and C.G. Fox, 2001. "Geographic and seasonal variation of blue whale calls in the North Pacific." *Journal of Cetacean Research Management,* 3(1):65–76.

Stafford, K.M., S.E. Moore, and C.G. Fox, 2005. "Diel variation in blue whale calls recorded in the eastern tropical Pacific," *Animal Behaviour,* 69:951-958.

Star Bulletin, 2007. "Sales, prices drop for neighbor isle properties," Volume 12, Issue 6 – Saturday, January 6, 2007 [Online]. Available: http://starbulletin.com/2007/01/06/business/story01.html.

State of Hawaii, 1993. *Botanical Database and Reconnaissance Survey of the Polihale Area, Kaua`i,* Division of State Parks, Department of Land and Natural Resources, Honolulu.

State of Hawaii, 2001. *Environmental Impact Statement Preparation Notice for the Proposed Kalaeloa Desalination Facility*, Board of Water Supply, City, and County of Honolulu.

State of Hawaii, 2005a. *Index of /dlnr/dofaw/cwcs/files/NAAT final CWCS/Chapters/Terrestrial Fact Sheets* [Online]. Available: http://www.state.hi.us/dlnr/dofaw/cwcs/files/NAAT%20final%20CWCS/Chapters/Terrestrial%20Fact%20Sheets/

State of Hawaii, 2005b. *Northwestern Hawaiian Islands Passerines* "Nihoa Millerbird *Acrocephalus familiaris*," p. 3-16 [Online]. Available: http://www.state.hi.us/dlnr/dofaw/cwcs/files/NAAT%20final%20CWCS/Chapters/Terrestrial%20Fact%20Sheets/NWHI/Nihoa_Millerbird%20NAAT%20final%20!.pdf

State of Hawaii, 2006. Hawaii Ocean Resources Management Plan Department of Business, Economic Development & Tourism, Office of Planning, December, 2006. 73 pp.

State of Hawaii Department of Business, Economic Development and Tourism, 2006. *"2005 Annual Visitor Research Report,"*

State of Hawaii, Department of Land and Natural Resources, 2005. "Draft Newell's Shearwater Five-year Work Plan," Drafted by the NESH Working Group--October 2005 [Online]. Available: http://www.state.hi.us/dlnr/dofaw/fbrp/docs/NESH_5yrPlan_Sept2005.pdf.

State of Hawaii Office of Planning, 2005. "Hawaii Statewide GIS Program," [Online]. Available: http://www.hawaii.gov/dbed/gis [October 2005].

Stern, J.S., 1992. "Surfacing rates and surfacing patterns of minke whales (*Balaenoptera acutorostrata*) off central California, and the probability of a whale surfacing within visual range," *Reports of the International Whaling Commission,* 42:379-385.

Stevens, J., 2000. *Isurus oxyrinchus.* In: IUCN 2004 The 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org [10 December 2004].

Stevens, J. 2000a. *Lamna nasus* (Northeast Atlantic subpopulation). In: *2003 IUCN Red List of Threatened Species*. [Online]. Available: www.redlist.org

Stevens, J.D., 2000b. "The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. International Council for the Exploration of the Sea," *Journal of Marine Science*, 57(3):476-494.

Stevick, P.T., B.J. McConnell, and P.S. Hammond, 2002. "Patterns of movement," pp. 185-216. In: A.R. Hoelzel, ed. *Marine mammal biology: An evolutionary approach,* Oxford: Blackwell Science.

Stewart, B.S., 1997. "Ontogeny of differential migration and sexual segregation in northern elephant seals," *Journal of Mammalogy,* 78:1101-1116.

Stewart, B.S., and R.L. DeLong, 1995. "Double migrations of the northern elephant seal, *Mirounga angustirostris," Journal of Mammalogy,* 76:196-205.

Stewert, B.S. and S. Leatherwood, 1985. Minke whale - *Balaenoptera acutorostrata,* pp. 91-136. *In:* S.H. Ridgway and R. Harrison (eds.). *Handbook of Marine Mammals.* Academic Press, London.

Stewart, B.S., P.K. Yochem, H.R. Huber, R.L. DeLong, R.J. Jameson, W.J. Sydeman, S.G. Allen, and B.J. Le Boeuf, 1994. "History and present status of the northern elephant seal population," pp. 29-48. In: B.J. Le Boeuf and R.M. Laws, eds. *Elephant seals: Population ecology, behavior, and physiology,* Berkeley: University of California Press.

Stiles, M., 2004. "Effectiveness: Do pingers work?," *Pingers Warning cetaceans away from the nets*, Cetacean Bycatch Resource Center, Reviewed by Dr. Jay Barlow, May. [Online]. Available: http://www.cetaceanbycatch.org/pingers_effectiveness.cfm: Available: http://www.cetaceanbycatch.org/pingers.cfm.

Stockin, K.A., D. Lusseau, V. Binedell, N. Wiseman and M. B. Orams, 2008. "Tourism Affects the Behavioural Budget of the Common Dolphin (Delphinus sp.) in the Hauraki Gulf, New Zealand", *Marine Ecology Progress Series*, 355:287-295.

Stone, C.J. and M.J. Tasker, 2006. "The effects of seismic airguns on cetaceans in U.K. waters," *Journal of Cetacean Research and Management*, 8(3):255-263.

Stone, G.S., S.K. Katona, A. Mainwaring, J.M. Allen, and H.D. Corbett, 1992. "Respiration and surfacing rates for finback whales (*Balaenoptera physalus*) observed from a lighthouse tower," *Reports of the International Whaling Commission,* 42:739-745.

Sullivan, M.J., and R.B. Conolly, 1988. "Dose-response hearing loss for white noise in the Sprague-Dawley rat," *Toxicological Sciences*, 10:109-113.

Suter II, G.W., L.W. Barnthouse, S.M. Bartell, T. Mill, D. Mackay, and S. Paterson, 1993. *Ecological risk assessment*. Lewis Publishers, Boca Raton, Florida.

Sverdrup, A., E. Kjellsby, P.G. Krueger, R. Floysand, F.R. Knudsen, P.S. Enger, G. Serck-Hanssen G, and K.B. Helle, 1994. "Effects of experimental seismic shock on vasoactivity of arteries, integrity of the vascular endothelium and on primary stress hormones of the Atlantic salmon," *Journal of Fish Biology,* 45:973-995.

Swartz, S.L., A. Martinez, J. Stamates, C. Burks, and A.A. Mignucci-Giannoni, 2002. "Acoustic and visual survey of cetaceans in the waters of Puerto Rico and the Virgin islands: February-March 2001," NOAA Technical Memorandum NMFS-SEFSC-463:1-62.

Sweeny, M.M., J.M. Price, G.S. Jones, T.W. French, G.A. Early, and M.J. Moore, 2005. "Spondylitic changes in long-finned pilot whales (*Globicephala melas*) stranded on Cape Cod, Massachusetts, USA, between 1982 and 2000," Journal of Wildlife Diseases 41:717-727.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry, 1999. "Killer whale (*Orcinus orca*) hearing: auditory brainstem response and behavioral audiograms," *Journal of the Acoustical Society of America,* 106:1134-1141.

Tavolga, W.N. and J. Wodinsky, 1963. "Auditory capacities in fishes. Pure tone thresholds in nine species of marine teleosts," *Bulletin of the American Museum of Natural History,* 126:179-239.

Tavolga, W.N. and J. Wodinsky, 1965. "Auditory capacities in fishes: threshold variability in the blue-striped grunt *Haemulon sciurus*," *Animal Behavior,* 13:301-311.

Tavolga, W.N., 1974a. "Sensory parameters in communication among coral reef fishes," *Mount Sinai Journal of Medicine,* 41(2):324-340.

Tavolga, W.N., 1974b. "Signal/noise ratio and the critical band in fishes," *Journal of the Acoustical Society of America,* 55:1323-1333.

Teleki, G.C., and Chamberlain, A.J., 1978. Acute effects of underwater construction blasting on fishes in Long Point Bay, Lake Erie," *Journal of Fisheries and Research Board of Canada*, 35:1191-1198.

TenBruggencate, J., 2005. "Coral tests could unravel Nihoa's mysterious past" in the *Honolulu Advertiser.* August 29.

Tetra Tech, 2005. *Noise Monitoring Report, Mākua Military Reservation, Hawai`i*. Prepared by Tetra Tech, Inc., San Francisco, CA, February 22. Prepared for the U.S. Army Corps of Engineers, Honolulu Engineer District in support of the Environmental Impact Statement for the MaKua Military Reservation (MMR), Hawaii.

The Garden Island, 2007. "Kauai Leads State in Coastal Protection." Wednesday, December 26, 2007. [Online]. Available: http://www.kauaiworld.com/articles/2007/ 12/20/news/news01.txt

The Onyx Group, 2001. Supplemental Environmental Assessment, *Routine Training at Makua Military Reservation and PFC Pillila`au Range Complex Hawaii,* Prepared for G3 Range Division, 25th Infantry Division (Light) and U.S. Army-Hawaii, May.

Thode, A., D.K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin, 2002. "Depth-dependent acoustic features of diving sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico," *Journal of the Acoustical Society of America,* 112:308-321.

Thomas, J., N. Chun, W. Au, and K. Pugh, 1988. "Underwater audiogram of a false killer whale (*Pseudorca crassidens*)," *Journal of the Acoustical Society of America,* 84:936-940.

Thomas, J.A., P. Moore, R. Withrow, and M. Stoermer, 1990. "Underwater audiogram of a Hawaiian monk seal (*Monachus schauinslandi*)," *Journal of the Acoustical Society of America,* 87(1): 417-420.

Thompson, P.O., and W.A. Friedl, 1982. "A long term study of low frequency sounds from several species of whales off Oahu, Hawaii," *Cetology,* 45(I): -1 9.

Thompson, R., 2003. "Turtle's isle journey tracked by satellite," *Honolulu Star-Bulletin News,* March 28.

Thompson, T.J., H.E. Winn, and P.J. Perkins, 1979. "Mysticete sounds*," In: Behavior of Marine Animals, Vol 3*, Chapter 12, H.E. Winn and B.L. Olla, (eds.), Plenum, NY, 438 pp.

Thrum, T.G., 1906. "Tales from the Temples," (Preliminary paper In: the study of the heiaus of Hawai`i, with plans of the principal ones of Kaua`i and O`ahu), *The Hawaiian Annual*, Honolulu, Hawai`i. [For Official Use Only]

Thurman, H.V., 1997. *Introductory oceanography*, Upper Saddle River, New Jersey: Prentice Hall.

Tomich, P.Q., 1986. *Mammals in Hawaii: A synopsis and notational bibliography*, Honolulu: Bishop Museum Press.

Tracey, R., 2000. "Mass false killer whale beaching remains a mystery." Discovery Channel Canada's Website [Online]. Available: http://www.exn.ca/Stories/2000/06/05/56.asp [12 February 2007].

Transportation Research Board, 2000. *Highway Capacity Manual* [Online]. Available: http://onlinepubs.trb.org/onlinepubs/circulars/ec018/ec018toc.pdf.

Transportation Research Board, 2006. Highway Capacity Manual [Online]. Available: http://onlinepubs.trb.org/onlinepubs/circulars/ec018/ec018toc.pdf.

Trimper, P.G., N.M. Standen, L.M. Lye, D. Lemon, T.E. Chubbs, and G.W. Humphries, 1998. "Effects of lowlevel jet aircraft noise on the behaviour of nesting osprey," *Journal of Applied Ecology,* 35:122-130.

Turl, C.W., 1993. "Low-frequency sound detection by a bottlenose dolphin," *Journal of the Acoustical Society of America,* 94:3006-3008.

Turnpenny , A.W.H., K.P. Thatcher, and J.R. Nedwell, 1994. "The effects on fish and other marine animals of high-level underwater sound." Report FRR 127/94 prepared by Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.

Tyack., P.L., 1983. "Differential responses of humpback whales, *Megaptera novaeangliae*, to playback of song or social sounds." *Behavioral Ecology and Sociobiology* 13:49-55.

Tyack, P.L., M. Johnson, N.A. Soto, A. Sturlese, and P.T. Madsen, 2006. "Extreme diving of beaked whales," *Journal of Experimental Biology*, 209:4238-4253.

Tynan, C.T., D.P. DeMaster, and W.T. Peterson, 2001. "Endangered right whales on the southeastern Bering Sea shelf," *Science,* 294:1894.

U.S. Air Force, 2005. Air Force Center for Environmental Excellence. *Air Conformity Applicability Model, Version 4.3.3.* Technical Documentation, December.[Online}, Available: #C:\Documents and Settings\john.dixon\Desktop\ACAM\TD Report Ver 4.3.doc.

U.S. Air Force, Air Combat Command, 1997. *Environmental Effects of Self-Protection Chaff and Flares*. Prepared for Headquarters Air Combat Command, Langley Air Force Base, Virginia.

U.S. Air Force 15th Airlift Wing, 2005. "Final Work Plan Feasibility Study at Sites LF01, LF23, LF24, and AOC 18, Bellows AFS and MCTAB," Bellows Air Force Station, Oahu, Hawaii, 4 March.

U.S. Army Center for Health Promotion and Preventive Medicine, 2002. *Depleted Uranium: Sources, Exposure and Health Effects.* [Online]. Available: http://www.who.int/ionizing_radiation/pub_meet/DU_Eng.pdf

U.S. Army Corps of Engineers, 2001. "Training and environment mix in Hawaii," *Engineer Update* [Online]. Available: http://www.hq.usace.army.mil/cepa/pubs/aug01/story17.htm

U.S. Army Corps of Engineers, 2003. *Estimates for Explosives Residue from the Detonation of Army Munitions* [Online]. Available: http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/TR03-16.pdf, September.

U.S. Army Corps of Engineers, 2007. Explosives *Residues Resulting from the Detonation of Common Military Munitions, 2002-2006.* Final Report. Prepared for the Strategic Environmental Research and Development Program (SERDP), ERDC/CRREL TR-07-2 . February.

U.S. Army Corps of Engineers, Honolulu Engineer District, 2005. *Integrated Cultural Resources Management Plan (ICRMP) Marine Corps Base Hawai`i, O`ahu, Hawai`i*. Prepared by Wil Chee – Planning, Inc. Subcontractors: Fung Associates (Historic Architecture) and Pacific Legacy, Inc. (Archaeology), February.

U.S. Army Garrison, Hawaii, 1996. "Pohakuloa Training Area (PTA) External Standing Operating Procedures," 1 August.

U.S. Army Garrison Hawaii, 2005. "2005 Status Report Makua Implementation Management Plan, Island of Oahu," [Online]. Available: http://www.botany.hawaii.edu/faculty/duffy/DPW/2005_MIP/TOC.pdf

U.S. Army Garrison Hawaii, 2006. A quarterly publication of the Environmental Division, Directorate of Public Works, U.S. Army Garrison, Hawaii. *Ecosystem Management Program Bulletin*, 35:1-5, May.

U.S. Army Garrison Hawaii and U.S. Army Corps of Engineers, 1997. *Final Endangered Species Management Plan Report for the Oahu Training Areas*, Prepared for U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers. October. 250 pp.

U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, 1998. *Ecosystem Management Plan Report for Pohakuloa Training Area*, U.S. Army Garrison, Hawaii, and U.S. Army Corps of Engineers, Contract #DACA83-92-D-004, Delivery Order No. 0024, March.

U.S. Army, Hawaii and 25th Infantry Division (Light), 2003. *Integrated Wildland Fire Management Plan Oahu and Pohakuloa Training Areas,* [Online]. Available: http://www.25idl.army.mil/sbcteis/documents/FMP/00_Cover.pdf

U.S. Army, Pacific Public Affairs, 2007. "Army Reaffirms Commitment to Hawaii on Depleted Uranium." [Online]. Available: http://www.army.mil/-news/2007/08/30/4671-army-reaffirms-commitment-to-hawaii-on-depleted-uranium, [25 October 2007].

U.S. Army Program Executive Office, 1995. *Final Environmental Assessment Army Mountain Top Experiment*, May.

U.S. Army Space and Missile Defense Command, 2001. *North Pacific Targets Program Environmental Assessment*, April.

U.S. Army Space and Missile Defense Command, 2002. *Theater High Altitude Area Defense (THAAD) – Pacific Test Flights-Environmental Assessment,* Missile Defense Agency, 20 December 2002.

U.S. Army Space and Missile Defense Command, 2003. *Ground-Based Midcourse Defense (GMD) Extended Test Range (ETR) Final Environmental Impact Statement,* July.

U.S. Army Space and Missile Defense Command, 2004. *Use of Tributyl Phosphate (TBP) in the Intercept Debris Measurement Program (IDMP) at White Sands Missile Range (WSMR) Environmental Assessment, April.*

U.S. Army Space and Strategic Defense Command, 1993a. *Final Environmental Impact Statement for the Restrictive Easement, Kauai, Hawaii,* October.

U.S. Army Space and Strategic Defense Command, 1993b. *Programmatic Environmental Assessment, Theater Missile Defense Lethality Program,* August.

U.S. Army Space and Strategic Defense Command, 1993c. *Ground Based Radar (GBR) Family of Strategic and Theater Radars Environmental Assessment,* May.

U.S. Army Space and Strategic Defense Command, 1994. *Final Environmental Impact Statement Theater Missile Defense Extended Test Range,* November.

U.S. Army Space and Strategic Defense Command, 1995. *Theater Missile Defense Flight Test, Supplemental Environmental Assessment*, November.

U.S. Army Strategic Defense Command, 1990. *Exoatmospheric Discrimination Experiment (EDX) Environmental Assessment,* September.

U.S. Army Strategic Defense Command, 1992. *Final Environmental Impact Statement for the Strategic Target System.*

U.S. Census Bureau, 2000a. "Honolulu County, Hawaii," [Online]. Available: http://factfinder.census.gov/servlet/ [30 October 2006].

U.S. Census Bureau, 2000b. "Kauai County, Hawaii," [On-Line]. Available: http://factfinder.census.gov/servlet/, 2 October 2006.

U.S. Census Bureau, 2006a. "American Community Survey, Honolulu County, Hawaii." [Online]. Available: http://factfinder.census.gov/servlet/ACSSAFFFacts?_ event=Search&_lang=en&_sse=on&_state=04000US15&_county=Honolulu%20County

U.S. Census Bureau, 2006b. "American Community Survey, Hawaii." [Online]. Available: http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=&geo_id=04000US15&_geoContext=01000US%7C04000US15%7C05000US15003&_street=&_county=Honolulu+County&_cityTown=&_state=04000US15&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=050&_submenuId=factsheet_1&ds_name=ACS_2006_SAFF&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=

U.S. Census Bureau, 2006c. "American Community Survey, Hawaii Selected Housing Characteristics:2006." Online]. Available: http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=04000US15&-qr_name=ACS_2006_EST_G00_DP4&-ds_name=ACS_2006_EST_G00_&-_lang=en&-_sse=on

U.S. Census Bureau, 2006d. "American Community Survey, Hawaii Selected Economic Characteristics: 2006." Online]. Available: http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=04000US15&-qr_name=ACS_2006_EST_G00_DP3&-ds_name=&-_lang=en&-redoLog=false

U.S. Census Bureau, 2006e. "American Community Survey, Honolulu County, Hawaii Selected Economic Characteristics: 2006." [Online]. Available: http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=05000US15003&-qr_name=ACS_2006_EST_G00_DP3&-ds_name=ACS_2006_EST_G00_&-_lang=en&-redoLog=false&-_sse=on

U.S. Census Bureau, 2007a. "State and County QuickFacts - Kauai." Last Revised: Friday, 31-Aug-2007 10:22:39 EDT. [Online]. Available: http://quickfacts.census.gov/qfd/states/15/15007.html

U.S. Census Bureau, 2007b. "Honolulu County QuickFacts from the U.S. Census Bureau; State and County QuickFacts. Last Revised: Friday, 31-Aug-2007 10:22:39 EDT. [Online]. Available: http://quickfacts.census.gov/qfd/states/15/15003.html

U.S. Coast Guard, 1960. *Investigation of acoustic signaling over water in fog.* Prepared by BBN, Rep 674 for the U.S. Coast Guard. Rep. From Bolt Beranek & Newman, Inc., Cambridge, MA. Washington, D.C.

U.S. Department of Agriculture, 1990. *Silvics of North America, Volume 2,* Forest Service [Online]. Available: http://www.na.fs.fed.us/pubs/silvics_manual/table_of_contents.shtm [14 June 2006].

U.S. Department of the Air Force, 1990. *Environmental Assessment, Titan IV Solid Rocket Motor Upgrade Program,* Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base, California.

U.S. Department of the Air Force, 1997. *Environmental Assessment for atmospheric interceptor technology Program*, Headquarters, Space and Missile Systems Center, Material Command, November [Online]. Available : http://www.globalsecurity.org/space/library/report/enviro/eawthfon.pdf

U.S. Department of the Air Force, 2002. *Development and Demonstration of the Long Range Air Launch Target System Environmental Assessment,* October.

U.S. Department of the Air Force, 15th Airlift Wing, 2003. Final *Decision Document to Support No Further Response Action Planned (NFRAP) for AOC EA03 (Cesspool), Kaena Point Satellite Tracking Station Oahu, Hawaii,* 31 July.

U.S. Department of the Air Force, 2003. *Final Environmental Assessment for the C-17 Globemaster III Beddown, Hickam Air Force Base, Hawaii,* September.

U.S. Department of the Air Force, 2004. *Environmental Assessment for Minutman III Modification*. *Hill Air Force Base*, December.

U.S. Department of the Army, 2004. *Transformation of the 2nd Brigade, 25th Infantry Division (L) to a Stryker Combat Brigade Combat Team in Hawaii Environmental Impact Statement,* May.

U.S. Department of the Army, 2005. 25th Infantry Division (Light) and U.S. Department of the Army Hawaii, *Draft Environmental Impact Statement Military Training activities at Makua Military Reservation, Hawaii*, March.

U.S. Department of the Army, 2006. *Programmatic Environmental Assessment for Construction of Large-Scale Fence Units at Pohakuloa Training Area, Island of Hawaii,* May.

U.S. Department of the Army, 2008. *Permanent Stationing of the 2/25th Stryker Brigade Combat Team Draft Environmental Impact Statement*, February.

U.S. Department of the Army Headquarters, 2006. *Draft Programmatic Environmental Assessment with Anticipated FONSI for the Makua Implementation Plan, Oahu, Hawaii*, 25th Infantry Division and U.S. Department of the Army Hawaii, April.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration and State of Hawaii, Office of Planning, 1997. *Hawaiian Islands Humpback Whale National Marine Sanctuary Final Environmental Impact Statement and Management Plan,* February.

U.S. Department of Commerce, The Under Secretary of Commerce for Oceans and Atmosphere, 2007. Papahanaumokuakea Marine National Monument: Application for Inclusion of a Property in the U.S. World Heritage Tentative List. Friday March 30..

U.S. Department of Defense. 2004. *Strategic Plan for Transforming Training Defense Planning Guidance, FY 2004*.

U.S. Department of Defense, 2005. *Mobile Sensors Environmental Assessment*. Missile Defense Agency, 26 September.

U.S. Department of Defense, 2006. *Joint Hawaii Range Complex Management Plan – Final Draft, April 2006.*

U.S. Department of the Interior, Office of Environmental Policy and Compliance Pacific Southwest Region, 2007. Comments received from U.S. Department of the Interior on the *Hawaii Range Complex Draft Environmental Impact Statement/Overseas Environmental Impact Statement* regarding biological resources.

U.S. Department of the Navy, 1980. *Department of the Navy Environmental Impact Assessment Kaula Island Target Hawaii*, Commander, Naval Air Forces, U.S. Pacific Fleet, 20 February.

U.S. Department of the Navy, 1993. Commander, Surface Forces Pacific (COMSURFPAC) Instruction 3120.8D, *Procedures for Disposal of Explosives at Sea/Firing of Depth Charges and Other Underwater Ordnance.*

U.S. Department of the Navy, 1996a. Draft *Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK-46 and MK 50 Torpedoes.* Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons. CONFIDENTIAL.

U.S. Department of the Navy, 1996b. *Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK 48 Torpedoes. Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons.* [For Official Use Only].

U.S. Department of the Navy, 1998a. *Pacific Missile Range Facility Enhanced Capability Final Environmental Impact Statement Volume 1 of 3,* December.

U.S. Department of the Navy, 1998c. *Point Mugu Sea Range marine mammal technical report. Point Mugu Sea Range Environmental Impact Statement / Overseas Environmental Impact Statement*, Prepared by LGL Limited, Ogden Environmental and Energy Services, Naval Air Warfare Center Weapons Division, and Southwest Division Naval Facilities Engineering Command. 281 pp.

U.S. Department of the Navy, 1998d. *Rim of the Pacific (RIMPAC) 98 Environmental Assessment*, Commander THIRD FLEET, Hawaii, June.

U.S. Department of the Navy, 2000. *Rim of the Pacific (RIMPAC) Environmental Assessment*, Commander THIRD FLEET, Hawaii, May.

U.S. Department of the Navy, 2001a. *Integrated Natural Resources Management Plan: Pacific Missile Range Facility Hawaii,* Final report Prepared for Commander, Navy Region Hawaii, Honolulu, Hawaii by Belt Collins Hawaii Ltd., Honolulu, Hawaii.

U.S. Department of the Navy, 2001b. *Environmental Impact Statement for the Shock Trial of the WINSTON S. CHURCHILL*, (DDG-81), Department of the Navy, February.

U.S. Department of the Navy, 2001c. Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. Department of the Navy, Chief of Naval Operations. January 2001.

U.S. Department of the Navy, 2002a. *Rim of the Pacific (RIMPAC) Programmatic Environmental Assessment,* June 2002. Commander, Third Fleet (COMTHIRDFLT) Hawaii.

U.S. Department of the Navy, 2002b. "Record of Decision for Surveillance Towed Array Sensor System Low Frequence Active (SURTASS LFA) Sonar." Federal Register, Vol 67, No. 141, pp. 48145-48154. 23 July.

U.S. Department of the Navy, 2003a. *Advanced Amphibious Assault Vehicle Environmental Impact Statement.*

U.S. Department of the Navy, 2003b. *Regional Shore Infrastructure Plan, Pacific Missile Range Facility, Barking Sands Activity Overview Plan,* May.

U.S. Department of the Navy, 2004a. *Green turtle and Hawaiian monk seal geodatabase for Pacific Missile Range Facility Barking Sands*, NAVFAC Pacific.

U.S. Department of Navy, 2004b. *Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by USS SHOUP (DDG 86) in the Haro Strait on or about 5 May 2003.*

U.S. Department of the Navy, 2005a. Draft Overseas Environmental Impact Statement/Environmental Impact Statement – East Coast Underwater Water Training 24 Range.

U.S. Department of the Navy, 2005b. *Marine Resources Assessment for the Hawaiian Islands Operating Area, Final Report*, Prepared for the Department of the Navy, Commander, U.S. Pacific Fleet, December.

U.S. Department of the Navy, 2006a*. Rim of the Pacific Exercise After Action Report: Analysis of Effectiveness of Mitigation and Monitoring Measures as Required Under the Marine Mammals Protection Act (MMPA) Incidental Harassment Authorization and the National Defense Exemption from the Requirements of the MMPA for Mid-Frequency Active Sonar Mitigation Measures.*

U.S. Department of the Navy, 2006b. *Comprehensive Infrastructure Plan, Volume 1 of 2.* Pacific Missile Range Facility, Barking Sands, Kauai, Draft, June.

U.S. Department of the Navy, 2007a. *Draft Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement,* October

U.S. Department of the Navy, 2007b. *Undersea Warfare Exercise Programmatic Environmental Assessment,* January.

U.S. Department of the Navy, 2007c. *Composite Training Unit Exercise (COMPTUEX) / Joint Task Force Exercise (JTFEX) Environmental Assessment/Overseas Environmental Assessment.*

U.S. Department of the Navy, 2007d. Supplemental Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar.

U.S. Department of the Navy, [no date]. San Clemente Island Ordnance Database, Preliminary Environmental Impact Statement.

U.S. Department of the Navy, Commander THIRD Fleet, 2004. *2004 Supplement to the 2002 Programmatic RIMPAC Environmental Assessment.*

U.S. Department of the Navy, Commander THIRD Fleet, 2006. *2006 Supplement to the 2002 Programmatic RIMPAC Environmental Assessment.*

U.S. Department of the Navy, Commander Navy Region Hawaii, 2001a. *Pearl Harbor Naval Complex Integrated Natural Resources Management Plan,* Final report, Prepared for Commander, Navy Region Hawaii, Honolulu, Hawaii by Helber Hastert & Fee, Planners, Honolulu, Hawaii.

U.S. Department of the Navy, Commander Navy Region Hawaii, 2001b. *Naval Magazine Pearl Harbor Integrated Natural Resources Management Plan (INRMP),* November.

U.S. Department of the Navy, Commander Navy Region Hawaii, 2002. *Integrated Cultural Resources Management Plan, Pearl Harbor Naval Complex.* Prepared by Helber Hastert & Fee Planners, March.

U.S. Department of the Navy, Commander, U.S. Atlantic Fleet, 2005. *Draft Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS) Undersea Warfare Training Range.*

U.S. Department of the Navy, Commander, U.S. Pacific Fleet, 2004. *Report on the Results of the Inquiry into Allegation of Marine Mammal Impacts Surrounding the use of Active Sonar by USS Shoup (DDG 86) in the HARO Strait on or about 5 May 2003.*

U.S. Department of the Navy, Engineering Field Activity Chesapeake, 2006. *Noise and Accident Potential Zone Study for the Pacific Missile Range Facility Barking Sands*, November.

U.S. Department of the Navy, Naval Facilities Engineering Command, Pearl Harbor, 1996. *Environmental Baseline Study, Pacific Missile Range Facility, Second Working Copy*, January [For Official Use Only].

U.S. Department of the Navy, Naval Sea Systems Command, 2005. "Evaluation of Electric Power Supply Alternatives for the MDETC P-419 Electromagnetic Launcher (EML) Railgun Facility" Final Submittal, 26 April 2005.

U.S. Department of the Navy and U.S. Department of Commerce, 2001. *Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000.* December. [Online]. Available: http://www.nmfs.gov/prot_res/overview/publicat.html

U.S. Department of Transportation, 2001. *Programmatic EIS for Licensing Launches*, May 21. Prepared by ICF Consulting, Inc. Available: http://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/media/Volume1-PEIS.pdf

U.S. Department of Transportation, Federal Aviation Administration, 2002. *Aeronautical Chart User's Guide*, 5th Edition.

U.S. Environmental Protection Agency, 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Warfare with an Adequate Margin of Safety*. Office of Noise Abatement and Control. EPA Report No. 550/9-74-004. Washington, D.C.

U.S. Environmental Protection Agency, 1998. "Guidelines for ecological risk assessment." *Federal Register*, 63:26846 – 26924; *OSHA occupational noise regulations at 29 CFR 1910.95.*

U.S. Environmental Protection Agency, 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. Federal Register, Vol 65, No 97, p. 31682, 18 May.

U.S. Environmental Protection Agency, 2004. *Preliminary Remediation Goals*, October.

U.S. Environmental Protection Agency, 2005a. *Environmental Compliance History Online.*

U.S. Environmental Protection Agency, 2005b. Environmental Impact Statements: Notice of Availability- Weekly receipt of Environmental Impact Statements Filed 12/19/2005. *Federal Register*, Vol 70, No. 250, pp. 77380-77381, 30 December.

U.S. Environmental Protection Agency, 2006. *National Recommended Water Quality Criteria*.

U.S. Food and Drug Administration, U.S. Department of Agriculture, and Centers for Disease Control and Prevention, 2001. *Draft assessment of the relative risk to public health from foodborne Listeria monocytogenes among selected categories of ready-to-eat foods.* Food and Drug Administration, Center for Food Safety and Applied Nutrition; U.S. Department of Agriculture, Food Safety and Inspection Service; and Centers for Disease Control and Prevention. Rockville, Maryland and Washington, D.C.

U.S. Fish & Wildlife Service, 2000. "Endangered and Threatened Wildlife and Plants: Determination of Whether Designation of Critical Habitat is Prudent for 81 Plants and Proposed Designations for 76 Plants from the Islands of Kauai and Niihau, Hawaii, Proposed Rule," *Federal Register*, Vol 65, No. 216, pp. 66807-66884.

U.S. Fish & Wildlife Service, 2002. "Endangered and Threatened Wildlife and Plants; Revised Determination of Prudency and Proposed Designations of Critical Habitat for Plant Species From the Islands of Kauai and Niihau, Hawaii; *Federal Register*, Proposed Rule," Vol 68, No.18, pp. 3939-4098.

U.S. Fish & Wildlife Service, 2003a. "Endangered and Threatened Wildlife and Plants; Final Designation or Nondesignation of Critical Habitat for 95 Plant Species from the Islands of Kauai and Niihau, HI; *Federal Register*, Final Rule," Vol 68, No. 39, pp. 9115-9479.

U.S. Fish and Wildlife Service, 2003b. "Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Five Plant Species From the Northwestern Hawaiian Islands, Hawaii, Final Rule," 22 May. *Federal Register*, Vol 68, No.99, pp. 28054-28075 [Online]. Available: http://www.fws.gov/pacificislands/CHRules/nwhifinal.pdf.

U.S. Fish & Wildlife Service, 2003c "Endangered and Threatened Wildlife and Plants; Final Designation and Nondesignation of Critical Habitat for 46 Plant Species From the Island of Hawaii, HI; *Federal Register*, Vol 68, No. 127, pp. 39624-39672 [Online]. Available: http://ecos.fws.gov/docs/federal_register/fr4117.pdf.

U.S. Fish and Wildlife Service, 2003d. *Biological Opinion*, "Formal consultation on effects to the Mexican spotted owl,": p. 3 of the document. [Online].Available: http://www.fws.gov/southwest/es/arizona/Documents/Biol_Opin/99208_MtGrahm_Rockfall.pdf

U.S. Fish and Wildlife Service, 2004. U.S. Fish and Wildlife Service Biological Opinion under section 7 of the Endangered Species Act on the effects of the reopened shallow-set sector of the Hawaii-based longline fishery on the short-tailed albatross *(Phoebastria albatrus),* formal consultation log number 1-2-199-F-02.2 (supplementing 1-2-1999-F-02R), October.

U.S. Fish and Wildlife Service, 2005a. *Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision*, May.

U.S. Fish and Wildlife Service, 2005b. "PartnersOutside the Box? Efforts Save Kauai Albatross Chicks," in *Fish and Wildlife Journal*, 15 March [Online]. Available: http://www.fws.gov/arsnew/regmap.cfm?arskey=15065.

U.S. Fish and Wildlife Service, 2006a. "Welcome to Midway Atoll," [Online]. Available: http://www.fws.gov/midway/intro/default.

U.S. Fish and Wildlife Service, 2006b. "Listed species (based on published population data) – 328 listings," USFWS Threatened and Endangered Species System (TESS) [Online]. Available: http://ecos.fws.gov/tess_public/StateListing.do?state=HI&status=listed.

U.S. Fish & Wildlife Service, 2006c. "General Provisions; Revised List of Migratory, Birds, Federal Register, Vol 71, No 164, pp. 50194-50221,Thursday[24 August] [Online]. Available: http://www.epa.gov/fedrgstr/EPA-SPECIES/2006/August/Day-24/e7001.htm.

U.S. Fish and Wildlife Service, 2007a. Species List and Technical Assistance regarding Informal Section 7 Consultation for the Hawaii Range Complex. Letter dated 8 November 2007- Pacific Islands Fish & Wildlife Office, Honolulu, Hawaii.

U.S. Fish & Wildlife Service, 2007b. "Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List the Black-Footed Albatross (Phoebastria nigripes) as Threatened or Endangered," Federal Register, Vol 72, No 194, pp. 57278-57283, Tuesday, [9 October]. [Online]. Available: http://www.fws.gov/policy/library/E7-19690.html.

U.S. Fish and Wildlife Service. 2007c. "Papahānaumokuākea Marine National Monument, Hawaii; Monument Management Plan." Federal Register / Vol. 72, No. 64 , Wednesday, April 4, 2007- p. 16328. [Online]. Available: http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?dbname=2007_register&position=all&page=16328.

U.S. Fish and Wildlife Service, Pacific Islands, 2002. "Pacific Islands—National Wildlife Refuges, Pacific/Remote Islands National Wildlife Refuge Complex," [Online]. Available: http://www.fws.gov/pacificislands/wnwr/pnorthwestnwr.html, [29 October].

U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, 2007. Correspondence received from Kevin Foster, Marine Ecologist and Regional Diving Officer, U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office regarding concurrence with no significant impact from Terminal High Altitude Area Defense activities, January 10.

U.S. Fish and Wildlife Service, Pacific Region, 2002. "Critical Habitat for 83 Plant Species from Kauai and Niihau," *News Releases, Pacific Region,* [Online]. Available: http://pacific.fws.gov/news/2002/piea04/faq.pdf, [30 April].

U.S. Fish and Wildlife Service, and Hawaii Department of Land and Natural Resources, Division of Aquatic Resources, 2002. *Coral Reef Ecosystems of the Northwestern Hawaiian Islands: Interim Results Emphasizing the 2000 Surveys,* [Online]. Available: http://www.hawaiianatolls.org/research/NOWRAMP_2000.pdf..

U.S. Forest Service, undated. "*Chenopodium oahuense* (Meyen) Aellen `aheahea" [Online]. Available: http://www.fs.fed.us/global/iitf/pdf/shrubs/Chenopodium%20oahuenseFinalIEd2.pdf.

U.S. Government, The White House. 2006. *Establishment of the Northwestern Hawaiian Islands Marine National Monument, A Proclamation by the President of the United States of America*, [Online]. Available: http://www.whitehouse.gov/news/releases/2006/06/20060615-18.html.

U.S. House of Representatives, 2003. Congressman Ed Case – News Release. [Online] Available: http://wwwc.house.gov/case/press_releases/2003107.html

U.S. Navy NAVFAC Pacific Environmental Planning, 2007. Pacific Missile Range Facility *Wedge-tailed Shearwater Population Survey Project Summary Report.*

U.S. Office of Energy Statistics, Energy Information Administration, 2007. U.S. Carbon Dioxide Emissions By Sector and fuel for 2005 actual and 2030 projected, February, Available: http://www.eia.doe.gov/environment.html.

United Nations Convention On The Law Of The Sea, 1982. Agreement Relating To The Implementation Of Part XI Of The Convention, 10 December.

U.S. Pacific Command, 1995. *Final Hawaii Military Land Use Master Plan*, July 17.

University of Hawaii, undated. ReefWatcher's Field Guide to Alien and Native Hawaiian Marine Algae. [Online]. Available: http://www.hawaii.edu/reefalgae/natives/sgfieldguide.htm.

University of Hawaii Kapiolani Community College, undated. "Naio: Native Hawaiian Plants," Education Media Center [Online]. Available: http://old.kcc.hawaii.edu/campus/tour/plants/pnaio.htm [6 October 2006].

Uozumi, Y., 1996a. *Thunnus alalunga*. In: 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org.

Uozumi, Y., 1996b. *Thunnus obesus*. In: 2004 IUCN red list of threatened species [Online]. Available: http://www.redlist.org.

Urick, R.J., 1972. "Noise signature of an aircraft in level flight over a hydrophone in the sea," *Journal of the Acoustical Society of America*, 52 (3,P2):993-999.

Urick, R.J., 1983. *Principles of Underwater Sound*. 3rd Edition, McGraw Hill, New York, 423 pp.

Vanderlaan, A.S.M. and C.T. Taggart, 2007. "Vessel collisions with whales: the probability of lethal injury based on vessel speed," *Marine Mammal Science,* 23(1):144-156.

Vanderlaan, A.S.M., A.E. Hay, and C.T. Taggart, 2003. "Characterization of North Atlantic right-whale (*Eubalaena glacialis*) sounds in the Bay of Fundy," *IEEE Journal of Oceanic Engineering,* 28:164-173.

Van Dolah, F.M. 2005. "Effects of Harmful Algal Blooms," pp. 85-99. In: Marine Mammal Research, edited by J.E. Reynolds, W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen (John Hopkins University Press, Baltimore).

Van Dolah, F.M., G.J. Doucette, F.M.D. Gulland, T.L. Rowles, and G.D. Bossart, 2003. "Impacts of algal toxins on marine mammals," pp. 247-269. In: *Toxicology of Marine Mammals*, edited by J.G. Vos, G.D. Bossart, M. Fournier, and T.J. O'Shea (Taylor & Francis, London),.

Vanfossen, L., 2008. Personal communication from Lewis Vanfossen to Gene Nitta regarding "Turtle Bycatch Data,." 6 April 2008.

Veirs, V., 2004. "Source levels of free-ranging killer whale (*Orcinus orca*) social vocalizations," p. 32. In Abstract: *Journal of the Acoustical Society of America,* 116:2615(4pABIO 3:55).

Vidal, O., and Gallo-Reynoso, J.P.,1996. "Die-offs of marine mammals and sea birds in the Gulf of California, Mexico," *Marine Mammal Science*. 12:627-635.

Virginia Tech Conservation Management Institute, 1996. "(DRAFT) – Taxonomy Species Petrel, Dark-Rumped, Hawaiian Species Id ESIS101028," [Online]. Available: http://fwie.fw.vt.edu/WWW/esis/lists/e101028.htm.

Visser, I.K.G., J.S. Teppema, and A.D.M.E. Ostrhaus, 1991. "Virus infections of seals and other Pinnipeds," *Reviews in Medical Microbiology*. 2:105-114.

Visser, I.N. and F.J. Bonoccorso, 2003. "New observations and a review of killer whale (*Orcinus orca*) sightings in Papua New Guinea waters," *Aquatic Mammals* 29:150-172. 6

Von Holt, I., 1985. Stories of Long Ago AHN Ni'ihau, Kauai, Oahu. Report is on file at the Bishop Museum, Honolulu, Hawaii. [For Official Use Only].

Von Saunder, A., and J. Barlow, 1999. "A report of the Oregon, California and Washington line-transect experiment (ORCAWALE) conducted in West Coast waters during Summer/Fall 1996," NOAA Technical Memorandum NMFS-SWFSC-264:1-49.

Wade, L.S., and G.L. Friedrichsen, 1979. "Recent sightings of the blue whale, *Balaenoptera musculus*, in the northeastern tropical Pacific," *Fishery Bulletin,* 76:915-919.

Wade, P.R, and T. Gerrodette, 1993. "Estimates of cetacean abundance and distribution in the eastern tropical Pacific," *Reports of the International Whaling Commission 43:477-493*.

Walker, M.M., J.L. Kirschvink, G. Ahmed, and A.E. Dicton, 1992. "Evidence that fin whales respond to the geomagnetic field during migration," *Journal of Experimental Biology*, 171:67-78.

Walker, W.A., 1981. "Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific," *Southwest Fisheries Science Center Administrative Report LJ-81-03C*, La Jolla, California: National Marine Fisheries Service.

Walker, W.A., J.G. Mead, and R.L. Brownell, 2002. "Diets of Baird's beaked whales *Berardius bairdii*, in the southern Sea of Okhotsk and off the Pacific Coast of Honshu, Japan," *Marine Mammal Science,* 18:902-919.

Walker, R.J., E.O. Keith, A.E. Yankovsky, and D.K. Odell, 2005. "Environmental correlates of cetacean mass stranding sites in Florida," *Marine Mammal Science* 21, 327-335.

Waller, G., 1996. *SeaLife: A Complete Guide to the Marine Environment*. Washington, DC: Smithsonian Institution Press. pp. 485.

Walsh, M.T., R.Y. Ewing, D.K. Odell, and G.D. Bossart, 2001. "Mass Strandings of Cetaceans," pp. 83-96. In: *Marine Mammal Medicine*, edited by L. A. Dierauf, and F. M. D. Gulland (CRC Press, Boca Raton),.

Walsh, W.A., and D.R. Kobayashi, 2004. "A description of the relationships between marine mammals and the Hawaii-based longline fishery from 1994 to 2003," Report prepared by the University of Hawaii and Pacific Islands Fisheries Science Center.

Wang, M.C., W.A. Walker, K.T. Shao, and L.S. Chou, 2002. "Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters," *Acta Zoological Taiwanica,* 13:53-62.

Ward, W.D., 1960. "Recovery from high values of temporary threshold shift, *Journal of the Acoustical Society of America*," 32:497–500.

Ward, W.D., 1997. "Effects of high-intensity sound," In: *Encyclopedia of Acoustics*, ed. M.J. Crocker, 1497-1507. New York: Wiley.

Ward, W.D., A. Glorig, and D.L. Sklar, 1958. "Dependence of temporary threshold shift at 4 kc on intensity and time," *Journal of the Acoustical Society of America,* 30:944–954.

Ward, W.D., A. Glorig, and D.L. Sklar, 1959. "Temporary threshold shift from octave-band noise: Applications to damage-risk criteria," *Journal of the Acoustical Society of America,* 31: 522–528.

Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, D. Mackie, 2001. "Effects of seismic air guns on marine fish," *Continental Shelf Research,* 21:1005-1027.

Wartzok, D., and D.R. Ketten, 1999. "Marine Mammal Sensory Systems," pp. 117-175. In: *Biology of Marine Mammals* (ed. J.E. Reynolds III and S.A. Rommel).

Wartzok, D., A.N. Popper, J. Gordon, and J. Merrill, 2003. "Factors affecting the responses of marine mammals to acoustic disturbance," *Marine Technology Society Journal,* 37(4):6-15.

Watkins, W.A., and W.E. Schevill, 1975. Sperm whales (*Physter catodon*) react to pingers. Deep-Sea Research 22: 123-129.

Watkins, W.A., and W.E. Schevill, 1977. "Sperm whale codas," *Journal of the Acoustical Society of America,* 62:1485-1490.

Watkins, W.A., 1980. "Acoustics and the behavior of sperm whales," pp. 283-290. In: R.G. Busnel and J.F. Fish (editors). *Animal Sonar Systems*. Plenum Press; New York, New York.

Watkins, W.A., K.E. Moore, and P. Tyack, 1985. "Sperm whale acoustic behaviors in the southeast Caribbean," *Cetology*, 49: 1-15.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird, 1987. "The 20-Hz signals of finback whales (*Balaenoptera physalus*)," *Journal of the Acoustical Society of America,* 82:1901-1912.

Watkins, W.A., M.A. Daher, K.M. Fristrup, and T.J. Howald, 1993. "Sperm whales tagged with transponders and tracked underwater by sonar," *Marine Mammal Science,* 9:55-67.

Watkins, W.A., M.A. Daher, A. Samuals, and D.P. Gannon, 1997. "Observations of *Peponocephala electra*, the melon-headed whale, in the southeastern Caribbean," *Caribbean Journal of Science,* 33:34-40.

Watkins, W.A., M.A. Daher, N.A. DiMarzio, A. Samuels, D. Wartzok, K.M. Fristrup, P.W. Howey, and R.R. Maiefski, 2002. "Sperm whale dives tracked by radio tag telemetry," *Marine Mammal Science,* 18:55-68.

Watling, L., 2003. "A geographic database of deepwater alcyonaceans of the Northeastern U.S. continental shelf and slope." Version 1.0 CD-ROM. Natl Undersea Res Cent, Connecticut University, Groton.

Webb , J.F., J. Montgomery,and J. Mogdans, 2008. "Bioacoustics and the lateral line of fishes," In: *Fish Bioacoustics*, eds. J.F. Webb, R.R. Fay, and A.N. Popper. New York: Springer Science + Business Media, LLC.

Weilgart, L. and H. Whitehead, 1997. "Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales," *Behavior Ecology Sociobiology,* 40:277–285.

Weise, M.J., D.P.Costa, and R.M. Kudela, 2006. "Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005," *Geophysical Research Letters* 33: L22S10. pp. 6

Welch, B.L. and A.S. Welch (eds.), 1970. *Physiological effects of noise*. Plenum Press, New York, NY. pp.

Weller, D.W., B. Würsig, H. Whitehead, J.C. Norris, S.K. Lynn, R.W. Davis, N. Clauss, and P. Brown, 1996. "Observations of an interaction between sperm whales and short-finned pilot whales in the Gulf of Mexico," *Marine Mammal Science,* 12:588-593.

Wells, R.S., D.J. Boness, and G.B. Rathbun, 1999. "Behavior," *Biology of Marine Mammals* (ed. J.E. Reynolds III and S.A. Rommel), pp. 324-422.

Wenz, G., 1962. "Acoustic Ambient Noise" In: the Ocean: Spectra and Sources," *Journal of the Acoustical Society of America*, 34 12:1936-1956.

West, E. and K. Desilets, 2005. *Archaeological Survey and Testing in Support of a Launcher Relocation at Pacific Missile Range Facility (PMRF*), Mana Ahupua`a, Kona District, Kaua`i, Prepared for Commander, Navy Region Hawai`i, Department of the Navy, Naval Facilities Engineering Command, Pacific, October. [For Official Use Only].

Western Pacific Regional Fishery Management Council, 1998. “Magnuson-Stevens Act definitions and required revisions: Amendment 6 to the bottomfish and seamount groundfish fisheries management plan, Amendment 8 to the pelagic fisheries management plan, Amendment 10 to the crustacean fisheries management plan, and Amendment 4 to the precious corals fisheries management plan,” Honolulu, Hawaii: Western Pacific Regional Fishery Management Council, 449 pp.

Western Pacific Regional Fishery Management Council, 1999. “The value of the fisheries in the western pacific fishery management council area,” July. [Online]. Available: http://www.wpcouncil.org/documents/value.pdf

Western Pacific Regional Fishery Management Council, 2001. *Final Fishery management plan for coral reef ecosystems of the western Pacific region*. Volumes I-III including Amendment 7 bottomfish and seamount groundfish fisheries, Amendment 11 crustacean fisheries, Amendment 5 precious corals, fisheries, and Amendment 10 pelagic fisheries. Honolulu, Hawaii: NMFS Southwest Region, Pacific Islands Area Office, 1,221 pp. Online; [Available]: http://www.wpcouncil.org/coralreef.htm.

Western Pacific Regional Fishery Management Council, 2004. EFH/HAPC designations for fishery management units covered under the bottomfish, crustacean, pelagic, precious corals, and coral reef ecosystem fishery management plans. Updated. Honolulu, Hawaii: WPRFMC. 7 pp.

Western Pacific Regional Fishery Management Council, 2005. *Draft Programmatic Environmental Impact Statement Towards an Ecosystem Approach for the Western Pacific Region: From Species-based Fishery Management Plans to Place-based Fishery Ecosystem Plans,* 27 October [Online]. Available: http://www.wpcouncil.org/documents/DPEIS.pdf.

Western Pacific Regional Fishery Management Council, 2006. *2006 Black Coral Science and Management Workshop Report, April 18-19, 2006 Honolulu, Hawaii* [Online]. Available: http://www.wpcouncil.org/precious/Documents/2006%20Black%20Coral%20Science%20and%20Management%20Workshop%20Report-SCANNED%20VERSION.pdf.

Western Pacific Regional Fishery Management Council, National Oceanic and Atmospheric Administration, 2003. “Strategic Plan for the Conservation and Management of Marine Resources in the Pacific Islands Region,” p. 5. NOAA-NA04NM4-4410086

Westlake, R.L., and W.G. Gilmartin, 1990. “Hawaiian monk seal pupping locations in the Northwestern Hawaiian Islands,” *Pacific Science,* 44:366-383.

Wever, E.G., 1978. *The Reptile Ear: Its Structure and Function*. Princeton University Press, Princeton, NJ. 1,024 pp.

Whitehead, H., 2003. *Sperm whales: Social evolution in the ocean,* Chicago: University of Chicago Press. pp. 417.

Whitehead, H., and L. Weilgart, 1991. "Patterns of visually observable behaviour and vocalizations in groups of female sperm whales," *Behaviour,* 118:275-296.

Whittow, G.C. and G.H. Balazs, 1982. "Basking behavior of the Hawaiian green turtle (*Chelonia mydas*)," *Pacific Science,* 36:129-139.

Wiggins, S.M., M.A. McDonald, L.M. Munger, S.E. Moore, and J.A. Hildebrand, 2004. "Waveguide propagation allows range estimates for North Pacific right whales in the Bering Sea," *Canadian Acoustics,* 32:146-154.

Wiggins S.M., E.M. Oleson, M.A., McDonald, and J.A. Hildebrand, 2005. "Blue whale (*Balaenoptera musculus*) diel call patterns offshore of Southern California," *Aquatic Mammals*, 31:161–168.

Wilkinson, D.M., 1991. Report to the Assistant Administrator for Fisheries, pp. 1-171.In: Program Review of the Marine Mammal Stranding Networks," (U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Silver Springs, MD).,.

Williams, S. and T. Patolo, 1998. *Archaeological Inventory Survey of the Kahuku Training Area and Preparation of a Historic Preservation Plan for the Legacy Resource Management Program, O`ahu Island, Hawai`i.* Prepared for the US Army Corps of Engineers, Corps of Engineers District, Fort Shafter, Hawai`i. Ogden Environmental and Energy Services Company, Inc., Honolulu, Hawai`i.

Williams, S. and T. Patolo, 2000. *Final Report: Intensive Archaeological Survey and Monitoring for Proposed Modifications to the Company Combined Assault Course (CCAAC) and Construction of a Fire Access Trail at the US Army Makua Military Reservation, Makua Valley, Island of Oahu, Hawaii.* Ogden Environmental and Energy Services. [For Official Use Only]

Willis, P.M. and R.W. Baird, 1998. "Status of the dwarf sperm whale, Kogia simus, with special reference to Canada," *Canadian Field-Naturalist,* 112:114-125.

Wilson, B. and L.M. Dill, 2002. "Pacific herring respond to simulated odontocete echolocation calls," *Canadian Journal of Fisheries and Aquatic Science,* 59:542-553.

Wilson, O.B., Jr., S. N. Wolf, and F. Ingenito, 1985. "Measurements of acoustic ambient noise in shallow water due to breaking surf," *Journal of the Acoustical Society of America*, 78:190-195.

Wilson, J., L. Rotterman, and D. Epperson, 2006. "Minerals Management Service Overview of Seismic Survey Mitigation and Monitoring on the U.S. Outer Continental Shelf." Presented to the Scientific Committee of the *International Whaling Commission*, SC/58/E8. 13 pp

Winn, H.E., 1967. “Vocal facilitation and biological significance of toadfish sounds,” pp. 283-3036. In: *Marine Bio Acoustics, II*, ed. W.N. Tavolga, Oxford: Pergamon Press.

Winn, H.E., and P.J. Perkins, 1976. “Distribution and sounds of the minke whale, with a review of mysticete sounds,” *Cetology,* 19:1-12.

Winn, H.E., J.D. Goodyear, R.D. Kenney, and R.O. Petricig, 1995. “Dive patterns of tagged right whales in the Great South Channel,” *Continental Shelf Research,* 15:593-611.

Witherington, B.E., and N.B. Frazer, 2003. “Social and economic aspects of sea turtle conservation,” pp. 355-384. In: P.L. Lutz, J.A. Musick and J. Wyneken, eds. *The biology of sea turtles. Volume II*, Boca Raton, Florida: CRC Press.

Witteveen, B.H., J.M. Straley, O. Ziegesar, D. Steel, and C.S. Baker, 2004. “Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska,” *Canadian Journal of Zoology.*, 82:1352-1359.

Witzell, W.N., 1983. “Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus 1766) FIR/S137,” *FAO Fisheries Synopsis,* 137:1-78.

Wolanski, E., R.H. Richmond, G. Davis, E. Deleersnijder, and R.R. Leben, 2003. “Eddies around Guam, an island in the Mariana Islands group,” *Continental Shelf Research,* 23:991-1003.

Woodings, S., 1995. “A plausible physical cause for live cetacean mass strandings,” B.S. Thesis University of Western Australia, 71 pp.

Woods Hole Oceanographic Institution, 2005. *Beaked Whale Necropsy Findings for Strandings in the Bahamas, Puerto Rico, and Madiera, 1999 – 2002.* Technical Report, WHOI-2005-09.

Woodside, J.M., L. David, A. Frantzis, S.K. Hooker, 2006. “Gouge marks on deep-sea mud volcanoes in the eastern Mediterranean: Caused by Cuvier’s beaked whales?,”. *Deep-Sea Research I*, 53:1762–1771

World Health Organization, 2001. *Depleted Uranium: Sources, Exposure and Health Effects*. Report No: WHO/SDE/PHE/01.1, April.

Wright, K.J., D.M. Higgs, A.J. Belanger, and J.M. Leis, 2005. “Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae),” *Marine Biology* 147: 1425-1434.

Wright, K.J., D.M. Higgs, A.J. Belanger , and J.M. Leis , 2007. “Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). Erratum.” *Marine Biology,* 150:1049-1050.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin, 1998. "Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft," *Aquatic Mammals,* 24:41-50.

Wyneken, J., 1997. "Sea turtle locomotion: Mechanics, behavior, and energetics," pp. 165-198 In: P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles*, Boca Raton, Florida: CRC Press.

Wysocki, L.E. and F. Ladich, 2005. "Hearing in fishes under noise conditions," *Journal of the Association of Research Otolaryngology*, 6:28-36.

Wysocki, L.E., J.P. Dittami, and F. Ladich. 2006. "Ship noise and cortisol secretion in European freshwater fishers," Biological Conservation, 128:501-508.

Wysocki, L.E., J.W. III Davidson, M.E. Smith, A.S. Frankel, W.T. Ellison, P.M. Mazik, A.N. Popper , and J. Bebak, 2007. "Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout *Oncorhynchus mykiss*," *Aquaculture,* 272:687-697.

Yamada, 2002. Personal communication between Ron Yamada, Environmental Protection Specialist, Marine Corps Base Hawaii, and Kenneth Sims, U.S. Army Space and Missile Defense Command, regarding Cultural Resources on Marine Corps Base Hawaii, May 20.

Yasui, M., 1986. "Albacore, *Thunnus alalunga*, pole-and-line fishery around the Emperor Seamounts," from *Environment and Resources of Seamounts in the North Pacific*. R. Uchida, S. Hayashi, and G. Boehlert, eds. NOAA Technical Report NMFS 43, pp. 37-40.

Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and E.R. Fletcher, 1975. "The Relationship Between Fish Size and Their Response to Underwater Blast." Report DNA 3677 T, Director, Defense Nuclear Agency, Washington, DC.

Yelverton, J.T., 1981. "Underwater explosion damage risk criteria for birds, fish and mammals," Paper presented at the 102nd of the Acoustical Society of America. Miami Beach, FL, pp. 19.

Yochem, P.K., and S. Leatherwood, 1985. "Blue whale-*Balaenoptera musculus*," pp. 193-240. In: S.H. Ridgway and R. Harrison, eds. *Handbook of Marine Mammals Volume 3: The sirenians and baleen whales*, San Diego: Academic Press.

Yost, W.A. and Nielson, D.W., 1994. *Fundamentals of Hearing: An Introduction*, Chapter 6. Electrophysiology of the Peripheral Auditory Nervous System. San Diego: Academic Press. pp. 66-181.

Yost, W. A., 2000. *Fundamentals of hearing: An introduction* (4th ed.). San Diego: Academic Press, Young, G.A., 1991. "Concise methods for predicting the effects of underwater explosions on marine life," Naval Surface Warfare Center, Silver Springs, Maryland 20903. *NAVSWC MP 91-220*.

Young, R.W., 1973, "Sound pressure in water from a source in air and vice versa," *Journal of the Acoustical Society of America*, 53:1708-1716.

Yu, H-Y., H-K. Mok, R-C. Wei, and L-S., Chou, 2003. "Vocalizations of a rehabilitated rough-toothed dolphin, *Steno bredanensis*," p. 183. In *Abstracts: Fifteenth Biennial Conference on the Biology of Marine Mammals,* 14–19 December 2003. Greensboro, North Carolina.

Yuen, M.E., Nachtigall, P.E., and Supin, A. Ya, 2005. "Behavioral and AEP Audiograms of a false killer whale (*Pseudorca crassidens*)," *Journal of the Acoustical Society of America.* 118: 2688-2695.

Zeeberg, J.A. Corten, and E. de Graaf, 2006. " Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa," *Fisheries Research* 78:186-195.

Zelick, R., D. Mann, and A.N. Popper, 1999. "Acoustic communication in fishes and frogs," pp. 363-411. In: *Comparative Hearing: Fish and Amphibians*, eds. R.R. Fay and A.N. Popper, New York: Springer-Verlag.

Zimmer, W.M.X., P.L. Tyack, M.P. Johnson, and P.T. Madsen, 2005. "Three-dimensional beam pattern of regular sperm whale clicks confirms bent-horn hypothesis," *Journal of the Acoustical Society of America,* 117:1473-1485.

Zimmer, W.M.X. and P.L. Tyack, 2007. "Repetitive shallow dives pose decompression risk in deep-diving beaked whales," *Marine Mammal Science*. 23:888-925.

Zimmerman, S., 1991. "A History of Marine Mammal Stranding Networks in Alaska, with Notes on the Distribution of the Most Commonly Stranded Cetacean Species, 1975-1987," *In: Marine Mammal Strandings in the United States*: *proceedings of the Second Marine Mammal Stranding Workshop;* 3-5 December 1987, Miami, Florida (John E. Reynolds III and Daniel K. Odell, Eds.). NOAA Technical Report NMFS 98.

Zoidis, A.M., M.A. Smultea, A.S. Frankel, J.L. Hopkins, A. Day, S. McFarland, A.D. Whitt, and D. Fertl. 2008. "Vocalizations produced by humpback whale (*Megaptera novaeangliae*) calves recorded in Hawaii," *Journal of the Acoustical Society of America*. 123:1737-1746.

10.0 Distribution List

10.0 DISTRIBUTION LIST

Federal Agencies

Director
Office of Director of Installations and Facilities
U.S. Department of the Navy
Washington, DC

Missile Defense Agency
Washington, DC

Pacific Islands Administrator
Department of the Interior
Washington, DC

Mr. James Connaughton
Chair
President's Council on Environmental Quality
Washington, DC

Rear Admiral Bruce E. MacDonald
Judge Advocate General
U.S. Department of the Navy
Washington Navy Yard, DC

Dr. Willie Taylor
Director
Office of Environmental Policy and Compliance
Washington, DC

Mr. David Wennergren
Chief Information Officer
Department of the Navy Public Affairs
Washington, DC

Dr. Allen Awaya
Education Liaison
Joint Venture Education Forum
U.S. Pacific Command/J1
Camp H.M. Smith, HI

U.S. Army, IMA Region
Pacific Regional Office
Fort Shafter, HI

Lieutenant General John Brown III
Commander
U.S. Army, Pacific
Fort Shafter, HI

Brigadier General John W. Peabody
Commander and Division Engineer
Pacific Ocean Division Office,
U.S. Army Corps of Engineers
Fort Shafter, HI

U.S. Air Force Pacific
HQ, PACAF/CEVQ
Hickam AFB, HI

U.S. Army Garrison, I DPW
Schofield Barracks
Honolulu, HI

U.S. Coast Guard, Commanding Officer
Civil Engineering Unit Honolulu
Honolulu, HI

Marine Corps Base Hawaii, Environmental
Honolulu, HI

District Chief
U.S. Geological Survey District and Field Office
Honolulu, HI

Director
Pacific Area Office
U.S. Fish & Wildlife Service
Honolulu, HI

U.S. Department of Transportation
Aliiaimoku Building, Room 509
Honolulu, HI

Representative Neil Abercrombie
United States Representative District 1
United States House of Representatives
Honolulu, HI

Senator Daniel Akaka
United States Senator
United States Congress
Honolulu, HI

Representative Maize Hirono
United States Representative District 2
United States Congress
Honolulu, HI

Senator Daniel Inouye
United States Senator
United States Congress
Honolulu, HI

Ms. Barbara Maxfield
U.S. Fish and Wildlife Service
Honolulu, HI

Ms. Nova McCarroll
Manager, Pacific Islands Office
U.S. Environmental Protection Agency
Region 9
Honolulu, HI

Mr. Mike Molina
U.S. Fish and Wildlife Service
Honolulu, HI

Mr. John Naughton
National Marine Fisheries Service Pacific
Islands Office
Honolulu, HI

Mr. Donald Palowski
Director, Division of Refuges
U.S. Fish & Wildlife Service
Honolulu, HI

Mr. Bill Robinson
Regional Administrator
National Marine Fisheries Service Pacific
Islands Regional Office
Honolulu, HI

Ms. Debbie Saito
Federal Aviation Administration
Honolulu Control Facility
Honolulu, HI

Ms. Gina Shultz
Director
Office of Protected Resources
U.S. Fish & Wildlife Service
Honolulu, HI

Mr. Ron V. Simpson
Manager, Honolulu ADO
Federal Aviation Administration
Hawaii Pacific Basin
Honolulu, HI

Mr. Chris Yates
Chief
Protected Species
National Marine Fisheries Service
Honolulu, HI

Navy Region Hawaii
Pearl Harbor, HI

Mr. Jon Jarvis
Regional Director
U.S. National Park Service
Pacific West Regional Office
Oakland, CA

Ms. Patricia Port
Regional Environmental Officer
Office of Environmental Policy and
Compliance, Oakland Region
Oakland, CA

Deputy Director
Pacific Islands Office
U.S. Environmental Protection Agency
Region 9
San Francisco, CA

U.S. Environmental Protection Agency
Pacific Islands Contact Office
Honolulu, HI

Dr. Anthea Hartig
Director
National Trust for Historic Preservation
Western Region Office
San Francisco, CA

Mr. Wayne Nastri
Region 9 Administrator
U.S. Environmental Protection Agency
San Francisco, CA

Mr. David Cottingham
Executive Director
Marine Mammal Commission
Bethesda, MD

U.S. Department of Energy, NEPA
Compliance Officer
Kirtland Area Office
Albuquerque, NM

Mr. Ren Lohoefener
Regional Director
Pacific Region U.S. Fish & Wildlife Service
Portland, OR

Director
Office of Environmental Policy &
Compliance
Department of Interior
Washington, DC

State Agencies

Reserve Coordinator
NWHI Coral Reef Ecosystem Reserve
Hilo, HI

Mr. Allen Tom
Manager
Humpback Whale National Marine
Sanctuary
Kihei, HI

Terry O'Halloran
Chair
Hawaiian Islands Humpback Whale
National Marine Sanctuary Advisory Council
Kalaheo, HI

Brigadier General Peter Pawling
Commander
Hawaii Air National Guard 154th Wing
Kekaha, HI

Director
Hawaii State Department of Health
Environmental Management Division
Honolulu, HI

Director
State Council on Hawaiian Heritage
Honolulu, HI

Director
State of Hawaii Department of Business,
Economic Development and Tourism Office
of Planning
Honolulu, HI

Director
State of Hawaii Department of Land and
Natural Resources
Division of Forestry and Wildlife
Honolulu, HI

Director
State of Hawaii Department of Land and
Natural Resources
Division of State Parks
Honolulu, HI

Sanctuary Manager
Hawaiian Islands Humpback Whale
National Marine Sanctuary Oahu Office
Honolulu, HI

Honorable Lt. Governor James Aiona, Jr.
State of Hawaii
Executive Chambers
Honolulu, HI

Pua Aiu
Office of Hawaiian Affairs
Honolulu, HI

Ms. Patricia Brandt
Chief of Staff
State of Hawaii Office of Hawaiian Affairs
Honolulu, HI

Representative Cindy Evans
Chair
Public Safety and Military Affairs Committee
Hawaii State Legislature
Honolulu, HI

Mr. Jack Flanagan
Council Director
Navy League Honolulu Council
Honolulu, HI

Dr. Chiyome Fukino
Director
Department of Health State of Hawaii
Honolulu, HI

Representative Ken Ito
Chair
Water, Land, and Ocean Resources Committee
Hawaii State Legislature
Honolulu, HI

Mr. Timothy Johns
Board Member
State of Hawaii Department of Land and Natural Resources
Honolulu, HI

Micah Kane
Chair
Department of Hawaiian Home Lands Office of the Chairman
Honolulu, HI

Senator J. Kalani
English Chair
Transportation and International Affairs Committee,
Hawaii State Legislature
Honolulu, HI

Mr. Laurence Lau, Esq.
Director
Hawaii State Department of Health
Environmental Health Administration
Honolulu, HI

Honorable Governor Linda Lingle
State of Hawaii
Honolulu, HI

Major General Robert G.F. Lee
Adjutant General
State of Hawaii Department of Defense
Honolulu, HI

Mr. Theodore Liu
Director
Hawaii Office of Planning
Hawaii Department of Business, Economic Development, and Tourism
Honolulu, HI

Mr. Curtis Martin
Hazard Evaluation and Emergency Response Office
Honolulu, HI

Ms. Naomi McIntosh
Acting Manager
Hawaiian Islands Humpback Whale National Marine Sanctuary Fisheries Service
Honolulu, HI

Senator Clarence Nishihara
Chair
Tourism and Government Operations Committee
Hawaii State Legislature
Honolulu, HI

Mr. Francis Oishi
Recreational Fishing Program Manager
State of Hawaii Department of Land and Natural Resources
Division of Aquatic Resources
Honolulu, HI

Ms. Genevieve Salmonson
Director
State of Hawaii Office of Environmental Quality Control
Honolulu, HI

State Historic Preservation Officer
State of Hawaii Department of Land and Natural Resources
Honolulu, HI

Dr. Jeffery Walters
Co-Manager
Hawaiian Islands Humpback Whale National Marine Sanctuary
Division of Aquatic Resources
Department of Land and Natural Resources
Honolulu, HI

Mr. Peter Yee
Office of Hawaiian Affairs- Nationhood and Native Rights
Honolulu, HI

Mr. Peter Young Chair
State of Hawaii Department of Land and Natural Resources
Honolulu, HI

Mr. Benjamin Lindsey
Burials Program Manager
Hawaiian Islands Burial Council
Kapolei, HI

State of Hawaii
Attorney General
Honolulu, HI

State of Hawaii Department of Health
Clean Air Branch
Honolulu, HI

State of Hawaii Department of Health
Clean Water Branch
Honolulu, HI

State of Hawaii Department of Health
Solid & Hazardous Waste Branch
Honolulu, HI

State of Hawaii Department of Transportation
Honolulu International Airport
Honolulu, HI

State of Hawaii Department of Land and Natural Resources
Boating & Ocean Recreation
Honolulu, HI

State of Hawaii Department of Land and Natural Resources
Engineering Division
Honolulu, HI

Local Agencies

Council Members
County of Hawaii
Hilo, HI

Mayor Harry Kim
County of Hawaii Office of the Mayor
East Hawaii
Hilo, HI

Council Members
County of Maui
Office of Council Services Kalana O Maui Building
Wailuku, HI

Mr. Jeff Hunt
Director
County of Maui Planning Department
Wailuku, HI

Mayor Charmaine Tavares
County of Maui Office of the Mayor
Wailuku, HI

Council Members
County of Kauai Council Services Division
Lihue, HI

Mr. Bill Asing
Chair
County of Kauai Council
Lihue, HI

Mayor Bryan J. Baptiste
County of Kauai Office of the Mayor
Lihue, HI

Mr. Ian Costa
Director
County of Kauai Planning Department
Lihue, HI

Executive Secretary
Oahu Neighborhood Board Neighborhood Commission Office
Honolulu, HI

Councilmember Todd Apo
Honolulu City Council, District 1
Honolulu, HI

Councilmember Romy Cachola
Honolulu City Council, District 7
Honolulu, HI

Mr. Lester Chang
Director
City and County of Honolulu Parks and Recreation Department
Kapolei, HI

Councilmember Donovan Dela Cruz
Honolulu City Council, District 2
Honolulu, HI

Councilmember Charles Djou
Honolulu City Council, District 4
Honolulu, HI

Mr. Harry Eng
Director
City and County of Honolulu Planning and Permitting Department
Honolulu, HI

Councilmember Nestor Garcia
Honolulu City Council, District 9
Honolulu, HI

Mayor Mufi Hannemann
City and County of Honolulu Office of the Mayor
Honolulu, HI

Mr. Wayne Hashiro
Director
City and County of Honolulu Office of the Managing Director
Honolulu, HI

Senator Gary Hooser
7th Senatorial District
Honolulu, HI

Senator Lorraine Inouye
Chair
Intergovernmental and Military Affairs Committee
Hawaii State Legislature
Honolulu, HI

Councilmember Ann Kobayashi
Honolulu City Council, District 5
Honolulu, HI

Councilmember Barbara Marshall
Honolulu City Council, District 3
Honolulu, HI

Senator Ron Menor
Chair Energy and Environment Committee
Hawaii State Legislature
Honolulu, HI

Representative Hermina Morita
14th Representative District
Honolulu, HI

Councilmember Gary Okino
Honolulu City Council, District 8
Honolulu, HI

Representative Roland D. Sagum III
16th Representative District
Honolulu, HI

Senator Norman Sakamoto
Chair
Education Committee
Hawaii State Legislature
Honolulu, HI

Mr. Eric Takamura
Director
City and County of Honolulu
Environmental Services Department
Kapolei, HI

Councilmember Rod Tam
Honolulu City Council, District 6
Honolulu, HI

Libraries

Hilo Public Library
Hilo, HI

Kahului Public Library
Kahului, HI

Wailuku Public Library
Wailuku, HI

Lihue Public Library
Lihue, HI

Princeville Public Library
Princeville, HI

Waimea Public Library
Waimea, HI

Hawaii State Library
Hawaii and Pacific Section Document Unit
Honolulu, HI

University of Hawaii Hamilton Library
Honolulu, HI

Private Citizens

Island of Hawaii

Moanikeala Akaka
Hilo, HI

Bob Deurr
Hilo, HI

Roberta Goodman
Hilo, HI

Cory Harden
Hilo, HI

Colby Kearns
Hilo, HI

Diane Ley
Hilo, HI

John and Ruth Ota
Hilo, HI

Lauren Pagarigan
Hilo, HI

Odette Rickert
Hilo, HI

Craig Severence
Hilo, HI

Peter Sur
Hilo, HI

Randee Tubal
Hilo, HI

F.K. Vesperas
Hilo, HI

Dwight J. Vicente
Hilo, HI

Bonnie Bator
Hilo, HI

Alan McNarie
Hilo, HI

F. K. Vesperas
Hilo, HI

Linda Kroll
Keaau, HI

Danny H. Li
Keaau, HI

James V. Albertini
Kurtistown, HI

Mark Van Doren
Kurtistown, HI

Daryl Berg
Naalehu, HI

Harry Fergerstrom
Pahoa, HI

Raydiance Grace
Pahoa, HI

Leonard J. Horowitz
Pahoa, HI

Michael Hyson
Pahoa, HI

Jim McRae
Pahoa, HI

Star Newland
Pahoa, HI

Jon Olson
Pahoa, HI

Shelly Stephens
Pahoa, HI

Lynn Nakku
Papeekeo, HI

Leayne Patch-Highfill
Volcano, HI

Maui

Melissa Prince
Haiku, HI

Manuel M. Kuloloia
Kahului, HI

David Mattila
Kihei, HI

Vicki Vallis
Kihei, HI

Jan Wine
Kihei, HI

Gary Landis
Kihei, HI

Marilyn H. Parris
Makawao, HI

Kallie and Gil Keith-Agaran
Wailuku, HI

Skippy Hau
Wailuku, HI

Lukas D. Shield
Wailuku, HI

Howard Sharpe
Wailuku, HI

Kauai
Robert Sato
Kalaheo, HI

Rob Dorman – Gabrielle Olivier
Kapaa, HI

Rich Hoeppner
Kapaa, HI

Alan Hoffman
Kapaa, HI

Anne Walton
Kapaa, HI

Brenda Zaun
Kapaa, HI

Rayne Regush
Kealia, HI

Jose Bulatao, Jr.
Kekaha, HI

Robert J. Connelly
Kekaha, HI

Zena Seeley
Kekaha, HI

Carl Berg
Kilauea, HI

Rebecca Deren
Koloa, HI

Chris White
Koloa, HI

Jeff Deren
Lihue, HI

Thomas Kaiakapu
Lihue, HI

Nina Monasevitch
Lihue, HI

Ed Nakaya
Lihue, HI

Jean Russell
Lihue, HI

Jean Souza
Lihue, HI

Barbara Elmore
Lihue, HI

Bruce Pleas
Waimea, HI

Oahu

Paul Achitoff
Honolulu, HI

Sabrina Clark
Honolulu, HI

Rick Cornelius
Honolulu, HI

Joel Fischer
Honolulu, HI

Bill Hollingsworth
Schofield Barracks, HI

Ikailea Hussey
Honolulu, HI

Wayne Johnson
Honolulu, HI

Kyle Kajihiro
Honolulu, HI

Beverly and Deepe Keever
Honolulu, HI

George Krasnick
Honolulu, HI

Charles Ota
Honolulu, HI

Mr. Vincent K. Pollard
Honolulu, HI

Paul Sullivan
Honolulu, HI

Agnes Tauyan
Honolulu, HI

Cherry Torres
Honolulu, HI

Camille Paldi
Honolulu, HI

Earth Justice
Honolulu, HI

Michael Jones
Honolulu, HI

Glenn Metzler
Honolulu, HI

George Balagan
Honolulu, HI

Patty Billington
Kaneohe, HI

Kristen U`ilani Chong
Kaneohe, HI

Donna Camvel
Kaneohe, HI

Deborah Kern
Mililani, HI

Fred Dodge
Waianae, HI

California

Marcie Powers
San Francisco, CA

Cherly Magill
Santa Clara, CA

Natural Resources Defense Council
Santa Monica, CA

Tom Norris
Encinitas, CA

Delaware

Joyce O'Neal
Millsboro, DE

New Mexico

John Geddie
Albuquerque, NM

North Carolina

Heidi Rakotz
Gastonia, NC

Washington

Rick Spaulding
Bainbridge, WA

11.0 Agencies and Individuals Contacted

11.0 AGENCIES AND INDIVIDUALS CONTACTED

The National Environmental Policy Act (NEPA) regulations require that Federal, State, and local agencies with jurisdiction or special expertise regarding environmental impacts be consulted and involved in the NEPA process. Agencies involved include those with authority to issue permits, licenses, and other regulatory approvals. Other agencies include those responsible for protecting significant resources such as endangered species or wetlands. The agencies listed below were contacted during the preparation of this Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

Federal

U.S. Army, Corps of Engineers, Regulatory Branch
Honolulu District
Fort Shafter, HI

U.S. Army, IMA Region
Pacific Regional Office
Fort Shafter, HI

U.S. Air Force Pacific
HQ, PACAF/CEVQ
Hickam AFB, HI

Federal Aviation Administration
Honolulu Control Facility
Honolulu, HI

Marine Corps Base Hawaii, Environmental
Honolulu, HI

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Hawaiian Islands Humpback Whale National Marine Sanctuary
Honolulu, HI

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve
Honolulu, HI

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Pacific Islands Regional Office
Honolulu, HI

U.S. Army Garrison, I DPW
Schofield Barracks
Honolulu, HI

U.S. Army Pacific
Honolulu, HI

U.S. Coast Guard, Commanding Officer
Civil Engineering Unit Honolulu
Honolulu, HI

U.S. Department of Transportation
Aliiaimoku Building, Room 509
Honolulu, HI

U.S. EPA Region 9
Pacific Islands Contact Office
Honolulu, HI

U.S. Fish and Wildlife Service
PJKK Federal Bldg.
Honolulu, HI

U.S. Marine Corps
Honolulu, HI

U.S. Navy CNRH-PMRF
Honolulu, HI

Navy Region Hawaii
Pearl Harbor, HI

U.S. Navy, Pacific Fleet
Pearl Harbor, HI

U.S. Army Space and Missile Defense
Command/Army Strategic Command
Redstone Arsenal, AL

Council on Environmental Quality
Washington, DC

Missile Defense Agency
Washington, DC

U.S. Department of Energy, NEPA
Compliance Officer
Kirtland Area Office
Albuquerque, NM

State

National Oceanic and Atmospheric
Administration
National Marine Fisheries Service
Hawaiian Islands Humpback Whale
National Marine Sanctuary
Department of Land and Natural Resources
Honolulu, HI

State of Hawaii, Attorney General
Honolulu, HI

State of Hawaii, DBED&T
Office of Planning
Honolulu, HI

State of Hawaii
Department Land and Natural Resources
Honolulu, HI

State of Hawaii
Department of Land and Natural Resources
Division of State Parks
Honolulu, HI

State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
Honolulu, HI

State of Hawaii
Department of Defense
Hawaii Army National Guard
Environmental Office
Honolulu, HI

State of Hawaii
Department of Health
Clean Air Branch
Honolulu, HI

State of Hawaii
Department of Health
Clean Water Branch
Honolulu, HI

State of Hawaii
Department of Health
Kinau Hale
Honolulu, HI

State of Hawaii
Department of Health
Solid and Hazardous Waste Branch
Honolulu, HI

State of Hawaii
Department of Transportation
Honolulu International Airport
Honolulu, HI

State of Hawaii
Governor's Office
Honolulu, HI

State of Hawaii
Office of Environmental Quality Control
Honolulu, HI

State of Hawaii
Office of Hawaiian Affairs
Honolulu, HI

State of Hawaii
Recreational Fishing Program
Division of Aquatic Resources
Honolulu, HI

Ms. Laura Thielen
State Historic Preservation Officer
State of Hawaii Department of Land and Natural Resources
Honolulu, HI

Local

Advisory Council on Historic Preservation

THIS PAGE INTENTIONALLY LEFT BLANK