Integrated Natural Resources Management Plan

Pacific Missile Range Facility
Islands of Kauaʻi, Kaʻula, and Niʻihau, State of Hawaiʻi
August 2023

Integrated Natural Resources Management Plan
Pacific Missile Range Facility
Islands of Kauaʻi, Oʻahu, Kaʻula, and Niʻihau, State of Hawaiʻi

August 2023

Prepared for:
Naval Facilities Engineering Command, Hawaiʻi
Honolulu, Hawaiʻi

Contract #: # N62470-13-D-8017-KB01

This page left blank.

APPROVAL

This Integrated Natural Resources Management Plan fulfills the requirements of 16 USC §670a et seq. - Sikes Act, as amended; Department of Defense Instruction 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; and Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual. This document was prepared and reviewed in coordination with the Department of Interior, acting through the Director of the U.S. Fish and Wildlife Service, and the Chairperson/Chair of the Hawai'i Department of Land and Natural Resources in accordance with the 2013 Memorandum of Understanding for a Cooperative Integrated Natural Resources Management Program on Military Installations.

By their signatures below, or enclosed letters of concurrence, all parties grant their concurrence with and acceptance of the following document.

Approving Official – Pacific Missile Range Facility

_____ _____

Stephen D. Barnett Date
Rear Admiral, U.S. Department of the Navy
Commander, Navy Region Hawai`i

_____ _____

Brett A. Stevenson Date
Captain, U.S. Department of the Navy
Commanding Officer, Pacific Missile Range Facility, Kaua'i

_____ _____

Jessica H. Behnke Date
Installation Environmental Program Director
Pacific Missile Range Facility, Kaua'i

_____ _____

Brooke A. McFarland Date
Natural Resources Manager
Pacific Missile Range Facility, Kaua'i

This page left blank.

APPROVAL

This Integrated Natural Resources Management Plan fulfills the requirements of 16 USC §670a et seq. - Sikes Act, as amended; Department of Defense Instruction 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; and Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual. This document was prepared and reviewed in coordination with the Department of Interior, acting through the Director of the U.S. Fish and Wildlife Service, and the Chairperson/Chair of the Hawai‘i Department of Land and Natural Resources in accordance with the 2013 Memorandum of Understanding for a Cooperative Integrated Natural Resources Management Program on Military Installations.

By their signatures below, or an enclosed letter of concurrence, all parties grant their concurrence with and acceptance of the following document.

Approving Official – Naval Facilities Engineering Command, Hawai‘i

_____ _____

Cameron J. Geertsema Date
Captain, U.S. Department of the Navy
Commanding Officer, Naval Facilities Engineering Command Hawai‘i

_____ _____

Sherri Eng Date
Director, Regional Environmental Department
Naval Facilities Engineering Command Hawai‘i

This page left blank.

CONCURRENCE

This Integrated Natural Resources Management Plan fulfills the requirements of 16 USC §670a et seq. - Sikes Act, as amended; Department of Defense Instruction 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; and Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual. This document was prepared and reviewed in coordination with the Department of Interior, acting through the Director of the U.S. Fish and Wildlife Service, and the Chairperson/Chair of the Hawai‘i Department of Land and Natural Resources in accordance with the 2013 Memorandum of Understanding for a Cooperative Integrated Natural Resources Management Program on Military Installations.

By their signatures below, or an enclosed letter of concurrence, all parties grant their concurrence with and acceptance of the following document.

Approving Official – State of Hawai‘i

_____ _____

David Smith Date
Admistrator
State of Hawai`i Department of Land and Natural Resources
Divison of Forestry and Wildlife

This page left blank.

CONCURRENCE

This Integrated Natural Resources Management Plan fulfills the requirements of 16 USC §670a et seq. - Sikes Act, as amended; Department of Defense Instruction 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; and Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual. This document was prepared and reviewed in coordination with the Department of Interior, acting through the Director of the U.S. Fish and Wildlife Service (USFWS), and the Chairperson/Chair of the Hawai‘i Department of Land and Natural Resources in accordance with the 2013 Memorandum of Understanding for a Cooperative Integrated Natural Resources Management Program on Military Installations and the USFWS Guidelines for Coordination on Integrated Natural Resources Management Plans (USFWS 2018b).

By their signatures below, or an enclosed letter of concurrence, all parties grant their concurrence with and acceptance of the following document. Concurrence indicates that the INRMP is compliant as it relates to exemptions under ESA section 4(a)(3)(B)(i).

Approving Official – U.S. Fish and Wildlife Service

_____ _____

Dr. Earl Campbell Date
Field Supervisor
United States Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office

This page left blank.

CONCURRENCE

This Integrated Natural Resources Management Plan fulfills the requirements of 16 USC §670a et seq. - Sikes Act, as amended; Department of Defense Instruction 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; and Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual. This document was prepared and reviewed in coordination with the Department of Interior, acting through the Director of the U.S. Fish and Wildlife Service, and the Chairperson/Chair of the Hawai‘i Department of Land and Natural Resources in accordance with the 2013 Memorandum of Understanding for a Cooperative Integrated Natural Resources Management Program on Military Installations.

By their signatures below, or an enclosed letter of concurrence, all parties grant their concurrence with and acceptance of the following document. Concurrence indicates that the INRMP is compliant as it relates to exemptions under ESA section 4(a)(3)(B)(i).

Approving Official – National Marine Fisheries Service

_____ _____

Michael Tosatto Date
Regional Administrator,
Pacific Islands Regional Office, National Oceanic and Atmospheric Administration
National Marine Fisheries Service

This page left blank.

Executive Summary

This Integrated Natural Resource Management Plan (INRMP) is a long term planning document that is intended to guide implementation of natural resources conservation at Pacific Missile Range Facility (PMRF) to support "no net loss" in military mission capability for military installation lands, while protecting and enhancing natural resources, and meeting legal requirements in accordance with the Sikes Act, as amended. The goal of the PMRF INRMP is to provide an adaptive, ecosystem-based conservation program that efficiently supports the installation mission and provides for the sustainability of natural resources. The INRMP provides technical guidance for the integration of natural resource considerations into planning and decision-making processes. The INRMP is the primary means by which natural resources compliance and stewardship priorities are set and funding requirements are identified for DoD installations. The main purpose of the INRMP is to ensure the installation commanding officer has an effectively managed natural resource program that supports and is consistent with the military mission; conserves and rehabilitates natural resources on military installations; sustains multipurpose use of the resources; and allows for public access consistent with safety and security requirements. In addition, the INRMP goals, objectives, and management strategies provide conservation benefits for species listed under the Endangered Species Act (ESA) and encourage participation, as appropriate, in regional ecosystem initiatives.

Pacific Missile Range Facility (PMRF) is located within the Hawaiian archipelago, on lands that are owned, leased, or otherwise controlled by the Navy. Areas included in the INRMP are: 1) Main Base at Barking Sands, 2) the Mākaha Ridge Tracking Station, 3) the Kōkeʻe sites, 4) the Kamokala Ridge Magazines, and 5) limited actions at Port Allen, on Kauaʻi, 6) the Kaʻula Island target range 7) the Mauna Kapu communications and radar facility on Oʻahu, and 8) the Niʻihau Island sites.

This document is a revision of the 2010 INRMP, which was developed to address changes in natural resources management strategies and practices and changes in protected species status for several species known or with potential to occur on or near PMRF. The revision includes management of five additional species: the False Killer Whale (*Pseudorca crassidens*) and Band-rumped Storm-petrel or ʻAkēʻakē (*Oceanodroma castro*), which were listed as endangered in 2012 and 2016 respectively; and the Scarlet Honeycreeper or ʻIʻiwi (*Vestiaria coccinea* syn *Drepanis coccinea*), oceanic whitetip shark (*Carcharinus lonigmanus*), and giant manta ray or Hāhālua (*Manta birostris*), which are listed as threatened under the ESA. The Scarlet Honeycreeper was listed in 2017 and the oceanic whitetip shark and giant manta ray were listed in 2018. A complete list of federally listed species known to occur on or have critical habitat on or adjacent to PMRF are listed included in the document.

This INRMP was developed in accordance with 16 United States Code (USC) §670a et seq. – Sikes Act, as amended; DoD Instruction (DoDI) 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual and USFWS Guidelines for Coordination on Integrated Natural Resources Management Plans (USFWS 2018b). Numerous Navy personnel, tenants, and related organizations, as well as, federal, state, and regional representatives and other external

organizations were invited to participate in the development and review of this document. The participating federal agencies include the statutory partners, the U.S. Fish and Wildlife Service (USFWS) and the State of Hawai‘i (SOH) Department of Land and Natural Resources (DLNR), including the SOH DLNR Division of Forestry and Wildlife (DOFAW) and the SOH Division of Aquatic Resources (DAR). In addition, the National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Services (NMFS), also called the NOAA Fisheries is another key partner because of the nearshore resources adjacent to PMRF. The public was invited to review the document as required by Sikes Act and associated DoD and DoN regulations.

The 2021 Revised PMRF INRMP establishes planning and management strategies, identifies natural resources constraints and opportunities, supports the resolution of land use conflicts, provides baseline descriptions of natural resources necessary for the development of conservation strategies and environmental assessment, and serves as the principal information source for the preparation of future environmental documents for proposed base actions. The goals, objectives, and management strategies discussed in Section 4.1 through 4.9 are balanced with the requirements of PMRF to accomplish its mission with the highest efficiency. Appendix D provides a list of actions and/or projects to be implemented based on the discussions in Section 4. The effects of implementing this INRMP are addressed under the National Environmental Policy Act (NEPA) by an Environmental Assessment and Finding of No Significant Impact, appended to this document (**Appendix H**).

Table of Contents

Page

Acronyms and Abbreviations xi
1.0 Overview 1-1
1.1 Purpose and Authority 1-1
1.2 Scope of Plan 1-1
1.3 Vision, Goals, and Objectives 1-2
1.4 Navy Responsibilities 1-2
1.4.1 Office of the Chief of Naval Operations 1-2
1.4.2 Commander, Navy Installation Command 1-3
1.4.3 Commander, Navy Region Hawaii 1-3
1.4.4 Installation Commanding Officer 1-3
1.4.5 Public Affairs Office 1-4
1.4.6 Naval Facilities Engineering Systems Command 1-4
1.4.7 Air Operations 1-4
1.4.8 Morale, Welfare, and Recreation 1-5
1.4.9 Security Forces 1-5
1.5 External Partner Responsibilities 1-5
1.5.1 Integrated Natural Resource Management Plan Signatories 1-5
1.5.2 Other External Organizations and Partners 1-6
1.6 Stewardship and Compliance 1-6
1.7 Statutory Requirements Pertinent to Natural Resources Management 1-7
1.7.1 Sikes Act 1-7
1.7.2 Other Environmental Statutes 1-7
1.8 Navy Natural Resources Management 1-8
1.8.1 Ecosystem Management 1-8
1.8.2 Adaptive Management 1-9
2.0 Location, Land Use, History 2-1
2.1 General Overview 2-1
2.1.1 Location of PMRF Facilities 2-1

2.1.2 Nearshore Areas....2-1
2.1.3 Offshore Areas....2-1
2.2 Barking Sands Location, History, and Mission....2-6
2.2.1 Location....2-6
2.2.2 Abbreviated History and Pre-Military Land Use....2-8
2.2.3 Military Mission, Operations, and Activities....2-10
2.2.4 Possible Mission Constraints....2-11
2.2.5 Emergent and Future Training....2-14
2.3 Mākaha Ridge Tracking Station Location, History, and Mission....2-14
2.3.1 Location....2-14
2.3.2 Abbreviated History and Pre-Military Land Use....2-16
2.3.3 Military Mission, Operations, and Activities....2-16
2.3.4 Possible Mission Constraints....2-16
2.4 Kōkeʻe Sites Location, History, and Mission....2-18
2.4.1 Location....2-18
2.4.2 Abbreviated History and Pre-Military Land Use....2-18
2.4.3 Military Mission, Operations, and Activities....2-20
2.4.4 Possible Mission Constraints....2-20
2.5 Kamokala Ridge Magazines Location, History, and Mission....2-20
2.5.1 Location....2-20
2.5.2 Abbreviated History and Pre-Military Land Use....2-21
2.5.3 Military Mission, Operations, and Activities....2-21
2.5.4 Possible Mission Constraints....2-21
2.6 Port Allen Location, History, and Mission....2-21
2.6.1 Location....2-21
2.6.2 Mission, Operations, and Activities....2-21
2.7 Kaʻula Island Location, History, and Mission....2-24
2.7.1 Location....2-24
2.7.2 Abbreviated History and Pre-Military Land Use....2-24
2.7.3 Military Mission, Operations, and Activities....2-25
2.7.4 Possible Mission Constraints....2-25

2.8 Mauna Kapu Location, History, and Mission 2-25
2.8.1 Location 2-25
2.8.2 Abbreviated History and Pre-Military Land Use 2-25
2.8.3 Military Mission, Operations, and Activities 2-26
2.8.4 Possible Mission Constraints 2-26
2.9 Niʻihau Sites Location, History, and Mission 2-26
2.9.1 Location 2-26
2.9.2 Abbreviated History and Pre-Military Land Use 2-28
2.9.3 Military Mission, Operations, and Activities 2-28
2.9.4 Possible Mission Constraints 2-28
3.0 Natural Resources Present 3-1
3.1 Physical Environment 3-1
3.1.1 Geology 3-1
3.1.2 Geography 3-1
3.1.3 Climate 3-3
3.1.4 Hydrology 3-4
3.2 Biotic Environment 3-5
3.2.1 General Flora 3-5
3.2.2 Special Status Plant Species 3-6
3.2.3 Invasive Plant Species 3-7
3.2.4 General Fauna 3-8
3.2.5 Special Status Wildlife Species 3-9
3.2.6 Invasive Fauna 3-9
3.3 Barking Sands Natural Resources 3-16
3.3.1 Topography, Geology, and Soils 3-16
3.3.2 Hydrology 3-19
3.3.3 Terrestrial Habitats, Vegetation Communities, and Land Cover 3-21
3.3.4 Invasive and Introduced Wildlife Species 3-24
3.3.5 Special Status Species 3-25
3.3.6 Coastal and Nearshore Environment 3-32
3.4 Mākaha Ridge Tracking Station Natural Resources 3-35

3.4.1 Topography, Geology, and Soils....3-35
3.4.2 Hydrology....3-39
3.4.3 Terrestrial Habitats, Vegetation Communities, and Land Cover....3-39
3.4.4 Invasive and Introduced Species....3-43
3.4.5 Special Status Species....3-43
3.5 Kōkeʻe Sites Natural Resources....3-43
3.5.1 Topography, Geology, and Soils....3-43
3.5.2 Hydrology....3-49
3.5.3 Terrestrial Habitats, Vegetation Communities, and Land Cover....3-49
3.5.4 Invasive and Introduced Wildlife....3-52
3.5.5 Special Status Species....3-52
3.6 Kamokala Ridge Magazines Natural Resources....3-55
3.6.1 Topography, Geology, and Soils....3-55
3.6.2 Hydrology....3-60
3.6.3 Terrestrial Habitats, Vegetation Communities, and Land Cover....3-60
3.6.4 Invasive and Introduced Wildlife Species....3-63
3.6.5 Special Status Species....3-63
3.7 Port Allen Natural Resources....3-64
3.7.1 General Description....3-64
3.7.2 Special Status Species....3-64
3.8 Kaʻula Island Natural Resources....3-64
3.8.1 Topography, Geology, and Soils....3-64
3.8.2 Hydrology....3-66
3.8.3 Terrestrial Habitats, Vegetation Communities, and Land Cover....3-66
3.8.4 Invasive and Introduced Wildlife Species....3-66
3.8.5 Special Status Species....3-66
3.9 Mauna Kapu Site Natural Resources....3-67
3.9.1 Topography, Geology, and Soils....3-67
3.9.2 Hydrology....3-76
3.9.3 Terrestrial Habitats, Vegetation Communities, and Land Cover....3-76
3.9.4 Invasive and Introduced Wildlife Species....3-76

3.9.5 Special Status Species 3-76
3.10 Niʻihau Natural Resources 3-77
3.10.1 Topography, Geology, and Soils 3-77
3.10.2 Hydrology 3-80
3.10.3 Terrestrial Habitats, Vegetation Communities, and Land Cover 3-80
3.10.4 Invasive and Introduced Wildlife Species 3-80
3.10.5 Special Status Species 3-81
4.0 Natural Resource Management 4-1
4.1 General Natural Resources Management 4-1
4.1.1 Environmental Planning 4-1
4.1.2 General Habitat Management 4-1
4.1.3 General Nuisance and Invasive Animal Management 4-6
4.1.4 Special Status Species Management 4-9
4.1.5 Terrestrial Invertebrate and Pollinator Management 4-20
4.1.6 Data Collection and Database and Records Management 4-22
4.1.7 Outdoor Recreation 4-23
4.1.8 Natural Resources Awareness, Education, and Training 4-27
4.2 Barking Sands Natural Resources Management 4-28
4.2.1 Albatross Management 4-29
4.2.2 Wedge-tailed Shearwater Management 4-31
4.2.3 Wetland and Waterbird Management 4-34
4.2.4 Marine Mammal and Sea Turtle Management 4-37
4.2.5 Marine Nearshore Management 4-42
4.2.6 Niʻihau Panicgrass (*Panicum niihauense)* Critical Habitat Management 4-43
4.3 Mākaha Ridge Tracking Station Natural Resource Management 4-44
4.3.1 Dwarf Iliau, Hawaiʻi Scaleseed, and Other Listed Plant Species 4-44
4.4 Kōkeʻe Sites Natural Resource Management 4-45
4.4.1 Hawaiian Picture-wing Fly 4-45
4.5 Kamokala Ridge Magazines Natural Resources Management 4-46
4.6 Port Allen Natural Resource Management 4-47
4.7 Kaʻula Island Natural Resource Management 4-47

4.8 Mauna Kapu Site Natural Resource Management 4-49
4.9 Niʻihau Natural Resource Management 4-49
5.0 INRMP Integration and Implementation....5-1
5.1 Integration with Other Installation Plans....5-1
5.1.1 Navy Region Hawaiʻi Regional Integration Plan....5-1
5.1.2 Integrated Cultural Resources Management Plan....5-1
5.1.3 Environmental Restoration Plan....5-1
5.2 Relationship to Regional Conservation Planning Efforts....5-2
5.2.1 State Wildlife Action Plan....5-2
5.2.2 Hawaiian Bird Conservation Action Plan....5-3
5.2.3 Regional Biosecurity Plan for Micronesia and Hawaiʻi....5-3
5.2.4 Kawaiʻele Bird Sanctuary....5-4
5.2.5 Mānā Plain Forest Reserve Wetland Restoration....5-4
5.3 Integrating Natural Resources and Mission Sustainability....5-5
5.3.1 Natural Resources Support of the Military Mission....5-5
5.3.2 Sustainability Challenges....5-5
5.4 INRMP Review and Revision....5-11
5.4.1 Streamlined INRMP Review....5-11
5.4.2 Annual Conservation Program Metrics Review....5-13
5.5 NEPA Analysis on INRMPs....5-13
5.5.1 Environmental Planning Library and Reporting Requirements....5-14
5.5.2 Navy Conservation Website....5-14
5.6 Funding Priority and Strategy....5-16
5.6.1 Environmental Readiness Levels....5-16
5.6.2 Funding Sources....5-17
5.6.3 Federal Anti-Deficiency Act....5-17
5.7 Staffing Needs....5-17
5.7.1 Professional Development and Natural Resources Training....5-17
6.0 References....6-1

APPENDICES (Volume II)

APPENDIX A – Key Federal Statutes Related to Natural Resources Management
APPENDIX B – Memoranda of Understanding and Agreements
APPENDIX C – PMRF Floral and Faunal Species Lists
APPENDIX D – INRMP Project, Schedule, and Implementation Table
APPENDIX E – Protected Species Standard Operating Procedures
APPENDIX F – Protected Species Management Plans
APPENDIX G– Protected Species Outreach Materials
APPENDIX H – Environmental Assessment for PMRF INRMP

This page left blank.

Table of Figures

Figure 2-1. PMRF Site Locations and Supported Offshore Ranges 2-3
Figure 2-2. Barking Sands Overview 2-7
Figure 2-3. Barking Sands Constraints 2-13
Figure 2-4. Mākaha Ridge Tracking Station Overview and Facilities 2-15
Figure 2-5. Mākaha Ridge Tracking Station Constraints: Surface Water, Bare Soil, and Endangered Plants 2-17
Figure 2-6. Kōkeʻe Sites Overview 2-19
Figure 2-7. Kamokala Ridge Magazines Overview 2-22
Figure 2-8. Kamokala Ridge Magazines Constraints 2-23
Figure 2-9. Niʻihau Island Overview and Facilities 2-27
Figure 3-1. The Hawaiian Archipelago 3-2
Figure 3-2. Barking Sands Elevation Contours 3-17
Figure 3-3. Barking Sands Soils 3-18
Figure 3-4. Barking Sands Wetlands and Surface Water 3-20
Figure 3-5. Barking Sands Vegetation Types 3-22
Figure 3-6. Special Status Species Habitat at Barking Sands 3-31
Figure 3-7. Barking Sands Marine Sectors 3-34
Figure 3-8. Mākaha Ridge Elevation Contours 3-36
Figure 3-9. Mākaha Ridge Tracking Station Soils 3-37
Figure 3-10. Mākaha Ridge Tracking Station Wetlands and Surface Water 3-40
Figure 3-11. Mākaha Ridge Tracking Station Vegetation 3-41
Figure 3-12. Special Status Species Habitat at Mākaha Ridge Tracking Station 3-44
Figure 3-13. Kōkeʻe Sites Elevation Contours 3-47
Figure 3-14. Kōkeʻe Sites Soils and Adjacent Wetlands and Surface Waters 3-48
Figure 3-15. Kōkeʻe Sites Vegetation Map 3-50
Figure 3-16. Protected Species Designated Critical Habitat near the Kōkeʻe Sites 3-56
Figure 3-17. Kamokala Ridge Magazines Elevation Contours 3-57
Figure 3-18. Kamokala Ridge Magazines Soils 3-59
Figure 3-19. Kamokala Ridge Magazines Wetlands and Surface Waters 3-61
Figure 3-20. Kamokala Ridge Magazines Vegetation Map 3-62
Figure 3-21. Soils and Surface Waters Adjacent to the Mauna Kapu Facility 3-75
Figure 3-22. Protected Species Critical Habitat Adjacent to the Mauna Kapu Facility 3-78
Figure 3-23. Elevation Contours, Surface Waters, and Critical Habitat on Niʻihau Island 3-79
Figure 4-1. Barking Sands Recreational Areas 4-25
Figure 5-1. Agricultural Preservation Initiative Leased Lands 5-7
Figure 5-2. Predicted One and Three-Foot Sea Level Rise at Barking Sands 5-11

Table of Tables

Table 2-1. Lands Owned, Leased or Otherwise Used by the PMRF 2-4
Table 2-2. Kōkeʻe Site Summary 2-18
Table 3-1. Threatened and Endangered Plant Species and Critical Habitat on or adjacent to PMRF Sites 3-6
Table 3-2. State Noxious Weeds, Kauaʻi Invasive Species Committee Target Species, and Select Invasive Plants Identified at PMRF 3-7
Table 3-3. Federal and State Threatened and Endangered Wildlife Species on or adjacent to PMRF Sites 3-10
Table 3-4. Marine Mammal Protection Act and Native Migratory Bird Treaty Act Protected Species on or adjacent to PMRF Sites 3-12
Table 3-5. Invasive and Injurious Wildlife Identified at PMRF 3-15
Table 3-6. Soil Series at Barking Sands 3-16
Table 3-7. Vegetation Cover Types at Barking Sands in 2005 3-21
Table 3-8. Special Status Species on or near Barking Sands 3-26
Table 3-9. Soil Series at Mākaha Ridge Tracking Station 3-38
Table 3-10. Vegetation Communities at Mākaha Ridge Tracking Station 3-39
Table 3-11. Special Status Species on or near at Mākaha Ridge Tracking Station 3-45
Table 3-12. Soil Series at the Kōkeʻe Sites 3-49
Table 3-13. Vegetation Communities at the Kōkeʻe Sites 3-51
Table 3-14. Special Status Species on or near the Kōkeʻe Sites 3-53
Table 3-15. Soil Series at the Kamokala Ridge Magazines 3-58
Table 3-16. Vegetation Communities at Kamokala Ridge Magazines 3-60
Table 3-17. Special Status Species on or near Kamokala Ridge Magazines 3-65
Table 3-18. Special Status Species on or near Kaʻula Island 3-69
Table 3-19. Special Status Species on or near Niʻihau Island 3-82

Acronyms and Abbreviations

ac	Acre
AFB	Air Force Base
AICUZ	Air Installation Compatibility Use Zone
Air Ops	Airfield Operations
AOA	Airfield Operations Area
APHIS-WS	Animal and Plant Health Inspection Service-Wildlife Services
API	Agricultural Preservation Initiative
APZs	Accident Potential Zones
ARDEL	Advanced Detection Radar Laboratory
AT/FP	Antiterrorism/Force Protection
BASH	Bird/Animal Aircraft Strike Hazard
BL	Badland
BM	Badland-Mahana
BS	Beach Sand
C	Celsius
CECOS	Civil Engineer Corps Officer School
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	Centimeters
CNIC	Commander, Navy Installation Command
CNRH	Commander, Navy Region Hawai‘i
CO	Commanding Officer
COMUSFLTFORCOM	Commander, United States Fleet Forces Command
COMUSPACFLT	Commander, United States Pacific Fleet
CWCS	Comprehensive Wildlife Conservation Strategy
CZ	Clear Zones
DAR	Division of Aquatic Resources
DL	Dune Land
DLNR	Department of Land and Natural Resources
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOE	Department of Energy
DOFAW	Division of Forestry and Wildlife
DoN	Department of The Navy
DPS	Distinct Population Segment
E	Endangered
EDRR	Early Detection and Rapid Response
EFH	Essential Fish Habitat
EMI	Electromagnetic Interference
EMR	Electromagnetic Radiation

EMRG	Electromagnetic Railgun
EMS	Environmental Managment Systems
EOs	Exeutive Orders
EPA	Environmental Protection Agency
EPR	Environmental Program Requirements
ER	Environmental Restoration
ERL	Environmental Readiness Level
ESA	Endangered Species Act
ESQD	Explosives Safety Quantity Distance
F	Fahrenheit
Fd	Fill Land
FONSI	Finding of No Significant Impact
FPCON	Force Protection Conditions
FR	Federal Register
ft	Feet
ft^2	Square Foot/Feet
GHAs	Ground Hazard Areas
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectare
HAPC	Habitat Areas of Particular Concern
HERF	Hazard of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
HIANG	Hawai‘i Air National Guard
HWMO	Hawai‘i Wildfire Management Organization
ICRMP	Installation Cultural Resources Management Plan
IEPD	Installation Environmental Program Director
iNFADS	Internet Naval Facilities Assets Data Store
INRMP	Integrated Natural Resources Management Plan
KESRP	Kaua‘i Endangered Seabird Recovery Project
Kf	Kaloko Clay Loam
Kfa	Kaloko Clay
KISC	Kaua‘i Invasive Species Committee
km^2	Square Kilometer(S)
KTF	Kaua‘i Test Facility
LEONIDAS	Low Earth Orbit Nanosat Integrated Defense Autonomous Systems
LUC	Land Use Commission
m	Meter(S)
m^2	Square Meter(S)
MaD	Mahana Silt Loam
MBTA	Migratory Bird Treaty Act
MHI	Main Hawaiian Islands
mi	Mile(s)

MILCON	Military Contruction
MMPA	Marine Mammal Protection Act
MnC	Mamala Stoney Silty Clay Loam
MOAs	Memoranda of Agreements
MOUs	Memoranda of Understanding
MWR	Morale, Welfare, And Recreation
n.d.	No Date
NASA	National Aeronautics and Space Administration
NAVFAC HI	Naval Facilities Engineering Command Hawai‘i
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NEPA	National Environmental Policy Act
NFWF	National Fish and Wildlife Foundation
NERTP	Navy Environmental Readiness Training Program
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
nm^2	Square Nautical Mile(S)
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NRC	Natural Resources Conservation
NRHP	National Register of Historic Places
NRM	Natural Resources Manger
NTSP	Navy Training System Plan
NWCF	Navy Working Capital Fund
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
O&M, N	Operations and Maintenance, Navy
OPNAV M	Chief of Naval Operations Manual
OPNAVINST	Chielf of Naval Operations Instruction
PAO	Public Affairs Office
PMC	Pest Management Consultant
PVC	Polyvinyl Chloride
RBP	Regional Biosecurity Plan for Micronesia And Hawai‘i
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Testing, and Evaluation
REPI	Readiness and Environmental Protection Integration
RPM	Remedial Project Manager
rRO	Rock Outcrop
rRR	Rough Broken Land
SCAMP	Spacecraft Antenna on Medium Pedestal
SCS	Soil Conseration Service
SOH	State of Hawai‘i
SOPs	Standard Operating Procedures
SOS	Save Our Shearwaters
STARS	Strategic Target Systems

SWAP	State Wildlife Action Plan
T	Threatened
THAAD	Terminal High Altitude Area Defense
TNC	The Nature Conservancy
TOA	Temporary Operating Area
U.S.	United States
UHF/VHF	Ultra-High Frequency/Very High Frequency
USAF	U.S. Air Force
USC	United States Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U. S. Geological Survey
UXO	Unexploded Ordnance
WPRFMC	Western Pacific Regional Fishery Management Council
WRCC	Western Regional Climate Center

1

1.0 OVERVIEW

1.1 Purpose and Authority

In accordance with Title 16 United States Code (USC) §670a et seq. – Sikes Act, as amended; DoD Instruction (DoDI) 4715.03 – Natural Resources Conservation Program; Department of Defense Manual (DoDM) 4715.03 – Integrated Natural Resources Management Plan Implementation Manual; Chief of Naval Operations Instruction (OPNAVINST) 5090.1E – Environmental Readiness Program; and Chief of Naval Operations Manual OPNAV M-5090.1 – Environmental Readiness Program Manual, the Department of the Navy (DoN) is required to implement and maintain a balanced and integrated program for the management of natural resources. This INRMP has been developed for the Commander, Navy Region Hawai‘i (CNRH) and the PMRF Installation to ensure consistency with the installation's military mission and to support "no net loss" in mission capability, while providing for the conservation and rehabilitation and the sustainable multipurpose use of natural resources on PMRF. In accordance with DoD policy on natural resources conservation programs, an INRMP must work to guarantee DoD's continued access to its land, air, and water resources for realistic military training and testing and to sustain the long-term ecological integrity of natural resources and the ecosystem services they provide (DoDI 4715.03). The INRMP must also ensure natural resources conservation and military operations are integrated and consistent with Navy policy on stewardship and all legal requirements concerning natural resources.

This INRMP is a long-term planning document that guides implementation of natural resources conservation at PMRF to ensure support for the installation mission, while protecting and enhancing natural resources, and meeting legal requirements. It provides technical guidance for the integration of natural resources issues into planning and decision-making processes based, to the maximum extent practicable, on the tenets of ecosystem management.

1.2 Scope of Plan

INRMPs are applicable to all DoD operations, activities, real property, and property interests owned, leased, permitted, or controlled in the United States, including public lands withdrawn from all forms of appropriation pursuant to public land laws and reserved for use by DoD, as well as State lands used for military training and testing. DoD operations, activities, and installations in the United States; U.S. territories, trusts, and possessions; and Government-owned and contractor-operated facilities are included within the scope (DoDI 4715.03).

This INRMP was prepared for PMRF, which is located within the Hawaiian archipelago, primarily on Navy-owned property on the western shore of the island of Kaua‘i. Several other leased, rented, or owned properties including Ni‘ihau Island, Ka‘ula Island, and Mauna Kapu, O‘ahu comprise portions of the facility.

The INRMP is applicable to the lands, waters, airspace, and coastal resources of all properties assigned to PMRF including 1) Main Base at Barking Sands, 2) the Mākaha Ridge Tracking Station, 3) the Kōke‘e sites, 4) the Kamokala Ridge Magazines, 5) limited areas at Port Allen, and 6) the Miloli‘i

Ridge reflector on Kauaʻi 7) the Kaʻula Island target range 8) the Mauna Kapu communications and radar facility and 9) the Mount Kaʻala communications center on Oʻahu, and 10) the Niʻihau Island sites. Some of these sites have no natural resources as they are merely building facilities or are only a few square feet (ft^2) in size. Land and water areas covered under this INRMP are more fully described in Section 2.1.2.

1.3 Vision, Goals, and Objectives

The vision for the PMRF Natural Resources Conservation (NRC) Program is to ensure the sustainability of all the ecosystems within the installation and a no net loss of the capability of installation lands or facilities to support the military mission. Maintenance of healthy ecosystems supports realistic military training and testing, which in turn promotes mission readiness. To ensure the success of the NRC Program the following must be accomplished:

- Integrate NRC responsibilities with military activities, installation planning and programming, and other activities as appropriate to ensure no net loss to the Navy mission;
- Ensure sustainable multipurpose use of the resources and public access when consistent with the mission, and safety and security requirements; and
- Interact with the surrounding community to develop positive and productive community involvement, participation, and educational opportunities.

The goal of the PMRF INRMP is to provide an adaptive ecosystem-based conservation program that efficiently supports the installation mission and provides for the sustainability of natural resources. An installation overview is provided in Chapter 2. Natural resources present at the installation are identified in Chapter 3. Management objectives and strategies are identified in Chapter 4. INRMP implementation, five-year and annual reviews, including Navy metrics, and updates are described in Chapter 5.

1.4 Navy Responsibilities

The responsibility for the development, review, revision, and implementation of INRMPs is shared by several commands and other internal Navy stakeholders. The roles and responsibilities for Navy natural resources management are fully described in SECNAVINST 5090.8A, dated 2006 and Manual 5090.1E, dated 2019 and in the Navy guidance for INRMP development and implementation (U.S. Navy 2006). A brief overview of responsibilities for natural resources management at the national and regional levels and at PMRF follows.

1.4.1 Office of the Chief of Naval Operations

The Chief of Naval Operations, Energy and Environmental Readiness Division (N45) is responsible for all Navy environmental and natural resources programs and the development and dissemination of Navy policy guidance for environmental readiness. N45 also serves as the principal leader to provide policy, guidance, and resources for the development, revision, and implementation of INRMPs and represents the Navy on issues and resolves high-level conflicts regarding development and implementation of INRMPs. With N45 support, DoD produces an end-of-year Environmental

Management Review, the Defense Environmental Programs Annual Report to Congress (DEPARC), to meet Congressional and in-house requirements from data derived from the annual metrics review.

1.4.2 Commander, Navy Installation Command

The Commander, Navy Installation Command (CNIC) has overall shore installation management responsibility and authority as the Budget Submitting Office for installation support and the Navy point of contact for installation policy and program execution oversight. The CNIC must ensure the programming of resources necessary to maintain and implement INRMPs; participate in the development and revision of INRMPs; endorse INRMPs and promote and coordinate their implementation, and evaluate and validate Program Objectives Memorandum (POM) submittals and other requests for funds for natural resources projects. The CNIC must also ensure professionally trained natural resources managers have been assigned to implement installation NRC programs and ensure natural resources on government-owned, contractor-operated installations are managed in compliance with natural resources laws, regulations, and applicable policy and guidance.

1.4.3 Commander, Navy Region Hawaii

The Commander, Navy Region Hawaii (CNRH) ensures that installations comply with DoD, Navy, and CNO policy on INRMPs and their associated National Environmental Policy Act (NEPA) documentation; that CNRH INRMPs undergo annual reviews and formal five-year evaluations; and the programming of resources necessary to maintain and implement INRMPs, which involves the evaluation and validation of Environmental Program Requirements (EPR) web-based project proposals and the funding of installation natural resources management staff.

1.4.4 Installation Commanding Officer

The PMRF Installation Commanding Officer (CO) oversees the operations occurring at the facility and is ultimately responsible for all aspects of the facility. The COs role is to: act as steward of natural resources under his or her jurisdiction and integrate natural resources requirements into the day-to-day decision making process; ensure natural resource management and INRMPs comply with all natural resources related Federal regulations, directives, instructions, and policies; involve appropriate tenant, operational, training, or testing commands in the INRMP review process to ensure no net loss of military mission; designate a Natural Resources Manager/Coordinator responsible for the management efforts related to the preparation, revision, implementation, and funding for INRMPs, as well as coordination with subordinate commands and installations; involve advice and counsel with respect to legal matters related to natural resources management and INRMPs; and endorse INRMPs via CO signature. The Installation Commanding Officer is required to participate in the annual natural resources program and INRMP metrics review. The Installation Commanding Officer is required to participate in the annual natural resources program and INRMP metrics review. The Commanding Officer must further send a written report to USFWS and the appropriate state fish and wildlife agency following the annual INRMP metric review no later than 31 January of each year. The report is discussed further in Section 5.4. Annual reviews must also be documented and signed by these parties.

1.4.5 Public Affairs Office

The Public Affairs Office (PAO) provides a significant link between the INRMP and the on-off-facility communities. The PAO can facilitate communication between the facility and the community regarding environmental management initiatives. Any proposed communications outside the facility should be discussed with the PAO.

1.4.6 Naval Facilities Engineering Systems Command

Naval Facilities Engineering Systems Command Hawai‘i (NAVFAC HI) serves as the technical and contracting support command to CNRH and PMRF. NAVFAC HI Natural Resources staff work together with PMRF and Navy activities in an on-going effort to sustainably manage the natural resources at the base. NAVFAC Pacific (NAVFAC PAC) provides additional support to NAVFAC HI, as needed.

1.4.6.1 Public Works Department

Environmental Division

The Public Works Officer is the representative of NAVFAC HI and is responsible to the CO for the PMRF Environmental Program supervised by the Installation Environmental Program Director (IEPD). Within the environmental program, the IEPD oversees natural resources, cultural resources, environmental protection and compliance on the installation. The IEPD is supported by an on-site Natural Resources Manager (NRM) who coordinates implementation of NRC Program projects and natural resources management activities at PMRF. The NRM is the point of contact to provide relevant information on issues with potential to affect natural resources and assures coordination among facility planners and federal and state officials to ensure the base’s continued ability to support the Navy mission. Conservation actions and natural resources management activities are implemented by a team of Natural Resources biologists through a Cooperative Agreement with the Pacific Cooperative Studies Unit (PCSU). This team, in conjunction with the NRM, ensures that appropriate avoidance and mitigation measures are in place to assure protection of federally listed threatened and endangered, or otherwise protected species and their habitats. Natural Resources biologists conduct field surveys and work closely with state and federal agencies to develop and implement the NRC Program. Interns, volunteers or biological technicians may also be brought on to assist with natural resources tasks, when needed. The NRM in coordination with other stakeholders conducts annual reviews to assess the INRMP goals and objectives, establish a realistic schedule for undertaking proposed actions, and determine adjustments needed to keep INRMPs current. It is recommended that the review for operation and effect be conducted during the annual INRMP metrics review.

Integrated Pest Management (IPM) at PMRF is also under the jurisdiction of the Public Works Officer and is conducted through the Base Operations Support Contract for Pest Management, which employees a Pest Management Technician.

1.4.7 Air Operations

Responsibility for the bird/animal aircraft strike hazard (BASH) program primarily lies with the Air Operations Officer at PMRF. The BASH program, however, coordinates with all entities supporting

the aviation mission, including the Environmental Program. The IEPD is responsible for ensuring the BASH program is compliant with all applicable state and federal environmental laws and regulations, and all applicable DoD, DoN, and U.S. Navy policies, directives, and instructions (CNICINST 3700). In addition, CNIC has a work/financial plan with the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) to provide BASH support at Barking Sands.

1.4.8 Morale, Welfare, and Recreation

Morale, Welfare, and Recreation (MWR) provides recreational opportunities to active and retired military and their dependents, DoD civilians, and sponsored guests at PMRF. MWR manages the beach cottages, recreational beach facilities, and access via the base to recreational beaches at Barking Sands and sponsors many outdoor recreational activities. MWR works with the Environmental Program to avoid and mitigate any impacts recreational activities may have on protected and sensitive species and other natural resource and collaborates on beach clean-up and Earth Day events.

1.4.9 Security Forces

Security Forces at PMRF are responsible for base security and provide support to the Environmental Program in several ways. During daily security patrols, they are asked to report particular sightings of note of rare, threatened, or endangered species that may occur on base or in the nearshore environment; and they provide a single point of contact for environmental emergencies such as injured bird response (Security then conducts proper notifications to Environmental). Conservation law enforcement is also under the purview of Security Forces and as such they enforce beach restrictions and ensure that all protective measures for protected species and wildlife are enforced. PMRF has a designated game warden who oversees the PMRF Archery Club and coordinates hunts with PMRF Command and Division of Forestry and Wildlife (DOFAW).

1.5 External Partner Responsibilities

1.5.1 Integrated Natural Resource Management Plan Signatories

A number of federal and state agencies have an interest or a role in the management of natural resources at PMRF. The involvement of these agencies is based on signatory responsibilities, cooperative agreements, regulatory authority, and technical assistance as required by federal laws and regulations. The signatories include the USFWS, National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Services (NMFS), also called the NOAA Fisheries; and the SOH DOFAW. These partners participate in INRMP reviews for operation and effect, provide advice and subject matter expertise on conservation objectives and strategies, participate in project development, and, where applicable, participate in project implementation. The partners also provide feedback on annual INRMP implementation.

The primary mission of the USFWS is working with others to conserve, protect and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people (USFWS 2019a). The USFWS provides the Navy technical assistance with rare plant and wildlife issues. In addition, the DoD and Navy consult formally and informally with the USFWS on the impacts of Navy activities on

federally listed species and designated critical habitat under section 7 of the ESA, as amended (16 U.S.C. §1631).

NOAA Fisheries is responsible for the stewardship of the nation's ocean resources and their habitat. They provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems (NOAA Fisheries 2019). The Navy coordinates and consults with NOAA Fisheries regarding marine resources including Hawaiian Monk Seal or ʻIlio-holo-i-ka-uaua (*Neomonachus schauinslandi*), marine mammal, and sea turtle surveys, strandings, and management.

The mission of DLNR DOFAW is to responsibly manage and protect watersheds, native ecosystems, and cultural resources and provide outdoor recreation and sustainable forest products opportunities, while facilitating partnerships, community involvement and education (SOH DOFAW 2019). The Navy coordinates with DOFAW on seabird protection and other wildlife management issues.

This INRMP reflects the mutual agreement of these parties concerning conservation, protection, and management of fish and wildlife resources. Future involvement of the state and federal wildlife agencies will ensure continued mutual agreement and cooperation in managing the natural resources at PMRF through annual INRMP reviews and reviews for operation and effect. The INRMP also supports critical habitat exemptions for listed species on PMRF land.

1.5.2 Other External Organizations and Partners

PMRF also maintains strong, collaborative working relationships with the SOH DLNR Division of Aquatic Resources (DAR), the County of Kauaʻi Department of Planning, the University of Hawaiʻi /Kauaʻi Community College, the Kauaʻi Invasive Species Committee (KISC), non-governmental organizations including the Cascadia Research Collective, The Nature Conservancy (TNC), the National Tropical Botanical Gardens, the Kauaʻi Endangered Seabird Recovery Project, Save our Shearwaters (SOS), Native Hawaiian Organizations, and two Hawaiian language charter schools for children from Niʻihau.

PMRF is an active member of the Kauaʻi Conservation Alliance, which is a consortium of governmental non-governmental organizations and individuals who gather quarterly to share experiences and lessons learned in their various specialties and areas of interest, with the focus on cultural and natural resource conservation and education related specifically to Kauaʻi. It is an informal outreach forum where natural resources managers and concerned citizenry from different backgrounds with different mandates and/or opinions can network at a personal level.

1.6 Stewardship and Compliance

The Navy is responsible for complying with all applicable environmental laws and regulations including Presidential Executive orders (EOs); and Memoranda of Agreements or Understanding (MOAs or MOUs), and DoD and Navy directives, instructions, and manuals. The DoN further recognizes that actions beyond complying with environmental regulations are often required to sustain the mission and meet environmental stewardship responsibilities. Stewardship is the responsibility to inventory, manage, conserve, protect, and enhance the natural resources entrusted to one’s care in a

way that enhances the resources and their benefits for present and future generations (OPNAV M 5090.1). This INRMP identifies both stewardship and compliance actions and projects that help meet natural resources management goals at PMRF.

Key environmental regulatory drivers and their implication for natural resources management at PMRF were considered during the development of this INRMP and are described in **Appendix A**.

1.7 Statutory Requirements Pertinent to Natural Resources Management

1.7.1 Sikes Act

The Sikes Act is the primary federal statute requiring natural resource management on military installations. The Sikes Act requires, to the extent appropriate and applicable, that the INRMP provide for:

- Fish and wildlife management, land management, forest management, and fish- and wildlife-oriented recreation;
- Fish and wildlife habitat enhancement or modifications,
- Wetland protection, enhancement, and restoration, where necessary for support of fish, wildlife, or plants;
- Integration of, and consistency among the various activities conducted under the plan;
- Establishment of specific natural resources management objectives and time frames for proposed actions;
- Sustained use by the public of natural resources to the extent such that use is consistent with the needs of fish and wildlife management and subject to installation safety and security requirements;
- Enforcement of applicable natural resources laws and regulations;
- No net loss in the capability of installation lands to support the military mission of the installation; and
- Such other activities as the Secretary of the military department determines appropriate.

The development and implementation of this INRMP revision fulfills the statutory requirements as defined under the Sikes Act.

1.7.2 Other Environmental Statutes

Additional federal environmental laws that are primary legal drivers for natural resources management at PMRF include, but are not limited to:

- Endangered Species Act (ESA)
- Migratory Bird Treaty Act (MBTA)
- Marine Mammal Protection Act (MMPA)
- Clean Water Act
- Coastal Zone Management Act
- Magnuson-Stevens Fisheries Conservation and Management Act
- Federal Noxious Weed Act

- NEPA
- Clean Air Act

Environmental mandates also include several presidential EOs and MOUs such as:

- EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds
- EO 13751 – Safeguarding the Nation from the Impacts of Invasive Species
- EO 11990 – Protection of Wetlands
- EO 11988 – Floodplain Management
- EO 12962 – Recreational Fisheries
- MOU between DoD and USFWS and the Association of Fish and Wildlife Agencies for a Cooperative Integrated Natural Resources Management Program on Military Installations (Tripartite Agreement)
- MOU between DoD and the Pollinator Partnership
- MOU between DoD and USFWS to Promote the Conservation of Migratory Birds
- MOU between DoD and Bat Conservation International.

A description of these statutory drivers and copies of the above-referenced MOUs that are integral to natural resources management at PMRF are provided in Appendix A and B, respectively.

1.8 Navy Natural Resources Management

Navy policy on natural resources management, as summarized from OPNAVINST 5090.1E, is to manage natural resources in support of and consistent with the installation mission, while protecting and enhancing those resources. Land use practices and decisions must be based on scientifically sound conservation procedures and techniques, use scientific methods, and have an ecosystem management approach.

1.8.1 Ecosystem Management

DoDI 4715.03 further requires that INRMPs incorporate the principles of ecosystem management for natural resources under the stewardship and control of DoD. DoD recognizes that maintaining or improving biodiversity contributes to overall ecosystem integrity and sustainability in support of the military mission. The goals of this strategy are to maintain and improve the sustainability and biological diversity of terrestrial and aquatic ecosystems while supporting sustainable economies, human use, and the environment required for realistic military training operations. The basic principles and guidelines of ecosystem management are to:

- Preserve the function and integrity of natural ecosystems,
- Integrate human social and economic interests with environmental considerations,
- Involve all interested parties and stakeholders in identifying management goals, and
- Adapt to changing conditions and requirements.

It is DoD policy to conduct installation programs and activities to identify, maintain, and restore the composition, structure, and function of natural communities that comprise ecosystems to ensure their

long-term sustainability and biodiversity at landscape and other relevant ecological scales to the maximum extent that the mission allows.

1.8.2 Adaptive Management

In order to be responsive to new information, changing conditions, or changes in mission requirements, an adaptive management approach should be implemented for natural resources management. Adaptive management is the process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans and use the resulting information to improve policy and management decisions (OPNAV M-5090.1). Annual reviews with installation stakeholders help facilitate adaptive management.

2.0 LOCATION, LAND USE, HISTORY

2.1 General Overview

2.1.1 Location of PMRF Facilities

PMRF is part of and falls under the command of CNRH. CNRH is comprised of over 23,000 ac (9,308 ha) of land and water resources. PMRF is comprised of the Main Base at Barking Sands on the western shore of the island of Kauaʻi and the support facilities at Mākaha Ridge (secondary range), Kōkeʻe (tracking radars, telemetry, communications, command and control), Kamokala Ridge Magazines (explosive storage), Miloliʻi Ridge (reflector site), and Port Allen (pier and building facilities) on Kauaʻi; Kaʻula Island (aircraft gunnery and inert ordnance target practice); Mauna Kapu, and Mount Kaʻala (communications and radar) on Oʻahu; and the Niʻihau Sites (radar, optics, and electronic warfare) on Niʻihau Island (**Figure 2-1, Table 2-1**).

No management activities or projects are recommended for the Miloliʻi Ridge reflector site on Kauaʻi or the Mount Kaʻala communications center on Oʻahu. The Miloliʻi site only encompasses posts supporting three passive 200 ft^2 reflectors and the Mount Kaʻala facility consists only of leased office space; neither site presents natural resources management opportunities.

The Navy also holds a restrictive easement for an area of 2,100 ac (850 ha) adjacent to Barking Sands. For public safety, the easement allows the Navy to restrict access during missile testing and launches. Management of this area is conducted by the SOH and is therefore not addressed in this INRMP.

2.1.2 Nearshore Areas

Nearshore areas include all submerged lands titled to the military and all other submerged lands that are adjacent to installations that extend from the mean high-water level, offshore to the boundary of any security areas controlled by the Military Services (DODI 4715.03). Although the PMRF installation boundary ends at the high-water mark and the Navy does not own submerged lands seaward of the high-water mark, PMRF conducts monitoring and implements proactive management to ensure conservation benefits are provided to aquatic species and habitats in waters adjacent to the installation.

The Navy also controls primary land access to water assets off Barking Sands. All persons, boats, vessels, or other craft are prohibited from entering, transiting, or remaining within, the danger zone during range operations, test and training activities, or increases in force protection that pose a hazard to the general public (33 Code of Federal Regulations [CFR] Section 334.1390). There is a no anchorage zone off Barking Sands because of the presence of underwater cables.

2.1.3 Offshore Areas

PMRF provides support for the operation of 1,100 square nautical miles ([nm^2]; 3,773 km^2) of offshore underwater ranges. The underwater ranges are within open ocean areas and extend into territorial waters, which are not under the jurisdiction of PMRF. The Navy does however conduct annual marine mammal monitoring for the Hawaiʻi Range Complex including offshore areas at PMRF (DoN 2008b). The natural resources of the underwater ranges are discussed in detail in the Hawaiʻi Range Complex

Environmental Impact Statement (DoN 2008a) and the Marine Resources Assessment for the Hawaiian Islands Operating Area (DoN 2005) as well as annual marine resources monitoring reports.

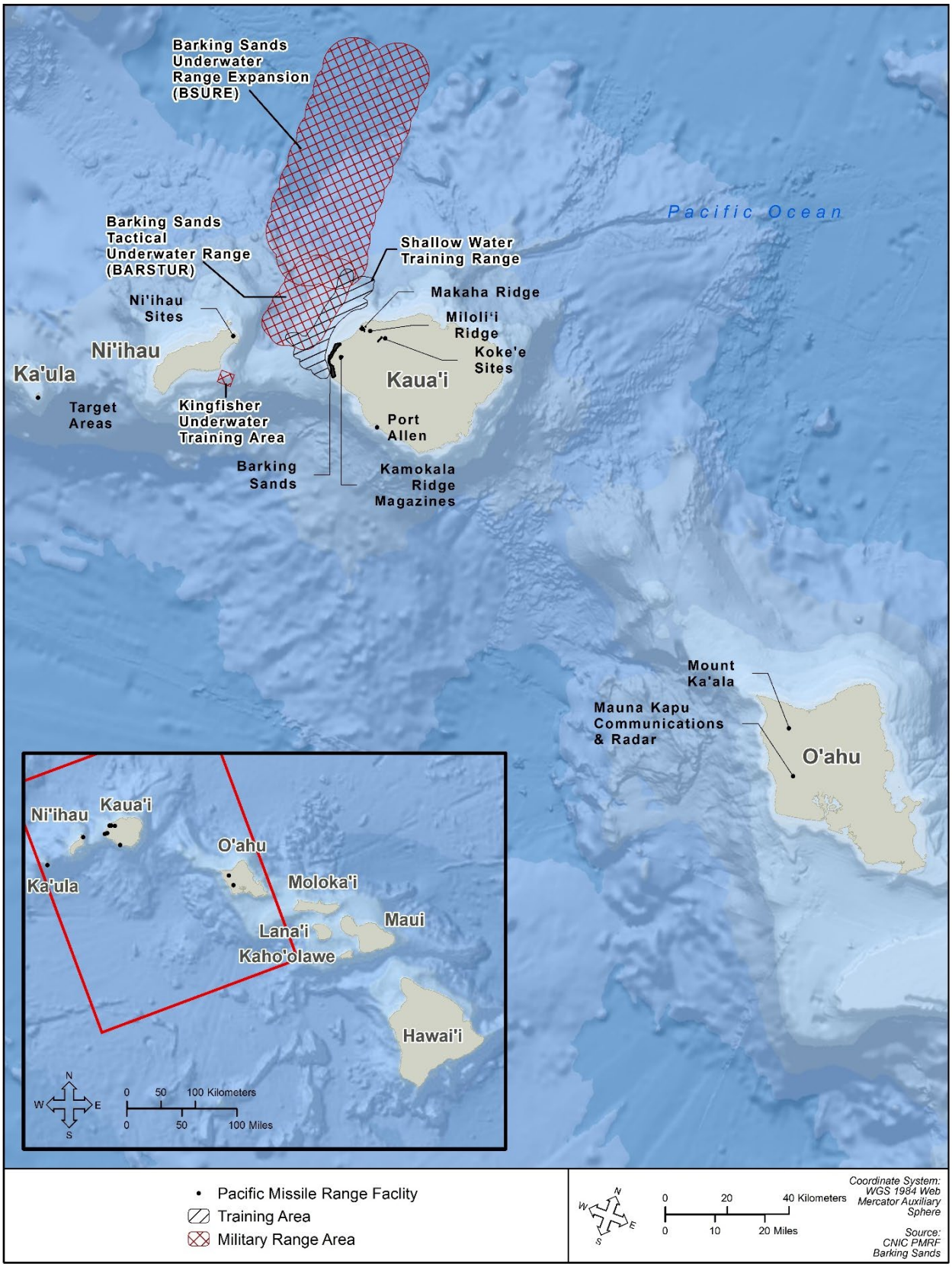


Figure 2-1. PMRF Site Locations and Supported Offshore Ranges

Table 2-1. Lands Owned, Leased or Otherwise Used by the PMRF

PMRF Facility	Land Area (ac / ha)	Ownership/Lease	Land Use and Types of Operations	Included in INRMP
KAUA‘I				
Barking Sands (Main Base)*	2,338 / 946	Navy	Range operations, missile assembly and launch, radar tracking, communications, aviation and aviation support, torpedo shop, personnel support	Yes
	200 / 81	SOH Lease		
	2,100 / 850	Restrictive Easement on SOH land	Ground hazard area during launches; Safety arcs ranging from 6,000 to 10,000 ft (1,829 to 3,048 m)	No
Mākaha Ridge Tracking Station	244 / 99	SOH Lease	Secondary operations area: (1) radar tracking; (2) telemetry receiving/recording; (3) frequency monitoring; and (4) target control	Yes
Kōke‘e Sites	22.4 / 9.1	NASA Sublease, SOH land		
Site A	4.6 / 1.9		Support buildings: (1) tracking; (2) command; (3) training; (4) administration; and (5) logistics	Yes
Site B	2.1 / 0.8		Power plant and fuel storage facility	Yes
Site C	2.1 / 0.8		Bore sight equipment, microwave antenna, and radar support buildings	Yes
Site D	6.9 / 2.8		Transmitter building and antenna support facilities	Yes
Site E	6.7 / 2.7		National Aeronautics and Space Administration’s (NASA’s) Kōke‘e Geophysical Observatory with large antenna arrays	Yes
Kamokala Ridge Magazines	104 / 42	SOH Lease	Magazines for ordnance storage	Yes
Miloli‘i Ridge	0.015/0.006	SOH Lease	Three 10 ft^2 (0.9 m^2) reflector sites (posts), each supporting one 200 ft^2 reflector	No

PMRF Facility	Land Area (ac / ha)	Ownership/Lease	Land Use and Types of Operations	Included in INRMP
Port Allen	1.0 / 0.4	SOH Lease	Warehousing, surface craft–support - building space only	Yes
NI‘IHAU				
Ni‘ihau Sites (Pāni‘au Radar Site)	1,170 / 473	Ni‘ihau Ranch Lease	Communications/electronics training activities, Perch Site and Optical Tracking Station; and Pāniau Radar Site	Yes
KA‘ULA				
Ka‘ula Island	108 / 43	Navy	10 ac (4 ha) target range for aircraft gunnery and inert ordnance	Yes
O‘AHU				
Mauna Kapu Facility	2.0 / 0.8	1.9 ac (0.8 ha) leased from the Gill-Ewa Lands LLC 0.1 ac (0.08 ha) under use agreement with U.S. government	Communications and radar tracking facility and frequency monitoring station building on a 0.4 ac (0.2 ha) site; 1.5 ac (0.6 ha) in utility easements	Yes
Mount Ka‘ala	1.8 / 0.7	FAA Lease	Communication– Center - building space only	No

*Barking Sands (Main Base) Combined Ownership/Lease Land Area 4,638 ac / 1877 ha

Commander, United States Fleet Forces Command (COMUSFLTFORCOM) and Commander, United States Pacific Fleet (COMUSPACFLT) are designated as the area environmental coordinators while at sea. COMUSFLTFORCOM and COMUSPACFLT ensure consistent application of environmental policy for Navy actions occurring on fleet training ranges and at sea operating areas from the high-water mark seaward within their assigned areas of responsibility.

2.2 Barking Sands Location, History, and Mission

2.2.1 Location

The principal operations area for PMRF is located at the Barking Sands facility on the western shore of the island of Kauaʻi. The Main Base at Barking Sands is approximately 26.5 mi (42.6 km) west of Līhuʻe, the county seat and second largest city on Kauaʻi. Barking Sands occupies approximately 2,538 ac (1,027 ha) of Navy-owned and leased land that extends from Polihale State Park in the north to Kokole Point in the south **(Figure 2-2**). Barking Sands has approximately 7.6 mi (12.2 km) of shoreline. It is just over 0.6 mi (1.0 km) at its widest points at the northern and southern boundaries and narrows to 0.3 mi (0.5 km) in the middle of the base. The northern section of Barking Sands also houses Sandia National Laboratories launch areas for the Department of Energy (DOE) and provides PMRF with rocket launch services for target systems and upper atmosphere measurements. Land seaward of the upper wash of waves or the vegetation line is unencumbered state land and the Navy has no direct management authority over this shoreline. The Navy, however, is given the authority by 33 CFR 334.1390 to limit public access to restricted beach areas for safety during operational hours.

Barking Sands is in a SOH Land Use Commission (LUC) designated State Conservation District with its eastern border adjacent to a State Agricultural District (SOH LUC 2012). A 5,000-ac (2,023-ha) Agricultural Preservation Initiative (API) area, which is administered by the SOH Department of Agriculture, Agribusiness Development Corporation, lies within the agricultural district. These lands are leased to various agricultural operations, including multi-national seed corporations.

Polihale State Park lies to the north of Barking Sands. This remote 140-ac (57 ha) beach park along the coastal dunes provides camping areas and day use facilities. The southern end of Barking Sands is bordered by the State's 158-ac (64 ha) Kekaha Agricultural Park, and Kekaha Landfill, which the County is planning to expand via vertical expansion (AECOM 2013), and the 68-ac (28 ha) Hawaiʻi Army National Guard Kekaha Range Facility. A small area of land along the southeast side of the base is also used for inland shrimp farming. The 37-ac (15 ha) Kawaiʻele Waterbird Sanctuary, which is managed by DOFAW, is situated near the middle of the base east of the boundary; the first phase of the adjacent DOFAW-managed Mānā Plain Wetland Restoration Project will be 60 ac (24 ha) and completed in 2022.

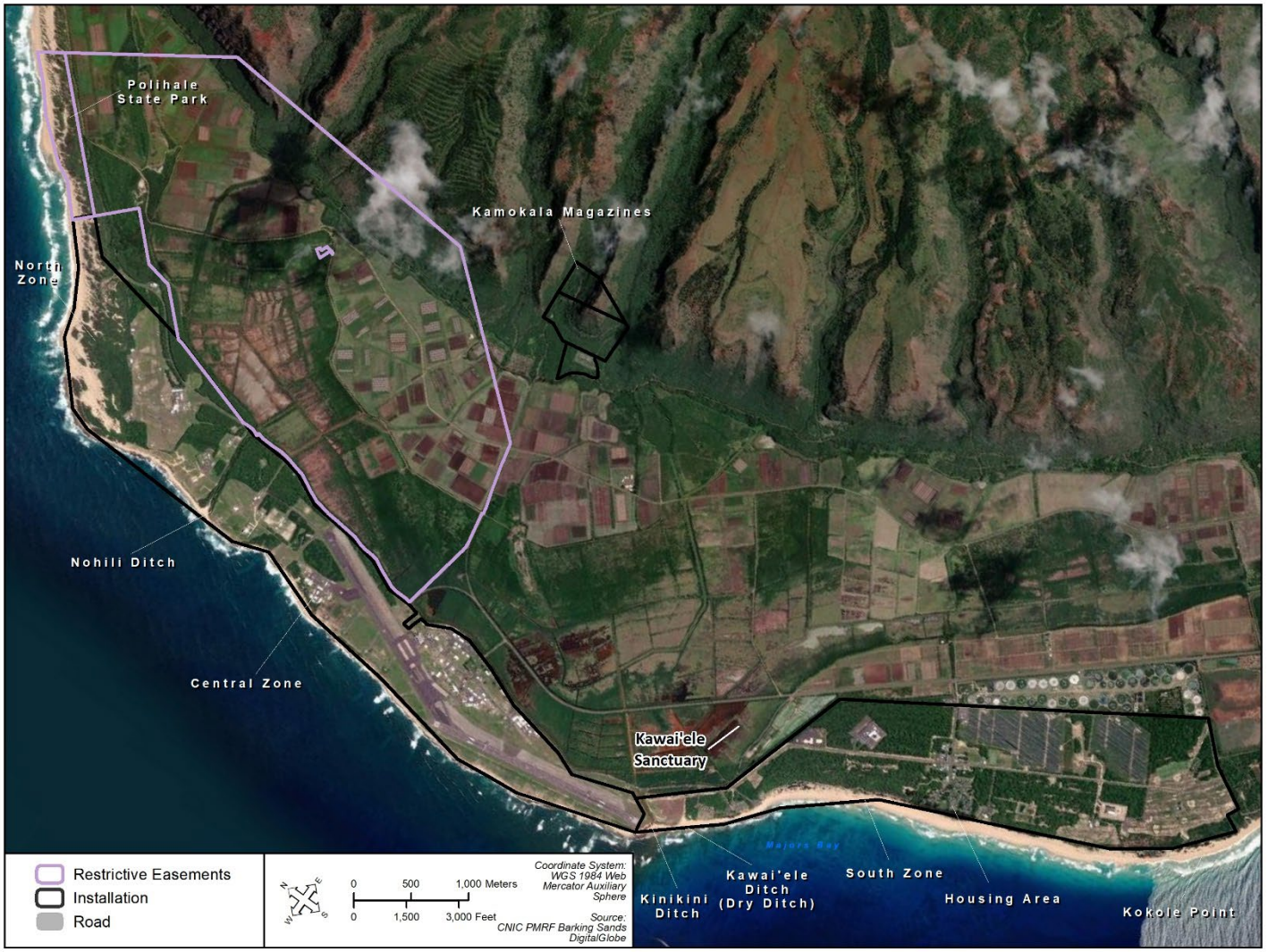


Figure 2-2. Barking Sands Overview

Kekaha, with a population of approximately 3,540 in 2010 (City Data 2015), is the nearest town and is located about 5.5 mi southeast of Barking Sands. Tourism, education, agriculture, and waste management are the leading industries in Kekaha (City Data 2015).

2.2.2 Abbreviated History and Pre-Military Land Use

Archaeological studies indicate that traditional land use in the Mānā Plain region included habitation, fishing, agriculture, and ceremonial activities. The Mānā area was especially known for its offshore fishing grounds and both temporary, seasonal fishing camps and permanent dwellings were located on the dunes or coastal back beach areas. During pre-Contact times, the coastal dunes were also used as burial grounds and human remains have been found in the sands from the north end of Barking Sands to Waiokapua Bay or Majors Bay (DoN 2012a).

Numerous historic properties including Native Hawaiian sites, plantation-era sites, and World War II-era military sites have been identified at Barking Sands. Most of these sites are located within the coastal dunes, which are considered an area of high archaeological sensitivity both because of the known buried cultural deposits and Native Hawaiian human remains, and because of the potential for encountering additional subsurface resources in the future (DoN 2012a). Plantation-era sites include a Japanese cemetery, Kawai‘ele Ditch, numerous burial sites, and a dump site. The dump site, found in 1999, was observed in the missile storage area and consisted of four to five decades worth of household items (e.g., bottles, ceramic wares, cans), vehicles, refrigerators, stoves, washing machines, 55-gallon drums, and steel cables (DoN 2012a). World War II-era sites include concrete pillboxes, concrete boxes, concrete piers and metal gun turret, wooden structures, revetments and concrete tanks (DoN 2012a). Architectural studies have also identified a number of Plantation-era elements (Kawai‘ele Ditch, Kinikini Ditch, and Nohili Ditch), and World War II-era and Cold War-era buildings at Barking Sands that are eligible for listing on the National Register of Historic Places (NRHP) (DoN 2012a).

Barking Sands Landing Field was established in 1921 as a territorial airport, one of many landing fields that were established and maintained by the U.S. Military, the government of the Territory of Hawai‘i, and commercial airlines. The 2012 Integrated Cultural Resources Management Plan (ICRMP, DoN 2012a) indicates the following key historical events leading to the present status of Barking Sands:

1922: Wetlands inland of Barking Sands were drained via a ditch through the Nohili Dune by the Kekaha plantation manager to convert the low-lying marshes into sugar cane fields. Natural water flow was replaced by a system of pumps and side canals.

1923: The Governor of the Territory of Hawai‘i designated 143 ac (57 ha) south of the Nohili Dunes as Mānā Park.

1928: An additional 550 ac (222 ha) south of Mānā Park became the site of the Mānā Airport. The airport was seldom used and was later disestablished by the Governor.

Mana Airport, looking south, 1935. Courtesy of the National Archives and Records Administration

1939-1944: The Governor set aside the former Mānā Airport land as the site for the Mānā Airport Military Reservation. Development began in 1940, and an additional 1,509 ac (610 ha) were acquired for base expansion. In 1941, the Governor withdrew control of the Mānā Park land from the County Board of Supervisors. Development of base defensive positions followed. The primary mission of the newly expanded Barking Sands Army Base during World War II was flight training. The base played a supporting role for U.S. Army Air Corps B-17s engaged in the Battle of Midway. Use of Barking Sands diminished with the end of World War II.


Barking Sands Army Base, looking south, 27 October 1943. Courtesy of the National Archives and Records Administration

1947-1949: The U.S. Air Force (USAF) was established and the base was re-designated as Barking Sands Air Force Base (AFB). Within a year, the USAF declared the base excess and deactivated the facility.

1953: Following the Korean War, Barking Sands was reactivated, renamed Bonham AFB, and was used to stockpile ordnance, missile loaders, and vehicles. Soon thereafter, Bonham AFB was downgraded to an Air Force Station. The Hawai‘i Air National Guard conducted quarterly flight deployment activities until 1992.

1956: The Navy was given permission by the USAF to use Barking Sands for the Regulus missile program, which continued until 1965. The missiles were stored and maintained at Barking Sands.

1958: Barking Sands became one of four fixed Pacific Missile Range stations in Hawai‘i as part of a network including three bases in California and eight islands in the Pacific. These stations tracked ballistic missiles launched from California and detected the impact of missile reentry.

1961-1962: Sandia National Laboratories (an Atomic Energy Commission/DOE contractor) established the Kaua‘i Test Facility (KTF). Rocket launching facilities were established at the northern end of Barking Sands in the Nohili Dunes area. These facilities supported atmospheric nuclear testing in the Pacific and later became available for other research, development, testing, and evaluation (RDT&E) activities by other federal and international agencies and laboratories.

1961-1964: The Navy was recognized as the primary user of Barking Sands and requested a transfer of lands from USAF. Three years later the transfer was completed and Bonham Air Force Station became the Navy's Auxiliary Landing Field Bonham. During the transition, the Navy transferred 229 ac (92 ha) at the southern end of the base for the Army's Pacific Scatter Station, which operated until 1967. The land was then returned to the Navy.

1966-1976: Auxiliary Landing Field Bonham was renamed Pacific Missile Range Facility or PMRF. The PMRF Hawai'i and Area Headquarters moved from Kāne'ohe Bay, O'ahu, to Barking Sands, Kaua'i. Development of an enlarged underwater range began in 1976 and became fully operational shortly thereafter.

1993-1994: PMRF supported research and development launching associated with Strategic Target Systems.

2.2.3 Military Mission, Operations, and Activities

Barking Sands is the principal operations area for PMRF and supports surface, subsurface, air, and space activities. The Mission of Barking Sands is to oversee and coordinate training events from unit level to multi-national exercises while simultaneously conducting or supporting RDT&E of U.S. Navy, other DoD, and Federal agency programs and platforms. In support of this mission, the base provides integrated range services in a modern, multi-threat, multi-dimensional environment that ensures the safe conduct and evaluation of training and RDT&E missions.

Barking Sands consists of 1,100 square nautical mi (nm^2) of instrumented underwater ranges, 42,000 nm^2 of controlled airspace, and a Temporary Operating Area (TOA) that primarily extends north and west of Kaua'i and covers some 2.1 million nm^2 of ocean area. The ranges are capable of supporting surface, subsurface, air and space events and activities simultaneously. The large area of the TOA, coupled with tracking and surveillance radars, data processing, and other communications networks Barking Sands supports RDT&E activities in the TOA for missile defense testing. Operations and activities and their associated support facilities at Barking Sands can be divided into three major areas with unique activities that dictate the constraints for that area (see **Figure 2-2**). The three areas include the:

North Zone. This area consists of all lands north of Nohili Ditch and includes the DOE KTF, a tenant aboard the base, the northern launch pad areas, and a Terminal High Altitude Area Defense (THAAD) anti-ballistic missile facility. The area is devoted to missile assembly and launch operations and RDT&E programs. Area access (including public beach access) is controlled during missile launches.

Central Zone. The central third of Barking Sands, delineated by Nohili Ditch on the north and Kawai'ele Ditch (also known as Dry Ditch) on the south includes the Main Operations Area, which supports functions that relate to flight line operations, supply and storage, public works maintenance, and range operations. The Airfield Operations Area (AOA) includes the 6002-ft (1,829-m) runway and associated airfield operations (Air Ops) facilities. In addition to the runway, these facilities include 3 helicopter landing pads, main hangar, and administrative buildings. The airfield supports C5- and C17-type cargo aircraft, tactical aircraft, and helicopters. Operations support aircraft consist primarily of C-26 airplanes used for logistics and range surveillance, and S-61 helicopters used for personnel transfer,

logistics, surveillance, and target recovery. This area is constrained by runway clear zones and accidental potential zones, as well as imaginary surfaces established (Aviation Safety Zones) to avoid dangerous encroachments into PMRF's navigational airspace.

South Zone. The Southern Zone lies south of Kawai'ele Ditch (also known as Dry Ditch) and consists of personnel support, bachelor and family housing units and community support, and recreation facilities such as a Navy Exchange and Shoppette, gymnasium, youth center, fitness center, soccer field, and movie theater. Range operations and antenna fields, a THAAD radar facility, AEGIS Ashore facility, undeveloped lands, a sewage treatment plant, and the southern launch pad are located at the southern end of this zone. A Hawai'i Air National Guard (HIANG) complex is also located in this zone.

2.2.4 Possible Mission Constraints

Current and future land uses at Barking Sands are limited by some constraining factors that need to be considered in the planning phase of construction or land use change. Natural and cultural resources constraints include wetlands habitat; nesting or overflight areas for rare, threatened, and endangered species; and sites on which significant cultural resources occur. Other restrictions on mission and land use are due to operational, environmental, and safety constraints. Base functions include radar tracking and surveillance, global positioning system (GPS) data processing, communications, and Range Operations Center command and control. In addition, Barking Sands supports an active airfield with target support, a live ordnance area, an ordnance and launching area, and a torpedo shop for torpedo operations and recovery. Land use constraints related to operations and training are designed to safeguard the public and base personnel from the potential hazards associated with operation and training activities and include Ground Hazard Areas, Electromagnetic radiation (EMR) zones, Explosive Hazard Zones, Aviation Safety Zones, and Range Safety Zones (**Figure 2-3**).

2.2.4.1 Ground Hazard Areas

Ground Hazard Areas (GHAs) have been established for the U.S. Navy Vandal missile launches and Strategic Target Systems (STARS) launches. These GHAs consist of arcs with a radius of 6,000 ft (1,829 m) for Vandal launches and 10,000 ft (3,048 m) for STARS launches to exclude non-essential personnel and the public from the hazardous areas. Some of these areas extend off base. As such, PMRF coordinates with the SOH and DLNR Division of State Parks to ensure impacted areas of Polihale Beach Park remain clear during missile launches.

2.2.4.2 Electromagnetic Radiation Zones

Line of sight requirements exist for microwave antennas and in the path of radars, as such unobstructed paths must be maintained. These required "look angles" constrain the development and placement of structures in order to avoid the introduction of electromagnetic interference (EMI). EMR zones are placed around transmitter sites and tracking radars to negate hazards of electromagnetic radiation to personnel (HERP), hazards of electromagnetic radiation to ordnance (HERO), or hazards of electromagnetic radiation to fuel (HERF). Radar and transmitter sites are situated for clear lines of sight so as to eliminate hazards to personnel in areas immediately in front of each emitter.

2.2.4.3 Explosives Safety Quantity Distance

The DoD requires that Explosives Safety Quantity Distance (ESQD) arcs be established around all activities involving explosives. These activities include storage, handling, transportation and staging of explosives. The distance an ESQD arc extends from an individual potential explosion site is based upon:

- The construction and type of potential explosion site.
- The hazard division (also known as explosive hazard classification/division) of net explosive weight for quantity distance determination of ammunition and explosives in the potential explosion site.
- The construction and type of exposed site.
- The distance separating the potential explosion site from the exposed site.
- In some instances, the orientation of the potential explosion site and the exposed site.

The land use within ESQD arcs and required separation distance is dependent on its purpose, for instance, activities and facilities not directly related to explosive storage and handling must be located at greater distances from a potential explosion site then activities and facilities directly related to explosives storage and handling operations. The ESQD arcs shown in **Figure 2-3** indicate inhabited building distances and the area within which construction of occupied facilities is not allowed. The ESQD arcs on Barking Sands extend beyond its borders into agricultural lands and the ocean on the northern portion of the base. Barking Sands has an MOA with the SOH to restrict land use within the ESQD arcs that extend off base property.

2.2.4.4 Aviation Safety Zones

Aviation Safety Zones are established around airfields to protect flight operations from encroachment by activities that are not compatible with aviation and to mitigate the impact flight operations have on activities not associated with aviation. Military installations develop Air Installation Compatibility Use Zone (AICUZ) programs to promote compatible development in the vicinity of their airfields. The AICUZ itself is a composite of many factors: day-night average noise levels, accident potential, and aircraft flight paths and altitudes. The purpose of the AICUZ program is the protection of public safety and health as well as protection of the Navy's national defense mission.

Clear zone (CZ) and accident potential zone (APZ) designation is based upon statistical analysis of past DoD aircraft accidents. The CZ, the area closest to the runway end, is the most hazardous. The overall risk is so high that DoD generally acquires the land through purchase or easement to prevent development. APZ I is an area beyond the CZ that possesses a significant potential for accidents. APZ II is an area beyond APZ I having a lower, but still significant, potential for accidents. While aircraft accident potential in APZs I and II does not warrant acquisition by the Navy, land use planning and controls are strongly encouraged in these areas for the protection of the public. The Navy's CZ is a trapezoidial shape, 3,000 ft (914.4 m) long, and divided into three sections called the Type 1, Type 2 and Type 3. The CZ Type 1 is defined by an area 1,500 ft (457.2 m) wide (centered on the runway) and extending from the end of the runway to 1,000 ft (304.8 m) past the end of the runway. The CZ Type 2 is 500 ft (152.4 m) wide (centered on the runway) extending from the end of the CZ Type 1 for

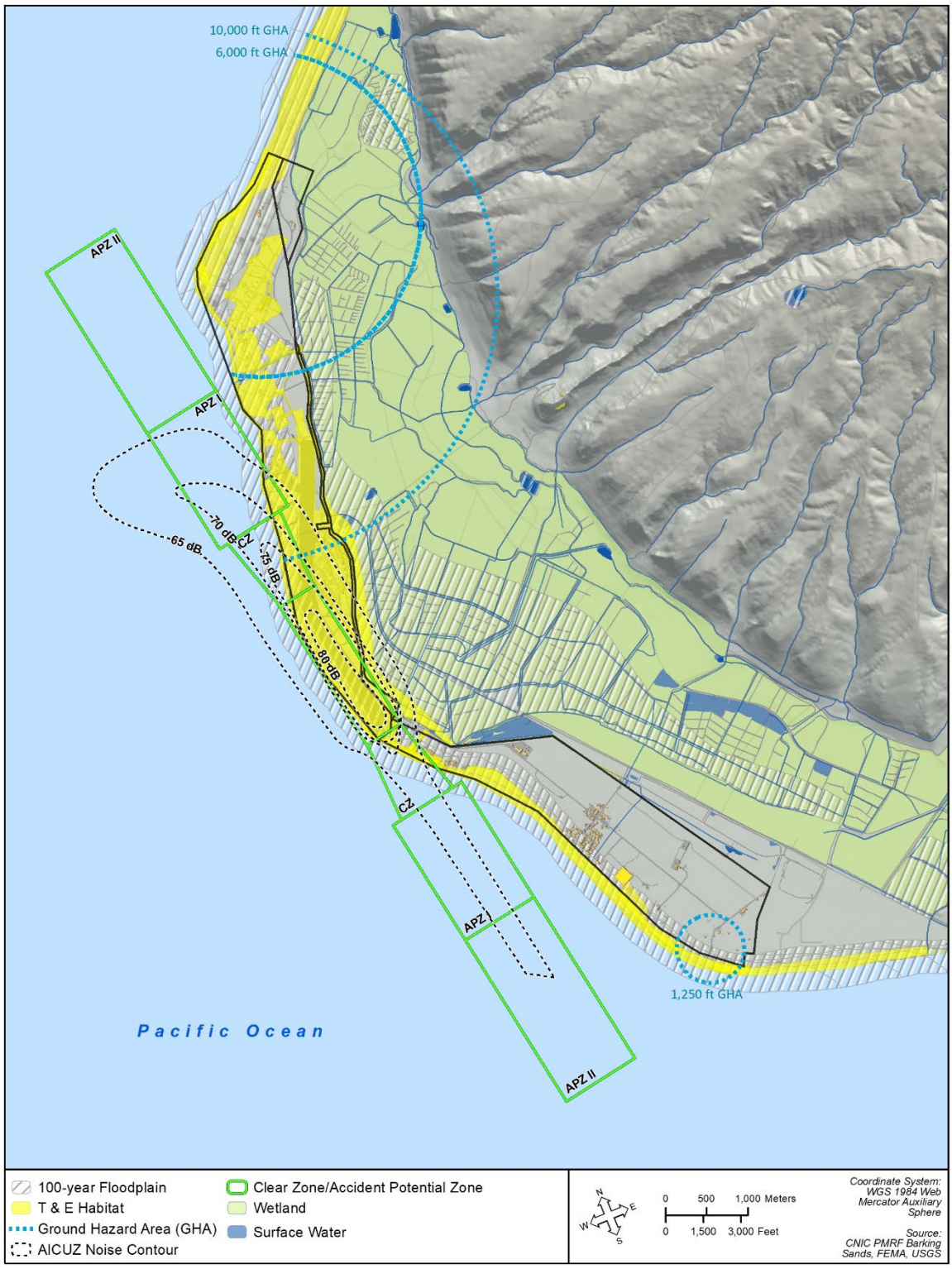


Figure 2-3. Barking Sands Constraints

2,000 ft (609.6 m). The CZ Type 3 is located on either side of the CZ Type 2. The Barking Sands recreation beach also lies within the CZ Type 1 and Type 3 for runway 16. CZ Type 1 is closed to recreation purposes when the airfield is in use. An APZ I and an APZ 2 extends from both the north and south ends of the runway; however, APZ 1 and APZ II are not required for either end since the current number of annual arrival or departure operations do not exceed 5,000.

2.2.5 Emergent and Future Training

PMRF is utilized for training by the Navy and other agency partners, generally involving both land and sea components. The tempo of training events fluctuates from year to year, but includes a bi-annual international Rim of the Pacific (RIMPAC) and other Large Scale Exercise (LSE) events that may include amphibious landings at Waiokapua (Major's) Bay. Requirements for amphibious landings and other training activities are to mitigate such that no endangered or threatened species are in the affected area when activities occur, including Hawaiian Monk Seals and sea turtles on beaches during landings. Additionally, activities at Barking Sands, Kaʻula and Niʻihau avoid adverse effects or modification of designated critical habitat. Training and testing in the marine environment is conducted under the US Pacific Fleets programmatic EIS and adheres to the protective measures of the associated consultations and will not be further discussed.

2.3 Mākaha Ridge Tracking Station Location, History, and Mission

2.3.1 Location

The Mākaha Ridge Tracking Station is located 7 mi (11 km) north of Barking Sands at approximately 1,400 ft (427 m) to 1,850 ft (564 m) in elevation on a high ridge top of the central mountain range of Kauaʻi. The facility overlooks the Kauhao Valley to the south and the Mākaha Valley to the north (**Figure 2-4**). The station encompasses approximately 244 ac (99 ha) of land leased from the SOH within the Nā Pali-Kona Forest Reserve. The station is located on the Nā Pali ridgeline, which is characterized by high volcanic uplands segmented by V-cut valleys and bounded by extremely steep coastal cliffs.

Figure 2-4. Mākaha Ridge Tracking Station Overview and Facilities

Mākaha Ridge Tracking Station is in the Waimea-Kekaha region on the western side of Kauaʻi in the SOH LUC designated State Conservation District (SOH LUC 2012). The site is bordered by steep cliffs to the north and west. Several state parks, natural area reserves, and forest reserves (Kuʻia Natural Area Reserve, Waimea Canyon State Park, and Puʻu Ka Pele Forest Reserve) lie to the east of the site.

2.3.2 Abbreviated History and Pre-Military Land Use

Cultural resources surveys have not identified any traditional Hawaiian archaeological sites, features, or buried cultural deposits at the Mākaha Ridge Tracking Station (DoN 2012a). Since 1965, the Navy has leased Mākaha Ridge from the SOH for communication, research, development, testing, tracking, evaluation, guidance, and related government purposes.

2.3.3 Military Mission, Operations, and Activities

Military use of Mākaha Ridge began during the cold war era when the Navy initiated multiple new construction projects, including radar and telemetry facilities on the ridge. Among the first buildings on Mākaha Ridge, completed in 1966, were a communications facility, power station, tracking radar, and surveillance radar (DoN 2012a).

Today, the Mākaha Ridge Tracking Station serves as PMRF's secondary missile tracking and surveillance station. The station has advanced tracking and surveillance radars as well as telemetry and recording equipment systems for the range. The site is also used by other agencies to test new radar technologies. Public access is restricted at the station.

The Mākaha Ridge Tracking Station contains a guard shack at the entrance, a Frequency Interference Control Building, Maintenance Facility, Telemetry Building, a boresight tower, telemetry antennas, water tanks, a laboratory, radar sites, communications, a power plant, antennas, a helicopter pad, and a "sea clutter site." Most of these structures are found on the top of the ridge line and are in the line of sight of Barking Sands.

The Mākaha Ridge Tracking Station provides support for various activities related to missile tracking. The station supports radar tracking and surveillance, primary telemetry receiving and recording, frequency monitoring, target control, and electronic warfare and networked operation.

2.3.4 Possible Mission Constraints

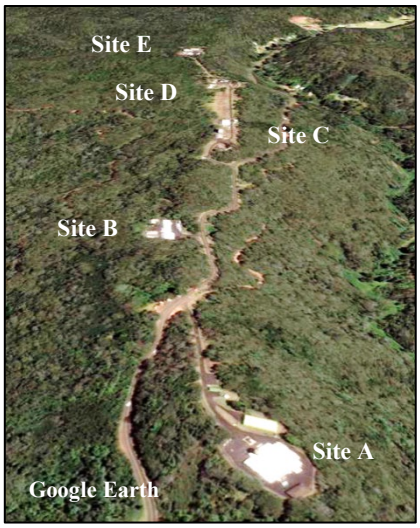
Constraints at the Mākaha Ridge Tracking Station are related to land ownership (as the sites are leased from the SOH and are located within the State Conservation District), military mission, and environmental issues. Military constraints result from restricted access and requirements that all buildings be located in unobstructed lines of sites for EMR zones. Environmental constraints result from several state and federal listed plant species that can be found at this station and the steep slopes around the southern, western, and northern borders of the site, which are severely eroded (**Figure 2-5**). The presence of nesting Nēnē (*Branta sandvicensis*), presence of federally listed Hawaiian Hoary Bat or ʻŌpeʻapeʻa (*Lasiurus cinereus semotus)*, and overflight of endangered seabirds are other potential constraints at Mākaha Ridge Tracking Station.

Figure 2-5. Mākaha Ridge Tracking Station Constraints: Surface Water, Bare Soil, and Endangered Plants

2.4 Kōkeʻe Sites Location, History, and Mission

2.4.1 Location

The PMRF Kōkeʻe sites are located within Kōkeʻe State Park east of Mākaha Ridge and at the northwestern terminus of Waimea Canyon. They are located at 3,500 ft (1,067 m) in elevation on a north-northeasterly coastal ridgeline called Kaunuohua Ridge. This volcanic terrain is characterized by numerous finger ridges, which are highly eroded, and contains many major valleys and drainage patterns.



The facility at Kōkeʻe consists of five parcels, A through E, that run along Kōkeʻe Road (**Figure 2-6**) and which are leased from the SOH by NASA. The combined area of the parcels is approximately 22 ac (9 ha) (**Table 2-2**). The Navy uses sites A through D through an agreement with NASA. Much of this land is graded and covered with asphalt, however there are open areas with mowed lawns and remnant forested areas along the property boundaries.

The Kōkeʻe sites are located within the SOH Conservation District of the Waimea-Kekaha region on the western side of Kauaʻi (SOH LUC 2012). Lands surrounding the Kōkeʻe sites are primarily used for recreation and include numerous on-site amenities such as trails, campgrounds, and scenic overlooks for recreation and tourism.

Table 2-2. Kōkeʻe Site Summary

Site	Area ac (ha)	Primary Facility and Infrastructure
Site A	4.6 (1.9)	Support buildings (tracking, command, training, administration, logistics)
Site B	2.1 (0.8)	Power plant and fuel storage facility
Site C	2.1 (0.8)	Boresight equipment, microwave antenna, radar, support buildings
Site D	6.9 (2.8)	Transmitter building, antenna support facilities
Site E	6.7 (2.7)	NASA's Kōkeʻe Geophysical Observatory with large antenna arrays
Total Area	**22.4 (9.1)**	

2.4.2 Abbreviated History and Pre-Military Land Use

The Navy has utilized land at the Kōkeʻe sites through an agreement with NASA since 1964 (DoN 2012a) for communication, research, development, testing, tracking, evaluation, guidance and related government purposes. Cultural resource surveys at the Kōkeʻe sites have found no historic sites (DoN 2012a).

Figure 2-6. Kōkeʻe Sites Overview

2.4.3 Military Mission, Operations, and Activities

The Kōkeʻe sites provide support for Navy surveillance and tracking. Each of the sites in Kōkeʻe supports various activities for the Navy and NASA. Kōkeʻe supports tracking radars, Ultra-High Frequency/Very High Frequency (UHF/VHF) communications, and seven command and control systems. Site A contains buildings that provide tracking, command, training, administration, and logistics support. Site B deals with power for the base and contains a power plant and fuel storage facility. Site C contains boresight equipment, a microwave antenna, radar, and operations and maintenance support buildings. Site D contains a transmitter building and support facilities for a Spacecraft Antenna on Medium Pedestal (SCAMP). Site E is operated by NASA which operates the Kōkeʻe Geophysical Observatory with its 22 ft (9 m) and 49 ft (20 m) antenna arrays.

2.4.4 Possible Mission Constraints

Current and future land use at the Kōkeʻe sites are limited by military protocols, mission requirements, natural resources, and land ownership, as the sites are located on leased land within the State Conservation District. Military constraints include restricted areas on the sites that are limited to approved personnel and visitors on official business. Mission requirements include maintaining vegetation height restrictions and clear lines of sight for facilities at Sites A, C, D, and E. Natural resources constraints are due to designated critical habitat for a Hawaiian picture-wing fly species that is located directly adjacent to the Kōkeʻe sites, as well as use by Hawaiian Hoary Bat, and overflights and potential strike risk to seabird species (Newell's Shearwater, Hawaiian Petrel).

2.5 Kamokala Ridge Magazines Location, History, and Mission

2.5.1 Location

Kamokala Ridge is 1.5 mi (2.4 km) east of Barking Sands at the scarp along the eastern boundary of the Mānā Coastal Plain (called Mānā Plain). The Kamokala Ridge Magazines are in the western edge of the Puʻu Ka Pele upland area. Occuping a total of 104 ac (42 ha), the Kamokala Ridge Magazines reach elevations between 240 ft (73 m) and 320 ft (97 m). Individual munitions cave storage units can be accessed via a surface road off the highway that loops through the facility. The site is leased from the SOH and is maintained by the Navy.

The Kamokala Ridge Magazines are in a State Agricultural District in the Waimea-Kekaha region on the western side of the island of Kauaʻi (SOH LUC 2012). The area to the west of the site is mostly agricultural and included in the API. The land immediately surrounding the magazine site and to the east is composed of finger ridges with steep barren, rocky slopes, and forests in the valleys between the ridges.

2.5.2 Abbreviated History and Pre-Military Land Use

No systematic archaeological surveys have been conducted at the Kamokala Ridge Magazines. However, during a 1992 field check, rock alignments that may be artifacts of traditional Hawaiian agriculture were discovered. The Navy has leased this site since 1964 with 10 of the 12 magazines built during World War II (DoN 2012a). These 10 magazines are eligible for NRHP. In 2004, the Navy built the two additional magazines (Dollar and Brock 2007). All of the structures and facilities are shown in **Figure 2-7**.

2.5.3 Military Mission, Operations, and Activities

The mission of the Kamokala Ridge Magazine area is to provide ordnance storage for the Navy, Hawai‘i Air National Guard, DOE, and other military commands with temporary requirements for training and storage, as necessary. The site consists of two earth-covered magazines, 10 ordnance storage magazines that have been excavated into the cliff face of Kamokala Ridge, and a missile assembly building. The magazine provides secure storage for Class 1.1 explosives.

2.5.4 Possible Mission Constraints

The main natural resource constraints at the Kamokala Ridge Magazines are steep terrain, erodible soils, and the potential for endangered bats. Military constraints are caused by ESQD arc requirements, which outline the hazard areas surrounding the magazines (**Figure 2-8**). In addition, access to the site is restricted to public works maintenance personnel and those involved in ordnance storage activities. The NRHP eligibility requires the Navy consider the effects of planned activities on such properties.

2.6 Port Allen Location, History, and Mission

2.6.1 Location

The Port Allen facility is located on the southwestern shore of Kaua‘i adjacent to Hanapepe Bay in the small town of ‘Ele‘ele. The greatest part of the facility is located on a pier constructed in Hanapepe Bay. PMRF leases part of a building, the north side of the pier, and a small parking lot from the State Department of Transportation, Harbors Division. The lease for this property must be renewed annually. PMRF also leases a paved outdoor storage area near the pier.

2.6.2 Mission, Operations, and Activities

The Port Allen facility provides berthing services for three Marine Department Weapons Recovery Boat operations, which support Seaborne Powered Targets boat operations, weapons and torpedo retrieval boats, and maintenance facilities. The outdoor storage area is used to store night lights, trailers, booms, target boats, other training equipment, and fueling trucks in support of the harbor facilities (DoN 2014a).

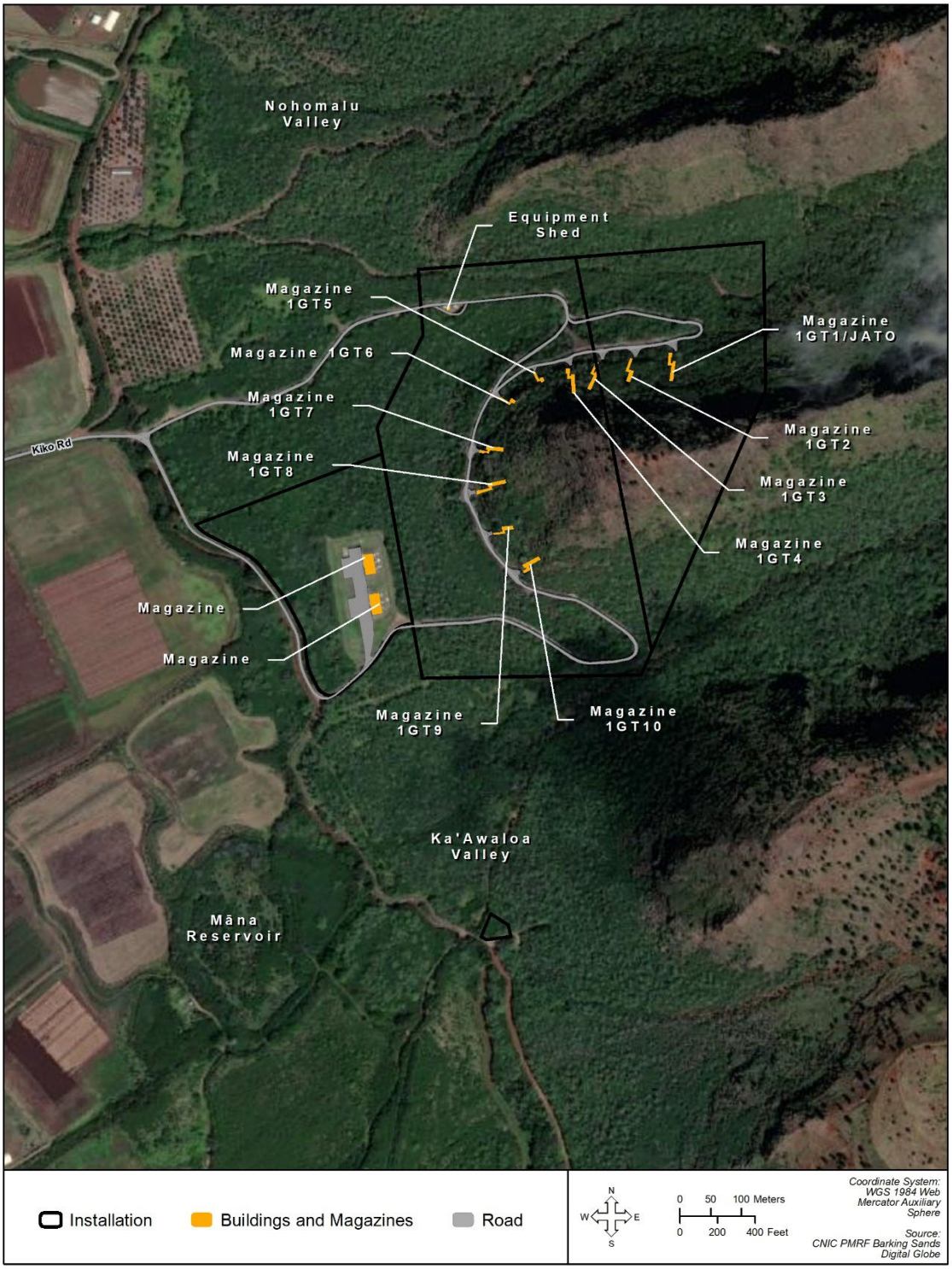


Figure 2-7. Kamokala Ridge Magazines Overview

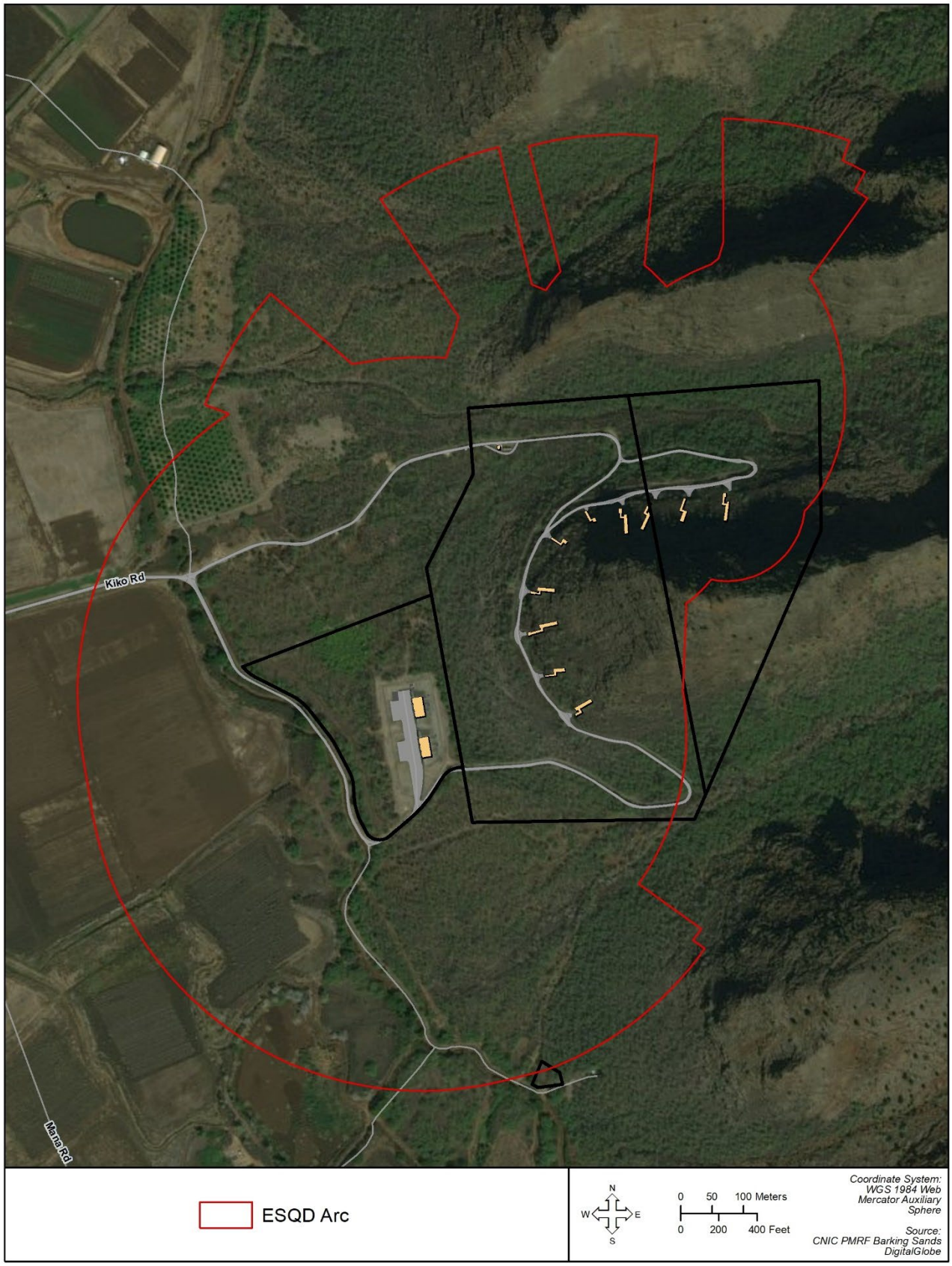


Figure 2-8. Kamokala Ridge Magazines Constraints

2.7 Ka‘ula Island Location, History, and Mission

2.7.1 Location

Ka‘ula Island, also called Ka‘ula Rock, is a small (108 ac [44 ha]), crescent-shaped volcanic islet located approximately 55 mi (88 km) southwest of Kaua‘i and 22 mi (35 km) west-southwest of Ni‘ihau. This uninhabited island is on a 27 mi^2 (70 km^2) shoal surrounded by the 100-fathom (0.2 km) depth contour. The land is owned by the U.S. government and is under the jurisdiction, control, accountability, and custody of the Navy.

Ka‘ula Island is used by the Navy for air-to-surface delivery of inert ordinance training restricted to the southern tip of the island. For safety purposes, the Navy has established a 3-mi (4.8-km) radius around Ka‘ula Island as a danger zone to prevent vessels or other crafts from entering or remaining in the danger zone except those that have been authorized by the Navy (33 CFR Section 334.1340). Fishing boats are permitted in the danger zone when bombing exercises are not being conducted. Seabirds, whales, dolphins, seals, and other marine wildlife are the primary users of the island and its surrounding waters.

2.7.2 Abbreviated History and Pre-Military Land Use

While there is no evidence of extensive human habitation on Ka‘ula Island, there are accounts of Hawaiians visiting the island to collect birds, eggs, and feathers. In addition to references to the islet in early Hawaiian lore, the discovery of six archeological sites indicate early use by native Hawaiians (DoN 2008a).

Ka‘ula Island is under the jurisdiction of the United States, and in 1924, through Territorial Executive Order, it was set aside for public purposes and put under the jurisdiction of the U.S. Lighthouse Service, which later merged with the U.S. Coast Guard (USCG). A light house was commissioned on Ka‘ula Island in 1932, which was in operation until 1947. Following World War II, the USCG used Ka‘ula Island as a radar navigation target. The Navy also used the island as an aerial bombing range under permit from the USCG. The USCG transferred the island to the Navy in 1965 (Pepi et al. 2009).

The Navy has used the southeastern portion of the island for training aviators in air-to-surface ordnance delivery since 1952. On 7 April 1965, the Kaua‘i County Board of Supervisors passed a resolution that requested the Navy cease bombing operations on Ka‘ula Island until the natural resources of the island could be evaluated for their potential as a bird sanctuary. In 1978, Ka‘ula Island was designated as part of the Hawai‘i State Seabird Sanctuary consisting of 34 islets and rocks by the SOH DLNR. Under this designation, the island is managed to conserve, manage, and protect indigenous wildlife (SOH DLNR and DoN 1998). The Navy, however, maintains jurisdiction over the island and continues to use the southern tip for ordnance training.

In 1971, the Navy agreed to allow fishermen within the 3-mi (4.8-km) restricted zone around the island when bombing exercises were not actively occurring. Since 1981, the munitions training by the Navy

at Kaʻula Island has been restricted to inert ordnance delivery and aircraft gunnery on the southern tip of the island to minimize impact to natural resources at the site.

2.7.3 Military Mission, Operations, and Activities

The Navy mission at Kaʻula Island is to train aviators in air-to-surface ordnance delivery. Approximately 9 percent, or 10 ac (4 ha), at the southern tip of Kaʻula Island is set aside to train aviators in air-to-surface (inert) weapons delivery. Gunnery exercises also include the firing of inert rounds from sea-based ships.

2.7.4 Possible Mission Constraints

Both the military mission and protected species constrain land use on Kaʻula Island. Past military use included bombing and strafing training with explosive ordnance. As a result of those activities, there are unexploded ordnance (UXO) hazards that remain in the area. As a result, access to the island is restricted by UXO hazards as well as current mission activities. Safely transporting personnel onto and off of the island by boat and helicopter is also difficult, especially when attempting helicopter insertions and extractions of personnel. Because of safety issues from UXO, BASH, and steep unstable terrain, access by any human to the island has not been granted since 1998. The presence of migratory birds and federally protected marine mammals on and in the vicinity of Kaʻula Island further constrain land use.

2.8 Mauna Kapu Location, History, and Mission

2.8.1 Location

The Mauna Kapu Communications and Radar Tracking Facility (Mauna Kapu Facility) is a 2-ac (0.8-ha) site on the island of Oʻahu. The facility is located in the southern portion of the Waiʻanae Mountain Range on Palikea Ridge, which overlooks Pearl Harbor.

The Mauna Kapu Facility is located in the SOH Conservation District (SOH LUC 2012) and land surrounding the site is largely undeveloped forest reserve. The Honouliuli Forest Reserve lies to the north of the facility and the Nānākuli Forest Reserve lies to the west directly adjacent to the facility. Recreational activities such as hiking, bird watching, camping, and sightseeing are conducted in the forest reserves. Several residential homes are also located in the area.

2.8.2 Abbreviated History and Pre-Military Land Use

The Navy initially leased the Mauna Kapu Facility from the James Campbell Company in 1963, and presently holds a lease with Gill-Ewa Lands LLC, which now owns the property. No cultural resources surveys have been conducted at the Mauna Kapu Facility and there is little recorded history of the mountain areas surrounding it (Belt Collins 2014).

2.8.3 Military Mission, Operations, and Activities

The Mauna Kapu Facility supports a remote transmitter/receiver facility for the Navy and DOE. The facility consists of one building, Building 204, and a radar equipment tower that supports electronic warfare and high frequency communication operations. The tower is anchored by cables attached to anchor blocks on the east side of the facility. The facility requires unobstructed lines of sight for electronic warfare coverage for Joint Base Pearl Harbor-Hickam and the Navy water ranges offshore of Oʻahu (DoN 2014a).

2.8.4 Possible Mission Constraints

Land use constraints at the Mauna Kapu facility results from extremely steep slopes on the east and west sides of the facility and the requirement for unobstructed lines of site for the military mission and restricted personnel access to those engaged in official business. There are no other constraints related to natural resources, although critical habitat for several species has been designated in the near vicinity. These areas contain critical habitat for the endangered Oʻahu ʻElepaio (*Chasiempis sandwichensis ibidis*) and provide habitat to other threatened or endangered plants or animals and non-listed native species (SOH DLNR 2009). Although not on site, potential affects to these resources must be considered via the NEPA process prior to implementing land use change or construction activities at the facility.

2.9 Niʻihau Sites Location, History, and Mission

2.9.1 Location

Niʻihau Island is a privately-owned island that is 44,800 ac (18,130 ha) in size and lies approximately 17 mi (27 km) southwest of Kauaʻi (SOH DLNR 2015). The dimensions of the island are approximately 18 mi (29 km) in length by 8 mi (13 km) in width stretching from the southwest to the northeast (Fletcher and Fiersten 2009). Navy-operated sites (**Figure 2-9**) are located on parcels throughout the island and total about 2.5 percent of the land, or approximately 1,170 ac (473.5 ha). However, with prior permission from the landowner and upon undergoing environmental review via the NEPA process, the Navy has the ability to conduct training activities throughout the island, its nearshore environments, and at low level altitudes above land or sea (DoN 2012b).

Niʻihau Island has been the property of the Robinson family since 1864 and is occupied by a traditional Hawaiian community, Puʻuwai, on the west-central part of the island. The people of Niʻihau have a subsistence lifestyle in which they fish and hunt pigs and wild turkey for food and collect seashells from local beaches to make shell leis that are sold throughout the state. The main sources of employment are from helicopter and safari tours, and the U.S. Navy (Niʻihau Cultural Heritage Foundation 2009a). The safari business offers hunting opportunities for feral pigs and sheep as well as limited imported African large game species. Fishing, boating, and scuba diving occur in the

Figure 2-9. Ni'ihau Island Overview and Facilities

waters around Niʻihau. Lehua Island, just north of Niʻihau, is a designated Hawaiian Island State Seabird Sanctuary and is owned by SOH.

2.9.2 Abbreviated History and Pre-Military Land Use

Niʻihau Island was one of the last Hawaiian Islands to be united under Kamehameha. The people of Niʻihau mostly depended on fishing, sweet potatoes, and breadfruit for sources of food. The islanders were also known for making the high quality makaloa mats, which were made from abundant perennial sedge.

The Island of Niʻihau was purchased by Elizabeth Sinclair in 1864 for $10,000 from King Kamehameha V. Elizabeth Sinclair and her descendants, the Robinson family, have restricted access to the island in order to preserve its cultural heritage (Niʻihau Cultural Heritage Foundation 2009b). The Robinsons opened a ranch that produced cattle, sheep, and honey and employed the people of Niʻihau.

2.9.3 Military Mission, Operations, and Activities

The Navy leases small parcels of land on Niʻihau but retains no permanent military personnel on the island and only periodically uses the leased areas to support PMRF range training missions (DoN 2012a). The Navy leases sites in the northern corner of the island, as well as a parcel with a Perch Site and a Radar Site parcel (see **Figure 2-9**). Additionally, the Robinson family has agreed to allow the Navy limited access to the island for training. With prior permission, Navy vessels currently come ashore on a periodic basis for maintenance and resupply visits (DoN 2012b).

2.9.4 Possible Mission Constraints

Constraints to military training activities on Niʻihau Island primarily consist of the presence of large numbers of federally listed species both on the island and in the surrounding waters and desginated Hawaiian Monk Seal critical habitat. NOAA Fisheries published a Final Rule designating critical habitat for Hawaiian Monk Seals in portions of the marine and terrestrial environments of Niʻihau Island in September 2015. However, because of the benefits conferred to the species, the critical habitat designation does not apply to areas covered by the PMRF INRMP (NMFS 2015).

3.0 NATURAL RESOURCES PRESENT

3.1 Physical Environment

3.1.1 Geology

The Hawaiian Archipelago was formed from a series of volcanic eruptions that created, and continue to create, the large volcanic mountain ranges of the Hawaiian Ridge. Volcanic eruptions occur as the Pacific Plate moves in a west-northwesterly direction over an area called the Hawai‘i Hot Spot, where magma forms and at times pushes through the plate (Rubin 2013). As the plate moves over the hot spot, active volcanoes move past the hot spot and become dormant and eventually extinct. These volcanoes leave the tops of the volcanic mountains exposed above the ocean surface creating the islands. Over time, the plate continues to move, shifting the islands further west-northwest. Volcanoes in the Hawaiian Islands are estimated to range in age from about 65 million years to currently active volcanoes on the Island of Hawai‘i (Rubin 2013).

3.1.2 Geography

The Hawaiian Archipelago consists of 137 islands, reefs, islets, and atolls that extend northwest from the SOH for approximately 1,700 mi (2,700 km) and end at the Kure Atoll (**Figure 3-1**) (Tilling et al. 2010). The SOH consists of 28 islands that are part of the Hawaiian Archipelago. The eight largest islands are designated as the Main Hawaiian Islands (MHI) and 20 are designated as the Northwestern Hawaiian Islands (NWHI). The general geography of Kaua‘i and O‘ahu, the two larger islands that support PMRF sites are discussed here. Ni‘ihau and Ka‘ula are discussed in Sections 3.8 and 3.10, respectively.

3.1.2.1 Kaua‘i

The Island of Kaua‘i is the northernmost of the eight MHI. It is somewhat circular in shape, with a length of 33 mi (53 km) and a width of 25 mi (40 km), covering approximately 552 mi^2 (1,430 km^2). The oldest of the principal islands, Kaua‘i was formed over five million years ago as the Pacific plate moved over the Hawai‘i Hot Spot. As such, Kaua‘i has been subjected to millions of years of natural erosion. The tallest mountain on Kaua‘i is Kawaikini Peak, at 5,243 ft (1,598 m), with two others at 5,148 ft and 4,120 ft (1,569 m and 1,256 m) (SOH 2013). The island has a variety of microclimates, due in part to its high mountains that trap moisture from the prevailing trade winds, causing intense rainfall and surface runoff events that have shaped deep canyons (University of Hawai‘i 2013a).

3.1.2.2 O‘ahu

O‘ahu is the third largest of the MHI, covering approximately 598 mi^2 (1,548 km^2). Like all the other islands in the Hawaiian Archipelago, O‘ahu is a volcanic island. The irregular shape of O‘ahu was significantly influenced by massive landslides that removed an estimated third of the northeastern portion and half of the western portion during the island’s volcanic period (University of Hawai‘i 2013b). There are two mountain ranges on O‘ahu that run nearly parallel, the Ko‘olau and Wai‘anae Ranges on the eastern and western sides, respectively. The highest mountain peaks on O‘ahu, Ka‘ala and Pu‘u Kalena are found in the Wai‘anae Range and are 4,003 ft and 3,504 ft (1,220 and 1,068 m) respectively.

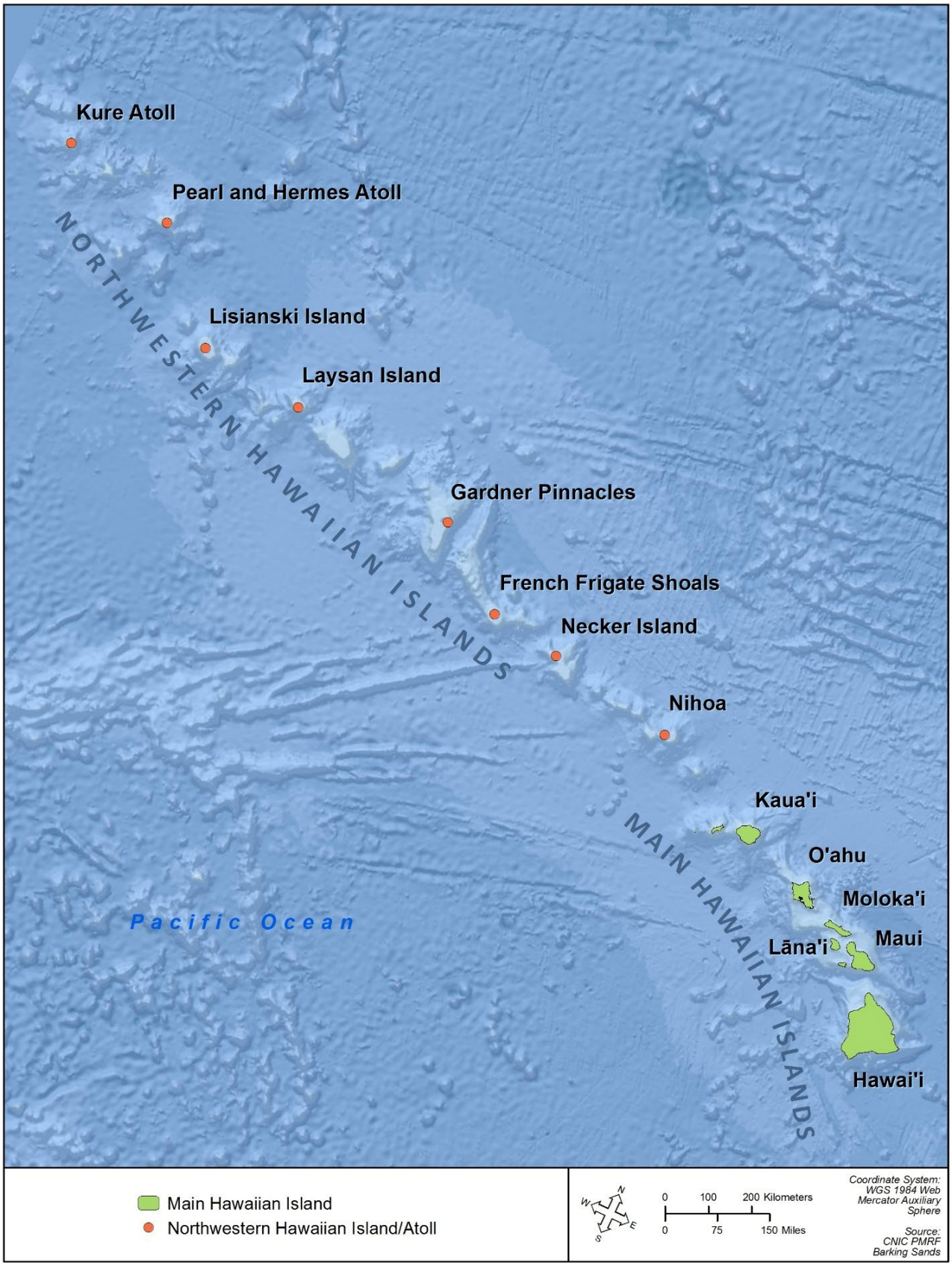


Figure 3-1. The Hawaiian Archipelago

3.1.3 Climate

In general, the climate of Hawai‘i is one of mild temperatures throughout the year, with moderate humidity, and persistent northeasterly winds (National Weather Service [NWS] 2007). There is a high degree of variability in rainfall within short distances, although severe storms are infrequent. Because Hawai‘i is located in the tropics, temperature is relatively uniform throughout the year. In addition, due to its distance from continental land masses, temperatures and humidity are considerably moderated by the surrounding ocean before reaching the islands. The seasonal variability of sea surface temperatures around Hawai‘i is only about 6 °, from a low of 73 °Fahrenheit (F) (22.8 °Celsius [C]) to a high of almost 80 °F (26.7 °C).

In the majority of the state, at elevations below 2,000 ft (610 m), rainfall is greatest in the winter. However, in extremely rainy areas above 2,000 ft (610 m) rainfall is fairly uniform throughout the year (Western Regional Climate Center [WRCC] 2015). In the lowland, rainfall is most likely to occur at night or in the morning hours throughout the year. In the summer, most rainfall is from trade-wind showers that are more likely to occur at night, while winter rainfall is the result of storms that are just as likely to occur during the day as at night (WRCC 2015).

Six of the eight main islands have mountains with elevations that rise from sea level to above 3,000 ft (1,000 m) in a relatively small area. This combination of elevation and subsequent orographic rainfall creates patterns of precipitation that range from extremely wet, in excess of 400 inches (in; 1,000 cm) of annual rainfall, to extremely dry, less than 10 in (25 cm) annually (TNC 2007). This allows for hot tropical and alpine desert regions to exist within 25 mi (40 km) of each other. There are several places in Hawai‘i in which the annual rainfall gradient exceeds 25 in per mi (40 cm per km; WRCC 2015).

3.1.3.1 Kaua‘i

The climate of Kaua‘i is sub-tropical, characterized by mild temperatures that typically range between 69 and 85 °F (21 to 29 °C). August tends to be the warmest month of the year. Kaua‘i has multiple regions with various climates; these include dry sand dune complexes in the west, cool mountain forests around Nā Pali and Waimea Canyon, interior tropical rain forests, pastoral plains in the east, and semi-arid tropical weather in the south. The variability of climates on Kaua‘i is partially a result of the island’s mountains, with peaks in excess of 5,000 ft (1,524 m), which influence rainfall patterns. One of the wettest places on earth is found on Kaua‘i; Mount Wai‘ale‘ale (5,148 ft [1,569 m]) receives an annual average of 486 in (1,234 cm) of rainfall (WRCC 2015), whereas the western part of Kaua‘i receives an annual average of 20 in (52 cm) of rainfall. The dry season in the western part of Kaua‘i occurs between June and August (<1 in [2.5 cm]) while the rainy season runs from October through March (>2 in [5 cm]) with most rain falling from November through January (≥ 3 in [8 cm]) (SOH DNLR DAR 2009).

3.1.3.2 O‘ahu

Temperatures of O‘ahu range between a high of 88 °F (31 °C) in August to a low of 66 °F (19 °C) in February. The nearly parallel Ko‘olau and Wai‘anae Ranges play a major role in O‘ahu’s climate. Tradewinds first interact with the Ko‘olau Range on the island’s eastern side. As such, this area receives the majority of rainfall, with average rainfall ranging from 65 to 275 in (200 to 700 cm)

annually (Giambelluca et al. 2013). The Central Plateau, which lies between O‘ahu’s mountain range, and the Wai‘anae Range, receives an average annual rainfall between 20 and 90 in (53 and 220 cm), with the highest concentration in the upper elevations. The driest areas on O‘ahu occur on the coastal plain in the southern and southwestern portions of the island, with an average annual rainfall of approximately 20 in (51 cm).

3.1.4 Hydrology

3.1.4.1 Surface Water Resources

Streams can be classified as ephemeral, perennial, or intermittent. Streams classified as ephemeral are those that only flow as a direct response to rainfall, with stream channels above the water table. Perennial streams flow continuously year-round. However, some perennial streams flow continuously throughout their course while others only flow perennially over sections of their course. Intermittent streams are those that are dry during certain periods and flow only when they receive discharge from groundwater or surface sources.

The majority of streams on the Hawaiian Islands originate in the mountainous interiors of the islands and flow outward to the coast (Oki 2003). Runoff from precipitation, such as rain or to a lesser extent fog drip, and high-elevation aquifer discharge are the main contributors to stream flow. Other sources include water returned from bank storage[1], rainfall directly into streams, and other water such as excess irrigation (U. S. Geological Survey [USGS] 2013).

The level of stream flow is determined by factors such as rainfall amount and intensity, and the geology, morphology, size, soil and land cover of the drainage basin. While climate is dependent on an individual island’s location and elevation, the wettest time of the year for windward areas is spring. Many leeward (southwest) sides of the islands can be quite arid, receiving less than 12 in (30.5 cm) of rain per year, with winter being the wettest season (NWS 2009).

Streams in Hawai‘i are highly variable in their flow. Some streams do not flow all the way to the coast because as they flow over highly permeable rock they infiltrate into the stream bed and recharge the groundwater. Stream flow is also dependent on the height of the water table because streams either gain or lose water when the water table is respectively higher than or lower than the stream water level. In areas where volcanic dikes have formed, streams sometimes intersect with impounded groundwater. This typically causes them to gain water which increases their streamflow, and usually results in perennial streams.

Humans also impact stream flow through diversions, impoundments, channelization, land use changes, and other factors. In areas where surface water and ground water are hydraulically connected, withdrawals of groundwater may reduce ground water discharge into streams and reduce flow.

Three man-made ditches transport surface water, agricultural runoff and pumped groundwater from the Mānā Plain and agriculture fields through Barking Sands. These ditches run through or adjacent to the installation for 6.3 miles, 1.1 miles of which is within PMRF boundaries.

[1] Bank storage is a result of heavy rainfall filling the stream and water is absorbed into its banks. This stored water may return to the stream as the water level falls, thus contributing to the streamflow.

3.1.4.2 Ground Water

The availability of ground water in Hawai‘i is impacted by saltwater intrusion, reduced discharge into streams, and lowering water tables (Oki et al. 1999). Saltwater intrusion occurs when excessive freshwater withdrawals shrink a freshwater lens and allow salt and brackish water to move upward and landward into areas that once contained freshwater. Intrusion of saltwater is dependent on factors such as rock permeability, recharge rate, pumping (withdraw) rate, and location. Wells located closer to the coast are at a higher risk of intrusion than those further inland. Water withdrawals from freshwater lenses also reduce discharge into springs, streams, and the ocean. The loss of discharge into springs and streams negatively impacts freshwater availability for wildlife habitat, agriculture, recreation, and aesthetics. In areas surrounding wells, freshwater withdrawals may lower surface water levels, which can shrink ponds and wetlands. Moreover, reduced discharge into the ocean may affect marine habitat and aquacultural activities.

3.2 Biotic Environment

Hawai‘i’s unique environment and native species have evolved together in isolation over the last 70 million years and over millions of years, an estimated 20,000 species arrived or evolved here. Due to its isolation, Hawai‘i also has high numbers of endemic species with an estimated 10,000 of its native species being found nowhere else (Hawai‘i Invasive Species Council 2015b).

The varied locations and habitats occupied by the eight PMRF facilities contribute to the wide diversity of biota supported by the base. Surveys of PMRF conducted in support of previous INRMPs and other activities have documented numerous birds, mammals, reptiles, insects, marine animals, plants, and vegetation communities. The following is a general description of the flora and fauna that occur across all of the PMRF facilities. Detailed discussions on the occurrence and management of each species for each PMRF siterespectively are in Sections 3.3 – 3.10.

3.2.1 General Flora

Hawai‘i’s native plants form a variety of community types, largely based on the availability of water. Tropical moist forests in Hawai‘i are comprised of mixed mesic forests (ranging from 750 to 1,250 m in elevation), rain forests (found above mixed mesic forests up to 1,700 m), wet shrublands, and bogs in swampy areas. Moist to wet forests are commonly found on the windward lowland and montane areas of the larger islands and on mountain tops of some of the smaller islands. Koa (*Acacia koa*) and ‘Ōhi‘a (*Metrosideros polymorpha*) are common dominant canopy tree species (World Wildlife Fund 2015).

Tropical dry forests of Hawai‘i typically occurred on the leeward side of the islands, but have largely been replaced by agriculture, invasive species, and development. These areas receive less than 50 in of rain a year. The Nā Pali Coast of Kaua‘i supports a relic area of tropical dry forest (World Wildlife Fund 2015). Shrubland communities frequently occur in coastal lowlands on the leeward sides of mountains and extend to considerable altitudes where rainfall is slight. These areas have also been greatly reduced by agriculture and invasive plants and are now primarily composed of non-native grasses, shrubs, and agricultural lands.

Although the vegetation at PMRF varies between sites, there are several vegetation types that can be found at most of the larger sites The Barking Sands, Mākaha Ridge Tracking Station, Kamokala Ridge Magazines, and the Niʻihau sites all contain some area of white leadtree, or Koa Haole (*Leucaena leucocephala*) shrubland, which is a non-native moderately dense dry coastal community that can grow at higher elevations. Also common are sparsely vegetated rocky environments such as the cliff/boulder fields of the Kamokala Ridge Magazines and the coastal cliffs of Mākaha Ridge Tracking Station. Ruderal vegetation likewise is found along roadsides and in other disturbed areas of the site. Each of PMRF's sites also contain landscaped areas with introduced, non-native ornamental vegetation. In total, 327 different plant species have been identified throughout PMRF's sites. Of these approximately 111 are identified as native (including 64 endemics), 4 are attributed to Polynesian introduction, and 212 are considered non-native introduced species (**Appendix C**).

3.2.2 Special Status Plant Species

Of the native flora, four state and federally endangered species, Dwarf Iliau (*Wilkesia hobdyi*), Hawaiʻi Scaleseed (*Spermolepis hawaiiensis*), Niʻihau Lobelia (*Lobelia niihauensis*), and Kauaʻi Schiedea or Māʻoliʻoli (*Schiedea apokremnos*) and one threatened species, Makou (*Peucedanum sandwicense*), as well as unoccupied critical habitat for the endangered Niʻihau Panicgrass or Lauʻehu (*Panicum niihauense*) are known to occur on PMRF. Several other listed species have been identified adjacent to some of the installation sites and must be considered in management decisions (**Table 3-1**).

Table 3-1. Threatened and Endangered Plant Species and Critical Habitat on or adjacent to PMRF Sites

Scientific Name	Common Name	Hawaiian Name	Status	Occurrence[1]		
				Barking Sands	Mākaha Ridge	Kōkeʻe Sites
Euphorbia halemanui (syn. *Chamaesyce halemanui*)	Halemanu ʻAkoko	ʻAkoko	E			X[2]
Lobelia niihauensis	Niʻihau Lobelia	---	E		X	
Panicum niihauense	Niʻihau Panicgrass (Unoccupied Critical Habitat)	Lauʻehu	E	X[3]		
Peucedanum sandwicense	Makou	Makou	T		X	
Schiedea apokremnos	Kauaʻi Schiedea	Māʻoliʻoli	E		X	
Sesbania tomentosa	Oʻahu Riverhemp	ʻŌhai	E	X[4]		
Spermolepis hawaiiensis	Hawaiʻi Scaleseed	---	E		X	
Wilkesia hobdyi	Dwarf Iliau	---	E		X	

State and Federally listed as E = Endangered, T = Threatened
[1] Only PMRF sites with documented threatened, endangered, or candidate species on or adjacent are included in table.
[2] Not documented on PMRF, but has been documented just outside the boundary of Kōkeʻe Site D
[3] Not documented on PMRF, but unoccupied critical habitat for Niʻihau panicgrass is designated on Barking Sands
[4] Not documented on PMRF, but has been documented at Polihale State Park north of Barking Sands
Sources: Char 2000a,b,c,d, DoN 2014c, and Nyber

3.2.3 Invasive Plant Species

Hawai‘i’s native vegetation is threatened by a variety of non-native invasive species. Invasive species are defined as plants, animals or pathogens that are non-native to the ecosystem under consideration and whose introduction causes or is likely to cause harm (USDA 2018). The SOH currently has a list of plant species designated as “Noxious Weeds for Eradication or Control Purposes”, which was developed in 1992 (Hawai‘i Invasive Species Council 2015a). In addition, KISC maintains lists of species identified for early detection and rapid response (EDRR) and species that are targeted for control with the intent of eventual eradication from Kaua‘i (KISC 2017). EDRR listed species are newly discovered non-natives with limited distribution in Kaua‘i that can potentially be eradicated from the island, whereas species on the KISC target list have been identified as invasive threats and are prioritized for control or eradication (KISC 2017).

Of the 216 non-native introduced species identified at the PMRF sites, the following seven are classified as state noxious weeds and/or as KISC EDRR or target species for control and eradication: Long-thorn Kiawe (*Prosopis juliflora*), Asian Melastome (*Melastoma candidum*), Firetree (*Morella faya*), Banana Poka (*Passiflora mollissima*), Spreading Mist Flower/Spreading Snakeroot (*Ageratina ripari*a), Prickly Blackberry (*Rubus argutus*), and Comb Hyptis (*Hyptis pecinata*) (**Table 3-2**). Several other species are considered extremely invasive and detrimental to native habitats and may warrant special attention for management. These species include Koa Haole and Golden Crown-beard (*Verbesina encelioides*). Of these noxious weeds and invasive plant species, Long-thorn Kiawe is considered the greatest threat to human safety because of its thorns which grow up to 4 inches long, whereas Koa Haole, Banana Poka, Asian Melastome, Firetree, and Golden Crown-beard are considered the threats to native habitats and wildlife at PMRF.

Table 3-2. State Noxious Weeds, Kaua‘i Invasive Species Committee Target Species, and Select Invasive Plants Identified at PMRF

Scientific Name	Common Name	Status	Occurrence[1]			
			Barking Sands	Mākaha Ridge	Kōke‘e Sites	Kamokala Ridge
Ageratina riparia	Spreading Mist Flower, Hāmākua Pāmakani	Noxious Weed		X		
Calotropis procera	Small Crown Flower	KISC EDRR	X			
Cirsium vulgare	Bull Thistle	KISC EDRR		X		
Hyptis pectinata	Comb Hyptis	Noxios Weed	X			
Leucaena leucocephala	Koa Haole, White Leadtree	Invasive	X	X		X
Melastoma candidum	Asian Melastome	Noxios Weed			X	
Morella faya	Firetree	Noxios Weed			X	
Passiflora mollissima	Banana Poka	Noxios Weed			X	

Prosopis juliflora	Long-thorn Kiawe, Algaroba, Mesquite	Noxios Weed, KISC Target	X			
Rubus argutus	Prickly Blackberry	Noxios Weed			X	
Verbesina encelioides	Golden Crown-Beard	Invasive	X			X

[1] Only PMRF sites with documented state noxious, KISC target, and select invasive species are included in table.
Source: Hawai'i Invasive Species Council 2015a, KISC 2017

3.2.4 General Fauna

The Hawaiian Islands support a unique selection of fauna because of their isolation. Species native to the Hawaiian Islands include a wide array of native and endemic birds, as well as sea turtles and marine mammals that inhabit the islands' near and offshore waters. With the exception of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) (Section 3.2.5.3. ESA-listed Mammal Species), no native terrestrial mammals are known to inhabit the SOH (SOH DLNR 2015). Hawai'i also has no native species of terrestrial-only amphibians or reptiles (Bailey 1995). However, numerous non-native birds, mammals, frogs, lizards, and freshwater turtle species have been introduced to the islands. A comprehensive list of species identified at PMRF, their regulatory status, origin, and which facilities they are known to occur on, is in **Appendix C**.

At PMRF, the avian fauna is the most diverse group of species documented. Of the 76 bird species that have been recorded base-wide, 46 species are native and 30 are non-native. Some of these birds are migratory and only stop over on their way to other areas, while others come to the island to nest, and still others are endemic and are found on the islands year-round. The most widespread bird species observed throughout the PMRF sites are the non-native Japanese White-eye (*Zosterops japonicus*) and non-native House Finch (*Carpodacus mexicanus*). Zebra Doves (*Geopelia striata*), Spotted Doves (*Spilopelia chinensis*), Common Mynas (*Acridotherestristis*), and Mannikins (*Lonchura* spp.), are other very common non-native birds.

Native bird species vary with elevation and habitat type available at each site and include a variety of seabirds, shorebirds, waterfowl, and even a native raptor. Native bird species that occur at PMRF are protected under the ESA and/or MBTA and will be discussed in Section 3.2.5 Special Status Wildlife Species and in Sections 3.3 – 3.10 below.

Sixteen mammal species have been documented at PMRF. The introduced Feral Cat (*Felis catus*) is the most common and widespread mammal, which is problematic due to its recognized impacts to native avian species. Feral cats are also a known threat to the endangered Hawaiian Monk Seal (*Neomonachus schauinslandi*) and Nēnē, and a variety of other marine mammals and birds as well as humans due to their being the definitive host for Toxoplasmosis, a parasitic disease (Barbieri et al. 2016, Harting et al. 2021). The introduced Columbian Black-tailed Deer (*Odocoileus hemionus columbianus*), Feral Pig (*Sus scrofa*), Feral Goat (*Capra hircus*), and Black Rats or Roof Rats (*Rattus rattus*) are also fairly widespread and common at PMRF. Feral Goats, Black-tailed Deer and Feral Pigs destroy vegetation and expose soils through browsing, trampling, wallowing and rooting increasing rates of erosion and associated stream and reef siltation at Mākaha Ridge. Known vectors of a variety

of pathogens and diseases, Feral Goats, Pigs, and Deer also pose a major threat to endangered species and human health and safety.

Several reptile and amphibian species have likewise been documented at PMRF, most of which are non-native terrestrial lizards and toads, though listed native sea turtles are known or have potential to occur as well (refer to **Section 3.2.5**). Marine surveys have been conducted in the nearshore environments of Barking Sands and Kaʻula Island have identified a wide variety of native fish, including several endemic species, commercially important fish, and corals.

3.2.5 Special Status Wildlife Species

PMRF facilities and adjacent near shore waters support several federally and state-listed species, as well as numerous marine mammals protected under the MMPA and birds protected under the MBTA. The federal and state-threatened or endangered species identified during surveys conducted in support of previous INRMPs and other base activities include 10 birds, five mammals, two reptiles, two fish, and two insects on or adjacent to the PMRF sites (**Table 3-3**). Two additional birds and one marine mammal have state-listed status but are not listed under the federal ESA. For protected birds, the table lists the site on which they have been observed or have potential to fly over when commuting between nesting and at-sea foraging areas and during initial flights to sea by fledglings. Listed sea turtles and monk seals may occur on the base or in the adjacent waters that are used for training; other protected marine mammals may occur in adjacent waters.

The coastal and nearshore waters around PMRF sites are also used by marine mammals that are not federally listed under the ESA but are protected under the MMPA and numerous species of birds that are not federally listed under the ESA but are protected under the MBTA. Of the MBTA-protected species, PMRF management programs are focused on protecting those species that are native to Hawaiʻi. All native species listed under these Acts are considered special status species and are managed under this INRMP. **Table 3-4** indicates the native MMPA-protected species and MBTA-protected species documented on or in the nearshore environments off PMRF sites.

3.2.6 Invasive Fauna

As with plants, numerous animal species have been introduced to the islands and are considered invasive and/or are designated as Injurious Wildlife Species by the SOH (Hawaiʻi Administrative Rules Chapter 13-124, Exhibit 5). Species listed as injurious include numerous birds, reptiles, and invertebrates as well as the small Indian Mongoose (*Herpestes javanicus*) and even-toed ungulates (excluding those listed as game species). KISC has also identified a number of invasive EDRR animal species they target for control on Kauaʻi. EDRR species include Coqui Frog (*Eleutherodactylus coqui*), mongoose, Coconut Rhinoceros Beetle (*Oryctes rhinoceros*), Brown Tree Snake (*Boiga irregularis*), and Little Fire Ant (*Wasmannia auropunctata*), among others. All known outbreaks of these species have been controlled or are under control through extensive efforts by KISC, HDOA, and other partner agencies (KISC 2017). Awareness and reporting these species are critical to their continued control. Hawaiʻi injurious wildlife and other non-native animal species documented at PMRF are listed in **Table 3-5**. No KISC ERDD species are known to occur on PMRF.

Table 3-3. Federal and State Threatened and Endangered Wildlife Species on or adjacent to PMRF Sites

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence[2]					
				Barking Sands	Mākaha Ridge	Kōkeʻe Sites	Kamokala Ridge	Kaʻula Island	Niʻihau Island
Birds									
Anas wyvilliana	Hawaiian Duck	Koloa maoli	E	X					X
Branta sandvicensis	Hawaiian Goose	Nēnē	FT, SE	X	X	X			
Fulica americana alai	Hawaiian Coot	ʻAlae keʻokeʻo	E	X					X
Gallinula galeata sandvicensis	Hawaiian Common Gallinule	ʻAlae ʻula	E	X					
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	E	X					X
Oceanodroma castro	Band-rumped Storm-petrel (Hawaiʻi DPS)	ʻAkēʻakē	E	X[3]	X[3]	X[3]			
Phoebastria albatrus	Short-tailed Albatross	---	E	X[4]					
Pterodroma phaeopygia sandwichensis	Hawaiian Petrel	ʻUaʻu	E	X[3]	X[3]	X[3]			
Puffinus auricularis newelli	Newell's Shearwater	ʻAʻo	T	X[3]	X[3]	X[3]			X
Asio flammeus sandwichensis	Short-eared Owl	Pueo	SE Oʻahu	X	X	X			X
Gygis alba	White Tern	Manu-o-Kū	ST					X	
Vestiaria coccinea syn *Drepanis coccinea*	Scarlet Honeycreeper	ʻIʻiwi	FT, SE			X			
Mammals									
Balaenoptera physalus	Fin Whale	---	E	X				X	X
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	E	X	X	X	X		

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence[2]					
				Barking Sands	Mākaha Ridge	Kōkeʻe Sites	Kamokala Ridge	Kaʻula Island	Niʻihau Island
Neomonachus schauinslandi	Hawaiian Monk Seal	ʻĪlio-holo-i-ka-uaua	E	X				X	X
Physeter macrocephalus	Sperm Whale	Palaoa	E	X				X	X
Pseudorca crassidens	False Killer Whale	---	E – MHI Insular DPS	X				X	X
Megaptera novaeangliae	Humpback Whale	Kōholā kuapiʻo	SE	X				X	X
Reptiles									
Chelonia mydas	Green Sea Turtle	Honu	T – Central North Pacific DPS	X				X[5]	X
Eretmochelys imbricata	Hawksbill Sea Turtle	Honuʻea	E	X[5]				X[5]	X[5]
Insects									
Drosophila musaphilia	Hawaiian Picture-wing Fly	---	E			X[6]			
Drosophila sharpi	Hawaiian Picture-wing Fly	---	E			X[6]			
Fish									
Carcharinus lonigmanus	Oceanic Whitetip Shark	---	T	X				X	X
Manta birostris	Giant Manta Ray	Hāhālua	T	X				X	X

[1] Federally and State listed as E = Endangered, T = Threatened, DPS = Distinct Population Segment, SE = State Endangered only, ST = State Threatened only
[2] Only PMRF sites with documented threatened, endangered, or candidate species on or adjacent are included in table.
[3] Potential to fly over and/or known to fall out on base
[4] Not observed at PMRF since 2000
[5] Not documented but likely to occur
[6] Not documented on site, but critical habitat is adjacent to Kōkeʻe sites

Sources: Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, Deakos et al. 2017, DoN 2008a, DoN 2014b and c, NMFS 2016c, Pepi et al 2009, Pyle and Pyle 2017, Richie et al. 2012, Uyeyama et al. 2011, VanderWerf 2012

Table 3-4. Marine Mammal Protection Act and Native Migratory Bird Treaty Act Protected Species on or adjacent to PMRF Sites

Scientific Name	Common Name	Hawaiian Name	Occurrence[1]					
			Barking Sands	Mākaha Ridge	Kōkeʻe Sites	Kamokala Ridge	Kaʻula Island	Niʻihau Island
Marine Mammals								
Globicephala macrorhynchus	Short-Finned Pilot Whale	---	X				X	X
Feresa attenuata	Pygmy Killer Whale	---	X				X	X
Grampus griseus	Risso's Dolphin	---					X	
Kogia breviceps	Pygmy Sperm Whale	---					X	X
Kogia sima	Dwarf Sperm Whale	---	X				X	X
Lagenodelphis hosei	Fraser's Dolphin	---	X				X	X
Megaptera novaeangliae	Humpback Whale	Kōholā Kuapiʻo	X				X	X
Mesoplodon desirostris	Blainville's Beaked Whale	---	X				X	X
Orcinus orca	Killer Whale	---					X	
Peponocephala electra	Melon-Headed Whale	---	X				X	X
Stenella attenuata	Pantropical Spotted Dolphin	Kiko	X				X	X
Stenella coeruleoalba	Striped Dolphin	---	X				X	X
Stenella longirostris	Spinner Dolphin	Naiʻa	X				X	X
Steno bredanensis	Rough-Toothed Dolphin	---	X				X	X
Tursiops truncatus	Bottlenose Dolphin	Naiʻa	X				X	X
Ziphius cavirostris	Cuvier's Beaked Whale	---	X				X	X
Birds								
Anas clypeata	Northern Shoveler	Koloa Mohā	X					
Anas crecca	Green-Winged Teal	---	X					

Scientific Name	Common Name	Hawaiian Name	Occurrence[1]					
			Barking Sands	Mākaha Ridge	Kōkeʻe Sites	Kamokala Ridge	Kaʻula Island	Niʻihau Island
Anous minutus	Black Noddy	Noio					X	X
Anous stolidus	Brown Noddy	Noio Kōhā					X	X
Arenaria interpres	Ruddy Turnstone	ʻAkekeke	X				X	X
Asio flammeus sandwichensis	Short-Eared Owl	Pueo	X	X	X			X
Bulweria bulwerii	Bulwer's Petrel	ʻOu					X	X
Calidris alba	Sanderling	Hunakai	X					
Fregata minor	Great Frigatebird	ʻIwa	X				X	X
Gygis alba	White Tern	Manu-o-Kū					X	
Chlorodrepanis stejnegeri	Kauaʻi ʻamakihi	ʻAmakihi			X			
Himatione sanguinea	ʻApapane	ʻApapane			X			
Larus atricilla	Laughing Gull	---	X					
Nycticorax nycticorax hoactli	Black-crowned Night-heron	ʻAukuʻu	X			X		X
Onychoprion fuscatus	Sooty Tern	ʻEwa ʻEwa					X	
Onychoprion lunatus	Gray-backed Tern	Pākalakala					X	
Phaethon lepturus	White-tailed Tropicbird	Koaʻe Kea		X				X
Phaethon rubricauda	Red-tailed Tropicbird	Koaʻe Ula					X	X
Phoebastria immutabilis	Laysan Albatross	Mōlī	X				X	X
Phoebastria nigripes	Black-footed Albatross	Kaʻupu	X				X	
Pluvialis fulva	Pacific Golden Plover	Kōlea	X	X	X	X	X	X
Pluvialis squatarola	Black-bellied Plover	---	X					
Procelsterna cerulean saxatilis	Blue-gray Noddy	---					X	

Pterodroma hypoleuca	Bonin Petrel	---					X	
Puffinus nativitatis	Christmas Shearwater	ʻAoʻū					X	X
Puffinus pacifus	Wedge-tailed Shearwater	ʻUaʻu Kani	X				X	
Sula dactylatra	Masked Booby	ʻĀ					X	X
Sula leucogaster	Brown Booby	ʻĀ	X				X	X
Sula sula	Red-footed Booby	ʻĀ					X	X
Tringa incana	Wandering Tattler	ʻŪlili	X				X	X

[1] Only PMRF sites with documented MMPA or MBTA species on or adjacent are included in table.
Sources: Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, Bruner 2000, DoN 2014b, Pepi et al. 2009, Pyle and Pyle 2017, Richie et al. 2012, Uyeyama et al. 2011

Table 3-5. Invasive and Injurious Wildlife Identified at PMRF

Scientific Name	Common Name	Status	Occurrence[1]					
			Barking Sands	Mākaha Ridge	Kōkeʻe Sites	Kamokala Ridge	Kaʻula	Niʻihau Island
Birds								
Bubulcus ibis	Cattle Egret	SOH Injurious	X	X		X		
Cettia diphone	Japanese Bush-Warbler	SOH Injurious	X	X	X			
Columba livia	Rock Dove, Rock Pigeon	SOH Injurious	X			X		
Lonchura malacca	Chestnut Mannikin	SOH Injurious	X			X		
Tyto alba	Barn Owl	SOH Injurious	X		X	X		
Zosterops japonicus	Japanese White-Eye	SOH Injurious	X	X	X	X		X
Herpetofauna								
Anolis carolinensis	Green Anole	SOH Injurious		X				
Cryptoblepharus poecilopleurus	Snake-Eyed Skink	SOH Injurious	X					
Hemidactylus frenatus	House Gecko	---	X	X				
Lampropholis delicata	Metalic Skink	SOH Injurious			X			
Lepidodactylus lugubrus	Mourning Gecko	---	X	X				
Rhinella marina syn. *Bufo marinus*	Cane Toad	SOH Injurious	X					
Mammals								
Canis familiaris	Feral Dog	---	X	X	X			
Capra hircus	Feral Goat	SOH Injurious		X				
Felis catus	Feral Cat	---	X	X	X	X		X
Odocoileus hemionus columbianus	Columbian Black-Tailed Deer	SOH Injurious	X	X	X	X		
Mus musculus	House Mouse	---	X					
Rattus norvegicus	Norway Rat	---	X		X			
Rattus rattus	Roof Rat	---	X	X	X			X
Rattus exulans	Polynesian Rat	---	X				X	
Sus scrofa	Feral Pig	SOH Injurious	X	X	X	X		X

[1] Only PMRF sites with documented state injurious, KISC target species, or other invasive animal species are included in table.

Source: Bruner 2000, DoN 2010, Fisher 1951, Hawaiʻi Invasive Species Council 2015a, KISC 2017

3.3 Barking Sands Natural Resources

3.3.1 Topography, Geology, and Soils

Barking Sands lies on the Mānā Coastal Plain (called Mānā Plain) with an average elevation of about 15 ft (4.6 m) above mean sea level (msl) (**Figure 3-2**). The Mānā Coastal Plain extends approximately 10 mi (16 km) along the west coast of the island, moving 3 mi (5 km) inland to the east and forming the gentle westerly slopes that border the ancient sea cliffs that stretch from Polihale to Waimea. The longest sandy beach in the state is found along the Mānā Coastal Plain. The Mānā Coastal Plain is a broad accretional strand that resulted from a convergence of longshore sediment from winter swell and trade wind transport from the northeast and summer swell and trade wind transport from the southeast, as well as the falling sea level at the end of the late Holocene (Fletcher and Fiersten 2009; University of Hawai‘i 2013a). The interior of the Mānā Coastal Plain is composed of sand and gravel deposits, and marl and clay that were deposited in an ancient shallow lagoon. The dunes along the seaward side of the plain are composed of moderately to well-cemented calcareous sand (University of Hawai‘i 2013a). Much of Barking Sands is dominated by beaches and large dunes. The dunes consist of hills and ridges of vegetation-stabilized sand. The beach berm is approximately 10 ft (3 m) high on average with dunes reaching 75 to 80 ft in the Nohili Dunes area (23 to 24 m) with two man-made channels that cut through at Nohili Ditch and Kinikini Ditch.

There are six types of soils that are found on Barking Sands (**Figure 3-3**, **Table 3-6**). The largest soil unit is Jaucas loamy fine sand (JfB), which is found on old beaches and windblown sand deposits in western and southern parts of Kaua‘i (USDA Soil Conservation Service [SCS] 1972). Soils in the Jaucas series consists of excessively drained, calcareous soils found as thin strips adjacent to the ocean on coastal plains. Permeability is rapid, runoff is very slow to slow, the water erosion hazard is slight, and the wind erosion hazard is severe where vegetation has been removed USDA SCS 1972). This soil is suitable for use for pasture, recreational areas, wildlife habitat, sugarcane, and alfalfa.

Table 3-6. Soil Series at Barking Sands

Map Unit Symbol	Map Unit Name	Surface Runoff	Hydric	Area ac (ha)	Percent of Area
BS	Beaches	Very low	Non-hydric	131 (53)	5.44%
DL	Dune land	Low	Non-hydric	137 (55)	5.70%
Fd	Fill land	Medium	Non-hydric	4 (1.6)	0.17%
JfB	Jaucas loamy fine sand, 0 to 8 percent slopes	Very low	Non-hydric	2,125 (860)	88.22%
Kf	Kaloko clay loam	Negligible	Hydric	3 (1.2)	0.14%
Kfa	Kaloko clay	Negligible	Hydric	7 (2.8)	0.29%
MnC	Mamala stoney silty clay loam, 0 to 12 percent slopes	Low	Non-hydric	1 (0.4)	0.04%
Total for Soil Survey Area				2,408 (974)	100%

Source: USDA NRCS 2015

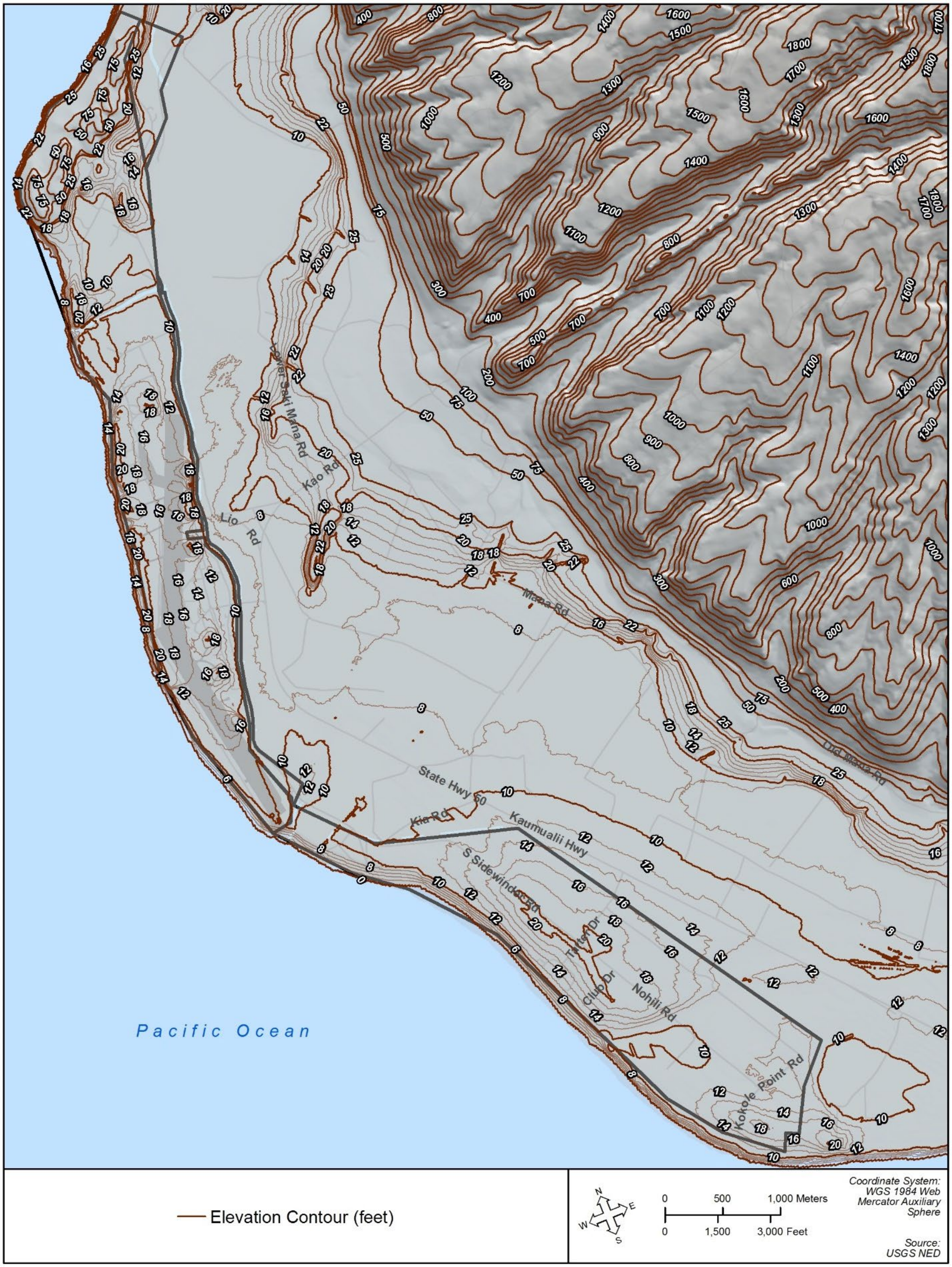


Figure 3-2. Barking Sands Elevation Contours

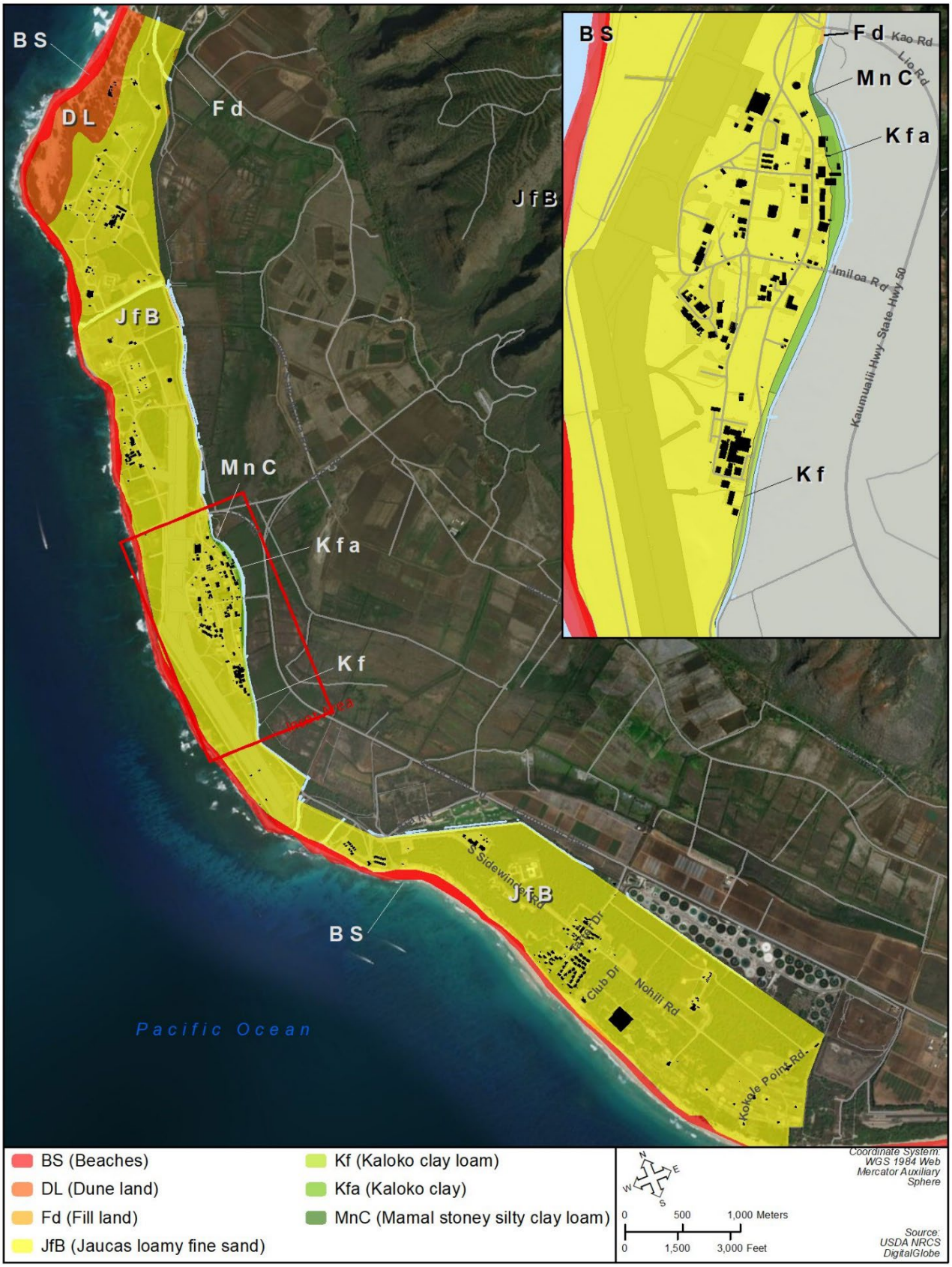


Figure 3-3. Barking Sands Soils

Dune land (DL) makes up approximately six percent of the soils at Barking Sands and includes hills and ridges formed from sand particles that have drifted and piled by wind (USDA SCS 1972). DL is actively shifting or has been so recently formed that no soil horizons exist. Dunes predominately consist of sand from coral and seashell. DL is suitable for wildlife habitat and recreational areas, though the presence of sensitive species and human remains may preclude areas from recreational use.

Beach sand (BS) comprises about five percent of the soils on Barking Sands. The BS series occurs as sandy, gravelly, or cobbly areas that are washed and rewashed by ocean waves (USDA SCS 1972). Most beaches consist of light-colored sands derived from coral and seashell, while some of the beaches consist of dark colored sands from basalt and andesite. Beaches are mainly suitable for recreational purposes and have no agricultural value.

There are small areas on Barking Sands that consist of Kaloko clay (Kfa) and Kaloko clay loam (Kf) series soils. This series consists of poorly drained soils developed in alluvium derived from basic igneous rock and deposited over marly lagoon deposits. Kfa soil consists of a dark-brown clay about 12 in (30.5 cm) thick covering a subsurface layer of dark reddish brown to weak red clay about 8 in (20.3 cm) thick (USDA SCS 1972). The permeability of Kfa is moderately slow to slow, with slow to very slow runoff, and a slight erosion hazard. This soil is difficult to work. The Kf soil found on the Mānā Plain differs slightly from Kfa in that the texture of sand in the surface layer and horizontal lenses of sand in the underlying material. Runoff is slow and there is no erosion hazard (USDA SCS 1972). Both soils are prime farmland soils if they are not frequently flooded during the growing season.

Fill land (Fd) is comprised mainly of bagasse and slurry from sugar mills but may also consist of material from dredging and excavation (USDA SCS 1972). Historically, these materials were generally dumped and spread over marshes, low-lying areas along the coastal flats, coral sand, coral limestone, or areas shallow to bedrock and do not support prime farmland.

3.3.2 Hydrology

Although Kauaʻi is known to have some of the largest rivers and the greatest amount of runoff in Hawaiʻi, the western portion of the island is relatively dry and lacks a significant amount of surface water (USGS 1986). The Mānā Plain, which once contained one of the largest wetlands in the state comprised of 1,700 ac (688 ha) of permanent, semi-permanent, and seasonal wetlands (SOH DLNR 2012), currently consist of only about 200 ac (81 ha) of aquatic habitat made up of sugar cane era reservoirs and ditches. The area also includes a waterbird sanctuary and permanent wetland area that was created when sand was mined in an area directly adjacent to PMRF (**Figure 3-4**).

Surface water and wetlands on Barking Sands are found in the Kawaiʻele (also known as Dry Ditch), Kinikini and Nohili ditches, which drain the agricultural lands east of the installation of water and associated sediment and residues. A man-made sewage oxidation pond complex is located on the southern portion of the installation. Narrow bands of wetland habitat border portions of the ditches and pond area. The estuarine and marine systems along the shoreline comprise the only natural wetland habitat on Barking Sands.

Figure 3-4. Barking Sands Wetlands and Surface Water

The 100-year floodplain encompasses all of the shoreline and a large portion of the north and central zones of Barking Sands. The primary flooding potential for western Kauaʻi, including Barking Sands, comes from overland flow after heavy rain events in Waimea Canyon that overflow streams and channels (USGS 2004). The Mānā Coastal Plain also has a high susceptibility from tsunamis and high waves resulting from tropical storms that generally pass to the west of Kauaʻi (USGS 2004).

3.3.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

Complete vegetation surveys of Barking Sands were conducted in 2000 (Char et al.) and cover types were described in detail; however, cover types have been somewhat altered by further expansion of invasive species in some areas and efforts to remove Long-thorn Kiawe and restore native habitat in other areas. An updated habitat classification and vegetation mapping effort conducted at Barking Sands in 2005 indicated the base is composed of extensive areas of landscaped vegetation (39 percent) and scrub habitat dominated by invasive introduced species such as Kiawe (*Prosopis pallida*), Long-thorn Kiawe, and Koa Haole (45 percent), with other non-native cover types such as ruderal (disturbed) (3 percent), agricultural (1 percent), and ditches and manmade wetlands (1 percent) (**Table 3-7**, **Figure 3-5**). It is important to note that Long-thorn Kiawe is currently present in small areas at PMRF and is almost eradicated within PMRF boundaries due to extensive removal and survey efforts.

Table 3-7. Vegetation Cover Types at Barking Sands in 2005

Cover Type	Native/Non-native	Area ac (ha)	Percent of Area
Agave	Non-native	2.3 (0.9)	0.10%
Agriculture	Non-native	22.5 (9.1)	0.96%
Long-thorned Kiawe (Long-thorn Algaroba)	Non-native	13.2 (5.3)[1]	0.56%[1]
Grass, Herb, Shrub	Non-native	0.3 (0.1)	0.01%
Kiawe Koa Haole Scrub	Non-native	1,053.1 (426.2)	45.03%
Landscaped	Non-native	921.7 (373.0)	39.41%
Ruderal	Non-native	73.3 (29.6)	3.13%
Wetland Vegetation with Koa Haole	Non-native	25.3 (10.2)	1.08%
ʻAʻaliʻi -Nama Scrub	Native	145.5 (58.9)	6.22%
ʻAki ʻaki (beach dropseed)	Native	0.2 (0.1)	0.01%
Naupaka	Native	20.9 (85)	0.89%
Naupaka, Ipomoea	Native	0.5 (0.2)	0.02%
Pō hinahina	Native	1.8 (0.7)	0.08%
Pōhinahina-Naupaka Dune	Native	57.5 (23.3)	2.46%
Ipomoea	Native and Non-native	0.4 (0.2)	0.02%
Total		2,338.5 (946.4)	100.00%

[1]Control efforts have significantly reduced Long-thorn Kiawe occurrence since 2005 mapping effort
Source: NAVFAC PAC 2005

Native vegetation types, including ʻAʻaliʻi-Nama (*Dodonaea viscosa-Nama sandwicensis*) scrub (6 percent) and Pōhinahina -Naupaka (*Vitex rotundifolia-Scaevola sericea*) dune vegetation (3 percent), comprise only 9 percent of the base's vegetation. General descriptions of each of the cover types as described by Char (2000a) are provided below. In addition to these two surveys, a partial botanical

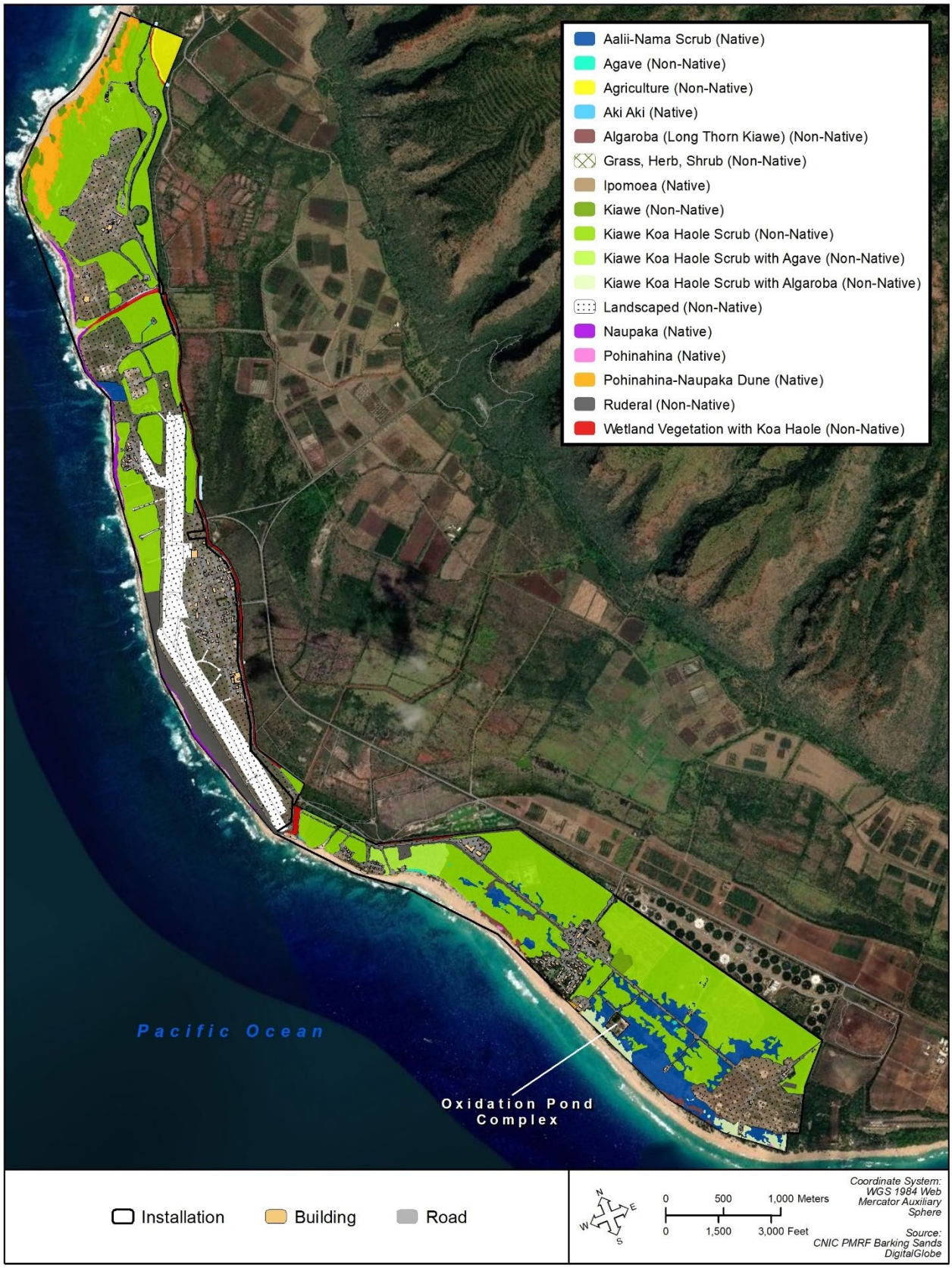


Figure 3-5. Barking Sands Vegetation Types

survey was conducted in 2006 that focused on documenting the Nohili dunes area and updating dramatic vegetation changes (NAVFAC PAC 2006b). To date, approximately 125 species have been identified at Barking Sands. Of these, approximately 97 species (78 percent) are introduced, 22 (18 percent) are indigenous, and 6 (5 percent) are endemic. For a full list of plant species from Barking Sands refer to **Appendix C**.

3.3.3.1 Kiawe and Koa Haole

Kiawe and Koa Haole are both abundant in dry, disturbed, lowland habitats. They are found in about equal numbers throughout the base. The tallest, most dense area of this vegetation type occurs behind the Nohili Point sand dunes between Nohili Road and the agricultural fields in the northern portion of the base. Non-native Guinea grass (*Urochloa maximum*) is also abundant and grows 2 to 3 ft (0.6 to 1 m) tall in this area. The Kiawe-Koa Haole scrub is more open on the southern half of the sitefrom the end of the runway near Waieli Drive to the housing area gate, with cover varying between 30 and 50 percent. Lantana shrubs (*Lantana camara*) form dense 5 to 7 ft (1.5 to 2 m) thickets between the trees. Kūpala (*Sicyos pachycarpus*) and Wild Basil shrubs (*Ocimum gratissimum*) are also abundant in some open areas. In the Kiawe-Koa Haole scrub around Majors Bay, non-native Agave (*Agave sisalana*) plants are also abundant.

3.3.3.2 ‘A‘ali‘i -Nama Scrub

The southern half of the site from the housing area to the antenna fields contains ‘A‘ali‘i -Nama scrub, with the most characteristic example of this native vegetation type found around the oxidation pond complex. ‘A‘ali‘i shrubs form a patchy 5 to 8 ft (1.5 to 2 m) cover with abundant low, rounded Nama in between these and other shrubs. The dominant vegetation is native. One of the many native plants frequently encountered is the Pololei fern (*Ophioglossum polyphyllum*). In addition, non-native Kiawe trees are scattered throughout the scrub either in small stands or as individual trees, surrounded by Buffelgrass (*Cenchrus ciliaris*), Guinea grass, and Lantana shrubs. Koa Haole shrubs grow along disturbed edges of the ‘A‘ali‘i -Nama scrub.

3.3.3.3 Pōhinahina-Naupaka Dune Vegetation

The seaward facing slopes of large dunes at Nohili Point contain native Pōhinhina-Naupaka dune vegetation. Low mats of Pōhinahina form over the dunes interspersed with low thickets of Naupaka. ‘Akoko (*Chamaesyce celastroides* syn. *Euphorbia celastroides*) is also locally abundant in the area of the launch pads. ‘Aki ‘aki grass (*Sporobolus virginicus*), Beach Morning Glory (*Ipomoea pes-caprae*) and Hunakai (*Ipomoea imperati*) are abundant closer to the beach. Inland of the Pōhinahina-Naupaka dune vegetation is dense Kiawe-Koa Haole scrub, and some Kiawe and Koa Haole scrub are scattered throughout the native dune vegetation.

3.3.3.4 Strand Vegetation

A narrow band along the coastline contains strand vegetation, which is mostly bordered by Kiawe-Koa Haole scrub on the inland side. The strand vegetation varies between the area north of Waieli Drive to the area south of Waieli Drive. The northern area contains few low, scattered shrubs of Naupaka, Pōhinahina, Koa Haole, and Indian Fleabane (*Pluchea indica*), along with abundant mats of ‘Aki‘aki

grass. The area south of Waieli Drive contains scattered patches of strand vegetation behind sandy beaches. The most common native species found here are Beach Morning Glory and ʻAkiʻaki grass, but several introduced species such as Buffelgrass are also common. The southernmost portion of the site previously consisted of dense thickets Long-thorn Kiawe though control efforts have been undertaken and the infestation is greatly reduced. There are also a few scattered pockets of native strand vegetation such as Naupaka and ʻAkiʻaki grass.

3.3.3.5 Drainageway/Wetlands

Various waterbirds, including five federally listed endangered birds, utilize the small area of this vegetation type on the property. Large, often floating mats of non-native species including seashore Paspalum (*Paspalum vaginatum*) line the ditches. The lower banks of the ditches contain dense thickets of Indian Fleabane and mats of California Grass (*Brachiaria mutica*) while the top of the banks are lined with a narrow band of Koa Haole, Kiawe, and Milo (*Thespesia populnea*).

3.3.3.6 Ruderal and Landscaped Vegetation

Ruderal vegetation is found along paved and unpaved roads, as well as in disturbed, overgrown areas. Buffelgrass and Bermuda Grass (*Cynodon dactylon*) are the most abundant species on roadsides. Various other weedy non-native, mostly annual species are scattered throughout these areas. Golden Crown-beard is an invasive pioneer species in disturbed sites that is scattered throughout a large open parcel near the northern drainage ditch along with Buffelgrass, Bermuda Grass, low stubs of Koa Haole and Lantana shrubs, and numerous other non-native species.

Landscaping at Barking Sands typically includes non-native ornamental species and large areas of mowed lawn. Frequently planted species include trees such as Coconut Palms (*Cocos nucifera*), flowering shrubs (native and non-native), and lawn that is primarily comprised of Buffelgrass and Bermuda Grass.

3.3.4 Invasive and Introduced Wildlife Species

Wildlife surveys were conducted in 1999 in support of the 2001 INRMP (Bruner 2000) and in 2006 (NAVFAC PAC 2006c). The only native terrestrial mammal found at PMRF is the endangered Hawaiian Hoary Bat. All other terrestrial mammal species are non-native. Feral Cats, Roof/Black Rats, Polynesian Rats (*Rattus exulans*), and the Common House Mouse (*Mus musculus*) were documented during these surveys. Feral Cats and Roof/Black Rats were the most common mammal species encountered in both surveys. Signs of Feral Pigs and Black-tailed Deer were also found during the 2006 survey. There have been reported sightings of mongoose at Barking Sands, though none have been captured. The introduced Barn Owl (*Tyto alba*) is also a common resident at Barkings Sands and evidence of the species targeting Wedge-tailed Shearwaters has been documented on the base. Barn Owls are targeted for predator control efforts at Barking Sands as well as protection of the airfield area from bird aircraft strikes. Reptiles documented at Barking Sands include the Mourning Gecko (*Lepidodactylus lugubrus*), House Gecko (*Hemidactylus Frenatus*), And Snake-Eyed Skink (*Cryptoblepharus Poecilopleurus*). The House gecko was the most common reptile found during the survey. The only amphibian recorded on Barking Sands was the Cane Toad (*Rhinella marina* syn. *Bufo marinus*).

3.3.5 Special Status Species

A total of 19 federally protected ESA species and one area of unoccupied critical habitat are known to occur on or adjacent to, as fly-overs, or in the nearshore waters of Barking Sands. Known occurrences, both on and off base, of these species are described in **Table 3-8** and on-base areas known to support special status species and the unoccupied habitat for Niʻihau panicgrass are shown in **Figure 3-6**.

In addition to these ESA-protected species, many others are protected by the MMPA and MBTA. Marine surveys conducted in 2000 and 2006 in support of previous INRMP updates and surveys conducted annually in support of Navy training operations have identified several MMPA-protected species: Spinner Dolphin (*Stenella longirostris*), Short-finned Pilot Whale (*Globicephala macrorhynchus*), Humpback Whale (*Megaptera novaengliae*), Rough-toothed Dolphin (*Steno bredanensis*), Bottlenose Dolphin (*Tursiops truncatus*), Melon-headed Whale (*Peponocephala electra*), and rarely, Pantropical Spotted Dolphin (*Stenella attenuata*), Striped Dolphin (*Stenella coeruleoalba*), Fraser's Dolphin (Lagenodelphis hosei), Dwarf Sperm Whale (*Kogia sima*), Pygmy Killer Whale (*Feresa attenuata*), Cuvier's Beaked Whale (Ziphius cavirostris) and Blainville's Beaked Whale (Mesoplodon desirostris), in the waters off of Barking Sands (Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, DoN 2014b, Mobley et al. 2017, Uyeyama et al. 2011, Richie et al. 2012).

Avian surveys conducted at Barking Sands have identified 54 species of birds (Bruner 2000, Hamer Environmental L.P. 2016, NAVFAC PAC 2006a, PMRF 2018). Of these, 25 are native and 29 are non-native, though many have become naturalized on Kauaʻi (Pyle and Pyle 2017). Although non-native, most of these species are migratory and protected by the MBTA. Laysan Albatross or Mōlī (*Phoebastria immutabilis*), Black-crowned Night-heron or ʻAukuʻu (*Nycticorax nycticorax hoactli*), Black-footed Albatross or Kaʻupu (*Phoebastria nigripes*), Brown Booby or ʻĀ (*Sula leucogaster*), Ruddy Turnstone or ʻAkekeke (*Arenaria interpres*), Pacific Golden Plover or Kōlea (*Pluvialis fulva*), Sanderling or Hunakai (*Calidris alba*), Hawaiian Short-eared Owl or Pueo (*Asio flammeus sandwichensis*), and Wedge-tailed Shearwater or ʻUaʻu Kani (*Puffinus pacificus*) are relatively common native bird species known to occur at Barking Sands that are protected under the MBTA. The Pacific Golden Plover is migratory and leaves Hawaiʻi in April to breed in Alaska and returns to Hawaiʻi in August (Pyle and Pyle 2017). Wandering Tattler or ʻŪlili (*Tringa incana*) is an uncommon native MBTA-species known to occur. House Finches, Northern Mockingbird (*Mimus polyglottos*), and Northern Cardinal (*Cardinalis cardinalis*) are examples of common non-native birds that are also protected by the MBTA.

Table 3-8. Special Status Species on or near Barking Sands

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Birds					
Anas clypeata	Northern Shoveler	Koloa mohā	MBTA	Winter resident (Sept. -April). Uncommonly observed at ditch outfalls and the oxidation pond.	NA
Anas wyvilliana	Hawaiian Duck	Koloa maoli	E, MBTA	Year-round resident. Frequently observed in ditches and at oxidation pond. Young hatchlings have been observed at the oxidation pond and Kawaiʻele Ditch (also known as Dry Ditch).	Breeding Season: Year-round, peak April-Sept. Incubation: ~30 days Fledges: 50-60 days
Anas crecca	Green-Winged Teal	---	MBTA	Winter resident (Sept. – April). Uncommonly observed at the oxidation pond.	NA
Arenaria interpres	Ruddy Turnstone	ʻAkekeke	MBTA	Migrant and winter resident, few over-summer. Frequently seen at the oxidation pond complex and commonly observed at beaches.	NA
Asio flammeus sandwichensis	Short-Eared Owl	Pueo	MBTA	Year-round resident. Commonly observed at Barking Sands however no nesting or breeding has been confirmed.	Breeding Season: Year-round, with peak in winter months Incubation: 21-37 days Fledges: ~ 29 days
Branta sandvicensis	Hawaiian Goose	Nēnē	FT, SE, MBTA	Year-round resident on Kauaʻi. Commonly observed throughout site known nesting at Kinikini Ditch, the oxidation pond complex, HIANG complex, THAAD complex, and beach cottages.	Breeding Season: Aug. – April, peak Oct.–Dec. Incubation: ~30 days Fledges: ~90 days
Calidris alba	Sanderling	Hunakai	MBTA	Winter resident (July – May), few over-summer. Commonly observed at beaches.	NA
Fulica americana alai	Hawaiian Coot	ʻAlae keʻokeʻo	E, MBTA	Year-round resident. Commonly observed at Kinikini Ditch and the oxidation pond where nesting is frequently recorded.	Breeding Season: Year-round, peak April-Sept. Incubation: ~25 days Fledges: 50-75 days
Gallinula galeata sandvicensis	Hawaiian Common Gallinule	ʻAlae ʻula	E, MBTA	Year-round resident. Commonly observed in Kinikini Ditch and Kawaiʻele Ditch (also known as Dry Ditch). Nesting has been documented in Kinikini Ditch and young hatchlings are routinely observed in the Kawaiʻele Ditch (also known as Dry Ditch) during the summer months.	Breeding Season: Year-round, peak Mar.-Aug. Incubation: ~22 days Fledges: 50-75 days

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	E, MBTA	Year-round resident. Commonly observed in the ditches surrounding the base, at the oxidation pond complex, and occasionally foraging on the beach. Not known to nest on installation however adults are regularly observed with their fledged young at Barking Sands.	Breeding Season: March-Aug., peak May-June Incubation: ~24 days Fledges: ~60 days
Larus atricilla	Laughing Gull	---	MBTA	Occasional vagrant winter visitor. Uncommonly seen at Barking Sands.	NA
Numenius tahitiensis	Bristle-Thighed Curlew	Kioea	MBTA	Winter resident	NA
Nycticorax nycticorax hoactli	Black-Crowned Night-Heron	ʻAukuʻu	MBTA	Year-round resident. Commonly observed at ditches and the oxidation pond complex.	Breeding Season: March – Oct. Incubation: ~25 days Fledges: 50-75 days
Oceanodroma castro	Band-rumped Storm-petrel (Hawaiʻi DPS)	ʻAkēʻakē	E, MBTA	Breeding visitor. Known to fly over base during trips between nesting and foraging sites. Fledglings also fly through the area on their first trip to the sea and may fall out during fledgling season.	Breeding Season: May – Oct. /April - June Incubation: 39 -51 days Fledges: mid Sept. – mid Dec.
Phoebastria albatrus	Short-Tailed Albatross	---	E, MBTA	Migrant. Rare, only one sighting at Barking Sands, recorded in 2000, near runway.	NA
Phoebastria immutabilis	Laysan Albatross	Mōlī	MBTA	Breeding visitor. Commonly observed during nesting season from Kinikini Ditch to north end of base.	Breeding Season: Nov. – Dec. Fledging: June to July Incubation: 65-66 days Fledges: ~185 days
Phoebastria nigripes	Black-Footed Albatross	Kaʻupu	MBTA	Breeding visitor (Niʻihau and Kaʻula). Uncommonly observed at Barking Sands, not known to nest on base.	Breeding Season: Oct. – Jun. Incubation: ~65-66 days Fledges: ~150 days
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Winter resident. Commonly observed throughout Barking Sands August – April (non-nesting season).	NA
Pluvialis squatarola	Black-Bellied Plover	---	MBTA	Winter resident. Uncommonly observed at Barking Sands beaches.	NA
Pterodroma phaeopygia sandwichensis	Hawaiian Petrel	ʻUaʻu	E, MBTA	Breeding visitor. Known to fly over the base when traveling between nesting and foraging areas. Fledglings also fly through the area on their first trip to the sea and may fall out during fledgling season.	Breeding Season: Feb. – May Incubation: ~56 days Fledges: Oct. – Dec.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Puffinus auricularis newelli	Newell's Shearwater	ʻAʻo	T, MBTA	Breeding visitor. Known to fly over base when traveling between nesting sites and at-sea foraging areas. Fledglings also fly through the area on their first trip to the sea and are vulnerable to fall out during fledgling season.	Breeding Season: March - April Incubation: ~51 days Fledges: mid Sept. – mid Dec.
Puffinus pacificus	Wedge-Tailed Shearwater	ʻUaʻu Kani	MBTA	Breeding visitor. Three active nesting colonies on Barking Sands; Nohili Dunes, Kinikini Ditch, and the beach cottages area with some burrows present sporadically along the coastal area near the airfield.	Breeding Season: March - June Incubation: ~50 days Fledges: mid Nov. – early Dec.
Sula leucogaster	Brown Booby	ʻĀ	MBTA	Breeding visitor (occasional) on Kauaʻi. Commonly observed foraging offshore.	Breeding Season: Jan. – Sept. and Oct. – Dec. Incubation: ~43 days Fledges: 130 – 260 days
Tringa incana	Wandering Tattler	ʻŪlili	MBTA	Winter resident. Regularly observed in the intertidal zone of Barking Sands.	NA
Mammals					
Balaenoptera physalus	Fin Whale	---	E	Considered rare, most likely to occur in fall and winter.	Breeding season: Late fall-winter.
Feresa attenuata	Pygmy Killer Whale	---	MMPA	Occurs in deeper waters year-round; may have island-associated resident populations	Calving likely peaks in summer.
Globicephala macrorhynchus	Short-finned Pilot Whales	---	MMPA	May be part of island-associated resident population that moves over area covering Kauaʻi, Niʻihau, Kaʻula, and offshore north of Barking Sands.	Breeding Season: Year-round, peaks July – Aug.
Kogia sima	Dwarf Sperm Whale	---	MMPA	May be part of an island- associated resident population; occur year-round.	Calving occurs in spring.
Lagenodelphis hosei	Fraser's Dolphin	---	MMPA	Occurs year-round in deeper waters in large pods; considered rare nearshore but has been recorded off of Barking Sands.	Calving occurs between spring and fall

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	E	Documented year-round, most common in winter, roosts, forages, and may breed at Barking Sands.	Breeding Season: Sept – Dec. Pupping: June – Aug. Mother likely stays with pups for 6-7 weeks.
Megaptera novaeangliae	Humpback Whale	Kōholā kuapiʻo	SE, MMPA	Occur winter / spring (Nov. – April). Commonly observed off the coast of Barking Sands.	Calving occurs in winter.
Mesoplodon desirostris	Blainville's Beaked Whale	---	MMPA	Occur in low numbers rear-round, possibly as part of a resident population.	No seasonality is known
Neomonachus schauinslandi	Hawaiian Monk Seal	ʻĪlio-holo-i-ka-uaua	E	Commonly observed on beaches at Barking Sands. One documented birth at Barking Sands, in 1999.	Breeding Season: Year-round Pupping: Feb. – Aug., peaks March – April. Mother nurses her pup for 5-6 weeks.
Peponocephala electra	Melon-headed Whale	---	MMPA	Occur year-round. Occasionally observed off the coast of Barking Sands.	No seasonality is known
Physeter macrocephalus	Sperm Whale	Palaoa	E	Higher occurrence in summer/ fall. Rarely recorded in adjacent waters.	Breeding season: Summer
Pseudorca crassidens	False Killer Whale	---	E – MHI Insular DPS	Occur year-round. Occasionally observed off the coast of Barking Sands.	No seasonality is known.
Stenella attenuata	Pantropical Spotted Dolphin	Kiko	MMPA	Rarely seen off the coast of Barking Sands.	Calving peaks in spring and fall.
Stenella coeruleoalba	Striped Dolphin	---	MMPA	Occur year-round, primarily in deeper waters, however rarely observed off the coast of Barking Sands.	Calving occurs summer to fall.
Stenella longirostris	Spinner Dolphin	Naiʻa	MMPA	Occur year-round. Commonly observed off the coast of Barking Sands.	Calving peaks range from spring to fall.
Steno bredanensis	Rough-Toothed Dolphin	---	MMPA	Occur year-round. Commonly observed. Tagged individuals tracked in PMRF area off Kauaʻi.	No seasonality is known.
Tursiops truncatus	Bottlenose Dolphin	---	MMPA	Occur year-round. Commonly observed off the coast of Barking Sands.	Calving peaks range from spring to fall.
Ziphius cavirostris	Cuvier's Beaked Whale	---	MMPA	Occur year-round, likely as part of an island-associated resident population. Occasionally observed off the coast of Barking Sands.	Breeding occurs year-round; calving peaks in spring.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Reptiles					
Chelonia mydas	Green Sea Turtle	Honu	T – Central North Pacific DPS	Occur year-round. Common at Nohili Ditch outflow, nesting and basking documented on several sites on coast of Barking Sands.	Nesting Season: May – July Incubation: ~ 60 days Hatch: July – Sept.
Eretmochelys imbricata	Hawksbill Sea Turtle	Honu‘ea	E	Rarely reported in the open waters offshore of Kaua‘i but has not been observed on land at Barking Sands.	NA
Plants					
Sesbania tomentosa[2]	O‘ahu Riverhemp	‘Ōhai	E	Occurs in sand dunes of Polihale State Park north of the Barking Sands property line. No plants have been documented at Barking Sands.	NA
Panicum niihauense[3]	Ni‘ihau Panicgrass	Lau‘ehu	E	Observed in Polihale State Park, ~ 183 ac (74 ha) of unoccupied critical habitat is designated within the beach strands and sand dunes of Barking Sands.	NA
Fish					
Carcharinus lonigmanus	Oceanic Whitetip Shark	---	T	Occurs in tropical and subtropical oceans throughout the world. They live from the surface of the water to at least 500 ft (152 m) deep. Breeding is thought to be concentrated in the central Pacific between 1°N and 15°N.	Mating occurs in late spring and summer. Gestation is 12-13months
Manta birostris	Giant Manta Ray	Hāhālua	T	Occurs worldwide in tropical, subtropical, and temperate waters and is commonly found offshore, in oceanic waters, and near productive coastlines. Breeding sites have been identified off the coast of Ecuador and in the Galapagos Islands.	The primary breeding season is July - August. Gestation is 12-13 months.

[1] State and Federally listed as E = Endangered, T = Threatened, DPS = Distinct Population Segment, SE = State Endangered only, Native MBTA = Species protected under the Migratory Bird Treaty Act; MMPA = Protected under Marine Mammal Protection Act

[2] Not known to occur on Barking Sands [3] Unoccupied critical habitat only is on Barking Sands

Sources: Ampela et al. 2015, Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, Bonfil et al. 2009, Deakos et al. 2017, DoN 2005, DoN 2010, DoN 2014b, Mobley et al. 2017, NAVFAC PAC 2006a,b,c; NMFS 2014a,b,c; NMFS 2016b,c,d, NOAA Fisheries 2018, Pyle and Pyle 2017, USFWS 2008b.

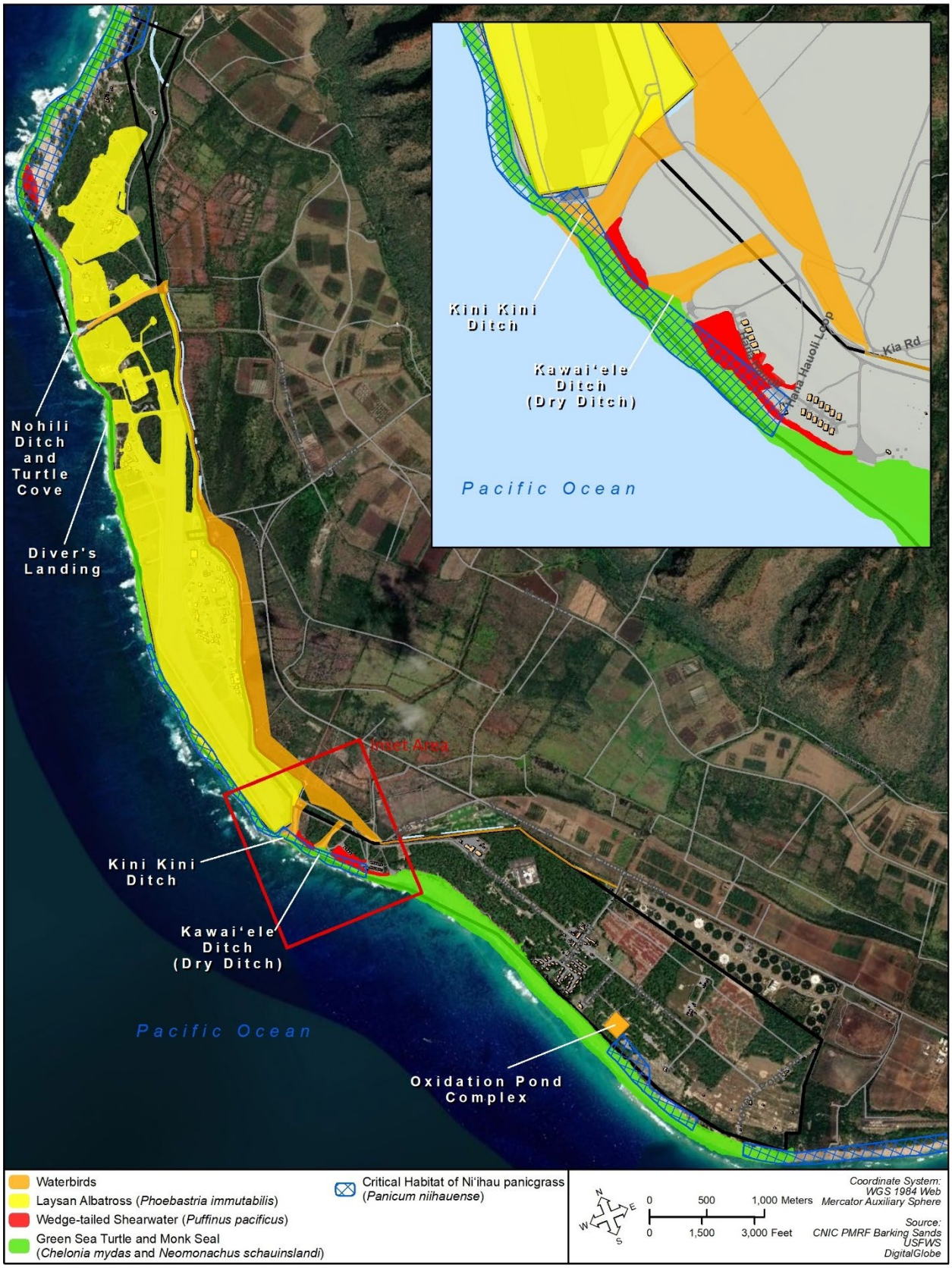


Figure 3-6. Special Status Species Habitat at Barking Sands

3.3.6 Coastal and Nearshore Environment

The nearshore environment adjacent to Barking Sands provides habitat for numerous species, including corals, macroinvertebrates, and fishes. Surveys of the marine environment were conducted in April 2000 (Dollar and Brock 2000) and August 2006 (Dollar and Brock 2007). These investigations involved point-to-point underwater swims at each dive site to evaluate abundance and other characteristics of marine communities. The investigations were limited to a maximum depth range of 65 ft (20 m) in the nearshore sector. The survey area was divided into four sectors separated by distinct physiographic and biotic structures as shown in **Figure 3-7**. The following is a summary of the 2000 and 2006 surveys (Dollar and Brock 2007) for coral reefs, fish, and macroinvertebrates. In 2022, biological and benthic habitat surveys are being conducted in the nearshore environment off of PMRF to identify any substrate or species composition changes, and to record all observations of protected species, including marine mammals and Green Sea Turtles (Miller et al. 2022).

3.3.6.1 Coral Reefs

Coral reefs are critical to the health of marine ecosystems that face severe threats world-wide. Currently 22 species of coral are protected under the ESA, however at this time, none have been listed in Hawai‘i (NMFS 2016a). The Cauliflower Coral or Ko‘a (*Pocillopora meandrina*) is present in PMRF’s nearshore marine environment and was determined to be at low risk of extinction (Smith 2019). Wave action is a major inhibiting factor on coral reef structure along much of the coastline of Kaua‘i and coral density is low.

At Barking Sands, a narrow fringing reef follows the coastline north from Mānā Point to Nohili Point. Total coral cover in the Nohili Sector ranges from 32 percent to 39 percent of the total bottom cover. The most abundant coral species are Lobe Coral or Pōhaku Puna (*Porites lobata*), Cauliflower Coral, and Ringed Rice Coral (*Montipora patula*). Along the central portion of Barking Sands in the Mānā Sector, living coral is sparsely distributed, and is approximately half of that found in the Nohili area. The dominant species are Lobe and Cauliflower Corals. The nearshore region of Majors Bay differs substantially from the two northern sectors in that there is little solid reef structure within the nearshore area within the 65 ft (20 m) depth contours. Rather, nearly the entire bottom consists of shifting sands. Coral cover in the Majors Bay Sector is less than two percent (Dollar and Brock 2007). The predominant coral found in the Offshore Sector is Antler Coral (*Pocillopora eydouxi*), which occurs as single large branching colonies. Other corals found on the platform, which have a collective coverage of about five percent, include Cauliflower Coral, Lobe Coral, Rice Coral, and others. Also present along the shelf break are Black Coral (*Antipathes griggi*) and Wire Coral (*Cirrhipathes anguina*).

3.3.6.2 Fish

The topographical complexity created by the eroded reef channels provides considerable shelter for many fish and motile invertebrate species. The Nohili sector contained the most abundant fish populations ranging from 72 to 78 species recorded over a 30-minute period of observation. Fish were less abundant on the flat limestone platforms of the Mānā sector compared to the Nohili sector. Where small depressions and undercutting were encountered in the hard bottom, a number of fishes were seen.

In 2000, 30 species of fishes were encountered in the Mānā Point survey and in the 2006 survey of this area, 55 species of fishes were recorded. Results of surveys of fish communities in Majors Bay reveal that in 2000, 22 species of fishes were documented and in 2006, 30 species of fishes were recorded. The average biomass remained essentially constant during the two surveys. **Appendix C** has a complete list of species observed during these survey efforts.

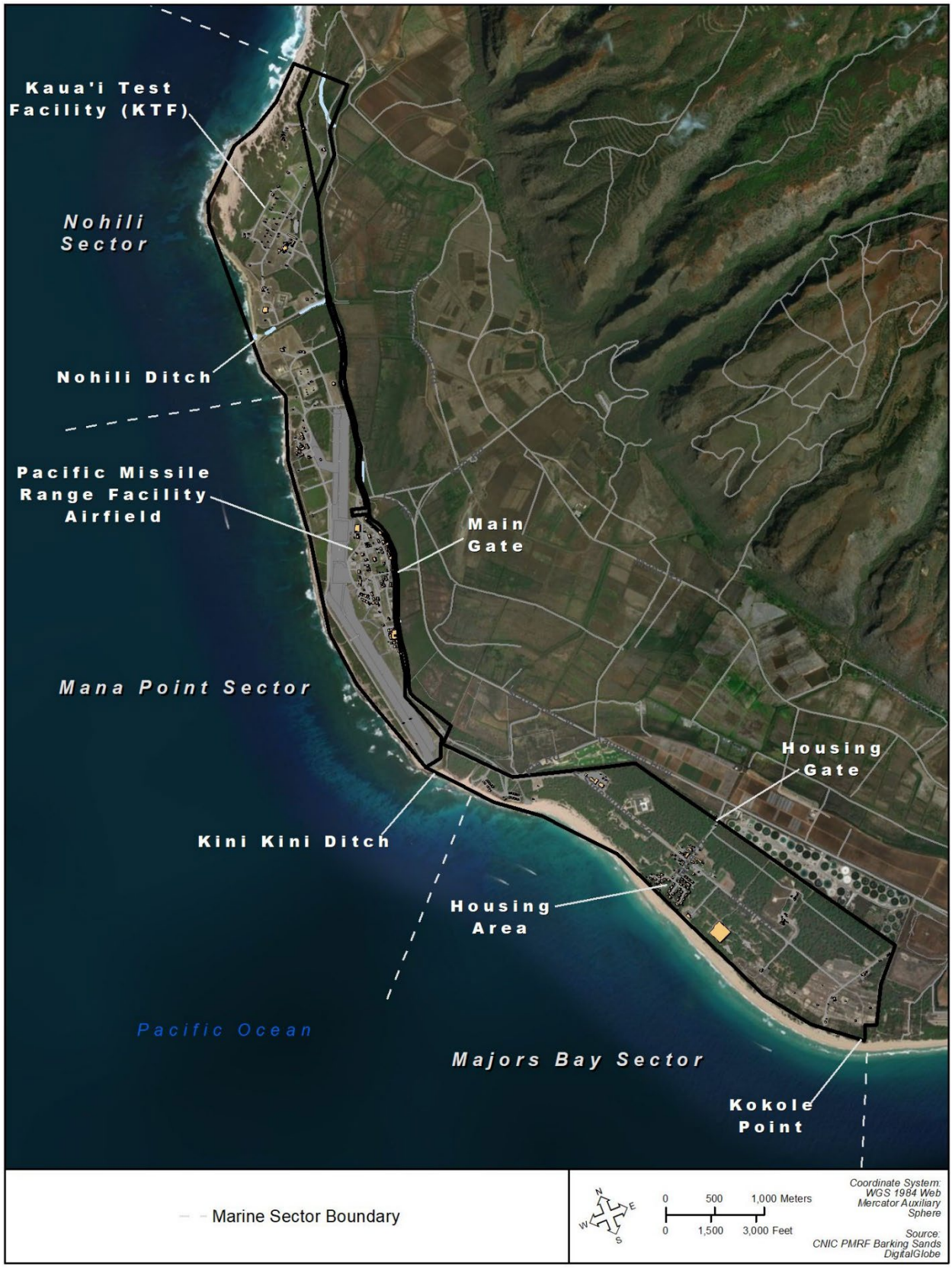


Figure 3-7. Barking Sands Marine Sectors

3.3.6.3 Essential Fish Habitat

Essential Fish Habitat (EFH) has been designated and described for the Hawaiian Islands including along the Kauaʻi shoreline and the surrounding waters. EFH consists of the waters and substrate needed for federally managed fisheries species to spawn, breed, feed, or grow to maturity. It has been designated for various life stages including eggs, larvae, juveniles, and adults for five management unit species complexes including bottomfish species, pelagic fishes, crustaceans, precious corals, and coral reef ecosystem taxa based on observed habitat utilization patterns in localized areas (Western Pacific Regional Fishery Management Council [WPRFMC] 2009a; WPRFMC 2009b; DoN 2005). Uku (*Aprion virescens*) was recorded at Waiokapua (Major's) Bay and Nohili during nearshore surveys in April 2000 (Dollar and Brock 2000) and August 2006 (Dollar and Brock 2007).

3.3.6.4 Macroinvertebrates

Macroinvertebrate species observed in the Barking Sands nearshore environment include limpets or ʻOpihi (*Cellana* spp.), littorine snails (*Littorina* sp. and *Nerita* sp.), Rock Oyster (*Spondylus tenebrosus*), cone shells (*Conus* spp.), Sea Urchins (*Echinometra mathaei*), and Sea Cucumber (*Holothuria atra*) (Dollar and Brock 2007). Of these organisms, ʻOpihi are culturally significant marine mollusks that have been historically over harvested in Hawaiʻi (Bird and Toonen 2014). In 2013, surveys were conducted along the entire coastline of the PMRF to assess the density and structure of ʻOpihi populations on the site and to compare them to other ʻOpihi populations on Kauaʻi and across the Hawaiian Archipelago (Bird and Toonen 2014). An estimated 110,000 Black Foot ʻopihi, or ʻOpihi Makaiauli (*Cellana. exarata*), and 4,000 Yellow Foot ʻopihi, or ʻOpihi ʻĀlinalina, (*C. sandwicensis*) were found at Barking Sands during the course of the study. Giant ʻOpihi, ʻOpihi Kōʻele (*C. talcosa*), though also observed, were extremely rare, likely due to lack of suitable habitat on the site (Bird and Toonen 2014).

3.4 Mākaha Ridge Tracking Station Natural Resources

3.4.1 Topography, Geology, and Soils

The cliffs of the Nā Pali ridgeline, on which the Mākaha Ridge Tracking Station is located, range in elevation from a low of 1,400 ft (426 m) at the cliff face to a high of 1,800 ft (548.6 m) at the eastern perimeter (**Figure 3-8**). While elevation varies across the site, the topography generally slopes west to southwest. The ridge on which the Mākaha Ridge Tracking Station is located is composed of lava formations from the Nā Pali formation of the Waimea Canyon series, associated with pyroclastic rocks from the flanks of the major Kauaʻi shield volcano, outside the caldera.

The soils at Mākaha Ridge Tracking Station include Rock outcrop (rRO), Rough broken land (rRR), Badland (BL), Badland-Mahana complex (BM), Mahana series, Niu series, Pakala series, and Puʻu ʻŌpae series soils (**Figure 3-9, Table 3-9**).

BL is mostly barren and steep to very steep with very rapid runoff and active erosion. Badland-Mahana complex (BM, 20 to 35 percent slope) encompasses 40 percent of the acreage and contains 60 percent

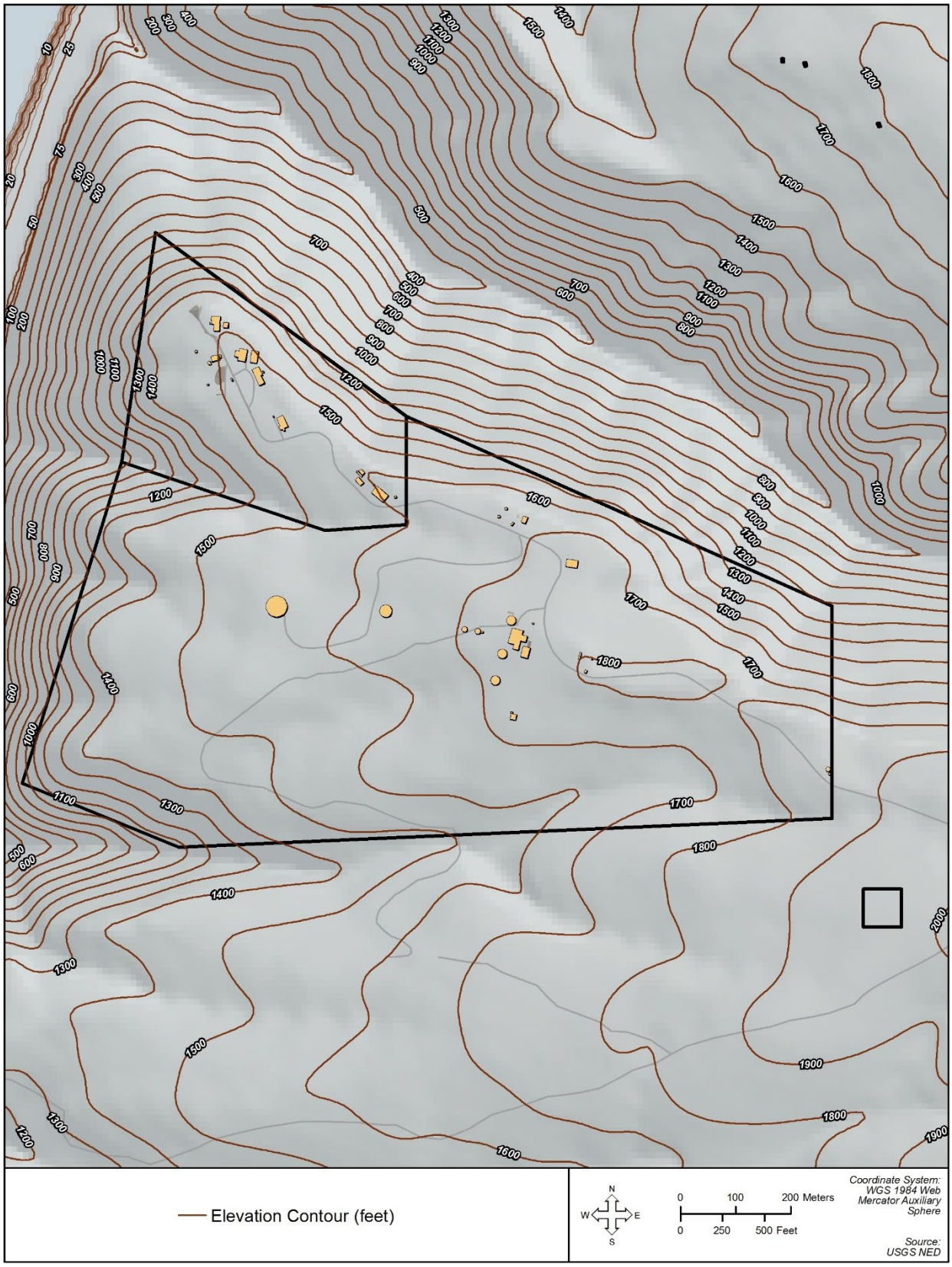


Figure 3-8. Mākaha Ridge Elevation Contours

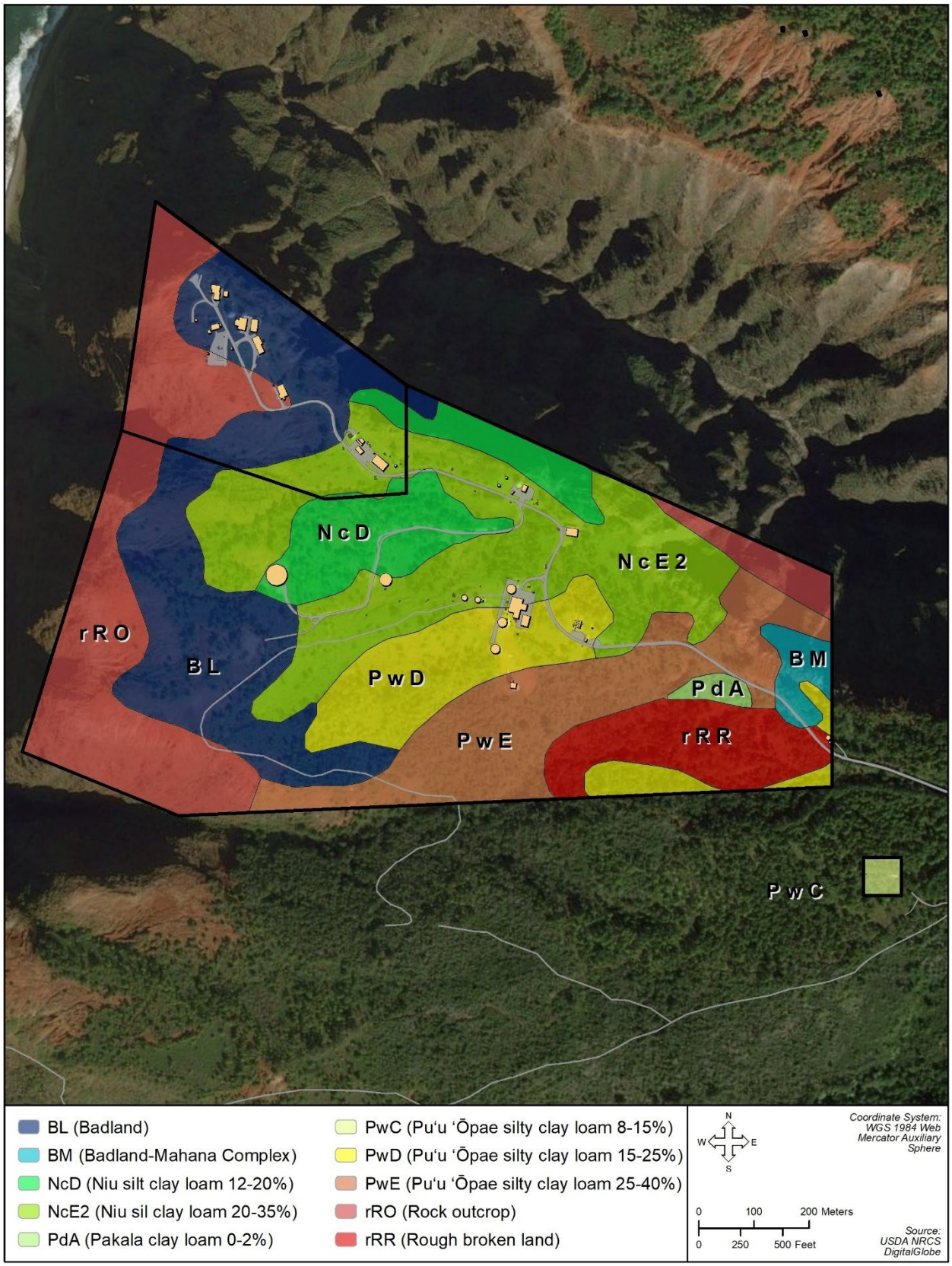


Figure 3-9. Mākaha Ridge Tracking Station Soils

Table 3-9. Soil Series at Mākaha Ridge Tracking Station

Map Unit Symbol	Map Unit Name	Surface Runoff	Hydric	Area ac (ha)	Percent of Area
BL	Badland	Very rapid	Non-hydric	49.6 (20.1)	20.4%
BM	Badland-Mahana complex, 20 to 35 percent slope	NA	Non-hydric	3.7 (1.5)	1.5%
MaD	Mahana silt loam, 12 to 20 percent slopes	Medium	Non-hydric	0.005 (0.002)	2.0 x10^{-3}%
NcD	Niu silty clay loam, 12 to 20 percent slope	Rapid	Non-hydric	20.3 (8.2)	8.4%
NcE2	Niu silty clay loam, 20 to 35 percent slope	Rapid	Non-hydric	52.8 (21.4)	21.7%
PdA	Pakala clay loam, 0 to 2 percent slope	Very slow	Non-hydric	1.5 (0.6)	0.6%
PwC	Puʻu ʻŌpae silty clay loam , 8 to 15 percent slope	Slow to Medium	Non-hydric	1.2 (0.5)	0.5%
PwD	Puʻu ʻŌpae silty clay loam, 15 to 25 percent slope	Medium	Non-hydric	23.1 (9.3)	9.5%
PwE	Puʻu ʻŌpae silty clay loam, 25 to 40 percent slope	Rapid	Non-hydric	31.3 (12.7)	12.9%
rRO	Rock outcrop	NA	Non-hydric	44.8 (18.1)	18.4%
rRR	Rough broken land, 40 to 70 percent slope	rapid	Non-hydric	14.9 (6.0)	6.1%
Total for Soil Survey Area				243.1 (98.4)	100%

Source: USDA NRCS 2015

BL and 40 percent Mahana silt loam. This is a barren soil with annual rainfall between 30 and 45 in (76 and 114 cm; USDA SCS 1972).

Rock outcrop (rRO) is comprised of locations in which over 90 percent of the surface is exposed bedrock, mainly basalt and andesite. The terrain is gently sloping to precipitous and it is found in locations where rainfall ranges between 22 and 55 in (56 and 140 cm). Rough broken land (rRR) is very steep land with intermittent drainage channels in gulches and on the mountainsides. The land has rapid runoff and active erosion. Soils are variable, but most places have weathered rock fragments below with the soil material. Nearly 50 percent of the Mākaha Ridge Tracking Station is comprised of these three barren, rocky soil types.

The Mahana series contains well-drained upland soils that are gently sloping to very steep. MaD is a soil in the Mahana series with medium runoff and moderate erosion. MaD has 12 to 20 percent slopes. The Pakala Series contains well-drained soils with nearly level to moderate sloping on bottom lands and alluvial fans. Pakala clay loam (PdA, 0 to 2 percent slope) has moderate permeability, very slow runoff, and less than slight erosion hazard.

The Puʻu ʻŌpae Series (PwC and PwD) includes well-drained soils from uplands on Kauaʻi that developed from weathered basic igneous rock. Puʻu ʻŌpae silty clay loam is a dusky-red silty clay loam with a subangular blocky structure. PwC has moderately rapid permeability, slow to medium runoff, and slight to moderate erosion hazard. PwD has medium runoff and moderate erosion hazard, while PwE has rapid runoff and severe erosion hazard. Because of the steep slopes and soil types,

erosion is a severe problem in parts of the station and many areas of the Mākaha Ridge and the Nā Pali Coast. Additionally, Feral Goats eat vegetation that would have held soil in place, which further exacerbates the problem of erosion. Much of the eroded soil is carried in runoff down the cliff-face into coastal waters below.

3.4.2 Hydrology

The Mākaha Ridge Tracking Station has several intermittent streams both on and adjacent to the station (**Figure 3-10**). However, no perennial water features occur at the site (NAVFAC PAC 2014). Two aquifers located beneath the site are valuable sources of drinking water although no wells are located at the station. One basal, unconfined, dike aquifer (aquifer code 20301112) is currently used for drinking water although no wells are located at the site This fresh water is classified as irreplaceable and highly vulnerable to contamination by the SOH Department of Health. The other aquifer (aquifer code 20301212) is also classified as an irreplaceable fresh drinking water source that is highly vulnerable to contamination but is not currently being used. This is a high-level, unconfined dike-confined aquifer. Both aquifers are part of the Waimea Aquifer Sector of the Kekaha Aquifer System (Mink and Lau 1992).

3.4.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

Plant surveys of Mākaha Ridge Tracking Station were completed in 2000 and 2006 (Char 2000b, Wood 2006) and an unmaned aerial drone survey was conducted in 2019 (Nyberg 2019). These surveys identified 134 species of vascular plants in total, 98 of which (73 percent) are introduced. Additionally, 34 are indigenous (25 percent), including 19 species are endemic (14 percent) and 2 single-island endemics (1.5 percent), and 2 (1.5 percent) are thought to be Polynesian introductions. The plant survey from 2000 describes three general vegetation types including cliff vegetation, pine plantings/mixed scrub, and ruderal vegetation at the Mākaha Ridge Tracking Station (Char 2000b; **Figure 3-11**).

Table 3-10 provides the acreage for specific vegetation cover types from NAVFAC PAC mapping that was completed in 2005. General descriptions of each of the community types are provided below. For a full list of plant species documented at Mākaha Ridge refer to **Appendix C**.

Table 3-10. Vegetation Communities at Mākaha Ridge Tracking Station

Cover Type	Native/Non-native	Area ac (ha)	Percent of Area
Eroded, Bare Soil	Non-native	44.2 (17.9)	18%
Hawaiian Mixed Shrub Coastal Cliff	Native	79.6 (32.2)	32%
Landscaped	Non-native	22.7 (9.2)	9%
Mixed Shrub Dry Coastal Cliff	Non-native	10.24 (4.1)	4%
Mixed Shrub Dry Coastal Cliff with Koa	Native	47.1 (19.1)	19%
Pine, Mixed Shrub	Non-native	43.6 (17.7)	18%
Total		247.4 (100.1)	100%

Source: NAVFAC PAC 2005

Figure 3-10. Mākaha Ridge Tracking Station Wetlands and Surface Water

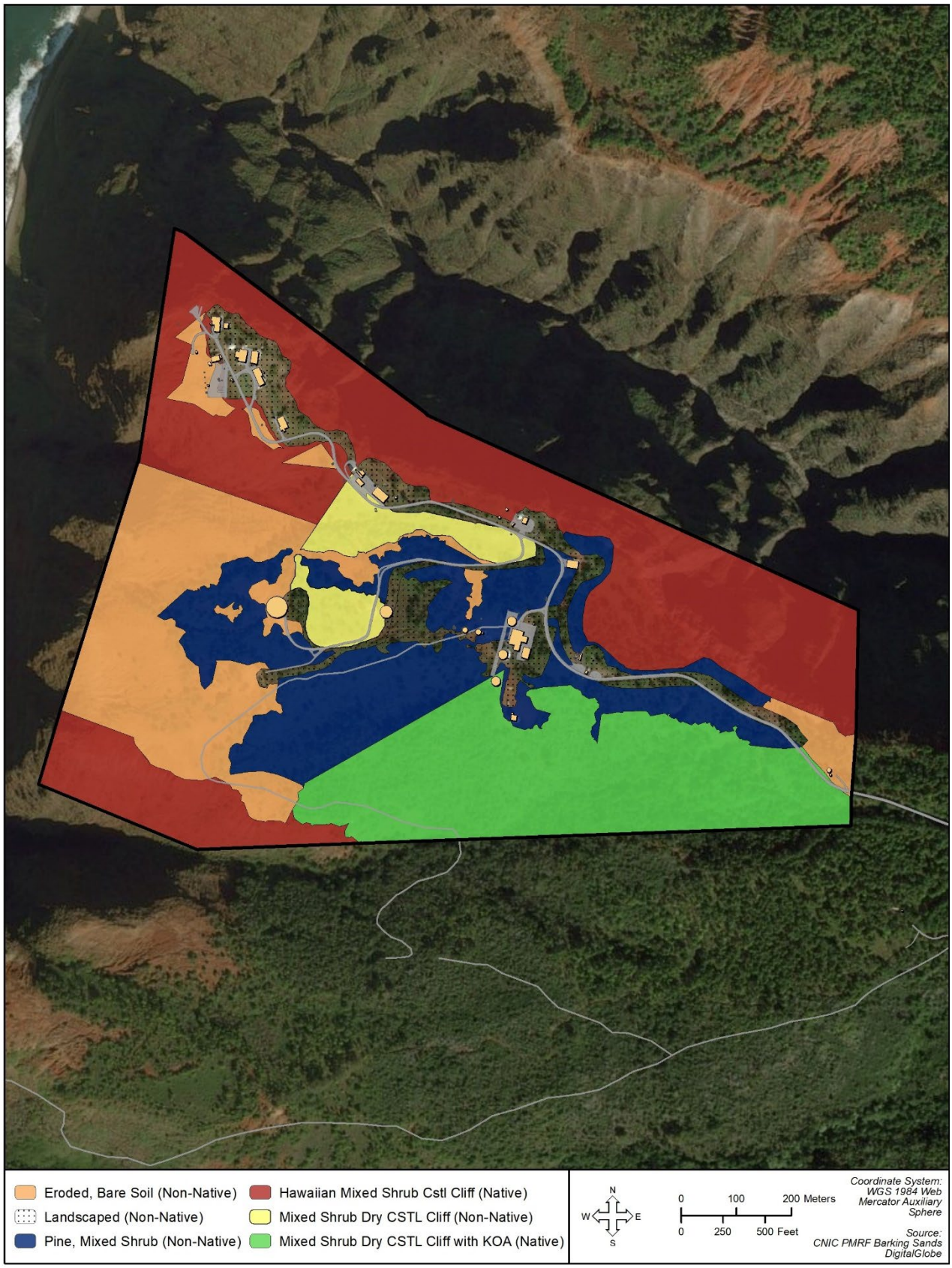


Figure 3-11. Mākaha Ridge Tracking Station Vegetation

3.4.3.1 Cliff Vegetation

Cliff vegetation is primarily composed of native Hawaiian mixed shrub coastal cliff and mixed shrub dry coastal cliff/Koa communities. A small percentage of the cliff vegetation is infested with non-native vegetation as well. Cliff vegetation is sparse with only 5 percent shrub cover and 10 to 20 percent grass cover. Most of the vegetation is either on severely eroded ridgetop or scattered in small patches along the cliff face, ledges, or long, narrow terraces. Kāwelu (*Eragrostis variabilis*), a bunch grass, was the most frequent native plant species on the cliffs in 2000, but the 2006 survey found this species severely decreased. Low (2 to 4 ft [0.6 to 1 m]) shrubs of False Sandalwood (*Myoporum sadwicense*) (Char 2000b).

***Myoporum sandwicense* (naio) dry cliff community**

The dry cliff community faces several threats. One threat is habitat degradation by Feral Goats. Several state and federally listed plants (see Section 3.4.5) are found on dry cliff communities as these extreme slopes serve as protection from browsed by Feral Goats. The other threats are competition with non-native plants and reduced reproductive vigor of rare species due to the limited number of remaining individuals (Wood 2006).

3.4.3.2 Pine Plantings/Mixed Scrub

Non-native pine plantings and mixed scrub vegetation typically includes Slash Pine (*Pinus radiata*), Lantana shrubs, and Silk Oak (*Grevillea robusta*) trees. Portions of these areas have grasses such as Little Bluestem Grass (*Schizachyrium condensatum*) or Bushy Bluestem (*Andropogon glomeratus*) or is exposed soil with unanchored small and large boulders that has been highly disturbed by goats (Char 2000b).

3.4.3.3 Landscaped Vegetation

Other than in the immediate vicinity of buildings and recent landscape improvements, very little of the station is landscaped. However, a severely eroded gulch on the southern side of the sitecontains many planted Eucalyptus trees (*Eucalyptus* sp.) with dense thickets of Strawberry Guava (*Psidium cattleianum*) on the lower slopes. Alahe‘e shrubs (*Psydrax odorata*) are abundant in areas and native Koa trees are also occasionally found here (Char 2000b).

3.4.3.4 Eroded, Bare Soil, and Ruderal Vegetation

Ruderal vegetation occurs in the disturbed and unmaintained areas. Various grasses and weedy, often annual herbaceous species compose the majority of this vegetation type (Char 2000b). Large, barren, eroded ridges surround the helicopter landing site and most of the buildings and other facilities. The majority of the vegetation in these areas is low, rounded clumps of Lantana that are 2 to 3 ft (0.6 to 1 m) high and mats of Molasses Grass (*Melinis minutaflora*).

3.4.4 Invasive and Introduced Species

Invasive and introduced species at Mākaha Ridge Tracking Station include a variety of birds, mammals, and reptiles. The most common and frequently observed bird species are the non-native Japanese White-eye followed by the Common Myna or Pihaʻekelo (*Acridotheres tristis*). Several birds that have been observed at the Mākaha Ridge Tracking Station are non-native MBTA species. Included were Northern Cardinal, House Finch, Northern Mockingbird, and Cattle Egret (Bruner 2000, NAVFAC PAC 2006a). Red Junglefowl or Moa (*Gallus gallus*) are abundant at the station as are non-native game birds including Erckel's Francolins, Black Francolin, and Chucker (*Alectoris chukar*). Feral Goats are also abundant and herds of up to 68 have been sighted (NAVFAC PAC 2006c). The presence of Feral Pigs, Columbian Black-tailed Deer, Feral Cats, and rats has also been documented at the site. Three introduced reptile species, including the Green Anole, Mourning Gecko, and House Gecko have been documented at Mākaha Ridge Tracking Station (NAVFAC PAC 2006c).

3.4.5 Special Status Species

A total of nine state and federally protected endangered species are known to occur on or fly-over the Mākaha Ridge Tracking Station. Three additional protected species are likely to fly over the site. One federally listed endangered bird species, the Nēnē, has been documented at the site (NAVFAC PAC 2006d) and is known to nest there. The endangered Hawaiian Petrel and Band-rumped Storm-petrel and the threatened Newell's Shearwater may fly over the site as active colonies are located in the region (Pyle and Pyle 2017), though these species have not been documented at this site. Two other native birds protected by the MBTA, White-tailed Tropicbird (*Phaethon lepturus*) and Pacific Golden Plover, have also been observed at the site. The Hawaiian Hoary Bat is a state and federally listed endangered mammal species that is frequently in the area of Mākaha Ridge and is known to roost or forage on the property and surrounding forest (Bruner 2000, Bonaccorso and Pinzari 2011). As previously noted, four endangered plants, Dwarf Iliau, Hawaiʻi Scaleseed, Niʻihau Lobelia, and Kauaʻi Schiedea, and one threatened species, Makou, are known to occur on the steep slopes dropping away from the Mākaha Ridge site (Wood 2006, Nyberg 2019, **Figure 3-12**). A summary of special status species known to occur or likely to fly over the Mākaha Ridge Tracking Station is provided in **Table 3-11.**

3.5 Kōkeʻe Sites Natural Resources

3.5.1 Topography, Geology, and Soils

The elevation of the Kōkeʻe sites ranges from 3,800 ft (1,158 m) at site E to 3,710 ft (1,130 m) at sites A, D, and E, with an average elevation of 3,710 ft (1,130 m) above msl (**Figure 3-13**). The slight elevation differential creates a gently sloping ridgeline in the southwest direction, which generally leads surface water runoff to flow in a northwesterly to southeasterly course.

The coastal ridge on which the Kōkeʻe sites are located is composed of lava formations from the Nāpali formation of the Waimea Canyon series, associated with pyroclastic rocks from the flanks of the major Kauaʻi shield volcano, outside the caldera.

The largest soil unit on the Kōkeʻe sites (**Figure 3-14, Table 3-12**) is Kōkeʻe silty clayey loam (KSKE, 0 to 35 percent slope). This series is highly acidic, well-drained, and was created from basic igneous

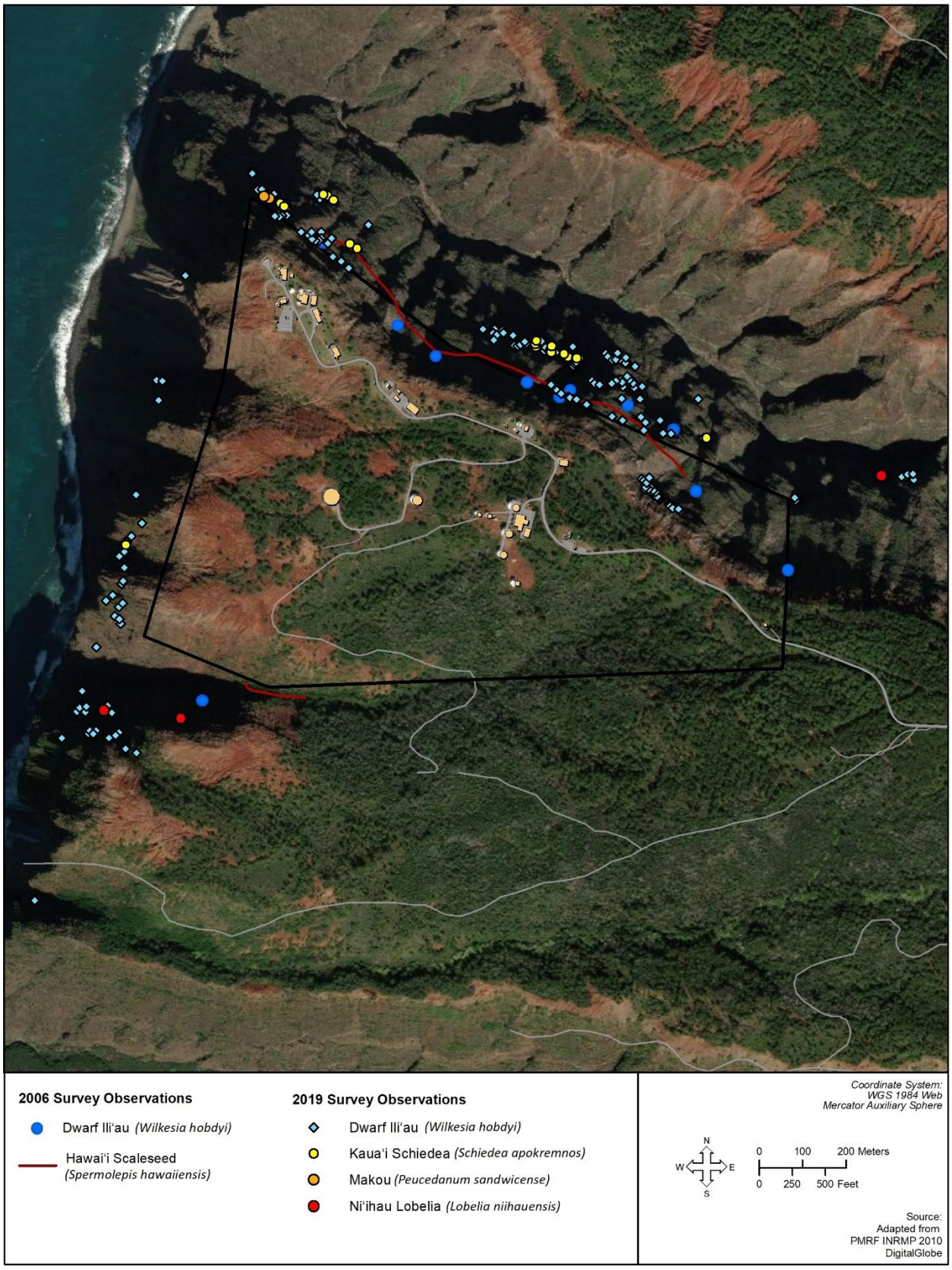


Figure 3-12. Special Status Species Habitat at Mākaha Ridge Tracking Station

Table 3-11. Special Status Species on or near at Mākaha Ridge Tracking Station

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Birds					
Branta sandviciensis	Hawaiian Goose	Nēnē	E, MBTA	Year-round resident. Live and breed in areas of managed grass, group of six regularly seen at Mākaha Ridge	Breeding Season: Aug. – April, peak Oct.–Dec. Incubation: ~30 days Fledges: ~90 days
Oceanodroma castro	Band-rumped Storm-petrel (Hawai‘i DPS)	‘Akē‘akē	E, MBTA	Breeding visitor. Not observed at Mākaha Ridge but may fly during trips between nesting and foraging sites. Fledglings also fly through the area on their first trip to the sea and have been documented as fall out during fledgling season.	Breeding Season: May - October/April - June Incubation: 39 -51 days Fledges: mid Sept. – mid Dec.
Phaethon lepturus	White-Tailed Tropicbird	Koa‘e Kea	MBTA	Breeding visitor. Commonly observed at Mākaha Ridge, though not known to breed there.	Breeding season: Year-round in Hawai‘i Incubation: 40 - 42 days Fledges: 10 -12 weeks
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Winter resident. Uncommonly observed at Mākaha Ridge.	NA
Pterodroma phaeopygia sandwichensis	Hawaiian Petrel	‘Ua‘u	E, MBTA	Breeding visitor. Not observed at Mākaha Ridge but may fly over when traveling between nesting and foraging areas. Fledglings also fly through the area on their first trip to the sea and may fall out during fledgling season.	Breeding Season: Feb. – May Incubation: ~56 days Fledges: Oct. – Dec.
Puffinus auricularis newelli	Newell’s Shearwater	‘A‘o	T, MBTA	Breeding visitor. Not observed at Mākaha Ridge but may fly over when traveling between nesting sites and at-sea foraging areas. Fledglings also fly through the area on their first trip to the sea and are vulnerable to fall out during fledgling season.	Breeding Season: March - April Incubation: ~51 days Fledges: mid-Sept. - mid-Dec.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Mammals					
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	E	Roost and forage at Mākaha Ridge and the surrounding area.	Breeding Season: Sept – Dec. Pupping: June – Aug. Mother likely stays with their pups for 6 - 7 weeks.
Plants					
Lobelia niihauensis	Niʻihau Lobelia	---	E	3 locations with 6 individuals on north and west facing cliff faces at Mākaha Ridge	Flowers Winter / Spring
Peucedanum sandwicense	Makou	Makou	T	2 locations with 3 individuals on the northwest cliff face at Mākaha Ridge	Flowers Winter / Spring
Schiedea apokremnos	Kauaʻi Schiedea	Māʻoliʻoli	E	5 colonies with 152 individuals on north facing cliff faces at Mākaha Ridge	Flowers Winter / Spring
Spermolepis hawaiiensis	Hawaiʻi Scaleseed	---	E	2 colonies on slopes at Mākaha Ridge at elevations between 2,000 - 2,200 ft (610 - 671 m)	Flowers: Winter / Spring
Wilkesia hobdyi	Dwarf Iliau	---	E	21 colonies with 3,635 individuals on dense, hard rock outcrops with nearly vertical faces at elevations between 1,320 - 1,680 ft (402 - 512 m)	Flowers: June, September, October, and December Fruits: November to January

[1]State and Federally listed as E = Endangered, T = Threatened,
MBTA = Indigenous species protected under the Migratory Bird Treaty Act
Sources: Bonaccorso and Pinzari 2011, DoN 2010, Nyberg 2019, Pyle and Pyle 2017, University of Hawaiʻi 2009, USFWS 2010, 2019c

Figure 3-13. Kōkeʻe Sites Elevation Contours

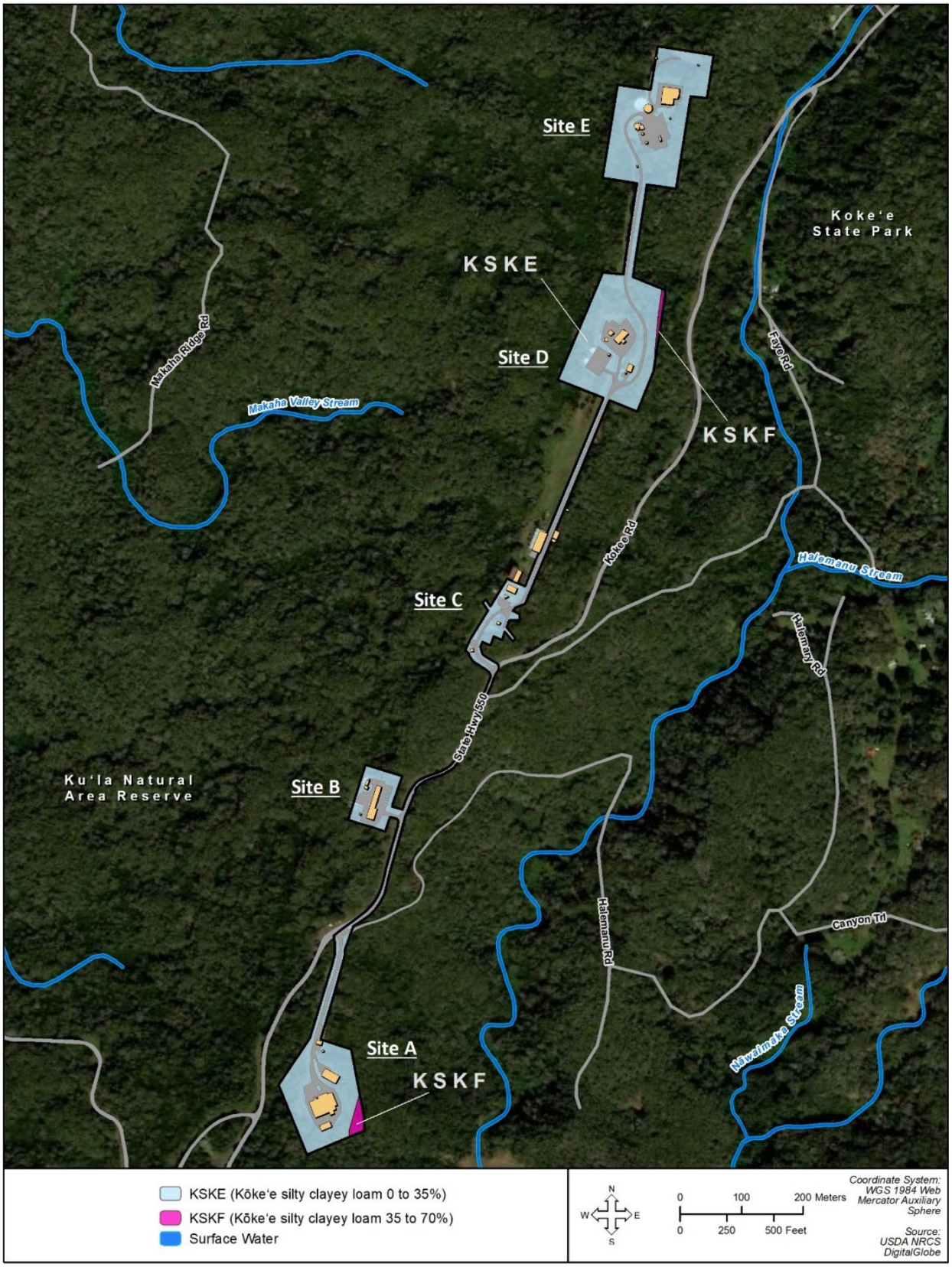


Figure 3-14. Kōke'e Sites Soils and Adjacent Wetlands and Surface Waters

Table 3-12. Soil Series at the Kōkeʻe Sites.

Map Unit Symbol	Map Unit Name	Surface Runoff	Hydric	Area ac (ha)	Percent of Area
KSKE	Kōkeʻe silty clayey loam, 0 to 35 percent slope	Medium	Non-hydric	22.8 (9.2)	98.4%
KSKF	Kōkeʻe silty clayey loam, 35 to 70 percent slope	Rapid	Non-hydric	0.4 (0.2)	2.6%
Total for Soil Survey Area				23.1 (9.3)	100%

Source: USDA NRCS 2015

rock and volcanic ash. KSKE has moderately rapid permeability, medium runoff, and slight to moderate erosion hazard (USDA SCS 1972). These sites are generally paved and surrounded by heavily wooded areas and there is no evidence of significant soil erosion. A small section of Site A contains Kōkeʻe silty clayey loam (KSKF, 35 to 70 percent slope), which is very similar to KSKE, but with a severe erosion hazard and rapid runoff.

3.5.2 Hydrology

The Kōkeʻe sites do not contain any surface water or wetland resources, though numerous streams lie at the bases of the surrounding canyons (see **Figure 3-14**).

There is one aquifer beneath the Kōkeʻe sites that is located in the Waimea Aquifer Sector within the Kekaha Aquifer System. This high-level, unconfined dike-confined aquifer (aquifer code 20301212) is considered an irreplaceable fresh water source and is highly vulnerable to contamination (Mink and Lau 1992).

3.5.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

The native terrestrial ecosystem of the Kōkeʻe sites is a dry and mesic forest, woodland, and shrubland (Juvik and Juvik 1998). Botanical surveys at the Kōkeʻe sites describe the vegetation types at each of the five parcels. A total of 77 species were identified. In contrast to Barking Sands and Mākaha Ridge, which have over 50 percent non-native species, the Kōkeʻe sites are comprised of 33 (46 percent) endemic, 9 (13 percent) indigenous, and 29 (41 percent) introduced plant species. However, a number of the introduced species are considered to be among the worst invaders at Kōkeʻe State Park. Included are Strawberry Guava, Sawtooth Blackberry (*Rubus argutus*), and Kāhili Ginger (*Hedychium gardnerianum*) (Kōkeʻe Resource Conservation Program 2015).

Figure 3-15 and **Table 3-13** summarize the vegetation types in all five parcels of the Kōkeʻe sites from NAVFAC PAC mapping that was conducted in 2004. General descriptions of each of the cover types as described by Char (2000c) are provided below, but for a full list of plant species from the Kōkeʻe sites, refer to **Appendix C**.

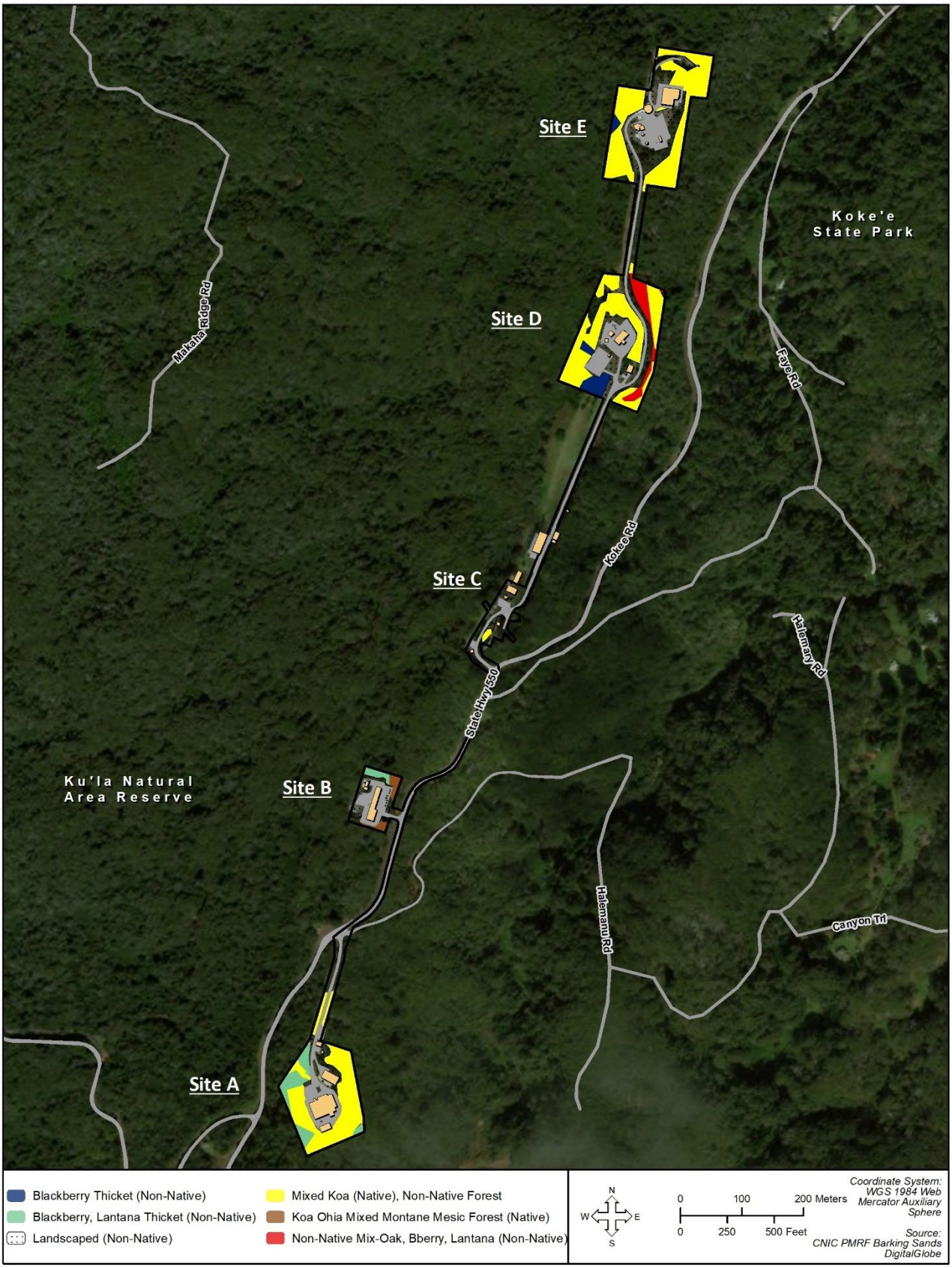


Figure 3-15. Kōkeʻe Sites Vegetation Map

Table 3-13. Vegetation Communities at the Kōkeʻe Sites

Cover Type	Native/Non-native	Area ac (ha)	Percent of Area
Blackberry Thicket	Non-native	0.4 (0.2)	2%
Blackberry, Lantana Thicket	Non-native	0.8 (0.3)	4%
Koa- ʻŌhiʻa Mixed Montane Mesic Forest	Native	0.3 (0.1)	2%
Landscaped	Non-native	8.9 (3.6)	45%
Mixed Koa, Non-Native Forest	Native	8.7 (3.5)	44%
Non-Native Mix-Oak, Blackberry, Lantana	Non-native	0.6 (0.2)	3%
Total		19.7 (7.9)	100%

Source: NAVFAC PAC 2005

Kōkeʻe Site A

Site A is mostly comprised of intact Koa-ʻŌhiʻa mesic native and non-native forest, although the invasive firetree lines the road leading up to the site and Blackberry thickets (*Rubus* sp.) are along the fences around the forest edge of the parcel (NAVFAC PAC 2006f). Non-native blackberries are considered some of the worst invasive plant species in the Kōkeʻe State Park. The Administration Building is adjacent to an area that has been graded and paved with asphalt, but inside the fence line the other buildings are surrounded by grassy lawns (Char 2000c). The vegetation lining the outside of the fence is periodically maintained and contains a strip of Kikuyu Grass (*Pennisetum clandestinum*) that is 3 to 5 ft (1 to 2 m) wide, as well as several other introduced species. Dense, prickly thickets of blackberry are located just outside the grassy strip (Char 2000c).

Native Koa-ʻŌhiʻa mesic forest

Kōkeʻe Site B

Site B is a landscaped and paved site that contains a power plant, fuel storage, and electric substation. Plum (*Prunus cerasifera* x *salicina*), Avocado (*Persea americana*), and Pear (*Pyrus communis*) trees grow at the site along with kikuyu grass and plantings of Ti Leaf (*Cordyline fruticosa*) on a small lawn behind the power plant. Inside the fence and south of the power plant is a semi-wooded sloping area (Char 2000c). The area immediately outside of the fence is dominated by dense Blackberry thickets and Kikuyu grass mats. Some remnants of the native forest also remain beyond the fence, predominantly hame (*Antidesma platyphyllum*) (NAVFAC PAC 2006f). Outside the fence on the north side of the site there are Plum, Avocado, and Banana (*Musa* x *paradisiaca*) plantings and more grassy lawn (Char 2000c).

Kōkeʻe Site C

Site C is a landscaped and paved parcel that contains the Boresight Tower, facilities building, and a microwave antenna. The site is surrounded by a fence with an entrance at the southern side. The site is

either covered in asphalt or open, grassy lawn, but just outside the fence are low Blackberry thickets, Kikuyu Grass matts, scattered Firetree and Firethorn (*Pyracantha angustifolia*), and other invasive plants (Char 2000c).

Kōkeʻe Site D

Site D contains the SCAMP Antenna and Transmitter Building and AN/FRS-16 radar building, surrounded by either pavement or Kikuyu Grass lawns. Two large ʻOheʻohe (*Tetraplasandra kavaiensis*) trees are growing to the west of Site D with Blackberry and Uluhe Fern (*Dicranopteris linearis*) in the understory. Kōkeʻe Site D contains a healthy, native forest with Koa, large ʻIliahi/Sandalwood (*Santalum freycinetianum*) trees, and othe natives. The hillside on the northeast of the AN/FRS-16 building holds a small, mostly non-native, forested area. Outside the fence line is a thick border of Blackberry, Firetree, and remnant native forests (Char 2000c). Asian Melastome, a highly invasive plant species, was found at the site in a small patch near the roadside (NAVFAC PAC 2006f); however, KISC and Navy biologists have conducted targeted invasive species control, including the treatment of Asian Melastome, in this area.

Kōkeʻe Site E

Site E is a mostly landscaped or paved parcel with the Unified S-Band Building and antenna and the Very Long Baseline Interferometry Facility. Graded pavement surrounds the buildings and antenna and leads into lawns of kikuyu grass and weeds. Hybrid roses (*Rosa* cultivar) and ʻĀkulikuli lei (*Lampranthus glomerata)* have been planted directly in front of the USB building (Char 2000c). The area directly outside the fence at Site E has similar native forest species to Site D except with fewer sandalwood trees. This area also differs because it contains fewer dense Blackberry thickets and Kikuyu Grass mats, and also contains a non-native Paperbark Tree (*Melaleuca quinquenervia*) that was not documented at any of the other Kōkeʻe sites (Char 2000c).

3.5.4 Invasive and Introduced Wildlife

Wildlife surveys conducted in 2000 and 2006 identified a number of invasive and introduced species at the Kōkeʻe sites. Feral Cats were present during the survey and signs of Feral Pigs were common. The rat species identified at the sites were the Norwegian Rat (*Rattus norvegicus*) and Black Rat or Roof Rat (Bruner 2000, NAVFAC PAC 2006c). A herpetological survey conducted in 2006 identified the Metallic Skink (*Lampropholis delicata*) at the Kōkeʻe sites (NAVFAC PAC 2006c). No other reptile or amphibian species have been documented.

Bird surveys conducted in 2000 and 2006 identified native and non-native bird species at the Kōkeʻe sites (Bruner 2000, NAVFAC PAC 2006a). Nineteen species were identified in total. Thirteen of the bird species that were observed are non-native species, while six are native.

3.5.5 Special Status Species

A total of nine state and federally listed species, including five bird, one mammal, and two insects, are known to occur on or fly over the Kōkeʻe sites (**Table 3-14**). One federally endangered native understory shrub, Halemanu ʻAkoko (*Euphorbia halemanui*), has also been documented outside of Site D, although none has been identified within the site boundaries (NAVFAC PAC 2006f).

Table 3-14. Special Status Species on or near the Kōkeʻe Sites

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Birds					
Asio flammeus sandwichensis	Short-Eared Owl	Pueo	MBTA	Year-round resident. Infrequent, one bird documented in a 2000 survey at Site E.	Breeding Season: Year-round Incubation: 21-37 days Fledges: ~ 29 days
Branta sandviciensis	Hawaiian Goose	Nēnē	E	Year-round resident. Common at Kōkeʻe sites, not known to nest on site.	Breeding Season: Aug. – April, peak Oct.–Dec. Incubation: ~30 days Fledging: ~90 days
Chlorodrepanis stejnegeri	Kauaʻi ʻamakihi	ʻAmakihi	MBTA	Year-round resident. Observed in small numbers throughout the Kōkeʻe sites, found in native ʻŌhiʻa and kKa forests.	Breeding Season: March – July Incubation: ~14 days Fledging: ~19 days
Himatione sanguinea	ʻApapane	ʻApapane	MBTA	Year-round resident. Most abundant native forest bird, observed throughout the Kōkeʻe sites, found in native ʻŌhiʻa and Koa forests.	Breeding Season: Dec. - July Incubation: ~13 days Fledging: ~ 14 days
Oceanodroma castro	Band-rumped Storm-petrel (Hawaiʻi DPS)	ʻAkēʻakē	E, MBTA	Breeding visitor. Not observed at Kōkeʻe sites but may fly-over during breeding season.	Breeding Season: May – Oct./April - June Incubation: 39 -51 days Fledging: mid Sept. – mid Dec.
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Winter resident. Common, recorded at Sites A, C, D, and E (non-nesting season).	NA
Pterodroma phaeopygia sandwichensis	Hawaiian Petrel	ʻUaʻu	E	Breeding visitor. Nest in the region, potential fly-over during breeding season.	Breeding Season: Feb. – May Incubation: ~56 days Fledging: Oct. – Dec
Puffinus auricularis newelli	Newell's Shearwater	ʻAʻo	T	Breeding visitor. Not observed at Kōkeʻe sites but may fly-over during breeding season.	Breeding Season: March - April Incubation: ~51 days Fledges: mid-Sept. - mid-Dec.

Vestiaria coccinea syn *Drepanis coccinea*	Scarlet Honeycreeper	ʻIʻiwi	FT, SE, MBTA	Year-round resident. Rare, two documented in 2000.	Breeding Season: Nov. – July Incubation: ~14 days Fledges: ~ 24 days
Mammals					
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	E	Documented at sites A and C. Occurs year-round.	Breeding Season: Sept – Dec. Pupping: June – Aug. Mother likely stays with their pups for 6 - 7 weeks.
Insects					
Drosophila musaphilia	Hawaiian Picture-wing Fly	---	E	Documented near but not on Site B, Critical Habitat adjacent to property	Year-round, depending on availability of decomposing host plant material
Drosophila sharpi	Hawaiian Picture-wing Fly	---	E	Critical Habitat adjacent to property (unknown if occupied)	Year-round, depending on availability of decomposing host plant material
Plants					
Euphorbia halemanui syn. *Chamaesyce halemanui*	Halemanu ʻAkoko	ʻAkoko	E	Several growing just outside the boundary of Site D	Flowers: Summer

[1]Federally and State listed as E = Endangered, T = Threatened, DPS = Distinct Population Segment, SE = State Endangered only, ST = State Threatened only,
MBTA = Indigenous species protected under the Migratory Bird Treaty Act
Sources: Bonaccorso and Pinzari 2011, Bruner 2000; NAVFAC PAC 2006a, f; DoN 2010, DoN 2014b, Pyle and Pyle 2017, VanderWerf 2012

Of the five ESA-protected bird species with potential to occur, the Nēnē and the Scarlet Honeycreeper or ʻIʻiwi (*Vestiaria coccinea* syn *Drepanis coccinea*) are the only ones documented on site. A 2006 survey of birds at the Kōkeʻe sites documented Nēnē at Site C (NAVFAC PAC 2006a). Newell's Shearwaters, Hawaiian Petrels, and Band-rumped Storm-petrels have been sighted in the region and may also fly over the sites (Pyle and Pyle 2017). Several additional native MBTA-protected species have been documented at the Kōkeʻe sites. Included are the Kauaʻi ʻAmakihi (*Chlorodrepanis stejnegeri*), ʻApapane (*Himatione sanguinea*), and Pueo, all of which are endemic to Hawaiʻi, and the Pacific Golden Plover, which is a native migratory species. Non-native MBTA-protected species, which include the Northern Cardinal and House Finch, are also present in small numbers at the Kōkeʻe sites, as is the Barn Owl (NAVFAC PAC 2006a).

The federally listed endangered Hawaiian Hoary Bat was documented at Site C of the Kōkeʻe sites during a survey in 2000 (Bruner 2000) and at Sites A and C during a 2010 survey (Bonaccorso and Pinzari 2011). Hawaiian Hoary Bats were present at Kōkeʻe during each survey sampling period from July 2010 through May 2011 (Bonaccorso and Pinzari 2011).

Two species of endangered Hawaiian picture-wing fly can also be found on or near the Kōkeʻe sites: *Drosophila musaphilia* andK*Drosophila sharpi*. These picture-wing flies are single-island endemic to Kauaʻi and have USFWS-designated critical habitat near the Kōkeʻe sites. *D. musaphilia* was identified near Site B in a 2010 survey (DoN 2010). Critical habitat has been designated for these Hawaiian picture-wing flies in the vicinity surrounding the Kōkeʻe sites (**Figure 3-16**). The native Koa tree, which is located in the forested area surrounding the sites, is the host plant for *D. musaphilia.*

3.6 Kamokala Ridge Magazines Natural Resources

3.6.1 Topography, Geology, and Soils

The Kamokala Ridge Magazine area lies along the scarp between the Mānā Coastal Plain and the site has a moderate slope from east to west and ranges in elevation from 80 ft (25 m) to 760 ft (232 m) (**Figure 3-17**).

The ridge on which the magazines are located is composed of lava formations from the Nāpali formation of the Waimea Canyon series, associated with pyroclastic rocks from the flanks of the major Kauaʻi shield volcano, outside the caldera. The volcanic terrain has been highly eroded and contains numerous valleys and established drainage patterns. The cliffs at this site were formed by ancient, high sea levels in a similar but older process to that which formed the nearby Nā Pali cliffs.

This site is located at a transition between irrigated agricultural fields below and stony, silty clays collected at the base of the Nahomalu Valley. Surface water flows from north to south into ephemeral streams of the Nahomalu and Kaʻawaloa Valleys and on into the Mānā Coastal Plain. Thus, the soils in the area are silty clay from elevated alluvial fans on the Mānā Coastal Plain, but the area is also locally stony from the rubble of volcanic boulders. The four soils that can be found at the Kamokala

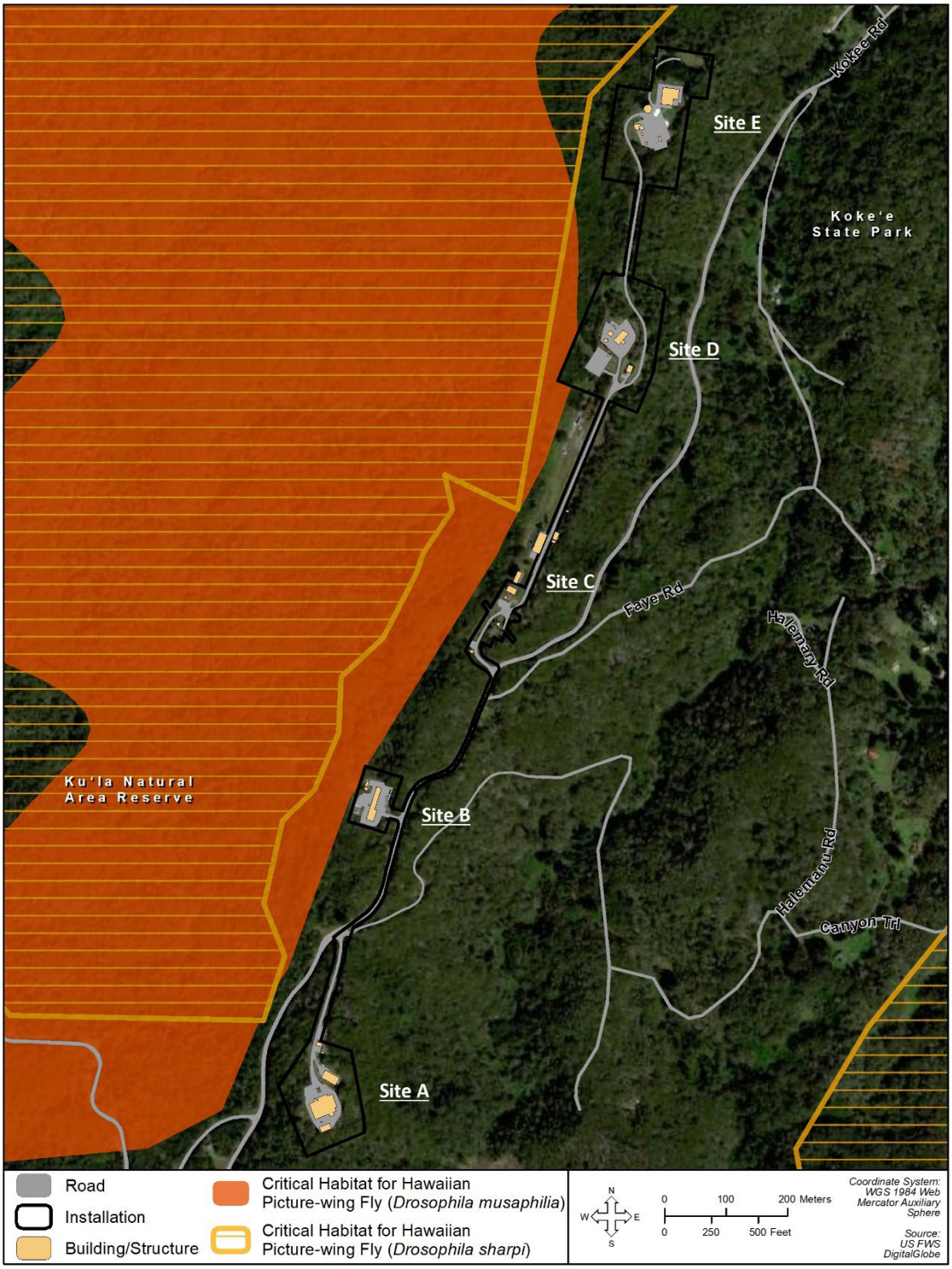


Figure 3-16. Protected Species Designated Critical Habitat near the Kōke'e Sites

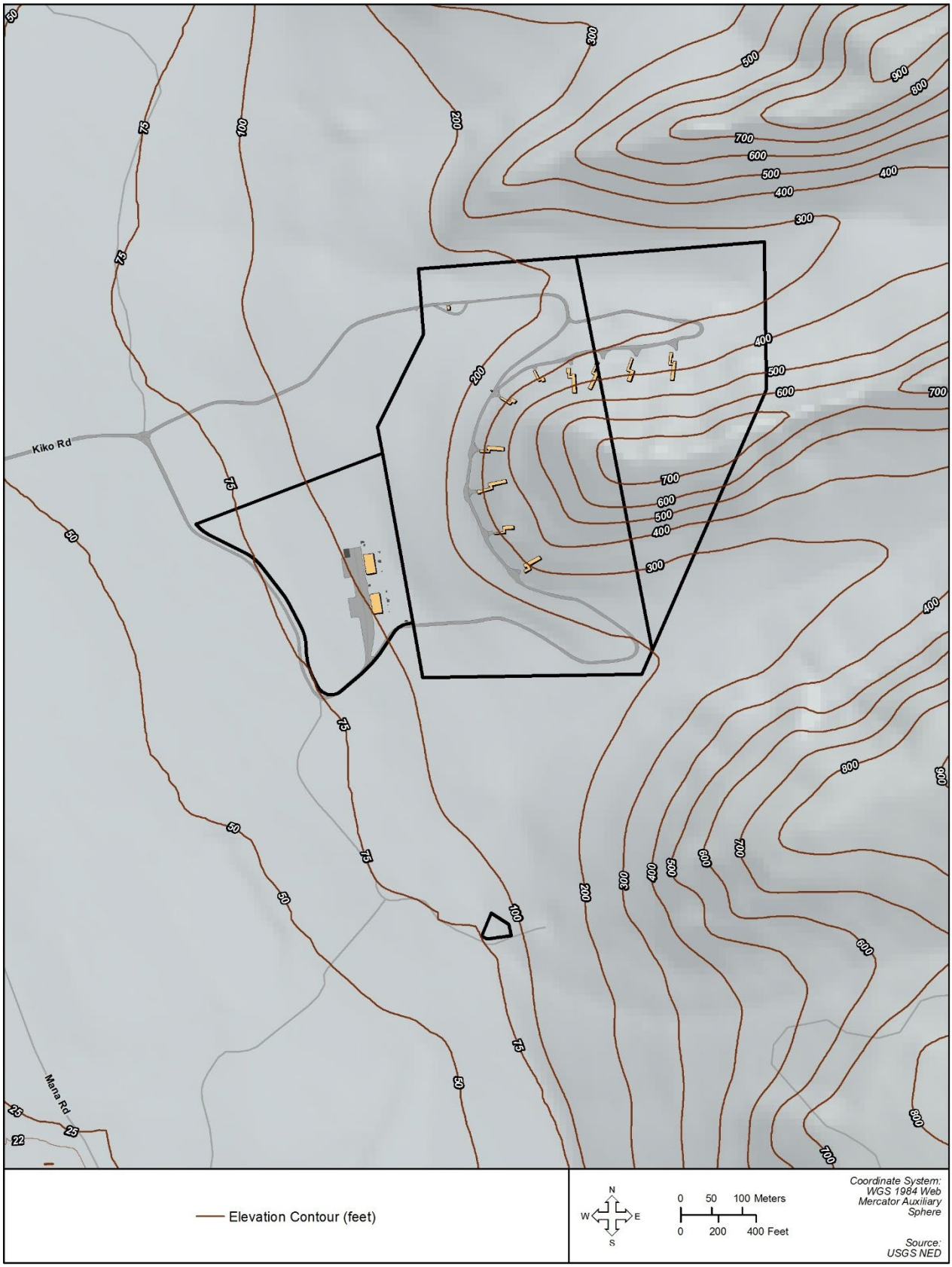


Figure 3-17. Kamokala Ridge Magazines Elevation Contours

Ridge Magazines include the Kekaha Series, Rubble Land (rRU), Rock outcrop (rRO), and the Waiawa series (**Table 3-15, Figure 3-18**).

Table 3-15. Soil Series at the Kamokala Ridge Magazines

Map Unit Symbol	Map Unit Name	Surface Runoff	Hydric	Area ac (ha)	Percent of Area
KoB	Kekaha clay, 0 to 6 percent slopes	Medium	Non-hydric	1.4 (0.6)	1.3%
KOYE	Kekaha extremely stony silty clay loam, 0 to 35 percent slopes	Slow to Medium	Non-hydric	32.2 (13.0)	30.9%
rRU	Rubble land	NA	Non-hydric	26.1 (10.6)	0.6%
rRO	Rock outcrop	NA	Non-hydric	0.6 (0.3)	25.1%
WJF	Waiwa extremely rocky clay, 30 to 80 percent slopes	Very Rapid	Non-hydric	43.9 (17.8)	42.1%
Total for Soil Survey Area				104.2 (42.2)	100%

Source: USDA NRCS 2015

Two soil types within the Kekaha Series can be found underlying the Kamokala Ridge Magazines. They are both well drained and developed as alluvium from upland soils. They can be found on alluvial fans and floodplains. Kekaha clay (KoB, 0 to 6 percent slope) is a 21 in (53 cm) thick, dark reddish-brown silty clay and clay. The soil is mildly alkaline to neutral, allows a medium runoff speed, and has a slight to moderate erosion hazard. Kekaha's extremely stony silty clay loam (KOYE, 0 to 35 percent slopes) has a slow to medium runoff speed and only moderate or lower erosion hazard (USDA 1972).

Rubble land (rRU) is any area with 90 percent stones or boulders at the surface. This land can typically be found directly below very steep to precipitous slopes with elevations between sea level and 500 ft (152 m). It occurs in locations where rainfall ranges from 22 to 55 in (56 to 140 cm) (USDA SCS 1972). The soil unit occurs on the south and west portions of this site below the magazine tunnels. At the Kamokala Ridge Magazines, some locations have boulders covering 70 to 80 percent of the terrain.

Rock outcrop (rRO) is found in areas where 90 percent of the surface is exposed bedrock, mostly basalt and andesite. The land is gently sloping to precipitous with elevations between sea level and 10,000 ft (USDA SCS 1972). The areas have a severe erosion hazard and rapid runoff. Fifty percent of the surface at the Kamokala Ridge Magazine site is covered by rock outcrops.

Only one soil type in the Waiawa Series can be found at the Kamokala Ridge Magazines, the Waiwa extremely rocky clay (WJF 30 to 80 percent slope). This is a well-drained, shallow, extremely rock soil that formed in colluvium and weathered basic igneous rock (USDA SCS 1972). The soil is slightly acidic to neutral, has moderate to moderately slow permeability, very rapid runoff, and a severe erosion hazard.

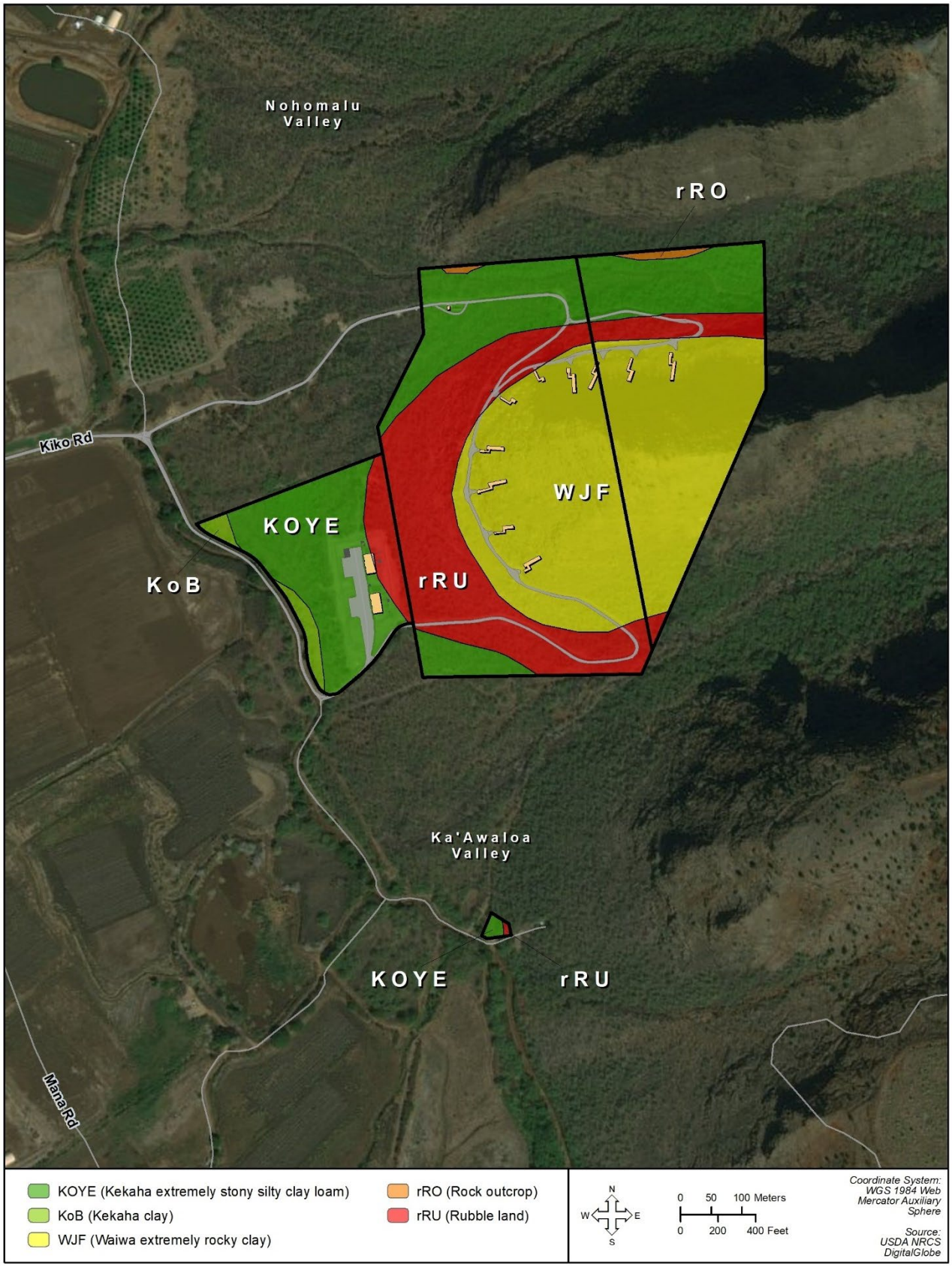


Figure 3-18. Kamokala Ridge Magazines Soils

3.6.2 Hydrology

The only surface water on this site is an intermittent, boulder-strewn stream that is usually dry, but floods during heavy rains (Char 2000d, NAVFAC PAC 2006g) (**Figure 3-19**).

The magazines are located over a freshwater aquifer in the Waimea Aquifer Sector within the Kekaha Aquifer System. The aquifer (aquifer code 20301112) is fresh, so it is currently used for drinking water and is classified as an irreplaceable aquifer and is highly vulnerable to contamination (Mink and Lau 1992). This is a basal, unconfined dike aquifer.

3.6.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

The Kamokala Ridge Magazines area consists of lowland dry and mesic forest, woodland, and shrubland (Juvik and Juvik 1998). The Kamokala Ridge Magazine area has approximately 50 percent vegetation cover and 50 percent is rock outcrop. Vegetation at this site is comprised largely of Koa Haole scrub forest, with scattered native dryland species including wiliwili (*Erythrina sandwicensis*), ʻAʻaliʻi, Pili (*Heteropogon contortus*), and Lance Fern (*Doryopteris decora*) with non-native Kiawe trees scattered throughout the site. Narrow bands of ruderal vegetation occur along roadsides and other paved areas. This highly disturbed site has a total of 70 identified plant speces, including one (1.4 percent) endemic species, 10 (14.3 percent) indigenous species, 58 (82.9 percent) introduced species, and one (1.4 percent) Polynesian introduction. **Table 3-16** and **Figure 3-20** provide information from NAVFAC PAC (2004) mappings of the distinct cover types within the two general vegetation types of Koa Haole scrub/forest and ruderal vegetation.

Kamokala cliffs and rock outcrop

Table 3-16. Vegetation Communities at Kamokala Ridge Magazines

Cover Type	Native/Non-native	Area ac (ha)	Percent
ʻAʻaliʻi Scrub	Native	3.9 (1.6)	4%
Cliff, Boulder Field	Non-native	0.8 (0.3)	1%
Grass, Herb, Shrub	Non-native	0.5(0.2)	0%
Greater Than 25% Wiliwili	Native	4.1 (1.6)	4%
Koa Haole Scrub, Forest	Non-native	73.4 (29.7)	75%
Koa Haole Scrub, Less Than 25% Wiliwili	Non-native	5.8 (2.4)	6%
Pili Grass	Native	4.4 (1.8)	4%
Ruderal	Non-native	4.9 (2.0)	5%
Total		97.7 (39.5)	100%

Source: NAVFAC PAC 2005

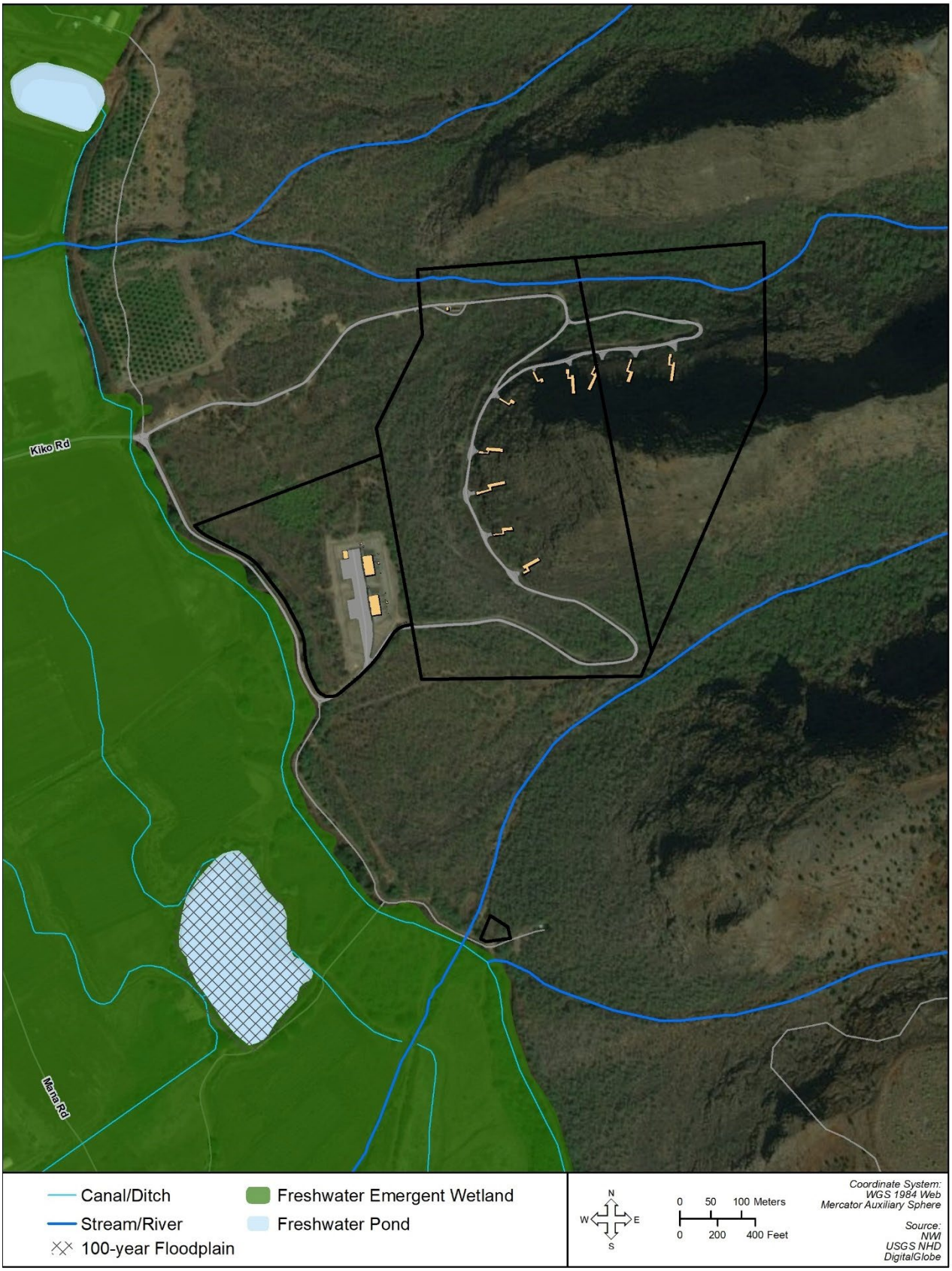


Figure 3-19. Kamokala Ridge Magazines Wetlands and Surface Waters

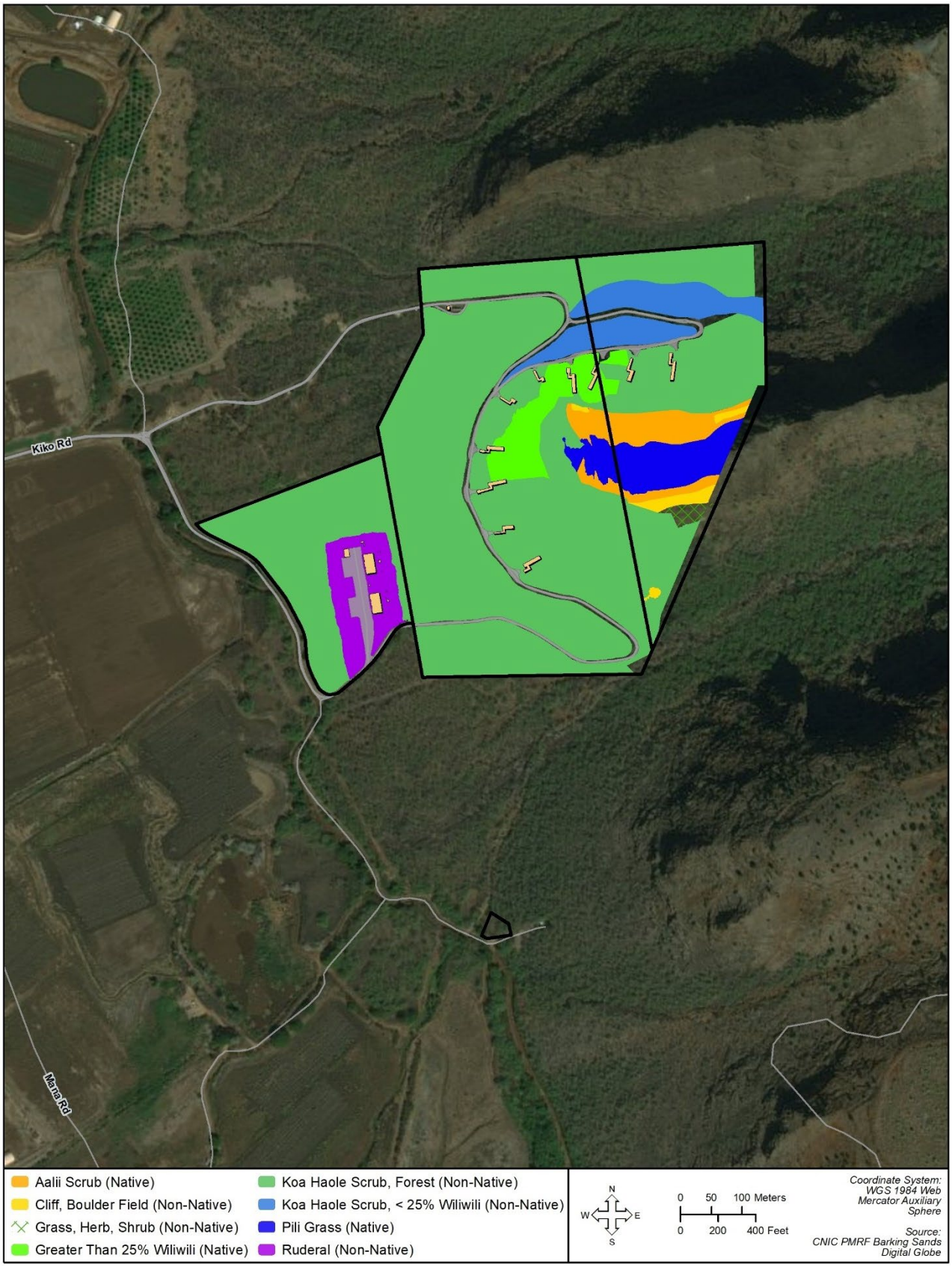


Figure 3-20. Kamokala Ridge Magazines Vegetation Map

3.6.3.1 Koa Haole Scrub/Forest

The majority of the Kamokala Ridge Magazines is Koa Haole scrub/forest vegetation, which consists primarily of 6 to 12 ft (2 to 4 m) tall Koa Haole shrubs. Vegetation consists of more open, patchy scrub on lower slopes with 20 to 30-ft (6 to 9-m) Wiliwili and Kiawe. The most abundant grass is Guinea Grass, but the area also contains small shrubs and herbaceous species at this location. The lower slopes have an abundance of non-native Lion's Ear (*Leonotis nepetifolia*), and the rock outcrops and ledges contain several native herbaceous species. *Parmelia* sp., a gray-white foliose lichen, also successfully grows on the rock outcrops (Char 2000d).

On the south and west portions of the site and Nahomalu Valley in the north, there are locations in which boulders cover 70 to 80 percent of the surface. The gently sloping terrain below the roads supports a dense 20 to 25-ft (6 to 8-m) forest with scattered Wiliwili and 30 to 45-ft (9 to 14-m) Kiawe trees (Char 2000d and NAVFAC PAC 2006g). The ground cover includes up to 3-ft (1-m) tall Guinea Grass among other species. Along the lower boundary of the site are a few large Chinese Banyan *(Ficus microcarpa)* and Be-still Tree *(Cascabela thevetia)* (Char 2000d).

The area north of the barbed wire fence that runs parallel to the access road in the Nahomalu Valley is used for cattle grazing. Therefore, this land contains much bare soil with low, patchy clumps of 0.5 to 1 ft (15 to 30 cm) tall Guinea Grass. An intermittent, boulder-strewn stream, which is usually dry, runs through the valley. This stream is lined by a few Java Plum (*Syzygium cumini*), Kiawe, Wiliwili, and Kukui (*Aleurites moluccana*) (Char 2000d).

3.6.3.2 Ruderal Vegetation

The ruderal vegetation along roadsides, loading areas, and other occasionally mowed or trimmed areas consists of low mats of grasses and weedy herbaceous species (Char 2000d). In areas with stonier soil or where pavement runs along a rocky shelf, 0.5 to 1-ft (15 to 30-cm) tall Guinea grass grows along with Koa Haole and Lantana shrubs (*Lantana camara*) (Char 2000d).

3.6.4 Invasive and Introduced Wildlife Species

The most common species identified at the magazine are Cattle Egrets, Chukars, Moa, Spotted Doves, Zebra Doves, Northern Cardinals, and Erckel's Francolins (NAVFAC PAC 2006a). Mammal surveys that were conducted in 2006 found Columbian Black-tailed Deer, Feral Pigs, Cows (family Bovidae) and Feral Cats at the Kamokala Ridge Magazines (NAVFAC PAC 2006c).

3.6.5 Special Status Species

Only one ESA-protected species, the Hawaiian Hoary Bat, has been identified at the Kamokala Ridge Magazines to date (Bonaccorso and Pinzari 2011, Bruner 2000; Char 2000d; NAVFAC PAC 2006a, c, g). The highest levels of bat occupancy were detected during the winter months. Call activity at Kamokala Ridge Magazines followed the same seasonal pattern as Barking Sands, but detectability and call activity were much lower at Kamokala, with no evidence of fall swarming activity (Bonaccorso and Pinzari 2011).

At least four native protected bird species use the Kamokala Ridge Magazines habitat, including two native MBTA-protected species, the Black-crowned Night-heron and Pacific Golden Plover. These

species were the only native protected species documented at this site during a 2006 survey (NAVFAC PAC 2006a), though Band-rumped Storm-petrel, Hawaiian Petrel, and Newell's Shearwater have potential to fly over the site. ESA-protected and native-MBTA-protected species documented at the Kamokala Ridge Magazines are listed in **Table 3-17**.

3.7 Port Allen Natural Resources

3.7.1 General Description

The Port Allen facility is located on the southwestern shore of Kauaʻi adjacent to Hanapepe Bay in the small community of Eleʻele. The greatest part of the facility is located on a pier constructed in Hanapepe Bay. PMRF leases part of a building, the north side of the pier, and a small parking lot from the State Department of Transportation Harbors Division. The lease for this property is renewed annually. PMRF also leases a paved outdoor storage area near the pier. Because of the limited land area and natural resources present at Port Allen, natural resources discussed in this INRMP will be limited to special status species that have potential to occur.

View of building and pier at Port Allen

3.7.2 Special Status Species

The pier leased by the Navy at Port Allen is in an area in which one ESA-listed species, the Newell's Shearwater, has been observed. As with other PMRF facilities, shearwaters are known to fly over Port Allen during their flights from inland breeding colonies to their at-sea foraging areas and shearwater fall out has been documented in the area (NAVFAC PAC 2014). Few other biotic resources are present on this site. Aquatic resources at Port Allen are regulated by the DLNR DAR (SOH DLNR DAR 2015).

3.8 Kaʻula Island Natural Resources

3.8.1 Topography, Geology, and Soils

Kaʻula Island formed from a crescent-shaped volcanic crater rim. Therefore, the island's structure is mostly comprised of tuff, or consolidated volcanic ash. The crater created steep-sloping walls and formed a small bay on the inner side. This inner curve has a 10 to 80-ft (3.1 to 24-m) wide rock terrace or bench along the shore that was likely formed by wave action when sea level was at a different height from the present level. The northern "horn" on the outer side of the island contains a 100-ft (30-m) deep sea cave with a 50-ft (15-m) ceiling. Kaʻula is covered by a sparse grass landscape and earthen/rock outcrops, reportedly underlain by a relatively thin soil layer with highly weathered limestone bedrock (DoN 2008a).

Table 3-17. Special Status Species on or near Kamokala Ridge Magazines

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Birds					
Nycticorax nycticorax	Black-crowned Night Heron	ʻAukuʻu	MBTA	Year-round resident. Rare, one individual observed in 2000 survey.	Breeding Season: March – Oct. Incubation: ~25 days Fledges: 50-75 days
Oceanodroma castro	Band-rumped Storm-petrel (Hawaiʻi DPS)	ʻAkēʻakē	E, MBTA	Breeding visitor. Not observed at Kamokala Ridge but may fly over during trips between nesting and foraging sites. Fledglings also fly through the area on their first trip to the sea and may fall out during fledgling season.	Breeding Season: May – Oct. /April - June Incubation: 39 -51 days Fledges: mid Sept. – mid Dec.
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Winter visitor. Uncommonly observed at Kamokala Ridge.	NA
Pterodroma phaeopygia sandwichensis	Hawaiian Petrel	ʻUaʻu	E, MBTA	Breeding visitor. Not observed at Kamokala Ridge but may fly over when traveling between nesting sites and at-sea foraging areas. Fledglings also fly through the area on their first trip to the sea and may fall out during fledgling season.	Breeding Season: Feb. – May Incubation: ~56 days Fledges: Oct. – Dec.
Puffinus auricularis newelli	Newell's Shearwater	ʻAʻo	T, MBTA	Breeding visitor. Not observed at Kamokala Ridge but may fly over when traveling between nesting sites and at-sea foraging areas. Fledglings also fly through the area on their first trip to the sea and are vulnerable to fall out during fledgling season.	Breeding Season: March - April Incubation: ~51 days Fledges: mid-Sept. - mid-Dec.
Mammals					
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpe ʻape ʻa	E	Occur year round and are particularly abundant in fall and winter.	Breeding Season: Sept – Dec. Pupping: June – Aug. Mother likely stays with their pups for 6 - 7 weeks.

[1]Federally and State listed as E = Endangered, T = Threatened, MBTA = Indigenous species protected under the Migratory Bird Treaty Act

Sources: Bonaccorso and Pinzari 2011, NAVFAC PAC 2006a

The target area has elevations as low as sea level and as high as 250 ft (76 m) above msl, but the entire island has elevations that range from sea level to 540 ft (165 m). The terrain drops steeply from the crest and steep V-shaped ravines that have been cut by ephemeral streams occur on the windward slopes, such that the island has little level terrain (Pepi et al 2009).

3.8.2 Hydrology

Surface water on the island is limited, and there are no perennial streams. Rainwater collects in small gullies and percolates downward or evaporates. However, during a deployment to the island in 1971, a freshwater source with a rate of flow of one pint per hour was discovered approximately 1,000 ft (305 m) from the southern target area used by the Navy (DoN 2010).

3.8.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

Plant surveys conducted in 1932, 1976, and 1998 identified 29 species including 5 (17 percent) endemic Hawaiian species, 8 (28 percent) indigenous species, and 15 (52 percent) introduced species including 1 (3 percent) Polynesian introduction (**Appendix C**). The dominant vegetation type on the island is semi-arid and strand plants of low growing shrubs and herbaceous plants. Many areas of the island have no plant cover and the plants that do grow on the island are all adapted for arid conditions and strong winds (Pepi et al. 2009).

3.8.4 Invasive and Introduced Wildlife Species

Six of the 27 bird species identified on Kaʻula Island during bird surveys from 1932 to 2011 are non-native. Of these, the Barn Owl, House Finch, and Japanese White-eyes were the only species consistently recorded in multiple surveys (Pepi et al. 2009). Non-seabirds were not recorded in the 2009 to 2011 ship-board surveys. Non-native rodent species, including Polynesian Rats and Common House Mice, have also been documented on Kaʻula Island (Pepi et al. 2009). No introduced herpetological species have been observed on land at Kaʻula Island (Pepi et al. 2009).

3.8.5 Special Status Species

Numerous biological surveys including avian, botanical, insect, and mammal have been conducted on Kaʻula Island since the 1930s (Bishop Museum 2015). However, as land access has not been granted for surveys of Kaʻula Island since 1998, recent surveys have been conducted via aerial imagery or have been ship-based surveys (Pepi et al. 2009, Uyeyama and Hanser 2010, Richie et al. 2012, DoN 2014b). Beginning in 2013, the Navy looked to improve their seabird data gathering efforts by exploring the use of higher altitude, very high-resolution aerial imaging surveys. The first survey using this improved imagery was conducted in April 2013 and has been conducted annually since then.

Throughout the avian surveys conducted on Kaʻula from 1932 through 2017, no ESA-listed bird species has been identified; however, many native MBTA-protected bird species have been identified (**Appendix C**). Seabird surveys indicate that the seabird species composition on the island has remained very consistent over time with nine species comprising a majority of the seabird observations over the past 80 years. Seabird numbers on Kaʻula are highest in the mid-summer months (NAVFAC PAC 2016b).

Federally-listed marine mammals are known to occur in the waters near or adjacent to Kaʻula Island. The endangered Hawaiian Monk Seal frequents the shoreline (Pepi et al. 2009, Uyeyama et al. 2011, Ritchie et al. 2012), and nearby waters support three federally listed cetacean species: the Fin Whale (*Balaenoptera physalus*), the Sperm Whale or Palaoa (*Physeter microcephalus*) and the False Killer Whale (*Pseudorca crassidens*). A further 16 MMPA-protected cetacean species have been observed nearby, including 11 dolphins: the Bottlenose Dolphin, Spinner Dolphin, Rough-toothed Dolphins, Striped Dolphin, Pantropical Spotted Dolphin, Fraser's Dolphin, Risso's Dolphin, Short-finned Pilot Whales, Pygmy Killer Whale, Killer Whale And Melon-headed Whale; and five whale species: Pygmy Sperm Whale, Dwarf Sperm Whale, Humpback Whale, Blainville's Beaked Whale And Cuvier's Beaked Whale (Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, Pepi et al. 2009, Uyeyama et al. 2011, Richie et al. 2012, DoN 2014b).

Sea turtles are not known to bask on ledges on Kaʻula Island nor have they been identified during ship-board or aerial surveys, but since the area contains suitable habitat they might be found in the nearshore waters (NMFS and USFWS 1998b). No federally protected insect or plant species have been identified on Kaʻula either (Bishop Museum 2015, Pepi et al. 2009). **Table 3-18** summarizes ESA, MBTA, and MMPA-protected species that have been documented on or near Kaʻula Island since 1932.

3.8.5.1 Essential Fish Habitat

As with Barking Sands, EFH has been designated for numerous species that occur in the waters adjacent to Kaʻula Island. Habitat Areas of Particular Concern (HAPC), which are particularly sensitive or rare and provide important habitat for managed species have also been identified within the designated EFH. Specifically, the coral bank surrounding Kaʻula Island is designated a coral reef ecosystem HAPC by the WPRFMC (DoN 2005).

3.9 Mauna Kapu Site Natural Resources

3.9.1 Topography, Geology, and Soils

The Mauna Kapu Facility is on the uppermost ridgeline of the Waiʻanae Range on Oʻahu at an elevation of approximately 2,720 ft (829 m) above msl. Steep topography and incised valleys surround the site.

The Mauna Kapu Facility is on the western side of the island in the 22-mi-long (35-km-long) Waiʻanae Range. This range is composed of shield lava from the Koʻolau and Waiʻanae Volcanoes below a thick layer of alkaline basalt (USGS 2013). Erosion has carved out huge valleys into the Waiʻanae Range, most of which discharge in the direction of the southwest. With the exception of the eastern portion, erosion and subsidence of more than 6,000 ft (1,829 m) have destroyed the extinct Waiʻanae Volcano (Hunt 1996).

The Tropohumults-Dystrandepts Association (rTP) is the predominant soil type below the Mauna Kapu Facility (**Figure 3-21**). The rTP series is found in mountainous areas within the Waiʻanae Range with slopes anywhere from 30 to 90 percent in areas dominated by deep, V-shaped drainage ways and narrow ridges. Tropohumults are found at higher elevations on narrow ridgetops. They are well-drained, strongly acidic to extremely acidic soils with a hard, purplish crust in areas where vegetation is depleted (USDA SCS 1972). Dystrandepts are found at lower elevations on steep side slopes and

narrow ridge tops. These soils typically form in volcanic ash (giving them a dark color), are well drained, and are medium to strongly acidic (USDA SCS 1972). Histosols are poorly drained soils that are found in small, wet positions near mountain peaks. The moisture of the soil along with other factors allow organic matter to accumulate as thick as 3 ft (1 m) in this soil type (USDA SCS 1972).

Table 3-18. Special Status Species on or near Ka‘ula Island

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Birds					
Anous minutus	Black Noddy	Noio	MBTA	Breeding visitor. From several individuals to 200 observed over multiple surveys.	Breeding Season: Breeding is highly variable and egg laying occurs year-round. Incubation: ~ 34 days Fledges: ~ 39 – 52 days, fledglings remain near their parents for up to 17 weeks
Anous stolidus	Brown Noddy	Noio Kōhā	MBTA	From several hundred to many thousand observed over multiple surveys.	Breeding Season: Spring and summer Incubation: ~ 30 to 37 days Fledges: ~ eight weeks
Arenaria interpres	Ruddy Turnstone	‘Akekeke	MBTA	Winter resident. 1 to 50 individuals observed over multiple surveys.	NA
Bulweria bulwerii	Bulwer’s Petrel	‘Ou	MBTA	Breeding visitor. 50 to several hundred observed over multiple surveys.	Breeding Season: April - June Incubation: ~42-46 days Fledges: early October
Fregata minor	Great Frigatebird	‘Iwa	MBTA	Migratory. From several individuals to several hundred observed over multiple surveys.	NA
Gygis alba	White Tern	Manu-o-Kū	ST, MBTA	Breeding visitor. From several individuals to 200 observed over multiple surveys.	Breeding Season: late spring and summer Incubation: ~ 36 days Fledges:~48 days
Onychoprion fuscatus	Sooty Tern	‘Ewa ‘Ewa	MBTA	Breeding visitor. Typically the most abundant species with several hundred up to 130,000 observed.	Breeding Season: eggs are generally laid beginning of February Incubation: ~28 – 30 days Fledges: 8-9 weeks, may stay around colony another 2-3 weeks

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Onychoprion lunatus	Gray-backed Tern	Pākalakala	MBTA	Breeding visitor. From less than 50 to several thousand observed over multiple surveys.	Breeding Season: Feb. – March Incubation: ~ Fledges: July
Phaethon lepturus	White-tailed Tropicbird	Koaʻe Kea	MBTA	Breeding visitor. One to three individuals observed over multiple surveys.	Breeding Season: Most breeding occurs in summer, with occasional breeding during winter months Incubation: ~43 days Fledges: 70 0 85 days
Phaethon rubricauda	Red-tailed Tropicbird	Koaʻe Ula	MBTA	Vagrant. From several individuals to several hundred observed during multiple surveys.	Breeding Season: Jan. – Aug. Incubation: ~44 days Fledges: ~82 days
Pheobastria immutabilis	Laysan Albatross	Mōlī	MBTA	Breeding visitor. From several individuals to 150 observed over multiple surveys.	Breeding Season: Nov. – Dec. Fledging: June to July Incubation: 65-66 days Fledges: ~185 days
Pheobastria nigripes	Black-footed Albatross	Kaʻupu	MBTA	Breeding visitor. From several individuals to 200 observed over multiple surveys.	Breeding Season: Oct. – Jun. Incubation: ~65-66 days Fledges: ~150 days
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Winter resident. From several individuals to 21 observed over multiple surveys.	NA
Procelsterna cerulean saxatilis	Blue-gray Noddy	--	MBTA	Vagrant. Observed twice, 200 in 1976 and 1 in 1998.	NA
Pterodroma hypoleuca	Bonin Petrel	--	MBTA	Migrant. One chick documented in 1932, may be a misidentification.	NA
Puffinus nativitatis	Christmas Shearwater	ʻAoʻū	MBTA	Breeding visitor. From 18 to several hundred observed over multiple surveys.	Breeding Season: March - April Incubation: ~51 days Fledges: mid-Sept. - mid-Dec.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Puffinus pacificus	Wedge-tailed Shearwater	ʻUaʻu Kani	MBTA	Breeding visitor. From one individual to several thousand observed over multiple surveys.	Breeding Season: March - June Incubation: ~50 days Fledges: mid Nov. – early Dec.
Sula dactylatra	Masked Booby	ʻĀ	MBTA	Breeding visitor. From several hundred to many thousand observed over multiple surveys.	Breeding Season: Jan. - July Incubation: ~45 days Fledges: five months
Sula leucogaster	Brown Booby	ʻĀ	MBTA	Breeding visitor. From 1 individual to 1,700 observed over multiple surveys.	Breeding Season: Jan. – Sept. and Oct. – Dec. Incubation: ~43 days Fledges: 130 – 260 days
Sula sula	Red-footed Booby	ʻĀ	MBTA	Breeding visitor. From several hundred to many thousand observed over multiple surveys.	Breeding Season: February - April Incubation: ~44 days Fledges: five months
Tringa incana	Wandering Tattler	ʻŪlili	MBTA	Winter resident. One to five observed during multiple surveys.	NA
Mammals					
Balaenoptera physalus	Fin Whale	---	E	Considered rare, most likely to occur in fall and winter.	Breeding season: Late fall-winter.
Feresa attenuata	Pygmy Killer Whale	---	MMPA	Occurs in deeper waters year-round; may have island-associated resident populations	Calving likely peaks in summer.
Globicephala macrorhynchus	Short-Finned Pilot Whales	---	MMPA	Frequently documented by ship-board surveys between Kauaʻi, Nʻiihau, and Kaʻula.	Breeding Season: Year-round, peaks July – Aug.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Grampus griseus	Risso's Dolphin	---	MMPA	Rarely seen, primarily in deeper waters.	No seasonality is known
Kogia breviceps	Pygmy Sperm Whale	---	MMPA	Rarely seen, primarily in deeper waters.	Calving peaks March-August
Kogia sima	Dwarf Sperm Whale	---	MMPA	May be part of an island- associated resident population; occur year-round.	Calving occurs in spring.
Lagenodelphis hosei	Fraser's Dolphin	---	MMPA	Rarely seen, but known to occur year-round in deeper waters in large pods.	Calving occurs between spring and fall
Megaptera novaeangliae	Humpback Whale	Kōholā kuapiʻo	SE, MMPA	Large pods visit the shoal area of Kaʻula every winter season.	Calving occurs in winter.
Mesoplodon desirostris	Blainville's Beaked Whale	---	MMPA	Occur in low numbers rear-round, possibly as part of a resident population.	No seasonality is known
Neomonachus schauinslandi	Hawaiian Monk Seal	ʻĪlio-holo-i-ka-uaua	E	Frequently documented basking on Kaʻula shores during multiple surveys.	Breeding Season: Breeding and pupping year-round. Peak pupping April – August. Mother nurses her pup for 5-7 weeks.
Orcinus orca	Killer Whale	---	MMPA	Hawaiian stock only; very rarely seen, typically in winter.	Breeding year-round

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Peponocephala electra	Melon-headed Whale	---	MMPA	Occur year-round.	No seasonality is known
Physeter macrocephalus	Sperm Whale	Palaoa	E	Higher occurrence in summer/ fall. Rarely recorded in adjacent waters.	Breeding season: Summer
Pseudorca crassidens	False Killer Whale	---	E – MHI Insular DPS	Frequently documented by ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	No seasonality is known.
Stenella attenuata	Pantropical Spotted Dolphin	Kiko	MMPA	Infrequently documented ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	Calving peaks in spring and fall.
Stenella coeruleoalba	Striped Dolphin	---	MMPA	Occur year-round, primarily in deeper waters.	Calving occurs summer to fall.
Stenella longirostris	Spinner Dolphin	Naiʻa	MMPA	Frequently documented by ship-board surveys between Kauaʻi, Niʻihau, and Kaulʻa.	Calving peaks range from spring to fall.
Steno bredanensis	Rough-toothed Dolphin	---	MMPA	Frequently documented by ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	Unknown breeding season.
Tursiops truncatus	Bottlenose Dolphin	Naiʻa	MMPA	Frequently documented by ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	Calving peaks range from spring to fall.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Ziphius cavirostris	Cuvier's Beaked Whale	---	MMPA	Occur year-round, likely as part of an island-associated resident population.	Breeding occurs year-round; calving peaks in spring.
Fish					
Carcharinus lonigmanus	Oceanic Whitetip Shark	---	T	Occurs in tropical and subtropical oceans throughout the world. They live from the surface of the water to at least 500 ft (152 m) deep. Breeding is thought to be concentrated in the central Pacific between 1°N and 15°N.	Mating occurs in late spring and summer. Gestation is 12- 13 months.
Manta birostris	Giant Manta Ray	Hāhālua	T	Occurs worldwide in tropical, subtropical, and temperate waters and is commonly found offshore, in oceanic waters, and near productive coastlines. Breeding sites have been identified off the coast of Ecuador and in the Galapagos Islands.	The primary breeding season is July - August. Gestation is 12-13 months.
Reptiles					
Chelonia mydas	Green Sea Turtle	Honu	T-Central North Pacific DPS	Not documented but likely to occur	NA
Eretmochelys imbricata	Hawksbill Sea Turtle	Honuʻea	E	Not documented but likely to occur	NA

[1]Federally and State listed as E = Endangered, T = Threatened, DPS = Distinct Population Segment, SE = State Endangered only, ST = State Threatened only
Native MBTA = Species protected under the Migratory Bird Treaty Act; MMPA = Protected under Marine Mammal Protection Act
Sources: Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, Bonfil et al. 2009, DoN 2005, DoN 1976, DoN 2014b, NMFS 2016b,c,d, NOAA Fisheries 2018, Pepi et al. 2009, Pyle and Pyle 2017, Ritchie et al. 2012, SOH DLNR 2015, USFWS 2019c, Uyeyama and Hanser 2010

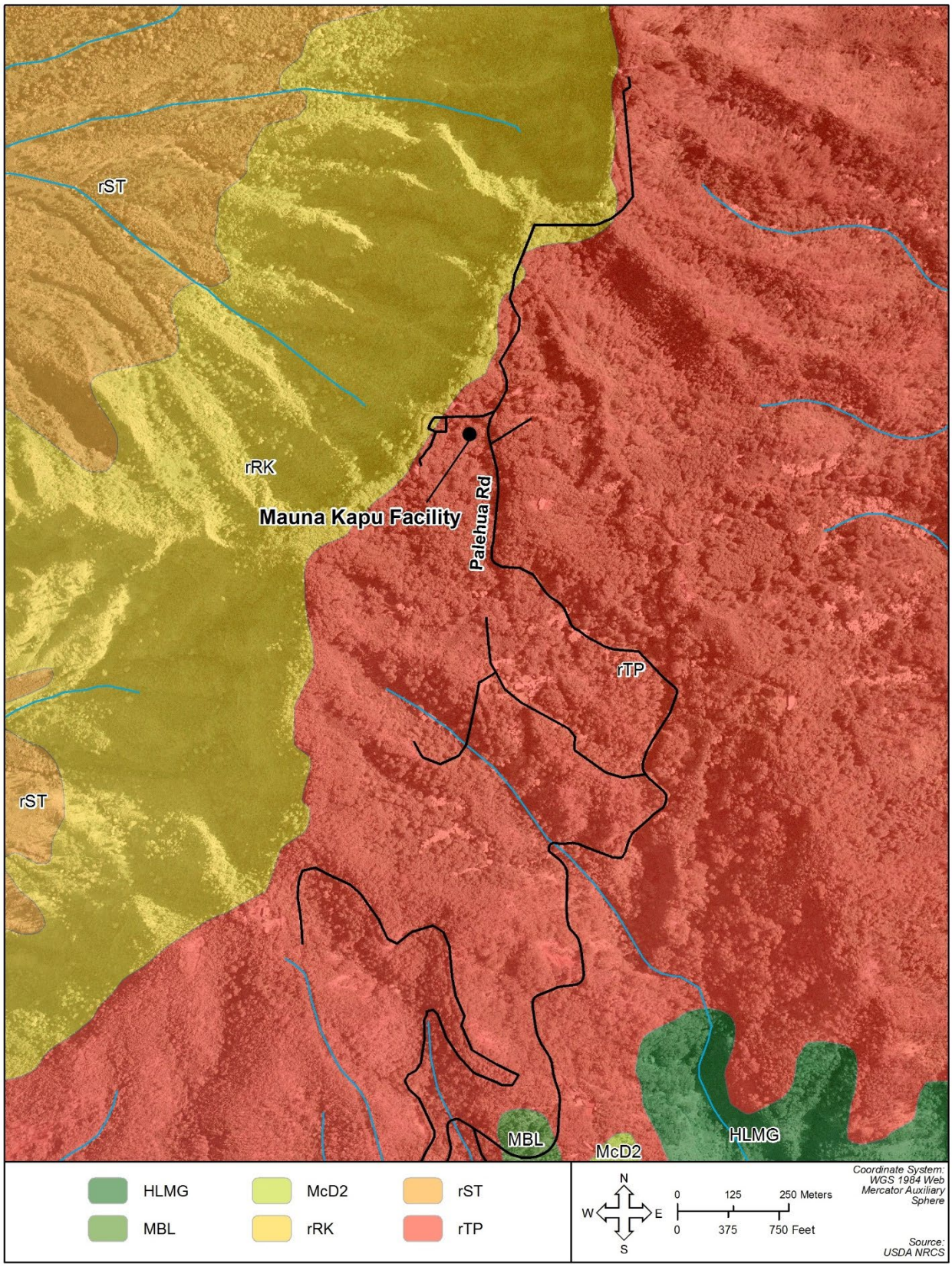


Figure 3-21. Soils and Surface Waters Adjacent to the Mauna Kapu Facility

3.9.2 Hydrology

The Mauna Kapu Facility has no surface water or wetlands (see **Figure 3-21**). The site overlies a high-level, unconfined, dike aquifer in the ʻEwa Aquifer System of the Pearl Harbor Aquifer Sector. This aquifer is classified as having irreplaceable freshwater and a high vulnerability to contamination (Mink and Lau 1992).

3.9.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

The small area of Mauna Kapu Facility is dominated by non-native species and contains only discrete, enclosed lawn and some cultivars (DoN 2010). Adjacent to the facility is a wide range of introduced and native flora of mixed mesic and wet mesic forests in the Honouliuli and Nānākuli forest reserves.

3.9.4 Invasive and Introduced Wildlife Species

Although no site-specific survey information is available, typical non-native avian species such as House Finches and Northern Cardinals can be expected to occur. Additionally, rats, which are known to be a problematic predator of endangered snail species in the Honouliuli Forest Reserve (SOH DFAW 2013) are likely occur on the site. Feral dogs, cats, mice, and mongoose may also occur (Belt Collins 2014).

3.9.5 Special Status Species

The Mauna Kapu Facility does not support any known federal or state-listed threatened, endangered, or candidate animal or plant species. However, the facility is located next to the Honouliuli Forest Reserve, which supports endangered bird species such as the endangered Oʻahu ʻElepaio; two listed Oʻahu tree snail species, or Kāhuli (*Achatinella mustelina* and *Achatinella concavospira*); numerous listed plants; and the Pueo which is state-listed as endangered on Oʻahu (SOH DLNR 2009, VanderWerf 2012). Designated critical habitat for the Oʻahu ʻElepaio and 34 plant species is located to the north and west of the facility (USFWS 2019b; **Figure 3-22**).

The Oʻahu ʻElepaio (*Chasiempis sandwichensis*) (Photo 5-2) is a federally endangered, endemic, monarch flycatcher. Historically found in a variety of forest types at all elevations on the island, Oʻahu ʻElepaio are now only found in mid-elevation to high-elevation forests in portions of the Koʻolau and Waiʻanae Mountain Ranges. Steep population declines and dramatic reductions in range (only 4% of the presumed historic range is currently occupied) led to the Oʻahu ʻElepaio being listed as endangered by the USFWS in 2000. In 2012, the estimated population size for the Oʻahu ʻElepaio was 1,261 birds with 477 breeding pairs and 307 single males, demonstrating the species' very strong male-biased sex-ratio (VanderWerf and Talpas, 2017). The final rule relating to Critical Habitat for the Oʻahu ʻElepaio was published on December 10, 2001 (66 FR 63751). Within the rule, five distinct units were designated as Critical Habitat for the Oʻahu ʻElepaio totaling 65,879 acres (26,661 hectares).

The ʻIʻiwi or Scarlet Honeycreeper (*Vestiaria coccinea*) (Photo 5-3) is an endemic Hawaiian honeycreeper federally listed as threatened and state listed as endangered on the island of Oʻahu. The scarlet honeycreeper can fly long distances in search of flowering ʻŌhiʻa trees and are important ʻŌhiʻa pollinators. They are found within mesic wet forests dominated by ʻŌhiʻa and Koa (*Acacia koa*) (DLNR, 2015). On Oʻahu, scarlet honeycreepers persist in higher and cooler elevation forests (82 FR

43873) with population estimates for the island ranging from 50 birds (DLNR, 2015b) to a few individuals (82 FR 43873).

The Oʻahu ʻAmakihi (*Chlorodrepanis flava*) (Photograph 5-5) is a small, olive green, native honeycreeper considered a species of conservation concern by the USFWS (USFWS, 2008c). Endemic to the island of Oʻahu, the Oʻahu ʻAmakihi is found in a variety of habitats from wet forests in the Koʻolau Mountains to dry forests in the Waiʻanae Mountains (DLNR, 2015). In the Waiʻanae Mountains, the Oʻahu ʻAmakihi is considered relatively uncommon and is mostly found above 1,640 feet (500 meters) elevation. Confirmed citizen and scientist observations of Oʻahu ʻAmakihi report observations in high elevations and along ridgelines of the Waiʻanae mountains as recent as 2021 and 2020 (eBird, 2021).

The ʻApapane (*Himantione sanguinea*) (Photograph 5-6) is an endemic honeycreeper considered a species of conservation concern by the USFWS (USFWS, 2008). While large numbers of ʻApapane survive on several of the Main Hawaiian Islands, only a small relict population is thought to remain on Oʻahu. Historically, the species was found in forested areas across the island of Oʻahu. Today, ʻApapane occur primarily in the Koʻolau Mountains and are less common in the Waiʻanae Mountains above 1,950 feet (600 meters) (DLNR, 2015).

3.10 Niʻihau Natural Resources

3.10.1 Topography, Geology, and Soils

The highest elevations on Niʻihau Island are volcanic uplands at Pānīʻau that reach 1,281 ft (390.4 m). The island also contains 3 mi (4.8 km) of sea cliffs that are at least 1,000 ft (304.8 m) in elevation (**Figure 3-23**). However, 75 percent of Niʻihau Island is lower than 500 ft (152 m) in elevation (SOH DLNR 2015).

Niʻihau Island was formed from the remnants of a single volcano approximately 4.89 million years ago, which was since been deeply eroded. The island is mainly comprised of rejuvenated-stage Pliocene to Pleistocene-age Kiekie Basalt over shield-stage Miocene to Pliocene-age Paniau Basalt. These layers are intruded by dikes. The island has extensive alluvial deposits, some of which are consolidated (Oki et al. 1999).

The low volcanic cliffs on Niʻihau Island are weathered and shaped by marine erosion. The island also has boulder beaches, recessed sandy beach systems with 98-ft (30-m) high dunes, small littoral sandy

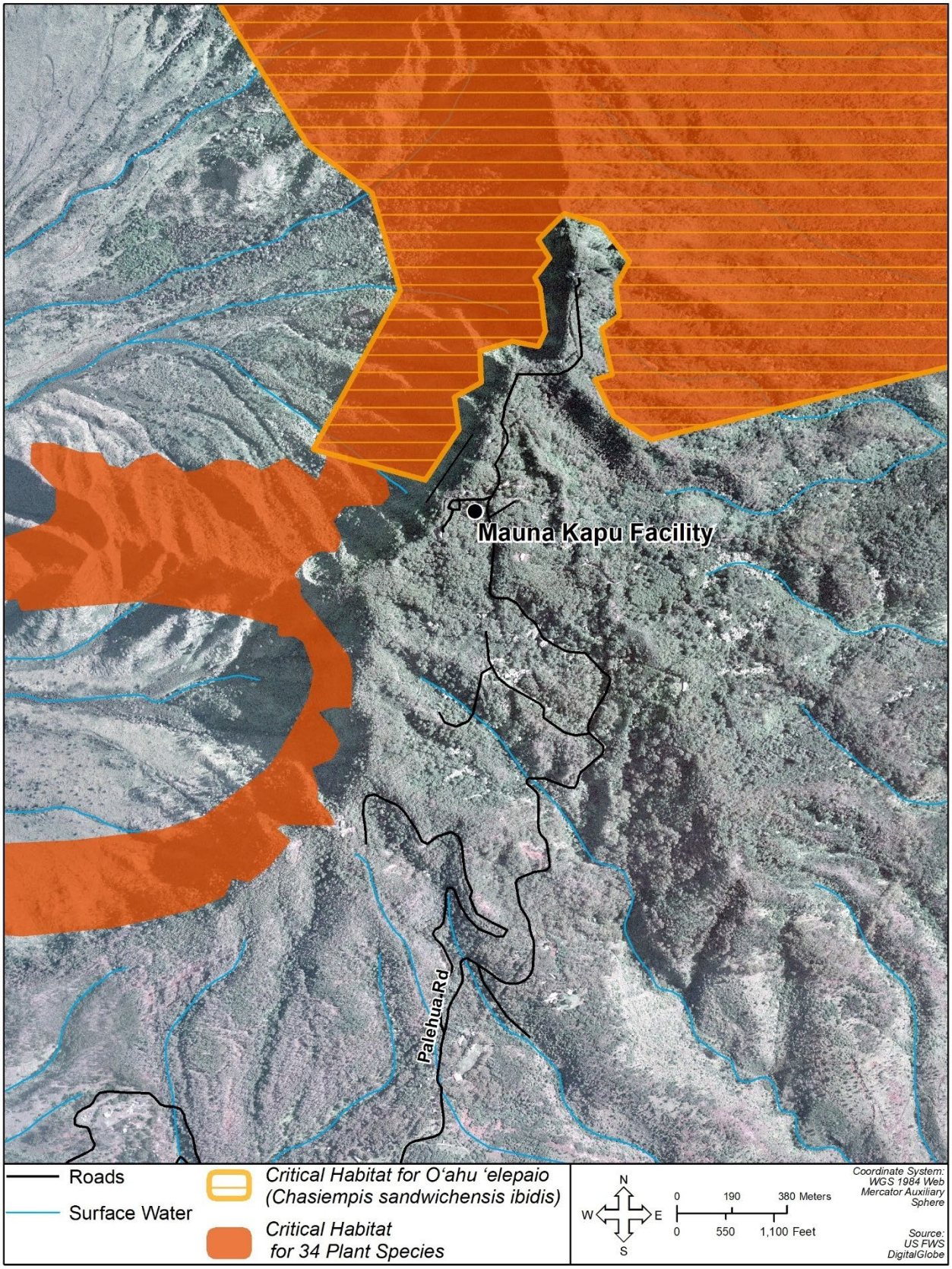


Figure 3-22. Protected Species Critical Habitat Adjacent to the Mauna Kapu Facility

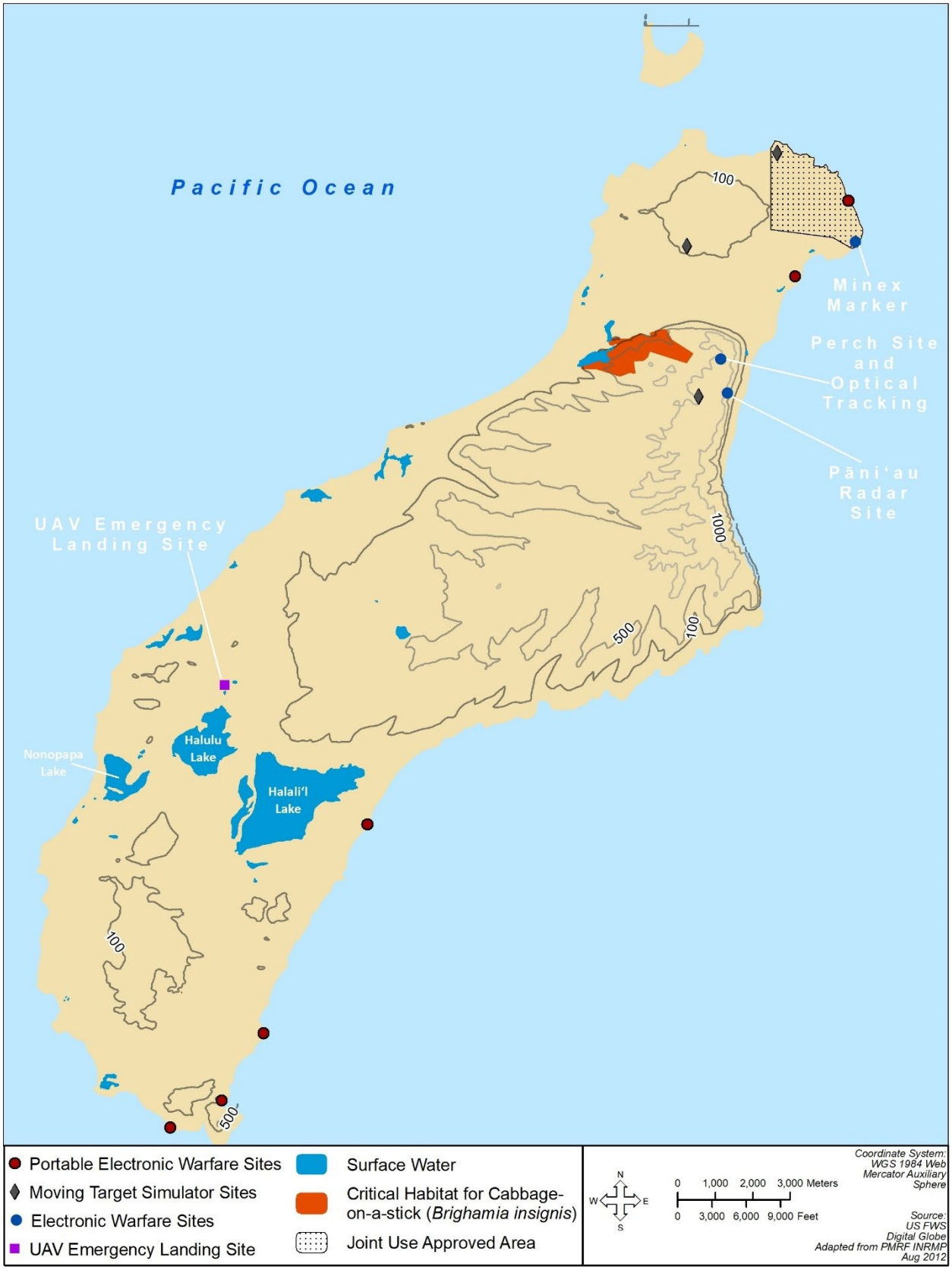


Figure 3-23. Elevation Contours, Surface Waters, and Critical Habitat on Ni'ihau Island

coves, and erosional sandy coasts with massive sections of beach rock eroded from large swells and stacked on shore (Fletcher and Fiersten 2009).

The Robinson family has not given permission for soil surveys to be conducted on Niʻihau Island (Bruland 2009) and soil data are not available from the NRCS Web Soil Survey (USDA NRCS 2015).

3.10.2 Hydrology

While there are no perennial streams on the island, there are several seasonal/ephemeral wetlands and lakes that have formed from surface runoff following winter rains, and one that receives spring inflow. However, most of the water evaporates from these lakes during dry seasons leaving the island with very little surface water. The three largest lakes include Halulu Lake, which is a natural freshwater lake approximately 182 ac (74 ha) in size, Halāliʻi Lake, which is an intermittent lake covering approximately 841 ac (340 ha) (SOH DLNR 2015), and Nonopapa Lake, which is approximately 160 ac (65 ha) (Google Earth 2018) (see **Figure 3-23**).

Several small springs and seeps can be found on the island at elevations of 500 ft (152 m) above msl and at Keanahaki and Kaumuhonu at 6.5 ft (2 m) above msl. The island has groundwater in beach sand, calcareous dunes, alluvium, eolianite, and the Kiekie and Paniau volcanic series, but only 3 out of 57 wells and waterholes that were tested yielded water with sufficiently low salt content for drinking (DoN 2012).

3.10.3 Terrestrial Habitats, Vegetation Communities, and Land Cover

The coastal and inland areas of Niʻihau Island are dominated by dense Kiawe forests, which open into mixed coastal dry communities with an extensive ʻIlima (*Sida fallax*) understory in northern lowland areas. Scattered locations with higher elevations on the island contain thick Koa Haole shrubland, a dry coastal community, with very little herbaceous understory due to the high density of the Koa Haole and the intense grazing pressure. Northeastern coastal regions contain coastal dry herbland/grassland communities. Most of the vegetation on Niʻihau is non-native, and small mixed Eucalyptus strands and Common Ironwood strands are found in sheltered areas at higher elevations. Non-native Ironwood (*Casuarina equisetifolia*) can also be found in coastal areas of the island. A native species, False Sandalwood, can also be found at higher elevations in mixed Kiawe/Koa Haole shrub associations (DoN 2012).

3.10.4 Invasive and Introduced Wildlife Species

A 1951 report on the avifauna of Niʻihau reported that at one time all native bird species had been extirpated and only exotic species such as Ring-necked Pheasant (*Phasianus colchicu*s), California Quail (*Callipepla californica*), Wild Turkey or Pelehū (*Meleagris gallopavo*) that were introduced occurred (Fisher 1951). Other introduced species such as Japanese White-eyes, Common Mynas, House Finches, and Cardinals that likely migrated from Kauaʻi were also numerous. By the 1950s however, many native species, including endangered seabirds and waterfowl, had reestablished populations on Niʻihau. Feral Cats, Feral Pigs, and rats were also noted as being ubiquitous during the 1951 study (Fisher 1951).

3.10.5 Special Status Species

Of the bird populations that have reestablished on Niʻihau Island, several endangered Hawaiian waterbirds including the Hawaiian Duck, Hawaiian Coot, and Hawaiian Stilt are known to occur (Pyle and Pyle 2017, USFWS 2011b). These species move between Niʻihau and Kauaʻi in response to changes in hydrologic conditions, as the lakes on Niʻihau are ephemeral. In addition, a large number of MBTA-protected seabird species also occur, though breeding has only been confirmed for a few of these species (Pyle and Pyle 2017).

The endangered Hawaiian Monk Seal and threatened green sea turtle frequent the beaches and occur in the nearshore waters of Niʻihau Island and are within the Navy training areas. Hawaiian Monk Seal uses the coastline to haul out, pup, and rear young. The green sea turtle has been observed basking on selected beaches and occasionally nests at some of these locations. The endangered False Killer Whale has been documented in the area by ship-board surveys (Carretta et al. 2018), and endangered sperm whale and Fin Whale have been rarely observed in adjacent waters. Dolphins that can occur in nearby or adjacent waters are: Short-finned Pilot Whale, Pygmy Killer Whale, Fraser's Dolphin, Melon-headed Whale, Pantropical Spotted Dolphin, Striped Dolphin, Spinner Dolphin, Rough-toothed Dolphin and Bottlenose Dolphin. Whales recorded in the area include the Pygmy Sperm Whale, Dwarf Sperm Whale, Humpback Whale, Blainville's Beaked Whale and Cuvier's Beaked Whale (Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b).

No threatened, endangered, or candidate plant species are known within the Navy-used sites. However, Nihoa Pritchardia or Wāhane (*Pritchardia aylmer-robinsonii*) and Cabbage-on-a-stick or ʻŌlulu (*Brighamia insignis*) have been documented on other parts of Niʻihau Island. The endemic and endangered Nihoa Pritchardia is a fan-leaved tree about 23 to 50 ft (7 to 15 m) tall that was previously found at three sites on the island, but in 2011 it was believed that only two plants remain on Kaʻali Cliff, though not confirmed by on-site surveys (USFWS 2011a). There is no designated critical habitat for Nihoa Pritchardia (USFWS 2003). The endemic and endangered Cabbage-on-a-stick has one unit of 357 ac (144 ha) of critical habitat on Niʻihau Island for a population that was documented on Kaʻali Cliff, but has not been observed since 1947 (USFWS 1996, SOH DOFAW 2013 (see **Figure 3-23**). The only known remaining wild Cabbage-on-a-stick is on the Nā Pali coast of Kauaʻi (USFWS 2007). Threatened, Endangered, Candidate Species and other protected species known to occur on Niʻihau Island are summarized in **Table 3-19**.

Table 3-19. Special Status Species on or near Niʻihau Island

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Birds					
Anas wyvilliana	Hawaiian Duck	Koloa Maoli	E, MBTA	Year-round resident. Few individuals recorded during USFWS surveys.	Breeding Season: Year-round, peak April-Sept. Incubation: ~30 days Fledges: 50-60 days
Anous minutus	Black Noddy	Noio	MBTA	Breeding visitor. Has been recorded but is not known to breed on island.	Breeding Season: Breeding is highly variable and egg laying occurs year-round. Incubation: ~ 34 days Fledges: ~ 39 – 52 days, fledglings remain near their parents for up to 17 weeks
Arenaria interpres	Ruddy Turnstone	ʻAkekeke	MBTA	Winter resident.	NA
Asio flammeus sandwichensis	Short-eared Owl	Pueo	SE Oʻahu MBTA	Year-round resident.	Breeding Season: Year-round Incubation: 21-37 days Fledges: ~ 29 days
Bulweria bulwerii	Bulwer's Petrel	ʻOu	MBTA	Breeding visitor. Has been recorded but is not known to breed on island.	Breeding Season: April - June Incubation: ~42-46 days Fledges: early October
Fregata minor	Great Frigatebird	ʻIwa	MBTA	Migratory.	NA
Fulica alai	Hawaiian Coot	ʻAlae Keʻokeʻo	E, MBTA	Year-round resident. Over a 10-year period (1998-2007), counts averaged about 500 individuals during USFWS surveys.	Breeding Season: Year-round, peak April-Sept. Incubation: ~25 days Fledges: 50-75 days
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	E, MBTA	Year-round resident. Numbers in the hundreds have occasionally been recorded during USFWS surveys.	Breeding Season: March-Aug., peak May-June Incubation: ~24 days Fledges: ~60 days

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Nycticorax nycticorax hoactli	Black-crowned Night-heron	ʻAukuʻu	MBTA	Year-round resident.	Breeding Season: March – Oct. Incubation: ~25 days Fledges: 50-75 days
Phaethon lepturus	White-tailed Tropicbird	Koaʻe Kea	MBTA	Breeding visitor. Has been recorded but is not known to breed on island.	Breeding Season: Most breeding occurs in summer, with occasional breeding during winter months Incubation: ~43 days Fledges: 70 0 85 days
Phaethon rubricauda	Red-tailed Tropicbird	Koaʻe Ula	MBTA	Vagrant. Known to breed on island.	Breeding Season: Jan. to Aug. Incubation: ~44 days Fledges: ~82 days
Phoebastria immutabilis	Laysan Albatross	Mōlī	MBTA	Breeding visitor. Up to 25 pairs recorded as breeding on island.	Breeding Season: Nov. – Dec. Fledging: June to July Incubation: 65-66 days Fledges: ~185 days
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Winter resident.	NA
Puffinus auricularis newelli	Newell's Shearwater	ʻAʻo	T, MBTA	Breeding visitor. Has been recorded but is not known to breed on island.	Breeding Season: March - April Incubation: ~51 days Fledges: mid Sept. – mid Dec.
Puffinus nativitatis	Christmas Shearwater	ʻAoʻū	MBTA	Breeding visitor. Has been recorded but is not known to breed there.	Breeding Season: March - April Incubation: ~51 days Fledges: mid-Sept. - mid-Dec.
Sula dactylatra	Masked Booby	ʻĀ	MBTA	Breeding visitor. Has been recorded but is not known to breed on island.	Breeding Season: Jan. - July Incubation: ~45 days Fledges: five months
Sula leucogaster	Brown Booby	ʻĀ	MBTA	Breeding visitor. Has been recorded but is not known to breed on island.	Breeding Season: Jan. – Sept. and Oct. – Dec. Incubation: ~43 days Fledges: 130 – 260 days
Sula sula	Red-footed Booby	ʻĀ	MBTA	Breeding visitor. Known to breed on island.	Breeding Season: February - April Incubation: ~44 days

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
					Fledges: five months
Tringa incana	Wandering Tattler	ʻŪlili	MBTA	Winter visitor.	NA
Mammals					
Balaenoptera physalus	Fin Whale	---	E	Considered rare, most likely to occur in fall and winter.	Breeding season: Late fall-winter.
Feresa attenuata	Pygmy Killer whale	---	MMPA	Occurs in deeper waters year-round; may have island-associated resident populations	Calving likely peaks in summer.
Globicephala macrorhynchus	Short-Finned Pilot Whales	---	MMPA	Move over an area spanning Kauaʻi, Niʻihau, Kaʻula, and Oʻahu	Breeding Season: Year-round, peaks July – Aug.
Kogia breviceps	Pygmy Sperm Whale	---	MMPA	Rarely seen, primarily in deeper waters.	Calving peaks March-August.
Kogia sima	Dwarf Sperm Whale	---	MMPA	May be part of an island- associated resident population; occur year-round.	Calving occurs in spring.
Lagenodelphis hosei	Fraser's Dolphin	---	MMPA	Rarely seen, but known to occur year-round in deeper waters in large pods.	Calving occurs between spring and fall.
Megaptera novaeangliae	Humpback Whale	Kōholā Kuapiʻo	SE, MMPA	Occur winter / spring (Nov. – April).	Calving occurs in winter.
Mesoplodon desirostris	Blainville's Beaked Whale	---	MMPA	Occur in low numbers rear-round, possibly as part of a resident population.	No seasonality is known.
Neomonachus schauinslandi	Hawaiian Monk Seal	ʻĪlio-holo-i-ka-uaua	E	Uses the coastline to haul out, bask, and pup, observed up to terrestrial boundary and within 5-ft (1.5 m) depth zone in the ocean.	Breeding Season: Year-round. Pupping: Feb. – Aug., peaks March – April. Mother nurses her pup for 5-6 weeks.
Peponocephala electra	Melon-headed Whale	---	MMPA	Occur year-round. Occasionally observed off the coast of Niʻihau.	No seasonality is known.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Physeter macrocephalus	Sperm Whale	Palaoa	E	Higher occurrence in summer/ fall. Rarely recorded in adjacent waters.	Breeding season: Summer.
Pseudorca crassidens	False Killer Whale	---	E- MHI Insular DPS	Frequently documented by ship-board survyes between Kauaʻi, Niʻihau, and Kaʻula.	No seasonality is known.
Stenella attenuata	Pantropical Spotted Dolphin	Kiko	MMPA	Infrequently documented ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	Calving peaks in spring and fall.
Stenella coeruleoalba	Striped Dolphin	---	MMPA	Occur year-round, primarily in deeper waters, however rarely observed off the coast of Niʻihau.	Calving occurs summer to fall.
Stenella longirostris	Spinner Dolphin	Naiʻa	MMPA	Frequently documented by ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	Calving peaks range from spring to fall.
Steno bredanensis	Rough-toothed Dolphin	---	MMPA	Occur year-round. Show fidelity to area near Kaʻula and Niʻihau.	No seasonality is known.
Tursiops truncatus	Bottlenose Dolphin	Naiʻa	MMPA	Frequently documented by ship-board surveys between Kauaʻi, Niʻihau, and Kaʻula.	Calving peaks range from spring to fall.
Ziphius cavirostris	Cuvier's Beaked Whale	---	MMPA	Occur year-round, likely as part of an island-associated resident population. Occasionally observed off the coast of Niʻihau.	Breeding occurs year-round; calving peaks in spring.
Reptiles					
Chelonia mydas	Green Sea Turtle	Honu	T – Central North Pacific DPS	Occur year-round. Bask on the beaches. Has been observed coming ashore and nesting on the beaches, up to terrestrial boundary and within 5-ft (1.5 m) depth zone in the ocean.	Nesting Season: May – July Incubation: ~ 60 days Hatch: July – Sept.

Scientific Name	Common Name	Hawaiian Name	Status[1]	Occurrence	Reproduction
Eretmochelys imbricata	Hawksbill Sea Turtle	Honu‘ea	E	Reported in the waters off of Ni‘ihau.	
Fish					
Carcharinus lonigmanus	Oceanic Whitetip Shark	---	T	Occurs in tropical and subtropical oceans throughout the world and live from the surface of the water to 500 ft (152 m) deep. Breeding is thought to be concentrated in the central Pacific between 1°N and 15°N.	Mating occurs in late spring and summer. Gestation is 12- 13 months.
Manta birostris	Giant Manta Ray	Hāhālua	T	Occurs worldwide in tropical, subtropical, and temperate waters and is commonly found offshore, in oceanic waters, and near productive coastlines. Breeding sites have been identified off the coast of Ecuador and in the Galapagos Islands	The primary breeding season is July - August. Gestation is 12-13 months.

[1]Federally and State listed as E = Endangered, T = Threatened, DPS = Distinct Population Segment, SE = State Endangered only,
Native MBTA = Species protected under the Migratory Bird Treaty Act; MMPA = Protected under Marine Mammal Protection Act
Sources: Baird 2005, Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, Bonfil et al. 2009, DoN 2014b, NMFS 2016a,b, NOAA Fisheries 2018, Pyle and Pyle 2017; SOH DLNR 2015, USFWS 2011b, 2019c

4.0 NATURAL RESOURCE MANAGEMENT

4.1 General Natural Resources Management

4.1.1 Environmental Planning

Navy environmental planning is the process of identifying and assessing the potential environmental effects of a proposed action to allow informed decision-making (OPNAV M-5090.1). Environmental planning is essential for ensuring the integration and coordination of all base programs and tenant organizations are in compliance with NEPA, EO 12114, ESA, MBTA, and other regulatory requirements.

Specific Concerns

- Unintentional or avoidable degradation of natural resources
- Compliance with environmental regulations

Current and Historical Management

PMRF assures coordination among facilities planners, resource managers, and government agencies. The PMRF IEPD and NRM are the primary points of contact to provide relevant information on issues with potential to affect natural resources. All new construction projects or modification to existing operations at Barking Sands and other PMRF locations are vetted by the IEPD to minimize natural resource impacts while meeting operational needs. The PMRF IEPD reviews base activities to ensure compliance with natural resources laws and regulations, including wetlands protection, migratory bird protection, critical habitat protection, and erosion control.

Objective: Avoid or minimize impacts to natural resources through coordination and vetting of all new and modified development/construction projects.

Strategies:

1. Continue to implement coordination among facilities planners, resource managers, SOH, and, county officials.
2. The PMRF IEPD and NRM should continue to be the points of contact to provide relevant information on issues with potential to affect wildlife and native habitat, such as military operations and training, and tower and other construction and repair projects.

4.1.2 General Habitat Management

4.1.2.1 Erosion Management

The high wave energy along much of the Barking Sands shoreline and predicted increases in storm surges have potential to threaten the base's coastal infrastructure and natural and cultural resources.

Another soil management issue at PMRF is a result of the base's droughty soils with high wind erosion hazard. Soil movement in the Nohili Dunes area, in particular, can be excessive when plants are disturbed and could result in loss of habitat for rare species. Many areas of the Mākaha Ridge also experience severe erosion because of the steep slopes and draughty soils. Additionally, Feral Goats,

Feral Pigs and Deer browse on, wallow, trample, and root vegetation, which further exacerbates the problem of erosion.

Specific Concerns

- Native plant species protection
- Invasive species control
- Development/anthropogenic influence
- Erosion, sedimentation, and changes in sand deposition
- Climate change (e.g., more intense storms/wave action or sea level rise)

Current and Historical Management

At Barking Sands, a recent study conducted by the University of Hawai‘i indicates that some areas of the shoreline are experiencing erosion at a rate of nearly 2 ft (0.6 m) per year, though on average 0.3 to 0.6 ft (9 to 10 cm) per year have been lost (University of Hawai‘i 2013c). The study also identified areas where sand accretion is occurring. Data resulting from this study were shared with the University of Hawai‘i Sea Grant Program and the County of Kaua‘i and Woods Hole Oceanographic Institution. In order to be prepared for future coastal erosion encroachments, the interactive beaches of the PMRF and bordering coastline should continue to be monitored.

To reduce erosion and protect cultural and natural resources in the Nohili Dunes area, vehicle access is restricted to base security personnel only during emergency response and they are instructed to only use established pathways and gravel roads to access the beach from the northern area.

Erosion Control at Mākaha Ridge Tracking Station

At the Mākaha Ridge Tracking Station, areas with highly eroded soils and sparse or no vegetation that threaten base infrastructure or may impact federally protected species have been targeted for restoration. Retaining walls have been installed and some vegetation restoration has been conducted by the PMRF Public Works Department. Additionally, efforts are underway to construct a feral ungulate exclusion fence that would surround the entire installation.

<u>Objective</u>: Monitor, minimize, and restore sites where erosion and soil compaction sites.

<u>General Strategies:</u>

1. Conduct general surveys for erosion and soil compaction issues annually to prioritize restoration sites.

<u>Barking Sands Strategies</u>:

1. Mitigate and prevent erosion of coastal dune habitat by out-planting, establishing and monitoring native dune building plants in areas identified as having erosion issues.
2. Implement additional security measures such as increased signage and roping off certain areas to reduce off-road vehicle presence in the Nohili Dunes area.

3. Participate in future cooperative studies assessing potential shoreline loss that threatens base infrastructure or sensitive habitats.

Mākaha Ridge Stategies:

1. Complete ungulate exclusion fencing by developing improvements that ensure the fence is ungulate-proof, and remove all ungulates from site by parterning with the PMRF Archery Club and performing trapping as needed. Once ungulate fence is complete, ensure fence is monitored for areas vulnerable to ingress monthly and regularly monitor site for ungulate presence. Target for no ungulate presence within the ungulate proof fence surrounding the Mākaha Ridge Tracking Station: 2022.
2. Maintain Mākaha Ridge ungulate exclusion fencing for erosion control.
3. Out-plant native, drought tolerant plants in areas identified as having erosion and soil compaction issues. Ensure that a regular monitoring schedule and a sufficient irrigation system are in place until plants are well established.

4.1.2.2 Invasive Plant Management

The Navy has conducted vegetation surveys and mapping efforts at nearly every PMRF site to identify native and non-native plant populations. Results from these surveys show that nearly 50 percent of identified plant species at PMRF are non-native species, therefore invasive plant management is a major natural resources concern for PMRF.

At Barking Sands, Long-thorn Kiawe, Kiawe, Koa Haole, and Ironwood are the main species found to encroach on native plant habitat. Much of the coastal area of Barking Sands is designated critical habitat for the endangered *Panicum niihauense* grass (see **Figure 3-6**) and is negatively impacted by the presence of non-native species.

There are also substantial populations of invasive plant species intermixed with native forest species present at the Kōkeʻe sites. Especially invasive species historically observed include Asian Melastome, Strawberry Guava, and non-native Blackberry species. At Mākaha Ridge invasive plant species may contribute to erosion issues at the site.

Specific Concerns

- Unintentional introductions of invasive species (e.g., equipment, vehicle, vessel and aircraft contaminated with seeds of invasive species)
- Displacement of native species by invasive species

Current and Historical Management

The Kauaʻi Invasive Species Committee (KISC) "Black List" species are identified on the KISC website: https://www.kauaiisc.org/pono/do-not-plant-list/.

Invasive species recognized on the formal SOH Noxious Weed List (Hawaiʻi Invasive Species Council 2015a), those recognized as a priority for control by KISC, and on those on the KISC "Black List" are never used for out-planting or landscaping projects at PMRF as ensured by the PMRF IEPD review process. The Black List species are identified on the KISC website: https://www.kauaiisc.org/pono/do-not-plant-list/.

Because of its extreme invasiveness, ability to hybridize with Kiawe, and potential threats to personnel, equipment, and sensitive native species, Long-thorn Kiawe has been identified as the highest priority for control. Targeted control efforts for this species have been undertaken in critical habitat areas in the past with significant removal efforts in 2005, 2006, 2007 and 2010. Beginning in 2015, Barking Sands began a base-wide eradication program for Long-thorn Kiawe. Long-thorn Kiawe is currently being actively controlled with herbicide and machinery when necessary and monitored at PMRF.

Long-thorn Kiawe leaf and thorn

Targeted invasive species control has been conducted at the PMRF Kōkeʻe sites by Navy biologists including the treatment of invasive Asian melastome observed along the roadside near Site D.

<u>Objective</u>: Minimize and prevent encroachment of invasive species into protected species habitats and other priority native vegetation communities to the greatest extent practicable.

<u>Strategies:</u>

1. Include biosecurity requirements and provisions in Base Operating Support (BOS) and construction contracts to reduce the risk of introduction of invasive species and plant diseases.
2. Ensure that species identified as invasive in Hawaiʻi are not utilized for landscaping or erosion control projects by developing a Landscaping Guide to include in all base contracts, integrate into the installation appearance plan, and provide to project managers that specifies an approval process for species selection.
3. Ensure early detection and a rapid response to invasive plant species in sensitive areas.
4. Conduct removal of invasive plant species in sensitive areas, monitor for re-growth, and restore with out-plantings, if necessary, with a target of 80% reduction in invasive species within the areas of concern.
5. Decrease driving on dune vegetation, which can further increase the spread of invasive species into native habitats; continue to prohibit driving in designated Niʻihau Panicgrass critical habitat and culturally sensitive areas.

4.1.2.3 Native Plant Management

As a large percentage of PMRF lands are landscaped or comprised of non-native species, native plant enhancement and management are important for improving habitat sustainability and providing habitat for sensitive species and native wildlife, including birds and pollinators. Using native plants in landscaped areas also provides an opportunity to educate base personnel and visitors as well as improve wildlife habitat. The use of native Hawaiian plant species can also reduce the need for intensive maintenance and the use of fertilizers and pesticides since they are better suited to local conditions.

The PMRF NRM and IEPD can provide assistance with plant selection. Numerous local nurseries have joined the “Plant Pono” movement and are endorsed by KISC and the Plant Pono organization. Plants

listed as invasive by the Hawai‘i Invasive Species Council and KISC must be entirely avoided in accordance with EO 13751 (2016).

Specific Concerns

- Native and protected plant species habitat encroachment from development or invasive species
- Destruction of native and protected plant species and habitat from issues such as climate change resulting in possible increases in wave action and/or sea level rise and off-road vehicles driving on coastal strand vegetation.

Current and Historical Management

Natural resource managers at PMRF have strived to use regionally native vegetation in re-vegetation efforts and to the extent practicable in landscaping. Efforts to enhance native vegetation at PMRF have included planting a variety of native trees, shrubs, and ground covers in the fenced Wedge-tail Shearwater nesting colony near MWR beach cottages and planting native naupaka along a bike path. A native plant nursery located on the south end of the base is in construction, expected to be completed in 2022. This facility will provide space to germinate native seedlings, re-pot larger plants to establish supply of individuals ready for outplanting, and to provide plants for partners, tenants and outreach events.

A native plant restoration project is currently underway at Nohili Dunes, to reduce fire risk and improve the native plant community. This project will inform future restoration efforts in the area.

Objective: Conserve and enhance native plant communities to the greatest extent practicable in a manner consistent with BASH requirements.

Strategies

1. Update baseline floral surveys to improve understanding of plant community at PMRF.
2. Ensure and assist in the selection of locally sourced, non-invasive, and preferably native species, with a minimum of 50 percent native species for all new landscape planting projects by 2022 and 100 percent by 2028 while adhering to BASH requirements.
3. Ensure that post planting care, including irrigation, invasive plant/weed control, and long-term monitoring and maintenance is implemented for all native plant restoration projects.
4. Identify suitable locations for planting native Hawaiian plants, particularly those that benefit native pollinators in support of national pollinator objectives.
5. Strive to find new opportunities to collaborate with partners on removing invasive and exotic vegetation and planting opportunities.

4.1.2.4 Wildland Fire Management

Historically, wildfire was an uncommon natural occurrence in Hawai‘i and did not play a significant ecological or evolutionary role in most Hawaiian ecosystems. However, the rapid spread of non-native grasses and fire-adapted species has changed the composition of many natural communities and has markedly increased fire frequency and size (Smith and Tunison 1992). Wildfire is now a major threat to communities and natural resources in Hawai‘i. Over the past decade, an average of over 1,000 wildfires burned over 17,000 acres each year in Hawai‘i (Hawai‘i Wildfire Management Organization

[HWMO] 2017). The HWMO has conducted wildland fire risk assessments for every community in the state and has identified areas of low, moderate, high, and extreme hazard for wildfire (HWMO 2017). Barking Sands and Kamokala Ridge are located in areas currently designated as high hazard. With increasing temperatures and high fuel levels from non-native grasses and other vegetation, wildland fire intensity and frequency can be expected to increase throughout Kauaʻi.

Specific Concerns:

- Health and safety of PMRF personnel and the surrounding community
- Protection of base infrastructure
- Protection of native vegetation communities

Current and Historical Management

PMRF and its tenant commands are cognizant of the risk of wildfire and have implemented procedures to reduce these risks. Procedures to reduce the risk of ignition include clearing dry vegetation from around the launch pads and spraying vegetation adjacent to launch pads with water just before launches. Emergency fire crews are available during launches to quickly extinguish any fire and minimize its effects. An open spray nozzle is 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 (PMRF 2010).

Objective: Provide technical support to tenant commands and base planners to help identify and mitigate wildland fire issues.

Strategies:

1. Coordinate with the PMRF Fire Department on developing updates to the existing Fire Management Plan.
2. Remove deadfall in high-risk areas including near the Barking Sands missile launch site and the Kamokala Ridge Magazines and replant with native, low fire risk species.

4.1.3 General Nuisance and Invasive Animal Management

Non-native predators are the primary invasive animal management issue at PMRF. Feral Cats, Pigs, Dogs, Rats, Mice, Cattle Egrets, and Barn Owls have been recorded at PMRF and can depredate the adults or young of ESA and MBTA listed species. Barn Owls also likely displace the native owl species, the Pueo. Control efforts for these priority invasive species are ongoing.

Due to the potential for free-ranging Feral Cat populations to act as disease reservoirs, which threaten human health, native wildlife, and natural ecosystems, Navy commands do not allow trap-neuter-release or similar programs on their lands (OPNAV M-5090.1). Increasing public awareness of the problems associated with feral animals is a primary factor in controlling feral populations. In accordance with Navy policy, PMRF has adopted proactive feral animal management policies that limit the establishment of free-roaming cat and dog populations and ensure the humane capture and removal of feral animals if they occur.

Ungulates are known to disturb native plant communities on Kauaʻi; ungulates present at PMRF are Feral Goats (*Capra hircus*), Black-tailed Deer (*Odocoileus hemionus columbianus*) and Feral

Pig. Feral Goat and Deer pose a threat to the persistence of rare native plants and to the success of future habitat and native-plant restoration projects. Goats are present at the highly erosible Mākaha Ridge site and deer are found in the sensitive areas of Nohili Dunes as well as at Mākaha Ridge. Pigs may also disturb the ground in native ecosystems, including within areas designated critical habitat for *Panicum niihauense*, and at culturally sensitive areas, if not controlled.

Several species not yet established on Kauaʻi have been identified by KISC as priority species for early detection and rapid response (EDRR), due to their rapid establishment on other Pacific islands and the extensive effects they have had to native plants, animals, and/or human populations. Brown Tree Snake (*Boiga irregularis*) and small Indian Mongoose (*Herpestes javanicus*) have the potential to decimate native seabird and waterbird populations on base, and native seabird, waterbird, and forest bird populations across the island. A successful invasion of Kauaʻi by Brown Tree Snake would cause damage to human infrastructure and agriculture, as is the case in Guam where they were accidentally introduced in the 1940s (USFWS, Fritts and Leasman-Tanner, 2001). Although there have been reported sightings of mongoose at Barking Sands, none have been confirmed and no mongoose have been captured during trapping efforts. All mongoose sightings at PMRF are immediately reported to KISC.

Jackson's Chameleon (*Chamaeleo jacksonii*) predate native invertebrates and birds where introduced, and Little Fire Ant (*Wasmannia auropunctata*) produce painful bites on humans and damage agriculture, as well as blinding and killing chicks and eggs of native bird species, including Wedge-tailed Shearwaters. The Coconut Rhinoceros Beetle (*Oryctes rhinoceros*) and Coqui Frog (*Eleutherodactylus coqui*) have the potential to alter the human environment on base and across the island by affecting agricultural crops and coconut palms, and changing the sound environment with a loud night chorus, respectively. Coqui Frogs also predate native invertebrates and may compete with Endangered Hawaiian Hoary Bat for prey species (Bernard and Mautz 2016).

Specific Concerns

- Impacts to federally endangered and other protected species from non-native animals
- Nuisance wildlife related disturbances
- Introductions of invasive species
- Priority invasive species (established or potential): Feral Cats, Dogs, Goats, Pigs, Rats, Mice, Deer, Cattle Egrets, Barn Owls, Mongoose, Little Fire Ant, Jackson's Chameleon, Coqui Frog, Coconut Rhinoceros Beetle, and Brown Tree Snake

Current and Historical Management

From 2006-2011, PMRF and USDA-WS had an interagency service agreement to control predators and other nuisance wildlife near the airfield operating area and other areas of base to eliminate BASH concerns for the airfield, nuisance species, and provide protection for protected species. Since 2012, CNIC and USDA-WS have had a Work/Financial Plan for BASH support on Navy Installations to include PMRF. In 2017, predator control efforts were increased with two full-time natural resources predator control positions being created through a cooperative agreement with the Navy and the Research Corporation for University of Hawaiʻi (RCUH) and PCSU. Predator control staff monitor and control for Feral Dogs, Cats, Goats, Rats, Barn Owls, and Pigs at the PMRF Barking Sands,

Mākaha Ridge, and Kōkeʻe sites for the protection of native and protected species and to help alleviate erosion issues. Although there are no confirmed populations of mongoose on Kauaʻi, any mongoose sightings at PMRF are to be immediately reported to KISC. Additionally, mongoose traps would be deployed in the area of the sighting by predator control personnel and left in place for two weeks. Control of non-native predators at PMRF is a required conservation measure per the 2014 PMRF Biological Opinion.

An ungulate exclusion fence, as mentioned in Section 4.1.3, has been completed at the Mākaha Ridge Tracking Station to reduce impacts from Feral Goats, Deer, Feral Dogs, and Pigs. In addition, the Navy has initiated a hunting program at the Mākaha Ridge Tracking Station to further reduce the Goat herd and other ungulate populations on the site.

The Navy has plans to develop a PMRF Biosecurity Plan that includes specific prescriptions to evaluate individual invasive species, to identify targeted species, to control further spread of those targeted species, and to develop and implement a program to monitor invasive species abundance. The plan will be coordinated with the Regional Biosecurity Plan for Micronesia and Hawaiʻi (U.S. Navy 2015).

Although the Coconut Rhinoceros Beetle has never been detected on Kauaʻi, there is potential for beetles to make their way to PMRF via air traffic from Oʻahu or Guam. These beetles lay their eggs in palm trees or piles of vegetative waste and can be devastating to palm species and agricultural products. There are currently ten Coconut Rhinoceros Beetle traps at PMRF that are checked and serviced monthly by the Hawaiʻi Department of Agriculture.

Objective: Reduce established non-native predator populations to the greatest extent practicable and reduce the risk of further introductions to protect special status species and other native wildlife.

Strategies:

1. Continue to fund control measures for non-native predator species at Barking Sands, Mākaha Ridge Tracking Station, and Kōkeʻe Site C (PMRF Biological Opinion, 2014).
2. Include biosecurity requirements and provisions in BOS and construction contracts to ensure invasive ants, frogs, and other non-native wildlife are not introduced via equipment or landscaping efforts.
3. Increase outreach to base personnel on reporting and early detection for invasive species not yet established at PMRF. Ensure all observations or reports of high-risk invasive species are communicated to KISC and to all other appropriate contacts.
4. Conduct surveys to improve baseline knowledge of populations of invasive animals at PMRF.
5. Work with partner organizations to identify sources of Feral Cats and Dogs off base so as to reduce the population of these non-native predators.
6. Consider partnering with the Department of Land and Natural Resources – Division of Forestry and Wildlife to do auditory predator deterrent studies on base and utilize the technology at PMRF if proven to be effective against predators.
7. Conduct ant surveys to assess presence of invasive ants including the little fire ants at the Nohili Dune's Wedge-tailed Shearwater colony. If Little Fire Ants are detected, report to KISC and implement active control by using granular bait after fledglings have left the area.

8. Increase outreach about the hazards of feeding feral/invasive species with all personnel on PMRF and assist in the enforcement of such policies by practicing good communication with Security.
9. Continue to partner with the Hawai‘i Department of Agriculture to ensure Coconut Rhinocerus Beetle traps are checked and maintained at PMRF.

4.1.4 Special Status Species Management

4.1.4.1 PMRF Base-wide Infrastructure, Operations, and Maintenance, Biological Opinion

A 2014 formal section 7 consultation with the USFWS resulted in the issuance of biological and conference opinions for Pacific Missile Range Facility Base-wide Infrastructure, Operations, and Maintenance, Kaua‘i, 2014-F-0066 (USFWS 2014). This Base-wide biological opinion (BO) addresses potential impacts to the federally listed endangered Hawaiian Stilt, Hawaiian Common Gallinule, Hawaiian Coot, Hawaiian Duck, Nēnē, Hawaiian Petrel, Hawaiian Hoary Bat, Band-rumped Storm-petrel, and the threatened Newell's Shearwater. A conference opinion was made in regard to the federal candidate species, Band-rumped Storm-petrel, which is now listed as endangered. The USFWS concurred with the no effect determination to the two federally protected plant species, Dwarf Iliau and Hawai‘i Scaleseed; Short-tailed Albatross, two species of-endangered Hawaiian picture-wing flies, and the critical habitat (currently unoccupied) for the endangered Ni‘ihau Panicgrass that occur at PMRF. In 2014, soon after the PMRF Base-wide BO went into affect, PMRF exceeded its take limit for Newell’s Shearwater and entered re-consulation with USFWS. In 2018, the Newell’s Shearwater portion of the BO was signed and implemented (USFWS 2018a). In addition to lighting related fledgling take, the re-consulation incorporated take estimates and limits that were determined by a USFWS produced model for adult Newell’s Shearwaters striking two communication towers at Kōke‘e Site C. The Navy proposed to contribute to the Hawaiian Seabird Conservation Account managed by USFWS and administered by the National Fish and Wildlife Foundation (NFWF) in exchange for transfer of liability of further compensatory mitigation actions and to receive credits to offset anticipated impacts. Prior to the signing of this BO, the Navy also pursued a proactive conservation initiative for Newell’s Shearwater conservation off-site through the DoD’s Readiness and Environmental Protection Integration (REPI) Program. This initiative was approved and is currently in the planning stages with NFWF acting as the lead implementation organization (See Section 5.3.2.1) Management of these federally protected species is conducted in accordance with the terms and conditions of these documents as discussed in the following sections.

4.1.4.2 Endangered Seabird Management

Newell’s Shearwater, Hawaiian Petrel, and the Band-rumped Storm-petrel are seabirds that spend a large part of the year at sea, forage in the open ocean, and come to shore to breed on Kaua‘i. Beginning in March and April, adults initiate breeding at colonial nesting grounds at high elevations in the interior portions of the island and fly over or near PMRF when traveling between nesting and foraging areas. Fledglings travel from the nesting colony to the sea in the fall, again with potential to fly near PMRF. Recent population estimates indicate there was a 94 percent decline overall in numbers of Newell’s Shearwaters (at an average rate of ~13 percent per year) and a 78 percent decline overall in numbers

of Hawaiian Petrels (at an average rate of ~6 percent per year) on Kaua'i between 1979 and 2015 (Raine et al. 2017).

These species generally fly to and from their burrows at night and depend on the moon and starlight for navigation. Due to this, the presence of unshielded lighting along their flyways can result in confusion and disorientation. The primary threat to endangered seabird populations at PMRF is the potential for these species to "fall-out" of the sky. The risk for fall-out is especially high during their fledgling season, which occurs from 15 September to 15 December. During this time, young birds take their first flight, relying solely on instinct rather than experience to navigate their way to the ocean to feed. This inexperience causes fledgings to be in danger of falling-out more than adults. Shearwaters and petrels that have fallen-out become vulnerable to predators, dehydration, starvation, and vehicle strikes. If found, the bird may be transferred to a wildlife rehabilitator and are usally well enough to be released the next day.

Ornithological surveillance radar surveys conducted between 1993 and 2008 have been used to detect and quantify over-flights of nocturnal seabirds at various sites throughout Kaua'i (NAVFAC PAC 2014). These studies indicate that relative to the northern and eastern sides of the island, few seabirds fly over the southern and western regions where Barking Sands is located. During surveys conducted by the DOFAW from 2004 to 2008, radar monitoring stations in Kekaha and the Mānā Plain indicated an average of 15 nocturnal seabirds per hour flew over the areas surveyed (NAVFAC PAC 2014). A similar radar study conducted by Hamer Environmental L. P. in 2015 at Barking Sands also found lower numbers of birds passing over the base compared to other sites on Kaua'i with an average of 2.12 target species per hour for the fall fledgling season. Passage rates were found to peak in early October with eight individuals of target species per hour. Hamer estimated that cumulatively, over the fall fledging season, an estimated mean of 92 per night and an estimated 5,128 shearwater or petrel species pass over and near the base during the fall sampling period (Hamer Environmental L.P. 2016).

Specific Concerns

- Endangered seabird attraction to artificial light sources
- Seabirds striking towers, powerlines, antennaes, and guy wires

Current and Historical Management

Dark Skies Program

To reduce potential fallout at Barking Sands, PMRF issues a Base Note annually to announce the beginning of the endangered seabird fledging season and the coinciding PMRF Dark Skies Program (PMRF NOTE 10570, **Appendix E**). The note details restrictions to lighting at PMRF between 15 September and 15 December and procedures for requesting waivers for proposed lighting needed during this period. All unnecessary night lighting is turned off during the nocturnal seabird fledgling period and, when possible, night training exercises that require lighting are scheduled outside of this season. All operations at PMRF during this season must coordinate with PMRF Environmental to submit a waiver request (**Appendix E**). Each waiver is reviewed by PMRF natural resources and environmental staff to ensure that the proposed lighting is minimized and modified if needed to

minimize risk of fall-out and then forwarded ultimately to the PMRF Executive Officer for final approval.

Dark Skies Working Group Meetings

Prior to fledgling season, PMRF Environmental hosts an annual meeting with Dark Skies Program stakeholders in attendance. An overview of the purpose and importance of the Dark Skies Program and history of fall out events at PMRF is provided along with species identification, waiver procedures, and protocols for found birds. An additional meeting is held after the fledging season is over and prior to the annual note being issued to incorporate feedback from department heads and give them enough time to submit and get waivers approved prior to the season.

Approved Night Operations

For approved night training events, including RDT&E missions, that require higher risk lighting, a trained biological monitor must be present. PMRF natural resources staff provides training and a copy of appropriate standard operating procedures (SOPs) to all biological monitors designated for missions as well as Security personnel.

Education and Outreach

Additional information on the Dark Skies Program is provided to MWR, tenants, residents, and visitors via table tents and reminders to turn off outdoor lights, particularly unshielded outdoor flood/security lights, and to close blinds in all beach cottages during the fledging season. Lanyards with a contact number to call in the event of fall out have also been developed and are provided to tenant commands as needed for missions and night training events.

Surveys and Monitoring

Even with the minimization of lighting during the endangered seabird fledging season, fallout can still occur. During this period, ground surveys are conducted every weekday morning at high risk night operation areas. All fall out events are reported to natural resources staff who document the event and respond to injured birds as needed. Natural resources staff also conduct weekly night-time surveys to check for problem areas prior to and during fledging season, to confirm that all lights are covered by an approved waiver, and to identify any potential new light sources that could affect fledglings. Surveys are conducted at Barking Sands, Mākaha Ridge, and the Kōkeʻe sites following protocols provided in **Appendix E**.

Save Our Shearwaters

PMRF supports a downed seabird collection station provided by the SOS program located at the Kauaʻi Humane Society. Seabirds found injured or fallen out at PMRF are collected and brought to the PMRF SOS station. SOS staff perform a health evaluation of each seabird and treat the bird until it is ready to be released back into the wild. PMRF further supports the SOS program by hosting a training opportunity for new SOS staff to practice seabird banding and handling skills on PMRF's Wedge-tailed Shearwater colony prior to fledging season and has a contract with SOS to provide care for injured or sick native birds found at PMRF.

SOS station at Barking Sands

Tower and Antenna Strikes

A number of communication towers that are located at Barking Sands, Mākaha Ridge, or Kōkeʻe Site C may constitute a threat to seabirds. Surveys have been conducted at each of these sites to assess mortality from tower strikes. Surveys conducted in 2010 and 2015 included scavenger trials, searcher efficiency trials, and carcass searches in accordance with USFWS communication tower monitoring protocols. Results of the 2010 study indicated no mortality of Hawaiian Petrels, Newell's Shearwaters, or Band-rumped Storm-petrels within the study area (Kleidosty 2011). During the 2015 study however, one downed live adult Newell's Shearwater was found during project set up and one intact Newell's Shearwater carcass was found at the Kōkeʻe Site. Using USFWS mortality estimation calculations, the study resulted in an estimated mortality of 0.225 birds per year, indicating that PMRF communication towers, particularly at Barking Sands, present a minimal threat to nocturnal seabirds (Kleidosty 2016).

Beginning in 2017, surveys of the Kōkeʻe Site C communication towers for seabird activity using night vision were implemented and conducted by natural resources staff. In 2018, acoustic monitoring for seabird strikes on the towers was also implemented. The protocol for these surveys is modeled after the Kauaʻi Endangered Seabird Project's underline monitoring project, which monitors for the frequency of seabird strikes on telephone lines. These monitoring programs were implemented in response to USFWS concerns with adult Newell's Shearwaters striking the towers as outlined in the model produced by the agency for the re-initiation of the Newell's Shearwater portion of the BO. This model estimates that up to an average of fifty (50) adult Newell's Shearwaters per year are likely to be taken in the form of injury or death due to collisions with the communication towers.

Objective: Minimize possible negative impacts to federally listed, endangered Hawaiian seabird species while providing maximum flexibility for training and operations.

Strategies:

1. Continue to promote base-wide awareness and implementation of the PMRF Dark Skies Program (PMRF Biological Opinion, 2018) through early annual trainings.
2. Continue to improve the Dark Skies Program lighting waiver system and grant standing waivers where applicable to stream-line the waiver process.

3. Continue Dark Skies implementation in areas adjacent to colonial nesting grounds at high elevation nesting sites during critical fledging timeframes.
4. Conduct systematic ground searches for fallen out seabirds after high risk night operations.
5. Continue to fund and implement surveys to assess mortality from tower strikes at Kōkeʻe Site C to include scavenger trials, searcher efficiency trials, and carcass searches in accordance with USFWS communication tower monitoring protocols (PMRF Biological Opinion, 2018).
6. Continue to fund and implement acoustic and visual monitoring programs of communication towers at Kōkeʻe Site C for seabird strikes to inform management and provide data to be used in the re-evaluation of the Newell's Shearwater portion of the PMRF Base-wide BO.
7. Minimize the potential for death or injury of Newell's Shearwater due to collisions with PMRF communication towers located at Kōkeʻe Site C (PMRF Biological Opinion, 2018).
8. Incorporate results of radar studies into future programs. Consider conducting additional radar studies at the Mākaha Ridge and Kōkeʻe sites.
9. Pursue avenues to provide funding to SOS to assist with seabird rehabilitation costs.
10. Continue to host a SOS shearwater aid station at PMRF and monitor station during business days with SOS monitoring on weekends and holidays (PMRF Biological Opinion, 2014).
11. Advise various tenants on base on appropriate safety lighting that is less attractive to endangered seabirds (i.e., motion sensing lights that go off after a set time period, shielded lights, facing light away from the coast, lower lumen, and lower to the ground).
12. Provide a 10-year calendar to mission planners with high-risk dates for endangered seabird fall out clearly depicted.

4.1.4.3 Nēnē Management

The number of Nēnē at PMRF has increased over the past several years, as has been generally experienced across Kauaʻi. Nēnē are primarily known to occur at Barking Sands and the Mākaha Ridge Tracking Station, with fewer known occurrences at the Kōkeʻe sites. The major threats to Nēnē at PMRF include predators, vehicles, and airfield operations.

Hawaiian Goose / Nēnē

Nēnē occur throughout Barking Sands but are most commonly observed at the PMRF oxidation pond complex, near the HIANG complex, the PMRF airfield, and just off PMRF property east of the Kinikini Ditch bridge, which is a concern because of its proximity to the airfield. Because the occurrence of Nēnē on or near the airfield increases BASH risk, they are discouraged from nesting and being present in the Airfield Operating Area (AOA) and surrounding areas. Hazing of non-breeding Nēnē is conducted in the AOA in accordance with the 2014 PMRF Base-wide BO and the 2020 Reclassification of the Hawaiian Goose with a Section 4(d) Rule. Through informal consultation with USFWS, PMRF natural resources personnel also developed an Airfield Nēnē Nest Response Protocol and Hawaiian Goose Family Hazing Standard Operating Procedure in response to nests and Nēnē with goslings being

present near the PMRF runway and roadways in 2017 and 2018, respectively. These documents are included in Appendix E.

In 2020, PMRF experienced two cases of potential organophosphate poisoning in Nēnē, which can lead to paralysis and death. PMRF does not use organophosphates for pest control, thus the determination was made that the exposure was not a result of pesticide use on the installation, however possible routes of exposure may be available on nearby properties.

At the Mākaha Ridge Tracking Station, Nēnē are usually observed near buildings on the ridge overlooking Mākaha Valley. The effects of invasive predators on Nēnē populations at Barking Sands have been observed to be minimal; however, there have been multiple observations of Nēnē attacked by Feral Pigs and possibly dogs at Mākaha Ridge likely resulting in nest failures, injuries, and mortalities. The number of nests at Mākaha Ridge has steeply declined over the last decade compared with Barking Sands, which has increased from one nest in 2009 to 39 nests in the 2021-2022 breeding season. The fence at Mākaha Ridge has been completed, and removing these predators will hopefully alleviate this issue.

Specific Concerns

- Presence near roadways and mortality or injury due to vehicular strikes
- Nest site protection
- Mortality or injury due to maintenance activities, specifically vegetation clearing
- Risk for bird/aircraft strikes (BASH) due to Nēnē feeding, loafing or breeding near the airfield
- Feeding of Nēnē or Nēnē inadvertently eating food thrown out by base personnel or visitors
- Tracking the movement of specific Nēnē to assess their behavior especially in relation to the PMRF airfield
- Exposure to pollutants carried through PMRF in the three ditches, especially Kinikini.

Current and Historical Management

Nēnē Management Plan

A Nēnē Management Plan for PMRF was provided to the USFWS and DOFAW for review and will be included in **Appendix F** when finalized. The Nēnē Management Plan serves two main functions: (1) it serves as a central source of Nēnē life history information for the DoN; and (2) it identifies management goals and recommended actions to aid in the continued recovery of the species while striving to maintain no net loss in mission capability and decrease BASH risk on the PMRF airfield. The plan is intended to be a living document subject to revisions and improvements through collaboration with partners as needed.

Nēnē Hazing

To reduce potential impacts to Nēnē and Air Ops personnel from risks associated with mission and training activities, Air Ops, and USDA-WS with the required training conduct weekday hazing of non-nesting Nēnē year-round on the airfield and the immediate surrounding area. During their breeding and nesting season (August through April), if Nēnē occur within the aforementioned area, authorized base personnel observe birds to determine whether a nest or goslings are present prior to conducting hazing

actions. USDA-WS staff notify natural resources staff when a Nēnē pair appear to be exhibiting nesting behavior so they can begin discussions with USFWS and DOFAW on further actions that can be taken to discourage nesting and as outlined in the Airfield Nēnē Nest Response Protocol. Nesting Nēnē with eggs or goslings are only hazed as outlined in the USFWS approved Airfield Nēnē Nest Response Protocol (2017) and Hawaiian Geese Family Hazing Standard Operating Procedure (2018).

Nēnē Monitoring

Regular monitoring of Nēnē is conducted by natural resources biologists to determine population trends, nesting success, and track locations and movements of banded birds. These surveys follow standardized monitoring protocols developed by natural resources staff and approved by USFWS and DOFAW **(Appendix E).**

During the Nēnē breeding season, nest searches are conducted when a male Nēnē is observed "standing guard" or routinely defending an area. Observations of all Nēnē nests or newly observed goslings are reported to the USFWS, DOFAW, and other partners via phone call or email within 24 hours. Information on goslings on base not observed to be from nests on base and those that are in need of banding are communicated to the DOFAW Kauaʻi Nēnē biologist. Natural resources biologists also communicate invasive predator activity observed during surveys to natural resources predator control staff.

Incidental Nēnē sightings of interest are also recorded. All observed Nēnē mortalities or injuries are reported to USFWS and partners within 24 hours of observation.

Nēnē Protective Measures

To discourage Nēnē nesting in high risk areas such as near roadways, near the PMRF airfield, and at the oxidation pond complex, vegetation removal is performed prior to the breeding season in August. Most Nēnē nests have been initiated on the southern portion of Barking Sands. Successful nest attempts typically produce one to four goslings. Additionally, evidence of families stealing goslings from other families with similar aged offspring has been observed at PMRF. When located, nests are flagged and reported to facilities management personnel who instruct landscaping contractors to avoid disrupting the nesters and to not remove vegetation within a 100-ft (30.5 m) radius of the nest. Signage is also used if a nest is observed close to a roadway or in an area of high human activity.

PMRF Nēnē crossing sign by HIANG building

Additionally, PMRF has installed signs and rumble strips along roadways where Nēnē are known to occur in an effort to reduce the potential for car collisions, and a 25 mile per hour limit from 1800-0600 has been enacted along the stretch of road most used by Nēnē. Vegetation along this stretch of road has been pushed back to more than 10' from the pavement to encourage Nēnē away from the road. Metal, wooden and electronic marquis signs warn drivers of Nēnē crossing areas and are actively patrolled by security.

Objective 1: Reduce impacts to the federally endangered Nēnē while providing maximum flexibility for testing and training.

Strategies:

1. Collaborate with USFWS, PMRF Air Ops, and DOFAW to continue to revise action plans for Nēnē that attempt to or successfully nest on the airfield to facilitate rapid response, based on past observations and new knowledge.
2. Coordinate with USFWS, DOFAW, PMRF Air Ops, and PMRF Public Works to annually review and update the PMRF Nēnē Management Plan (PMRF Biological Opinion, 2014).
3. Work with PMRF Air Ops and USDA-WS to insure Nēnē hazing efforts are increased prior to and during the breeding season with the possibility of including weekends especially if a Nēnē pair has been regularly observed on or near the airfield.
4. Continue to conduct regular, standardized surveys for Nēnē at PMRF Barking Sands, Mākaha Ridge, and Kōke'e sites to effectively detect Nēnē nests and inform management and determine habitat types that attract the species (PMRF Biological Opinion, 2014).
5. Continue to communicate with facilities maintenance personnel about Nēnē nest locations and collaborate to develop effective protective measures for the species and ensure that no vegetation removal or other persistent disturbances occur within 100 ft (30.5 m) of nest sites and goslings to reduce risk of take.
6. Support regular outreach to base visitors and personnel on the importance of not providing food and water to Nēnē (PMRF Biological Opinion, 2014), and develop outreach material aimed at increasing awareness of the species.
7. For all new construction at Barking Sands, including construction for tenant or customer DoD commands or other federal agencies, concrete, asphalt, gravel, xeriscaping, or native vegetation that does not act as a Nēnē attractant, rather than lawn, will be installed in open areas surrounding buildings and parking areas to decrease attraction of Nēnē (PMRF Biological Opinion, 2014).
8. Fund habitat modification that discourages Nēnē presence near roadways, the airfield, and construction sites at Barking Sands.
9. Supplement ongoing water quality testing to detect particulates and soluble chemicals in waters at PMRF. Testing should be conducted at least quarterly

Objective 2: Obtain life history information to inform adaptive management strategies that will provide a conservation benefit to federally endangered Nēnē.

Strategies:

1. Continue to communicate and share data with USDA-WS and DOFAW regularly.
2. Collaborate with DOFAW to have all Nēnē that hatch at PMRF banded and pursue permission and permits for PMRF natural resources staff to band birds if allowable.
3. Implement priority management actions identified in the PMRF Nēnē Management Plan. Work with partners to identify potential opportunities to collaborate on off-installation conservation efforts or research opportunites to inform Nēnē management at PMRF and ensure a holistic

approach that aligns with regional priorities for Nēnē protection and recovery (PMRF Biological Opinion, 2014).

4.1.4.4 Hawaiian Hoary Bat Management

Hawaiian Hoary Bat / ʻŌpeʻapeʻa

Acoustic surveys to determine seasonal occupancy of Hawaiian Hoary Bats were conducted from June 2010 – June 2011 at Barking Sands, Mākaha Ridge Tracking Station, Kamokala Ridge Magazines, and the Kōkeʻe Sites. These surveys documented year-round use of the installation by Hawaiian Hoary Bats, with the highest occupancy detected from September through February in all regions of PMRF. The frequency of foraging activity, as indicated by observations of feeding buzzes emitted by bats, indicates that the majority of the areas at PMRF are used year-round by foraging bats. The frequency of group activity, as indicated by calls made by more than one bat during a sound segment, indicates the importance of the Barking Sands region during the fall season, which is most likely related to fledging of pups and adult bats flocking in preparation for mating (Bonaccorso and Pinzari 2011). The likely use of the base for breeding and pup rearing indicates its importance to the success of the Hawaiian Hoary Bat. PMRF supports suitable roosting habitat, which consists primarily of woody vegetation greater than 15 ft (4.6 m) tall (SOH DOFAW 2015), and foraging habitat, including either open or densely vegetated habitats, open fields, open-ocean in bays near-shore, and streams and ponds.

The primary threats to the endangered Hawaiian Hoary Bat at PMRF include roosting habitat loss and potential mortality from barbed wire fences and radar transmissions.

Specific Concerns

- Injuries or mortalities of roosting bats due to woody vegetation removal
- Injuries or mortalities of bats due to entanglement in barbed wire fencing
- Negative impacts to bats caused by electro-magnetic frequency radiation from radar transmissions
- The decrease in or suitability of bat foraging habitat due to large-scale vegetation removal, development, or invasive species encroachment.

Current and Historical Management

Woody Vegetation Management

The loss of suitable roosting habitat is considered a primary threat to the recovery of Hawaiian Hoary Bats; therefore, impacts to this species are considered prior to conducting activities that disturb or remove potential roosting habitat. Additionally, all trimming or removal of woody plants greater than 15 ft (5 m) tall is conducted outside of the Hawaiian Hoary Bat pupping season of 1 June to 15 September per the 2014 PMRF Base-wide BO conservation measures.

Barbed Wire Fence Monitoring

In the 2014 PMRF BO, the implementation of an experiment to assess the efficacy of aluminum tags in preventing bat collisions with barbed wire at PMRF was listed as a conservation measure. As part of this implementation and prior to it, the BO stated that all barbed wire fences would be monitored at least once a month for mortalities. Beginning in 2014, surveys were conducted almost monthly by natural resources staff at Barking Sands with no mortalities observed. To decrease the likelihood of missing the observation of an entangled bat due to decomposition or scavenging, a more intensive, standardized monitoring protocol was developed by natural resources staff in 2016. The study incoproated feedback from USGS Hawaiian Hoary Bat biologists and was reviewed and approved by USFWS. The study took place at Barking Sands from September-November 2017 during the height of bat foraging activity in the region and was conducted by natural resources staff. The protocols included a scavenging trial, searcher efficiency trial, and twice weekly barbed wire fencing surveys. Zero mortalities were observed during this study. As a result, the Navy will continue to carry out periodic acoustic monitoring surveys, but does not currently have plans to implement an experiment on the effectiveness of bat deterrents along fencing at PMRF.

Pre-test Surveillance at ARDEL Facility

Electro-magnetic frequency radiation from radar transmissions are another potential threat to this endangered species. Management and operations requirements with respect to bats stem from a USFWS informal section 7 consultation letter (USFWS 2009) regarding ARDEL facility operations. The USFWS requires the area to be surveyed using ANABAT or the facilities closed circuit television cameras prior to operation of radar units at night, and if one or more bats are present in the area of impact, radio frequency emission may not begin until the bat(s) has left of its own accord.

Objective: Reduce impacts to the federally endangered Hawaiian Hoary Bat while providing maximum flexibility for training and operations.

Strategies:

1. Continue to avoid and minimize effects of base infrastructure, operations, and maintenance on Hawaiian Hoary Bats, by ensuring that trimming or removal of woody plants greater than 15 ft (5 m) tall is conducted outside of the Hawaiian Hoary Bat pupping season of 1 June to 15 September to avoid impacting bat pups (PMRF Biological Opinion, 2014).
2. Conduct follow-up acoustic surveys for Hawaiian Hoary Bats every 5 years. If bat roosting and pupping sites are of interest for management of the species, then a mist netting and tracking study could be performed if warranted (PMRF Biological Opinion, 2014).
3. Work with USFWS to develop and implement a standard operating procedure for bat roosting surveys if base operations warrant the need to remove and trim trees greater than 15 ft (5 m) tall during the Hawaiian Hoary Bat pupping season (PMRF Biological Opinion, 2014).

4.1.4.5 Migratory Bird Management

Other than threatened and endangered species, the most active MBTA species management programs undertaken at PMRF are for Laysan Albatross and Wedge-tailed Shearwaters that occur at Barking Sands. These programs are discussed in Sections 4.2.1 and 4.2.2. This section covers all other species

protected under the MBTA including shorebird species, the pueo, Black-crowned Night Heron, and non-native species such as Barn Owl, Cattle Egret, and other non-native songbird species.

PMRF's beaches provide ideal migratory shorebird habitat, especially in restricted access areas where human activity is minimal. Vagrant and winter resident MBTA species have also been observed utilizing PMRF as a stopover including Tundra Swan (*Cygnus columbianus*), Cackling Goose (*Branta hutchinsii*), Glaucous-winged Gull (*Larus glaucescens*), and Mew Gull (*Larus canus*).

The Pueo is commonly observed at Barking Sands and other PMRF sites especially during the winter months, although no confirmed instances of breeding on the base have ever been recorded.

Black-crowned Night Herons are commonly observed at all regularly monitored wetland areas including Kinikini Ditch near the PMRF airfield. The non-native Cattle Egret, Barn Owl, and other non-native songbird species are commonly observed near the airfield area and pose a significant BASH risk. USDA-WS primarily manages these species near the PMRF airfield using lethal and hazing measures to reduce risk.

Specific Concerns

- Presence of MBTA species near the PMRF airfield
- Negative impacts to species resulting from development or habitat fragmentation

Current and Historical Management

All migratory shorebird species, Black-crowned Night-Herons, and Cattle Egrets are recorded at all twice weekly monitored wetland areas on base. The Pueo and Great Frigatebird (*Fregata minor*) are also recorded when incidentally observed as well as during standardized surveys. In addition, all injured MBTA birds native to Hawai‘i are collected for treatment by SOS and natural resources staff record observations of all deceased MBTA bird species, when found, and store the remains in the natural resources freezer until shipment to a research institution for study or eventual disposal.

Due to BASH concerns for the airfield, PMRF holds a USFWS depredation permit, which covers the base for take of a small number of the native Black-crowned Night Heron and active Wedge-tailed Shearwater nests as well as non-native migratory bird species. In 2017, USFWS issued a depredation control order in Hawai‘i for the non-native Cattle Egret and Barn Owl as they are known to predate other species native to Hawai‘i (50 CFR Section 21.55). PMRF is covered for take of these two species under this control order with regards to BASH concerns and active control to reduce predation on native species.

Although natural resources staff does not regularly survey for non-native songbird species, PMRF has participated in the Audubon Christmas Bird Count since December 2017 during which all bird species at Barking Sands are recorded.

Objective: Maintain and protect nesting and foraging habitats of native bird species protected by the MBTA at PMRF when consistent with BASH and other mission constraints and discourage non-native MBTA species presence at PMRF.

Strategies:

1. Continue to incorporate monitoring of shorebirds, Cattle Egrets, and Black-crowned Night Herons at wetland sites. Record opportunistic observations of Barn Owls and Pueo at all other areas of base to inform control measures for non-native species and protective measures for native species.
2. Keep track of non-native songbird species at PMRF and their numbers by participating in the annual Audubon Christmas Bird Count.
3. Continue to advise development projects at PMRF that have potential to negatively impact native MBTA species and their habitat on how to avoid impacts.
4. Advise development projects at PMRF on how to avoid creating habitat and foraging availability for non-native MBTA species at PMRF especially near the PMRF airfield.

4.1.5 Terrestrial Invertebrate and Pollinator Management

General baseline surveys for terrestrial invertebrate species as well as additional surveys for the federally endangered *Drosophila musaphilia* and *Drosophila sharpi* were conducted at Barking Sands and Kōkeʻe Sites in 2021. While all fieldwork is complete identification of the large number of samples collected is on-going. To date, a total of 769 taxa have been found at PMRF with 675 of them identified to species. Of the 675 species identified, a significant number (347) are considered native endemics with numerous rare and undescribed species encountered. The high number of native and endemic terrestrial invertebrate species found at PMRF is noteworthy.

***Bryania bipunctata* (Diptera: Asteiidae), a rare endemic fly mostly known from the Northwest Hawaiian Islands, found at Nohili dune**

At Barking Sands the rare endemic fly *Bryania bipunctata*, previously known only from the Northwestern Hawaiian Islands and Kahoʻolawe was identified. This species was once a candidate for listing under the Endangered Species Act. Other significant finds include the full complement of native coastal midges, and a new invasive stink bug, *Agonoscelis puberula*.

***Doryonychus raptor*, a spider found only in the Halemanu area of Kōkeʻe, with inset showing the unique enlarged claw on each foreleg**

The PMRF Kōkeʻe sites, surrounded by native forest, were noted during the 2021 surveys to have a terrestrial invertebrate community that was overall highly diverse and primarily endemic with previously unrecorded species found in significant numbers. Notable finds include three species of rare false click beetles (*Dromaeolus*), the flightless stag beetle *Apterocyclus honoluluensis*, seven species of *Proterhinus* weevils, a remarkable 26 species of the parasitic wasp genus *Sierola* (all but two undescribed), and numerous specimens of a new species of the enigmatic moth genus *Tulla*, which had been previously known only from a single specimen collected on Oʻahu.

Two species of endangered Hawaiian Picture-wing Fly *Drosophila musaphilia* and *Drosophila sharpi* are known from the Kōkeʻe region. These picture-wing flies are single-island endemics on Kauaʻi and have USFWS-designated critical habitat near the facility's Kōkeʻe sites. During the surveys fermented baits for *Drosophila* were set out at all three PMRF sites. Aside from the common *D. picticornis* there were few *Drosophila* noted. The endangered *D. musaphilia* was however identified at Kōkeʻe Site E; it has previously been identified near Site B in a 2010 survey (DoN 2010). The native Koa tree (*Acacia koa*), which is located in the forested area surrounding the sites, is the host plant for *D. musaphilia.* A number of sap fluxes on Koa trees, the breeding habitat of the endangered *D. musaphilia*, were observed during the surveys especially at Kōkeʻe Site B. When *D. musaphilia* numbers are higher, it is thought that the species may show up at this site. Additionally, high elevation Ōhiʻa found at Kōkeʻe site could support native invertebrate populations.

The federally endangered picture wing fly (*Drosophila musaphilia*) found at Kōkeʻe Site E

Several introduced terrestrial invertebrate species known to occur at PMRF include: Monarch Butterfly (*Danaus plexippus plexippus*), Honeybee (*Apis mellifera*), and Sonoran Carpenter Bee (*Xylocopa sonorina*), among others identified in the PMRF Pest Management Plan.

In accordance with the Presidential Memorandum on pollinators and the MOU between the DoD and the Pollinator Partnership, in the event of available funding, the Navy could make plans for the protection and restoration of domestic populations of pollinators. To date, no native pollinator-specific protection or enhancement programs have been undertaken at PMRF; however, measures that will benefit pollinators include the increased use of native species in landscape plantings and in habitat restoration areas in accordance with other species management strategies and BASH constraints.

Specific Concerns

- Improper use of pesticides
- Native terrestrial invertebrate habitat loss

Current and Historical Management

Pest Management and Pesticide Use

Pest management at PMRF is conducted by a contracted Pest Management Technician. The PMRF Base Operations Support Contract for Pest Mangement describes known pest species present and serves as one of the few documents describing terrestrial invertebrate species present at PMRF. Overuse of pesticides, particularly neonicotinoids, is considered a primary cause of declines in pollinator populations. The neonicotinoid family includes acetamiprid, clothianidin, imidacloprid, nitenpyram, nithiazine, thiacloprid, and thiamethoxam. All pesticides used at PMRF are approved by the EPA, included on the Navy's Authorized Use List, and require approval by a Navy Pest Management Consultant (PMC). Additionally, all pesticides are used in accordance with the instructions on the label and applied by a DoD or state-certified applicator. Currently, pesticides are

reported to the NAVFAC PAC PMC for annual data submission, though use of the Navy's Online Pesticide Reporting site (NOPRs) is recommended.

Honeybees

Honeybees are known to occur at Barking Sands, with multiple swarms generally occuring each year (Currents 2016). In 2015, several bee swarms were captured, via swarm traps, and transferred to hives at the northern and southern ends of Barking Sands. The state apiarist inspected the hives for evidence of Varroa Mite (*Varroa destructor*) and other honeybee threats however found them to be in healthy condition. The hives are currently maintained by the PMRF Pest Management Technician and volunteers.

Objective: Monitor and maintain biodiversity of native terrestrial invertebrate and pollinator populations at PMRF.

Strategies:

1. Conduct species inventory at additional PMRF sites, and conduct monitoring for native invertebrate species. Consider coordinating with USFWS entomologists to identify priority species and provide expertise and training to natural resources staff.
2. Coordinate all use of pesticides by natural resources staff with the NAVFAC PAC PMC and ensure that all applicators have received appropriate certifications.
3. Ensure that treatments will not have negative effects on protected species.
4. Prohibit the use of neonicotinoids at PMRF sites.
5. Ensure that plant communities found to support native terrestrial invertebrate species are protected, enhanced, and that construction or removal projects have minimal effects on these populations.

4.1.6 Data Collection and Database and Records Management

Geographic and observational data are an integral part of natural resources protection and planning. Natural resources observational and geospatial data relating to PMRF is stored in the Natural Resources Program database which is managed by natural resources staff at PMRF and easily accessible by NAVFAC HI managers. PMRF geospatial data are also part of the NAVFAC GeoReadiness Repository maintained by Navy GeoReadiness Installation Geospatial Information and Services Program, which is the geospatial component of the Navy's Internet Naval Facilities Assets Data Store (iNFADS) authoritative database of real property assets. The repository was developed to provide geospatial information relative to the Navy's Real Property Inventory to support functional areas including facilities management, environmental management, antiterrorism/force protection, base development/planning, and regional planning. The GeoReadiness Repository provides a single source of authoritative strategic-level geospatial data for Class I (land) and Class II (facilities) properties. The GeoReadiness Repository also enforces the Spatial Data Standards for Facilities, Infrastructure, and Environment.

Specific Concerns

- Maintaining an up-to-date, easily accessible, and easily shareable database

- Lack of natural resources geospatial data in the NAVFAC GeoReadiness Repository

Current and Historical Management

All contracted and in-house projects implemented by the Natural Resources Program require electronic deliverables for geospatial data as well as detailed observational data. Beginning in 2016, an electronic natural resources database was created and stored in a shared drive which made it easily accessible by Navy personnel. Observational data, reports, records, and documents related to the PMRF Natural Resources Program are stored in this location. Also in 2016, standardized monitoring procedures and data collection standards for all endangered species found at PMRF were developed by natural resources staff and reviewed and approved by federal and state partner organizations. In 2017, standard operating procedures for predator control and monitoring were developed (**Appendix E**). Standardized monitoring and easily shareable observational data are essential for supporting USFWS reporting requirements as described in the 2014 PMRF BO, fostering effective collaboration with state partners, and ensuring that the best management decisions are made for the Natural Resources Program and PMRF as a whole.

Objective 1: Implement measures to ensure that natural resources data is collected in a consistent manner, that data is easily shared with internal and external partners, and streamline data imputing methods with the goal of decreasing errors and increasing efficiency.

Strategies:

1. Ensure that natural resources staff follow established standardized monitoring and surveying procedures.
2. Continue to require GIS deliverables for all contractors, including in-house projects that follow appropriate data collection standards and ensure that all geospatial data is incorporated into the NAVFAC GeoReadiness Repository and that it complies with the Navy Data Model (NDM) adaptation of the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) for GIS database management.
3. Consider acquiring tablets or Trimble units with excel/GIS uploading capabilities that natural resources staff can utilize for data collection in the field.
4. Acquire the ability to upload GPS data directly to government computers.
5. Coordinate data sharing with natural resources partner agencies USFWS, DLNR and NOAA; coordinate common data collection formatting as possible.

4.1.7 Outdoor Recreation

Current and Historical Management

PMRF employees, active duty, reserve and retired military and dependents have recreational access to approximately 2.0 mi (3.2 km) of coastline. Public access to the beaches and water areas along Barking Sands by vehicle from the beach along the seven-mile coastline has existed for decades, however, after the September 11, 2001, terrorist attacks, civilian beach access by vehicle was restricted. The public still accesses the beaches of PMRF from the southern and northern boundaries, however proceeding past the high tide line from the beach and within safety restricted areas without clearance is strictly prohibited and monitored by Security. PMRF currently has an MWR Guest Card Program. Guest cards

are available to U.S. citizens upon completion of a security background check. This program allows card-holding civilians to access PMRF through the main gate, travel unrestricted to Majors/Waiokapua Bay or Shenanigans, use Majors Bay and Shenanigans facilities, and access the recreational beach areas (**Figure 4-1)**. The areas accessible for fishing/surfing/recreation/and socializing extend from Shenanigans (All-Hands Club) to Kawai'ele Ditch (also known as Dry Ditch) (north of beach cottages), Monday through Friday, and into the Special Use Recreation Area (Kawai'ele Ditch [also known as Dry Ditch] to the northern windsock of the runway) on weekends and holidays, except during heightened force protection conditions or range operational periods. Beach use hours are from 5 a.m. to 10 p.m. There is the possibility for the general public to drive onto the north end of the base via the beach as no physical barriers to driving are present, although security efforts are enforced and other deterrents are being examined.

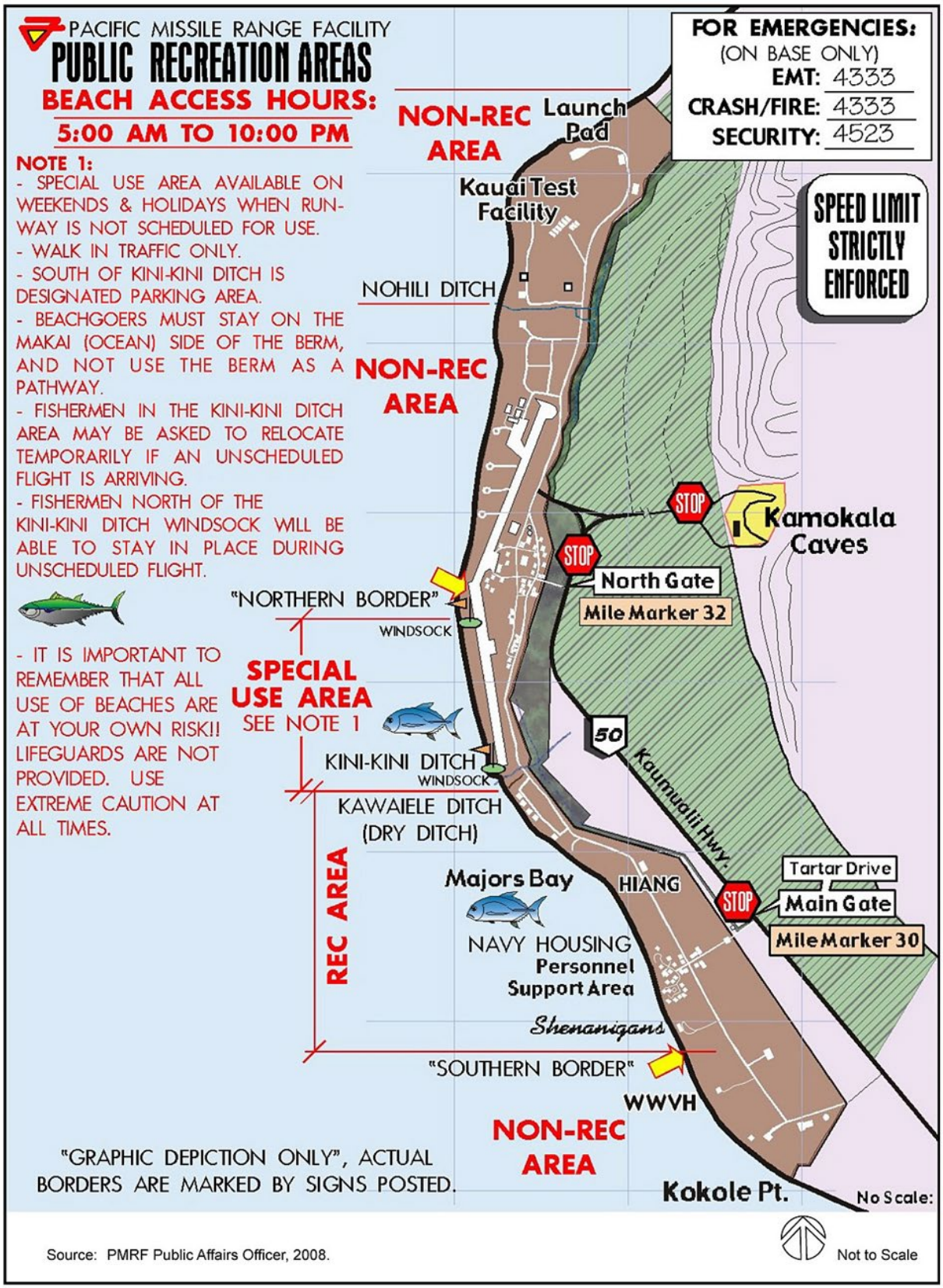


Figure 4-1. Barking Sands Recreational Areas

The Navy also maintains beach cottages adjacent to Majors/Waiokapua Bay, which provide recreational opportunities for visitors to Barking Sands. All PMRF recreational facilities are accessible to disabled persons in accordance with SECNAV Memorandum of 15 Aug 2002.

PMRF Cottages

Natural resources issues associated with the recreational beaches and beach cottages primarily involve human interaction with federally protected and sensitive species. Hawaiian Monk Seals are frequently observed at the recreational and special use beaches, and green turtles are known to occur. Nēnē and Wedge-tailed Shearwater are common in the Beach Cottage area as well.

Specific Concerns

- Public saftey
- Disturbance of sensitive species and sensitive habitats
- Dissturbance of cultural resources

<u>Objective</u>: Provide military personnel, their dependents, and the public, opportunities to participate in outdoor recreation activities that capitalize on natural resources. These activities, however, should be controlled and monitored when they interfere with natural resource management objectives and goals.

<u>Strategies</u>

1. Continue to provide public opportunities for natural resource related outdoor recreation where it does not conflict with public health and safety, the military mission, or security.
2. Ensure that the degree of access allowed for outdoor recreation is consistent with conservation of natural resources.
3. Continue to promote awareness among recreational users of the importance of resource stewardship and promote a sense of pride in the natural environment of PMRF.
4. Provide PMRF Recreation Pass Program applicants with information on pertinent natural resources information as part of the application process.
5. Continue to restore and enhance natural and cultural resource assets at PMRF for public benefit and enjoyment.
6. Develop a Natural Resources Information Center to include brochures and other materials promoting self-guided nature walks and bird watching opportunities both on base and in the surrounding areas. Information on threats to native Hawaiian ecosystems and threatened and endangered species should be included, with particular emphasis on the introduction and spread of alien plant species and the negative effects of off-road vehicles in sensitive environments and measures that can be taken to avoid such impacts.

4.1.8 Natural Resources Awareness, Education, and Training

The Natural Resources Program plays an important role in ensuring PMRF personnel, residents, and visitors are informed of important natural resource issues at PMRF.

Specific Concerns

- PMRF operations planners and facilities maintenance manager awareness of natural resources issues
- PMRF personnel, resident, and visitor awareness of natural resources issues
- Proper natural resources training for security and other appropriate personnel
- Supporting natural resources education for people on and off base

Current and Historical Management

Conducting environmental awareness, outreach, and training activities for PMRF personnel, visitors, and residents serves to raise awareness of Hawai‘i’s unique natural resources and can increase the feeling of responsibility for stewardship of installation natural resources among those at PMRF and in the community. Events such as Earth Day, National Public Lands Day, International Migratory Bird Day, and National Pollinator Week present opportunities to inform base personnel, residents, and visitors of environmental issues of importance at PMRF. Increasing awareness of Hawaiian cultural values and history as integrated into natural resources protection is another important aspect of the PMRF Natural Resources Program.

Natural resources staff is actively involved in ensuring that appropriate PMRF personnel are aware of natural resources related issues by practicing consistent communication, hosting working group meetings, and participating in indoctrination presentations for military personnel. In 2017, standard reporting and response protocols for sea turtles and their nests were developed specifically for security personnel and designed to be kept in security vehicles for quick reference.

Educational activities aimed at increasing awareness of natural resources issues at PMRF also include installing table tents in all PMRF beach cottages with seasonally appropriate info on species utilizing the cottage area and making informational materials for issues that need to be brought to the public’s attention available and visible in frequented areas of base such as the Navy Exchange, Pass and ID Gate Office, Shenanigans, and the beach cottages. The Environmental Program also provides information and updates regarding the popular Dark Skies Program and Laysan Albatross Egg Swap to local news outlets and magazines such as the Navy’s Energy and Environment magazine, *Currents*.

PMRF participation in Adopt-A-Highway program

PMRF also has a deep commitment to community involvement and sponsors and/or participates in many community activities such as the County’s Adopt-A-Highway program, community beautification service projects, and STEM Night and Career Day events at local schools. PMRF also hosts an annual Earth Day by

the Bay celebration in which local school children participate in educational presentations by local environmental organizations and work service projects such as beach cleanups and planting native plants. The base newsletter regularly highlights such activities. Community involvement programs promote the "good neighbor" concept and help the community understand PMRF's commitment to environmental conservation.

Objective 1: Promote natural resources, environmental, and cultural stewardship and awareness by providing all personnel on installation training and education related to the PMRF natural resources program and related protocols, laws, and policies.

Strategies:

1. Continue to present natural resources concerns and activities at quarterly indoctrination presentations.
2. Continue to implement trainings, educational materials, and presentations for security and other appropriate personnel on the proper response to wildlife related observations, and avoidance of driving on coastal strand vegetation and the culturally significant areas of base such as Nohili Dunes.
3. Ensure that standard reporting and response protocols for wildlife related observations are included in all security personnel vehicles.
4. Initiate a bi-annual natural resources newsletter about issues of concern as well as good news stories sent out through email, bulletin board, and social media, in coordination with the PMRF Public Affairs Office.
5. Provide the Public Affairs Office with flyers to send out by email and for posting on bulletin boards around base regarding seasonally appropriate natural resources issues.
6. Include natural resources information in Welcome Aboard packages for incoming Navy personnel.

Objective 2: Provide technical support for events that foster understanding and awareness of the environment through educational conservation programs and increase visitor and resident awareness of the PMRF natural resources program and related protocols, laws, and policies.

1. Coordinate and participate in volunteer events, educational programs, and natural resources related site visits from local schools.
2. Continue to coordinate with MWR to place natural resources related information in beach cottages, implement informational signage, and consider creating a permanent natural resources display near the beach cottages, Majors/Waiokapua Bay, and the MWR visitor check-in building.
3. Continue to work with base personnel on signage and other outreach and enforcement efforts to deter illegal feeding of animals as well as misuse of recreational areas.

4.2 Barking Sands Natural Resources Management

In addition to the base-wide natural resources management program activities described above, the Natural Resources Program has management responsibility for several other resources specific to

Barking Sands. Included are management actions for Laysan Albatross and Wedge-tailed Shearwater, four endangered Hawaiian waterbird species, marine mammals, sea turtles, and other marine resources.

4.2.1 Albatross Management

Because of their large size, tendency to soar along wind currents at high speeds, and attraction to the PMRF airfield due to its coastal orientation and favorable wind conditions, Laysan Albatross and Black-footed Albatross are considered a serious BASH concern for air operations at PMRF. Albatross are present at PMRF during their breeding season from late November to April. Laysan Albatross are the only species of albatross that currently nest at PMRF. The majority of Laysan Albatross nest within the PMRF airfield area but they also nest in areas north of the airfield and at Sandia Laboratories.

Specific Concerns

- BASH concerns
- Understanding of albatross behavior and movement at PMRF
- Predation of albatross by pigs and dogs

Current and Historical Management

Laysan Albatross Capture and Relocation

Laysan Albatross / Mōlī

In response to BASH concerns posed by the presence of Laysan Albatross near the PMRF airfield, a program of capturing and relocating Laysan Albatross and their eggs began in 1988 and is still in effect to this day. During the first few years of implementation, birds captured by USDA-WS were held until the airfield closed then released on PMRF property far from the airfield. In the 1990s, through an agreement with USFWS, PMRF began relocating birds to the Kīlauea Point NWR on the north shore of Kauaʻi. In 2014, translocations to Kīlauea Point NWR ceased and moved to the nearby Na Aina Kai Botanical Garden due to changes in the refuge's management plan. Translocations of albatross captured within all areas of base except the Sandia Laboratories area have occurred every year since the 1990s except for 2016 in which no albatross were translocated due to lack of proper staffing.

Albatross translocations began again in 2017 with natural resources staff taking responsibility for driving albatross to the north shore almost daily and only during the time period in which sub-adults are present at PMRF (January-April). USDA-WS still captures and bands albatross at PMRF with unique leg bands daily to provide positive identification on recaptures. Data recorded by USDA-WS on captured birds include: band number, date, time, location, behavior (breeding, sitting, standing, flying), presence of egg, observer action (observed, chased, captured), and location to which the bird was relocated. After captured albatross are released on the north shore, natural resources staff enter the identification information into a database shared through the Airtable app with various partners on the

island. This allows staff and partner organizations to easily track re-sights of PMRF albatross observed by partners on the north shore and at PMRF.

Mark and recapture data have been used in past years to refine what birds at Barking Sands are targeted for capture and relocation. Data analysis indicates it is less effective and efficient to capture and relocate breeding birds than capturing and relocating non-breeding sub-adult birds. Because of very high nest site fidelity and life-long bonding of breeding pairs, their removal can result in the same bird returning to the removal site multiple times, resulting in multiple captures and relocations. In contrast, capturing and relocating non-breeding sub-adult birds, generally between two and eight years old, is an efficient and effective way to reduce the number of albatross in a nesting colony. Research indicates that once a non-breeding sub-adult is removed from the airfield, there is a lower rate of return.

Albatross Egg Swap

In 2004 the PMRF Albatross Egg Swap Program was implemented in which viable PMRF eggs are placed with foster parents at Kīlauea Point NWR and other private properties. Prior to 2004, all albatross eggs at PMRF were destroyed. The Laysan Albatross surrogate parenting program prevents the fledging of chicks from Barking Sands. Because site fidelity is very strong at the time of fledging, this reduces the potential for chicks that fledge from translocated eggs to attempt to nest at Barking Sands and greatly reduces BASH concerns while still allowing for the conservation of the species.

Between 2004 and 2014, up to 40 eggs were translocated each year. However, beginning in December 2014, Kīlauea Point NWR stopped accepting albatross eggs due to changes in their management plans so the program was broadened to translocate PMRF eggs to various protected private properties on the north shore of Kauaʻi and the James Campbell NWR on Oʻahu where a new nesting colony was being established. Eggs intended for James Campbell NWR were first placed under surrogate albatross at Kaʻena Point to be incubated. 3 weeks after hatching, the chicks were taken to James Campbell NWR to be hand reared until fledging. The effort to establish the new colony on Oʻahu was a joint effort of the Navy, USFWS, and Pacific Rim Conservation, NFWF and many other partners. In 2018, Laysan Albatross eggs were no longer accepted into the James Campbell NWR colony program so that other high priorty species for conservation could be concentrated, however surrogate nests at Kaʻena Point are still used.

The PMRF Albatross Egg Swap Program involves effort from various partners and is coordinated by PMRF Natural Resources. Natural resources staff collect all eggs observed by USDA-WS in their area of operation for incubation in the natural resources office on base. In the Sandia Laboratories area, albatross eggs are left in place until just before the egg swap, when natural resources staff will search for and collect the eggs. In preparation for the egg swap occurring in early December, natural resources staff communicate with Pacific Rim Conservation who are contracted by the Navy to assist PMRF in coordinating with DOFAW, the Kauaʻi Albatross Network and private landowners and assess the fertility of eggs at PMRF and potential surrogate nests on Oʻahu and Kauaʻi. Natural resources staff are available during this time as needed to facilitate journalists requesting to write articles about the egg swap. The staff also assists with egg candling and coordinates the shipment of fertile albatross eggs to Pacific Rim Conservation on Oʻahu as needed and infertile eggs to the National Institute of Standards and Technology (NIST) for research.

In January, the natural resources staff conducts a last sweep of the base for albatross nests not detected by USDA-WS during their daily patrols and host a volunteer "Albatross Egg Hunt" day in which PMRF personnel and other partners are welcome to come assist in the search.

The number of albatross eggs laid at PMRF exhibits annual variability (average 68.7), however there is a downward trend from 2012-2022. The 2022 nesting season had the fewest eggs recorded (50), and 2013 had the most during this period (84).

Surveys and Monitoring

In 2017, during the Laysan Albatross breeding season (November – April), natural resources staff conducted surveys at Sandia Laboratories and the airfield tower to compare albatross behaviors and presence as management of the species and habitat is drastically different in the two areas. Results from those surveys were included in the Research Corporation of the University of Hawai'i, *PMRF FY17 Second Quarter Report* (Herring and Johnson 2017) and will be used to inform further research studies and management decisions.

Predator Control

Laysan Albatross mortalities caused by dogs (likely lost hunting dogs) and pigs is another management concern at Barking Sands, particularly in the Sandia area. Increased efforts to decrease these occurrences, as described in **Section 4.1.3** are expected to reduce these attacks.

Objective: Minimize impacts to Laysan Albatross while providing maximum flexibility for testing and training at PMRF and supporting regional Laysan Albatross conservation measures.

Strategies:

1. Continue the PMRF Laysan Albatross Egg Swap program.
2. Work with partners to ensure that as many albatross eggs as possible stay on Kaua'i and find new suitable egg relocation locations.
3. Continue to translocate albatross to the north shore of Kaua'i from January-April.
4. Coordinate with DOFAW on potential new albatross release sites.
5. Closely monitor re-sights of translocated albatross by working with partners on the north shore of Kaua'i to enter data into the Airtable app database.
6. Use data analysis to assess the effectiveness of albatross translocations based on location of translocation, time of year, and whether or not the albatross is a known breeder, sub-adult, or new bird to PMRF.
7. Support research on PMRF albatross populations that increases the understanding of their behavior as it relates to the PMRF airfield.
8. Continue base-wide predator control to protect MBTA-listed species including Laysan albatross; monitor for pigs, dogs, and cats in known breeding areas prior to the albatross breeding season and increase control efforts as needed.

4.2.2 Wedge-tailed Shearwater Management

Wedge-tailed Shearwaters are present along most of the coastline at PMRF during their breeding season (March-November). Primary breeding colonies are located at the Barking Sands beach cottages,

Kinikini Ditch, Nohili Dunes. Wedge-tailed Shearwaters also burrow in various isolated locations along the coastline adjacent to the airfield and near the Nohili Ditch outfall.

Specific Concerns

- Negative human interactions (e.g., burrows crushed by foot and vehicle traffic, complaints about noises and smells coming from colony)
- Habitat degradation
- BASH concerns

Current and Historical Management

Habitat Enhancement

Currently, a six-foot (1.8-meter) wood slat fence encloses a portion of the beach cottages colony on three sides to protect the birds from human disturbance. Habitat enhancement in this area, including the removal of non-native vegetation and planting a variety of native trees, shrubs, and ground covers, was conducted from 2006 to 2008. In addition, NAVFAC PAC Natural Resources staff installed artificial burrows in the cleared areas. Signs alerting the public to the presence of the colonies, the on-going restoration efforts, and restricted access to the colonies, were installed. Additional invasive plant control was conducted in 2010 and 2017 which focused on removal of Long-thorn Kiawe. By 2020 regrowth was once again intruding on colony areas and hand control reinitiated.

Wedge-tailed Shearwaters in the Kinikini Ditch and airfield area have been identified by PMRF Air Operations as a threat to night operations on the airfield, therefore enhancement of these colonies is not in the best interest of the birds or air operations.

Wedge-tailed Shearwater Protective Measures

The beach cottages Wedge-tailed Shearwater colony has received mixed feelings from cottage visitors over the years. Some visitors report enjoying watching and listening to the seabirds' nighttime calls, while others have filed complaints with MWR over the sounds and smells that emanate from the colony (R. Herring, personal communication, 2018). The presence of Wedge-tailed Shearwater burrows in the immediate vicinity of the visitor beach cottages also poses a safety risk to both the birds and people as visitors and maintenance personnel can potentially collapse the burrows and crush eggs, chicks, or adults inside. Foot traffic in sensitive areas is restricted by the use of rope fencing, signage, and wooden burrow covers to protect birds and people alike.

Wedge-tailed Shearwater in artificial burrow at Barking Sands

Discouraging Wedge-tailed Shearwaters from digging burrows in the immediate vicinity of the beach cottages is an ongoing effort at Barking Sands as this can threaten the structural integrity of the cottages, sidewalks, and other infrastructure. Habitat management, including watering the grasses to create a dense mat of vegetation and filling of unoccupied burrows has been conducted. However,

more effective measures such as installing permeable plastic pavers or concrete around the cottages should be assessed as more long-term solutions as the other measures conflict with Nēnē management strategies and are time intensive and their effectiveness has yet to be determined. Numerous predation events characteristic of cat and owl kills have been observed at the beach cottages colony therefore predator control efforts focus on this area during the breeding season.

Monitoring

In 2006, a baseline population survey of the Wedge-tailed Shearwater colony at the beach cottages was conducted to determine the geographic range, occupancy, and nesting success of the colony (Hebshi 2007). In 2007 and 2008, population monitoring using protocols recommended in the 2006 survey report and habitat assessments were conducted to assess population trends and the effectiveness of the habitat enhancements (NAVFAC PAC 2008, 2009). The data from these surveys indicate that the occupied area and number of Wedge-tailed Shearwater breeding pairs increased by 160 in 2008 compared to 2007 (NAVFAC PAC 2008 and 2009). This could be in part due to increased predator control in the area and habitat enhancement or simply due to year to year fluctuations in the numbers of birds breeding and food availability.

In 2012, KESRP biologists conducted Wedge-tailed Shearwater research in three areas of major occupancy at PMRF (Raine 2012). KESRP deployed song meters that recorded calls emanating from the colony and also counted the number of burrows in the direct vicinity of each song meter to measure colony density. The goal of the research was to test the viability of using song meters as a tool for estimating the colony size of shearwaters which is especially useful when determining the size of remote endangered seabird colonies.

In 2017 a full-scale population survey of the Wedge-tailed Shearwater population was conducted. Natural resource staff counted burrows in the beach cottages and Kinikini Ditch areas in which total numbers of unoccupied and occupied burrows were recorded. A total of 1070 burrows were identified, 340 of which were confirmed to be actively occupied. Although data from the 2006-2008 surveys and the 2017 survey is not directly comparable as monitoring protocols were likely different in 2017, it appears that the Wedge-tailed Shearwater population utilizing the beach cottages area has increased substantially over the last decade and has spread out into the surrounding areas.

In 2021 an intensive, base wide breeding census was performed. NR staff identified previously unknown colony locations and surveyed areas not included in previous years including the Nohili Dunes colony and several smaller colonies sporadically locaed along the PMRF beach line. The results of this survey estimate a base wide population of between 3101 and 4134 adult WTSH and a productivity output of up to 1366 chicks for the 2021 breeding year.

<u>Objective 1</u>: Manage, protect, and enhance Wedge-tailed Shearwater nesting colonies to ensure stable populations at appropriate nesting colonies on base while supporting maximum flexibility for testing and training at PMRF.

<u>Strategies</u>:

1. Enhance Wedge-tailed Shearwater habitat in areas far from the PMRF airfield and human presence and develop deterrent measures for burrows in areas of human traffic and near the airfield.

2. Research and work with facilities and MWR to implement methods for discouraging Wedge-tailed Shearwater burrowing in the immediate vicinity of the PMRF Beach Cottages.
3. Continue to implement protective measures that prevent the crushing of burrows in the beach cottages area (e.g., signage, temporary rope fencing, wooden burrow tents, outreach materials in cottages).

Objective 2: Improve understanding of Wedge-tailed Shearwater population dynamics at Barking Sands to guide future adaptive management decisions and support regional conservation of shearwater species.

Strategies:

1. Conduct annual Wedge-tailed Shearwater population surveys in the Kinikini Ditch, beach cottages, and Nohili Dune areas.
2. Work with partners to collect additional data that supports adaptive management on PMRF and regional conservation objectives for shearwater species.

4.2.3 Wetland and Waterbird Management

Endangered waterbirds including Hawaiian Gallinule, Hawaiian Coot, Hawaiian Duck, and Hawaiian Stilt utilize wetland areas adjacent to PMRF including the Kawai‘ele Waterbird Sanctuary and Mānā Plains Forest Reserve, as well as the Mānā Plain ditch system and ditches and ephemeral wetlands bordering PMRF property. On Barking Sands, they are generally limited to the PMRF oxidation pond complex, ditches, and beaches. Avian botulism breakouts have occurred at the PMRF oxidation pond complex and are of special concern for Hawaiian Coots and Hawaiian Ducks.

All species of endangered Hawaiian waterbirds, except Hawaiian Stilts, have been recorded nesting at PMRF. Successful nesting of Hawaiian Coots at PMRF has been documented annually since 2012 when one Hawaiian Coot nest was observed in the PMRF oxidation pond with two chicks successfully fledging. By 2021, there were six coot nests observed in the oxidation pond complex. Due to the risk of avian botulism at the site, strategic vegetation removal is essential for discouraging nesting at the site for protected species per USFWS recommendations. Hawaiian Gallinules, in addition to Hawaiian Coots, have been observed nesting in Kinikini Ditch. Measures must be taken to avoid negative impacts to these species and their nests in these areas.

Hawaiian Stilt / Ae‘o

A substantial number of very young Hawaiian ducklings have been observed at the oxidation pond complex over the past several years. Although no Hawaiian Duck nests have ever been observed at the oxidation pond complex, it is likely that Hawaiian Ducks do breed on PMRF property. Protective measures must be taken at the oxidation pond complex to avoid negative impacts to the species and their nests.

Specific Concerns

- Avian botulism
- Nest site protection
- Mortalities or injuries due to vehicle strikes
- Mortalities or injuries due to vegetation removal
- Habitat degradation
- BASH concerns
- Exposure to pollutants carried through PMRF in the three ditches, especially Kinikini.

Current and Historical Management

Surveys and Monitoring

Natural resources staff monitor all four waterbird species at all water holding areas on base and immediately bordering PMRF property at least twice weekly. Per conservation measures outlined in the 2014 PMRF BO issued by USFWS, all waterbird nests, mortalities, and injuries are reported to USFWS within 24 hours of observation. Appropriate PMRF contacts are notified of nest locations on base if an area is likely to be impacted by human activity. Signs and fencing are used if necessary to alert people to the presence of nests.

Hawaiian Coot are seen regularly, with average annual survey observations varying between 9.5 and 19.7. Hawaiian Stilt detections are more variable (average: 3.7-15.5). Hawaiian Duck and Hawaiian Gallinule are regularly seen in low numbers (4.3-5.9 and 1.1-2.6 birds per survey, respectively).

Avian Botulism

In the state of Hawai‘i, avian botulism epidemics are major catastrophic events that set back endangered waterbird recovery significantly. The most prevalent disease affecting Hawaiian waterbirds is avian botulism type C. Avian botulism is caused by a neurotoxin produced by a common bacterium (*Clostridium botulinum*). Normally dormant and not harmful, these spores release toxins only when certain conditions occur, including warm temperatures, high pH, low dissolved oxygen, and stagnant waters. Birds usually acquire the disease by eating invertebrates containing the toxin which can potentially lead to the death of the bird. Invertebrates such as maggots feeding on a deceased bird’s body can contain a concentrated amount of botulism toxin which is why removal of deceased birds from the affected areas as soon as possible is essential in stopping the spread of the disease. A significant botulism outbreak was experienced throughout Hawai‘i in 2012, which resulted in the loss of an estimated 400 – 500 birds (Pacific Joint Venture 2012).

An avian botulism outbreak occurred in the winter of 2014/2015 at Barking Sands, resulting in the loss of at least 22 birds including 20 Hawaiian Ducks and 2 Hawaiian Coots. Two additional Hawaiian Ducks were captured and rehabilitated by the SOS veterinarians and released. Since then, smaller outbreaks have occurred in the summer as well as winter but have been relatively under control due to increased monitoring efforts. When birds potentially affected by avian botulism are observed, natural resources staff follow the Botulism Response SOP developed by USFWS (**Appendix E**). The Natural

Resources Program also has avian botulism anti-toxin shots provided by SOS on-hand for emergency use in case of an avian botulism outbreak at the oxidation pond complex.

PMRF natural resources staff also work closely with Facilities Maintenance on natural resources issues at the oxidation pond complex. If an outbreak is observed or the amount of influent to the pond is abnormally low, natural resources staff will work with Facilities Maintenance to mitigate favorable avian botulism conditions by flushing it with fresh water. Any future dredging or design changes to the ponds will be coordinated through the PMRF Natural Resources Program to ensure that negative impacts to the protected species utilizing the pond are prevented.

Habitat Management

The PMRF oxidation pond at Barking Sands provides shallow water and abundant food resources that have been observed to support a substantial resident population of Hawaiian Coots year-round and Hawaiian Ducks and Hawaiian Stilts in the winter months. Other bird species such as migrant ducks and shorebirds also benefit from the pond as a migration stop-over. Since the 2014 avian botulism outbreak, vegetation at the complex has been kept at a minimum as nesting allows to aid in the location and removal of sick and deceased birds and to reduce the attractiveness of the area as a nesting site. The 2014 PMRF BO outlined conservation measures to manage the site for the benefit of waterbirds. After the outbreak in 2014, USFWS recommended that presence be discouraged at the site via vegetation maintenance.

The ditch system that runs through Barking Sands transports water from the agricultural fields and has the potential to carry pollutants harmful to waterbird species that spend much of their time in or foraging around the ditches. The components of this runoff may vary seasonally or with rainfall, making it difficult to identify exposure risk to waterbirds at PMRF, and to adaptively respond.

Vehicle Collisions

Waterbirds are struck and killed by vehicles at Barking Sands annually. Waterbird crossing caution signs have been installed along roadways where waterbirds are frequently observed to reduce potential for vehicle strikes.

Objective 1: Decrease negative interactions between Hawaiian waterbirds and PMRF operations by managing wetlands and waterbirds appropriately in order to minimize risks to waterbird and human safety.

Strategies:

1. Continue to coordinate closely with Facilities Maintenance regarding restrictions on vegetation removal practices within a 100-ft (30.5 m) radius of waterbirds or their nests.
2. Discourage waterbird presence and nesting at the oxidation pond complex by maintaining vegetation at a height of less than 6 inches and by funding the installation of exclusionary measures.
3. Continue to coordinate with Facilities Maintenance to obtain environmental data on the oxidation pond regularly to better inform causes of avian botulism outbreaks and identify high risk conditions that require management actions.

4. Coordinate with Public Works to develop oxidation pond flushing protocols in response to avian botulism outbreaks or high-risk conditions.
5. Coordinate with Facilities Maintenance on all oxidation pond complex construction and restoration plans.
6. Supplement ongoing water quality testing to detect particulates and soluble chemicals in waters at PMRF. Testing should be conducted at least quarterly.
7. Replace and improve waterbird crossing signage at PMRF as needed to reduce risk of vehicle strikes (PMRF Biological Opinion, 2014), evaluate efficacy of signs, and explore new tools to reduce vehicle strikes.

Objective 2: Improve understanding of Hawaiian waterbird population dynamics at Barking Sands to guide future adaptive management decisions.

Strategies:

1. Continue to conduct regular monitoring for Hawaiian waterbird species at Barking Sands to effectively detect and reduce impacts to nests (PMRF Biological Opinion, 2014).
2. Consider implementing a waterbird banding/telemetry program to track movement, monitor nest-site fidelity, and inform management on the base.

4.2.4 Marine Mammal and Sea Turtle Management

4.2.4.1 Hawaiian Monk Seal Management

Hawaiian Monk Seals have been documented utilizing the beaches of Barking Sands to "haul-out" or rest year-round. Beaches near the Kinikini Ditch outfall and Diver's Landing, just north of the PMRF airfield and ordnance, are popular resting beaches for the species and are both restricted access areas not frequented by humans. Seals also occasionally haul out at the publicly accessible Waiokapua (Major's) Bay beach area; signs are placed out to alert and educate the public to maintain adequate distance from the seal to avoid disturbance. One Hawaiian Monk Seal pupping event was documented in 1999, however no Hawaiian Monk Seals have been born at Barking Sands since.

Specific Concerns

- Harassment of hauled out Monk Seals
- Disturbance of Monk Seals due to military training and testing exercises
- Vehicle strikes
- Tracking individual movements
- Negative fisheries interactions
- Entanglement in or ingestion of marine debris
- Disease (i.e., toxoplasmosis transmitted by feral cat feces entering ocean)

Current and Historical Management

The majority of Barking Sands beaches are patrolled daily by security personnel and all Hawaiian Monk Seal sightings are reported to natural resources staff. Additionally, natural resources staff regularly monitor areas where security does not routinely patrol for monk seal activity. All observations of Hawaiian Monk Seals at PMRF are documented and reported to the NOAA Fisheries Hawaiian Monk Seal Hotline. SOPs developed by PMRF Natural Resources in cooperation with federal partners are followed regarding all monk seal sightings, injuries, or entanglements (**Appendix E**).

Hawaiian Monk Seal / ʻĪlio-holo-i-ka-uaua

To limit disturbance of hauled-out monk seals, security personnel erect signs around hauled-out seals in areas frequented by people to create a 150 ft. (46 m) buffer area that instructs people to stay back. Mitigation measures regarding marine mammal protection are also implemented during missile launches and beach training exercises at PMRF (DON 2008a) to ensure no endangered or threatened species are in the affected area when activities occur; beach areas are surveyed and activites moved or held until any seals present leave of their own accord.

PMRF hosts and participates in marine debris cleanups at the facility and in the surrounding community. Attendees are educated on the risks that debris poses to marine life such as ingestion and entanglement. Large nets observed washed up onshore are also removed and disposed of by natural resources staff.

The U.S. Navy funds bi-annual surveys of monk seal populations, which are performed by NOAA and DAR biologists with assistance from PMRF environmental and natural resources personnel. PMRF also supports regional conservation of the species by sharing sighting data with NOAA and DAR and working with NOAA to assist in the effective management of the species. In 2017, PMRF natural resources staff coordinated with NOAA to assist with the relocation of a young monk seal from a dangerous harbor on the east side of Kauaʻi to Waiokapua (Major's) Bay at PMRF.

Feral cat control at PMRF contributes to improving the water quality of the surrounding nearshore environment by reducing the amount of cat feces and therefore risk of toxoplasmosis to marine mammals utilizing the area. Between November 2016 and June 2019 two hundered and forty-nine feral cats were removed from PMRF sites with the majority coming from Barking Sands.

Objective 1: Maintain and enhance populations of Hawaiian Monk Seals to the greatest extent practicable.

Strategies:

1. Continue to ensure that Security reports sightings of monk seals during daily patrols at PMRF beaches and erects signage and barricades if observed where people frequent.

2. Continue to report observations of hauled-out Hawaiian Monk Seals to NOAA as soon as possible and provide high quality photos to assess seal health, ID, and aid in population abundance monitoring.
3. Collaborate with NOAA to implement Hawaiian Monk Seal recovery objectives when feasible.
4. Continue base-wide predator control to remove feral cats and collaborate with partners on studies regarding toxoplasmosis at PMRF to inform these efforts; conduct outreach about the disease and its effects on wildlife and human health.

Objective 2: Improve understanding of population dynamics to guide future adaptive management decisions and reduce probability of critical habitat designation within PMRF utilized areas.

Strategies:

1. Conduct regular surveys approximately five times per week of beaches near the Nohili Ditch outfall and Diver's Landing for monk seal presence, and all other beaches approximately twice per week.
2. Continue to conduct surveys through partnership with NOAA Fisheries for Hawaiian Monk Seals on Niʻihau.

4.2.4.2 Sea Turtle Management

Hawaiian Green Sea Turtles are known to routinely utilize PMRF's coastal waters for foraging and beaches for basking. Although no observations of Hawksbill Sea Turtle (*Eretmochelys imbricata*) activity have been recorded, there is a possibility for the species to nest at PMRF or forage in its nearshore waters. Hawaiian Green Sea Turtles are commonly observed basking on the beach and in the waters at the Nohili Ditch outfall or what is commonly referred to as the Turtle Cove area, which has a natural limestone ledge on the oceanside, rising several feet above the beach. Green Sea Turtles have also been observed basking on the beach in front of Shenanigans Restaurant. Sightings of sea turtles have been recorded during daily patrols by USDA-WS, Security, and natural resources staff since 2006. Green Sea Turtles have been documented nesting at Barking Sands relatively frequently in recent years with a total of ten confirmed nests laid between 2015 and 2021. Nests have been observed on the southern coast of Barking Sands, the beach near the southern end of the airfield and the Nohili Dunes area.

During nearshore surveys (Dollar and Brock 2007), numerous Green Sea Turtles were recorded at the surface and underwater resting off of Nohili Point, near the Nohili Ditch oufall, and directly offshore of this area four resting turtles were observed during underwater surveys. Preffered forage for Green Sea Turtles occurs along the limestone bench at Turtle Cove and abundant Limu Kohu (*Asparagopsis taxiformis*) was noted offshore. Marine nearshore surveys will be repeated in 2022 (Miller et al. 2022) and nearshore observations of sea turtles, seagrass and potential resting habitat will be reported.

Specific Concerns

- Damage to sea turtle nests by vehicles driving on beach (e.g. compaction of sand, crushing of eggs/hatchlings)
- Destruction or damage to sea turtle nests caused by the public

- Harassment of basking sea turtles
- Stranding or entanglement in marine debris or fishing gear
- Beachfront lighting

Current and Historical Management

Surveys and Monitoring

Since 2006, monitoring and reporting of sea turtle activity to federal and state partners has occurred at PMRF. All sea turtle sightings and potential sea turtle nests are documented during daily beach patrols by Security and reported to natural resources staff. If a sea turtle is observed basking in an area where people may frequent, signs and barricades are erected instructing people to stay back at least 100' (30m) during the day and 150' (46m) at night. Natural resources staff respond to all sightings to ensure the turtle is healthy and record observational data on the sighting. Observational data on basking sea turtles is reported to federal and state partners annually.

Green Sea Turtles / Honu at Nohili Ditch Outfall

During sea turtle nesting season, natural resources staff conduct one to two surveys weekly of beaches where sea turtles have the potential to nest. These surveys are conducted in accordance with the PMRF Sea Turtle Nesting Season SOP developed by PMRF natural resources staff and reviewed and approved by federal partners (**Appendix E**). All observed turtle pits are reported to USFWS, DLNR DAR, and NMFS within 24 hours and signs with ropes are set up to protect the nest from vehicles. A nighttime survey of the nest area for lights visible from the beach is conducted to ensure that turtles will not be attracted to the land upon hatching. Once the nest is observed to have hatched, natural resources staff coordinate with a DLNR DAR biologist who is authorized to excavate nests to check for any remaining unhatched eggs or hatchling turtles and determine hatching success.

<u>Objective 1</u>: Maintain, enhance, and improve understanding of sea turtle populations at Barking Sands.

<u>Strategies:</u>

1. Continue to ensure daily patrols of PMRF's beaches for sea turtles to collect observational data and check for stranded, injured, or entangled turtles are conducted by partnering with Security.
2. Conduct surveys by biologists approximately five times per week of beaches near the Nohili Ditch outfall and Diver's Landing for sea turtle presence, and ensure that marine surveys in nearshore areas quantify sea turtles and potential foraging or resting habitat.
3. Continue to survey beaches for sea turtle nesting activity during the nesting season, protect all nests observed with ropes and signage, mitigate light attraction issues on beaches, and coordinate with DAR to excavate nests.

4. Continue to encourage good communication between Security and natural resources regarding sea turtle activity on PMRF beaches to reduce negative impacts to the species from Security beach patrol vehicles.
5. Develop and use USFWS-approved outreach, educational materials, and signage with the objective to educate and provide information to residents, recreational users, visitors, and staff about proper procedures and acceptable activities within sea turtle habitat and how to act when coming in contact with sea turtles.
6. Continue to implement surveys to ensure no sea turtles are in affected areas during training exercises or in-water work.

4.2.4.3 Whale and Dolphin Management

All marine mammals known to occur in the waters adjacent to Barking Sands are protected by the ESA and/or the MMPA. At least 16 species of whales and dolphins have been observed in the waters off Barking Sands (Baird et al. 2019, Baird et al 2022, Baird et al. 2021a, Baird et al. 2021b, DoN 2014b, Uyeyama et al. 2011, Richie et al. 2012) (see **Tables 3-3** and **3-4**).

Specific Concerns

- Stranding
- Entanglement in or ingestion of marine debris
- Military training and testing exercises
- Disease (i.e., toxoplasmosis transmitted by feral cat feces entering ocean)

Current and Historical Management

Surveys and Monitoring

The waters off Barking Sands have been monitored through studies developed in cooperation with NMFS under the Pacific Fleet's Hawai'i Range Complex Monitoring Plan and the Navy's Integrated Comprehensive Monitoring Program since 2009. Observations of whales and dolphins during other, routine surveys of interest are recorded and entered into the PMRF natural resources database conducted by natural resources staff.

PMRF has also participated in the NOAA Ocean Count by hosting a survey site on the last Saturday of January, February, and March most years since 2002, in order to provide locations and frequencies of marine mammal sightings in the waters off Barking Sands. PMRF has facilitated NOAA volunteer access to the base and will continue to do so.

Stranding Reporting

There is a potential for beached and/or dead whales and other marine mammals to be found along the installation's shoreline. Any such finding is reported to NMFS, NAVFAC PAC and CPF immediately. NMFS requests the Navy provide a description of animal (s), the condition of the animal (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). Natural resources staff is available to assist with response efforts.

<u>Objective</u>: Protect and monitor populations of whales and dolphins, in waters adjacent to Barking Sands.

Strategies:

1. Continue to report all observations of marine mammal strandings or deaths to NMFS and assist in response efforts.
2. Improve coordination and communication regarding marine mammal strandings and other observations of note with NAVFAC PAC and CPF.
3. Implement and collaborate with partners on studies regarding toxoplasmosis at PMRF to inform predator control efforts and conduct outreach about the disease and its effects on wildlife and human health.
4. PMRF will coordinate with the Agribusiness Development Corporation (ADC) to ensure compliance with the Clean Water Act and other environmental regulatory requirements where there is a nexus with federal monies or property.

4.2.5 Marine Nearshore Management

PMRF employees, active duty, reserve and retired military and dependents have recreational access to approximately 2.0 mi (3.2 km) of coastline. Historically, the public also had access to the beaches and water areas along the Barking Sands shoreline, however, after the September 11, 2001 terrorist attacks civilian beach access became more restricted. A gradual lifting of restrictions occurred after 2005, and as of 2015, the public had access to all beach areas not indicated as restricted (CNIC 2015).

The Navy limits shore fishing at Barking Sands to the Recreation Area and the Special Use Area (see **Figure 4-1**). Fishing restrictions allow only for pole, throw net, and spear fishing. Fishing and beach access restrictions are enforced by installation security details, which patrol the beach.

As EFH is known to occur along the Barking Sands and Kaʻula Island shorelines, the Navy must provide a written assessment to NMFS for any activity that may adversely affect EFH. This notification will facilitate discussion of measures to conserve EFH so that NMFS can provide recommendations to minimize, offset, or mitigate impacts.

Specific Concerns

- Recreational fishing
- Operations and construction in nearshore waters
- Erosion as a result of sea-level rise

Current and Historical Management

The PMRF Natural Resources Program has conducted periodic surveys of the marine nearshore environment to assess species diversity, abundance, and demographic structure along the Barking Sands shoreline (Dollar and Brock 2000, Dollar and Brock 2007), and a further study is underway in 2022 (Miller et al. 2022).

To avoid impacting coral reefs in the coastal and nearshore environment, the Navy conducts environmental reviews of any action likely to affect U.S. coral reef ecosystems in accordance with NEPA and DoD policy.

Future nearshore surveys will be conducted to reassess the composition and extent of coral and other marine organisms and inform future management decisions.

Objective: Employ a systematic approach to managing coastal and nearshore resources, using a process that includes inventory, monitoring, modeling, management, assessment, and evaluation.

Strategies:

1. Establish a monitoring program for the nearshore environment of PMRF to inform future management decisions and monitor changes overtime.
2. Partner with DLNR DAR to incorporate regular monitoring site(s) in PMRF's nearshore waters into the state's regular monitoring schedule, as feasible.

4.2.6 Ni'ihau Panicgrass (*Panicum niihauense)* Critical Habitat Management

Much of PMRF's coastal strand habitat supports unoccupied USFWS designated critical habitat for Ni'ihau Panicgrass or Lau'ehu (*Panicum niihauense*) (see **Figure 3.6**). Threats to these areas are primarily invasive plant infestation and unauthorized off-road vehicle use.

Specific Concerns

- Unauthorized off-road vehicle use
- Coastal strand habitat restoration to remove invasive plants
- Monitoring for potential Ni'ihau panicgrass populations

Current and Historical Management

Surveys and Monitoring

The Navy conducted vegetation surveys of the base, including the two unoccupied Ni'ihau Panicgrass critical habitat areas in 2000 (Char 2000a) and in 2006 (NAVFAC PAC 2006b) to assess and monitor site conditions. The 2006 survey covered all of Nohili dunes, except where Long-thorn Kiawe forest was impassible on the eastern, inland portion of the dunes. In 2014 and 2019, follow-up surveys for Ni'ihau panicgrass were conducted with no individuals observed across the critical habitat at PMRF (NAVFAC PAC 2016a, RCUH 2019).

Access Restriction on Beaches and Dunes

Driving has been prohibited on the beach since late 2001, except by base security personnel. This significant decrease in vehicle traffic has allowed the native dune vegetation such as Pohuehue, Pōhinahina and Pa'u O Hi'iaka (*Jacquemontia ovalifolia*) to flourish and expand. Many plants become re-established in previously disturbed areas. This rebound in vegetation is positive as it encourages healthier native dune vegetation, ultimately resulting in reduced erosion. The NRC Program encourages security personnel to avoid driving over existing vegetation, allowing the vegetation to continue to recover.

Objective: Provide conservation benefit to Ni'ihau panicgrass designated critical habitat area under Section 202(a)(3) of the Sikes Act.

Strategies:

1. Work to improve protection, habitat and/or consider outplanting Ni'ihau panicgrass. Protections will be aimed at preventing unauthorized off-road vehicle use, and invasive plant removal and to demonstrate benefit to the species.

2. Out-plant native species and remove invasive species in areas with suitable Ni‘ihau panicgrass habitat and ensure an irrigation system is in place until plants become well established.
3. Consider undergoing the approval process to out-plant the endangered *Panicum niihauense* in the effort to remove or reduce amount of PMRF property designated as critical habitat for the species. Coordinate with Federal and State partners to secure material for outplanting if pursued.

4.3 Mākaha Ridge Tracking Station Natural Resource Management

In addition to the base-wide natural resources management issues such as erosion control, ungulate fencing, native plant enhancements, predator control, and management of protected species, as discussed in Section 4.1, the PMRF Natural Resources Program has management responsibility for two federally listed plant species that are known to occur at the Mākaha Ridge Tracking Station. Management of Dwarf Iliau and Hawai‘i Scaleseed are addressed in this section.

4.3.1 Dwarf Iliau, Hawai‘i Scaleseed, and Other Listed Plant Species

Substantial populations of Dwarf Iliau and Hawai‘i Scaleseed were noted on the cliff sides of the Mākaha Ridge Tracking Station in 2006 and 2019 (see **Figure 3-12**). These individuals are primarily located outside of the Navy leased area; only Dwarf Iliau were noted inside the installation, with 128 individuals and an addition 3,507 outside the boundary. Threats to the survival of these species are habitat degradation and competition with non-native plants. Habitat degradation for these species is largely caused by erosion resulting from excessive Feral Goat, Pig, and Deer grazing and browsing. An additional threat to these rare native species is the reduced reproductive vigor as the result of limited numbers of existing individuals (Wood 2006).

Specific Concerns

- Disturbance and browsing from feral animals
- Population monitoring

Current and Historical Management

In 2000 and 2006, botanical surveys identified the locations and abundance of the federally listed endangered plants Dwarf Iliau and Hawai‘i Scaleseed (Char 2000b, Wood 2006). Populations of both species were found on the steep slopes dropping away from the Mākaha Ridge. In 2006, 11 colonies of Dwarf Iliau were located on and around the Mākaha Ridge Tracking Station with 214 individuals observed. Follow-up surveys using unmanned aerial vehicle technology were conducted in 2019 during which 3,635 Dwarf Iliau individuals, within 21 colonies, were detected (Nyberg 2019). During the 2019 survey, other rare plant species never before recorded at Mākaha Ridge were detected. Included were the two additional endangered species Mā‘oli‘oli (*Schiedea apokremnos*) and Ni‘ihau Lobelia (*Lobelia niihauensis*); one threatened species, Makou (*Peucedanum sandwicense*), and two at risk species, Hawaiian Red Hibiscus or Koki‘o ‘Ula‘ula (*Hibiscus kokio* subsp *saintjohnianus*) and Hawaiian Caper or Maiapilo (*Capparis sandwichiana*).

To reduce potential impacts to these species, the Navy has completed a feral ungulate exclusion fence around the facility, begun ungulate removal efforts, and is pursuing landscaping and re-vegetation.

Objective 1: Assess current populations of dwarf iliau, Hawai‘i scaleseed, mā‘oli‘oli, Ni‘ihau lobelia, and makou to monitor population health.

Strategies:

1. Implement erosion control efforts that directly benefit areas where protected species are present.
2. Conduct a reassessment of the status and condition of listed plant species on the cliffsides of Mākaha Ridge Tracking Station populations every five years and collaborate with partners to grant them access for further research and conservation efforts.

4.4 Kōke‘e Sites Natural Resource Management

In addition to the general base-wide natural resources discussed in Section 4.1, the PMRF Natural Resources Program has management responsibility for two federally listed insect species that are known to occur at or near the Kōke‘e sites, which is addressed in this section.

4.4.1 Hawaiian Picture-wing Fly

In 2006, critical habitat was designated by USFWS for 11 endangered Hawaiian picture-wing fly species in the vicinity of the PMRF Kōke‘e sites, albeit not on PMRF leased property. *Drosophila musaphilia* is the only known endangered Hawaiian picture-wing fly species detected in the immediate vicinity of the Kōke‘e sites. Native trees at the site include Koa (*Acacia koa*), which is a host plant for the larval stage of *D. musaphila*, as well as ‘Olapa (*Cheirodendron trigynum*), and ‘Ohe‘ohe (*Tetraplasandra kavaiensis*), which are suspected host species for the Hawaiian picture-wing flies. Threats include feral ungulates, wildfire, yellowjacket wasps, and ants (USFWS 2008).

Specific Concerns

- Hawaiian picture-wing fly host plant availability

Current and Historical Management

A 2010 survey, conducted by expert entomologists, captured two *D. musaphilia* specimens within 30 ft (10 m) of Kōke‘e Site B (DoN 2010). Further surveys should be considered to further assess presence of endangered Hawaiian picture-wing fly species and inform management decisions.

Current base operations and maintenance activities at the Kōke‘e sites are low-impact and do not occur in the forested areas surrounding the sites and are therefore not likely to severely impact the federally listed Hawaiian picture-wing fly species (NAVFAC PAC 2014). Regular vegetation maintenance does occur at all PMRF Kōke‘e sites within the leased boundary. Mowers and other landscaping equipment can carry seeds and other propagules, which can encourage invasive plant species ingress into adjacent habitat. Additionally, removal of native trees and vegetation necessary to support operations has the potential to impact breeding habitat for listed Hawaiian picture-wing flies.

Management actions that would provide conservation benefit to the federally listed Hawaiian picture-wing flies include improving habitat by maintaining the availability of Koa and other potential host trees that occur on site and removing invasive species from the surrounding forested areas. A native

plant restoration project is underway in the area to encourage Koa recruitment and increase suitable habitat.

Objective 1: Provide conservation benefits to federally endangered Hawaiian picture-wing flies and inform management decisions.

Strategies:

1. Conduct surveys every five years to assess presence/absence of endangered Hawaiian picture-wing fly species at and directly adjacent to PMRF Kōkeʻe sites.
2. Conduct invasive plant removals annually in areas near known Hawaiian picture-wing fly habitat to promote native tree health and propagation and reduce introductions of invasive species into adjacent habitat due to Navy operations.

4.5 Kamokala Ridge Magazines Natural Resources Management

Due to the lack of protected species present at Kamokala Ridge, little natural resource management occurs at the site. Nuisance wildlife and predators at the Kamokala Ridge Magazine area include deer, Feral Cats, Pigs, and Goats and could be targeted for control in the future if funding allows. Only one special status species, Hawaiian Hoary Bat, has been identified in the Kamokala Ridge Magazines, as discussed in Section 4.1.

Specific Concerns

- Nuisance animals

Current and Historical Management

Bird and mammal surveys conducted at the Kamokala Ridge Magazine area have identififed only two native bird species, the Hawaiian Black-crowned Night-heron and Pacific Golden Plover. The Hawaiian Hoary Bat is the only native mammal noted. An abundance of non-native species including Black-tailed Deer, Pigs, and Feral Cats have also been observed (Bruner 2000, NAVFAC PAC 2006a, NAVFAC PAC 2006c). The Kamokala Ridge site is only partially fenced allowing continuous access by nuisance animals. Organized hunts have been conducted at Kamokala Ridge for Feral Goat control, but were considered ineffective, largely because of the site's dense vegetation, which creates poor hunting conditions.

Objective: Ensure sustainable use of Navy infrastructure at Kamokala Ridge.

Strategies:

1. Work with the PMRF Archery Club to control ungulate populations at the Kamokala Ridge site by implementing trapping and baiting stations if the animals become a nuisance to Navy operations or pose a risk to protected species.
2. Conduct observations to identify feral cat use at Kamokala Ridge and consider expanding cat trapping if use is consistent or becomes a nuisance.

4.6 Port Allen Natural Resource Management

Because of the limited land area and natural resources present at Port Allen, natural resources management actions are limited to measures focused on minimizing potential impacts to federally protected nocturnal seabirds.

Newell's Shearwaters have been known to fall out in the Port Allen vicinity, but to-date, none are known to have fallen out because of attraction or disorientation to lighting on the Navy-leased property (NAVFAC PAC 2014). To minimize potential impacts to these species, the Navy limits night activities during fledgling season (mid-September through mid-December) and particularly during new moon phases.

Specific Concerns

- Lighting

Current and Hsitorical Management

Exterior lighting is required at the pier at Port Allen for AT/FP purposes and to minimize nighttime trip and fall hazards near the water. Eleven lights are mounted under the roof overhang on the north side of the building, and one light is mounted on the front (east) side of the building. The light on the front of the pier building is owned and operated by the Navy and is a full cutoff fixture. The eleven lights along the northern side of the building are operated by Navy, but the light fixtures are State property. These lights are turned on each night for security camera lighting and safety purposes. Six higher-intensity lights are turned on only when personnel are working on docked boats during nights in which fueling or upload/offload of equipment occurs. The Navy does not have the authority to replace these state-owned lights with full cutoff fixtures (NAVFAC PAC 2014).

Objective: Minimize direct and indirect impacts to federally listed, endangered Hawaiian seabird species at the Navy leased portion of Port Allen while providing maximum flexibility for training and operations.

Strategies:

1. Coordinate with facilities owner and USFWS to address lighting issues and continue to implement the Dark Skies program to the extent possible at the facility.
2. Train staff to recognize, respond and report to any circling or downed seabirds seen at the facility.

4.7 Ka‘ula Island Natural Resource Management

As Ka‘ula Island is uninhabited, the primary potential threat to special status species including marine mammals, sea turtles, endangered seabirds, and migratory birds, and marine life is from military training and testing exercises. The Navy implements strict training SOPs and in support of Hawaiian Monk Seal and seabird conservation.

Specific Concerns

- Military training and testing exercises

- Predation of native bird species by barn owls

Current and Historical Management

Training/Operational Activities SOPs

Fleet Area Control and Surveillance Facility (FACSFAC), which controls air operations into Kaʻula's danger zone, checks all sorties flown to Kaʻula and issues authorization to proceed after the sortie is informed of the prohibition on dropping or firing practice munitions in the presence of marine mammals or sea turtles. Before commencing any exercises, a preliminary survey pass is flown to ensure the lack of marine mammals, sea turtles, or vessels near the island. If marine species are detected in the target area, the operation is delayed or aborted. In addition, using non-explosive rounds and limiting the firing to the southern tip of the island reduces the impact of training activities to sensitive species and marine life on the rest of the island.

Monitoring Programs

Kaʻula Island is used for inert ordnance delivery and aircraft gunnery as discussed in the Hawaii-Southern California Training and Testing (HSTT) Environmental Impact Statement (EIS). Prior to 1998, eleven land-based avian surveys were conducted on the island, but due to BASH and UXO concerns those did not continue. Boat based seabird surveys were conducted from 2009–2012 in support of US Pacific Fleet's Coastal Zone Management Act (CZMA) consultation with the State of Hawaiʻi on the HSTT EIS. Opportunistic marine mammal monitoring surveys were also conducted during that timeframe under Pacific Fleet's marine species monitoring program. Boat surveys were replaced by aerial digital surveys starting in 2013 with the goal of achieving better counts of seabirds sitting on the top of the island and Kaʻula-focused marine mammal surveys were discontinued. Survey reports are provided to the State of Hawaiʻi's Office of Planning and the frequency of the surveys may be modified through the Pacific Fleet's CZMA consultation process. Although the target species are seabirds, Hawaiian Monk Seals are regularly observed and are reported to NMFS, Pacific Islands Fisheries Science Center. Additionally, historically, Navy Region Hawaii will coordinate with the Commanding Officer and FASFAC to approve access to the water around Kaʻula Island on a not-to-interfere basis so that NMFS can conduct additional surveys from their vessels.

Objective 1: Maintain and enhance populations of special status species on Kaʻula Island.

Strategies:

1. Continue implementing all military training SOPS.

Objective 2: Improve understanding of special status species population dynamics to guide future adaptive management decisions.

Strategies:

1. Conduct aerial seabird surveys of Kaʻula Island as needed for management planning to inform species presence, location and numbers.
2. Seek authorization to conduct land-based updates to floral and faunal surveys on Kaʻula Island.
3. Partner with DOFAW and other partners to coordinate Barn Owl and other predator control efforts on Kaʻula Island if access is allowed.

4.8 Mauna Kapu Site Natural Resource Management

Natural resources management actions at the Mauna Kapu Facility are limited in scope because of the limited land area and lack of natural resources on site. However, as the facility lies adjacent the Honouliuli and Nānākuli Forest Reserves, which support several state and federally listed bird, snail, and plant species, management actions at the Mauna Kapu Facility have potential to impact listed species and must be assessed through the NEPA process.

Specific Concerns

- Protection of state and federally listed species

Current and Historical Management

Other than landscape maintenance, no natural resources management has been conducted at the leased Mauna Kapu Facility to date.

Objective: Assess the occurrence of wildlife populations utilizing the facility to better understand and manage for all wildlife species.

Strategies:

1. Conduct base-line flora and fauna surveys.

4.9 Niʻihau Natural Resource Management

Natural resources management actions on Niʻihau Island are limited in scope because of restrictions set out in the Navy's land use agreements with the landowners. Management activities that are conducted are limited to avoiding take and mitigating impacts to threatened and endangered species and species protected under the MMPA and MBTA.

Specific Concerns

- Disturbance of monk seals due to military training and testing exercises and activities
- Disturbance to endangered waterbirds due to military training and testing exercises and activities
- Disturbance to endangered seabirds due to military training and testing exercises and activities

Current and Historical Management

The Navy has supported and participated in a series of aerial, boat, and ground-based surveys along the Niʻihau coast since 2009 in support of training excersises conducted in the Hawaiʻi Range Complex. Surveys are conducted in relation to U.S. Navy training events to monitor for any potential strandings of marine mammals or sea turtles (Ampela et al. 2015, Mobley et al. 2017) in accordance with a 2008 NMFS biological opinion (NMFS 2008). The Navy has also funded a study of Hawaiian Monk Seal use and behavior in the Hawaiʻi Range Complex that included the Niʻihau coast (Ampela et al. 2015).

In 2011, the NMFS proposed to expand critical habitat areas for Hawaiian Monk Seals which included a terrestrial and marine designation on and around Niʻihau Island. As a result of this

proposal, the Navy developed an addendum to the 2010 PMRF INRMP to include monitoring for Hawaiian Monk Seals on Niʻihau Island to avoid the critical habitat designation. By funding these surveys, the Navy was able to eliminate the terrestrial environment on Niʻihau from being included in the expansion of critical habitat (NMFS 2015), which reduces potential restrictions on Navy operations. Hawaiian Monk Seal surveys on Niʻihau Island funded by the Navy are also conducted by the NOAA Fisheries Hawaiian Monk Seal Research Program and Niʻihau personnel and have involved Navy personnel participation over the years (Lopez et al. 2014). Surveys are conducted both on land and by helicopter on Niʻihau twice per year. A census-type survey in which all individual seals encountered in the survey area are recorded. Size, sex, and any identifying information are collected. These surveys indicate that a relatively large number of seals use the island for hauling out and rearing pups. Three monk seal surveys were conducted by Navy personnel in 2021, with assistance from DLNR-DAR staff. Surveys were conducted in January (54 seals), September (89 seals) and October (73 seals). There were a minimum of 20 pups born at Niʻihau in 2021.

Objective: Monitor protected species utlilizing Niʻihau to help inform operations and management of wildlife and provide conservation benefits to the species and its habitat under Section 202(a)(3) of the Sikes Act.

Strategies:

1. Continue to conduct surveys through partnership with NOAA Fisheries for Hawaiian Monk Seals on Niʻihau.
2. If proposed Navy operations have the potential to impact sea turtles or habitat, conduct surveys for listed sea turtles and nesting activity on Niʻihau to understand habitat use and trends.
3. If proposed Navy operations have the potential to impact waterbirds at Niʻihau, conduct surveys to understand habitat use and trends.

5.0 INRMP INTEGRATION AND IMPLEMENTATION

The successful implementation of an INRMP and DoD guidelines requires support of natural resources personnel, other installation staff, command personnel, and the installation tenants. The following section discusses INRMP integration with other Navy and regional planning efforts, implementation and review.

5.1 Integration with Other Installation Plans

In accordance with DoDI 4715.03 DoD must integrate mission requirements and priorities identified in the INRMP in other environmental programs and policies, where applicable, to help ensure these natural resources are maintained in the best ecological condition possible to fully support current and future mission requirements.

PMRF has several plans that specifically address land use on the installation and must be considered in the development of project prescriptions for fulfilling natural resources management objectives. The land use goals and objectives of these plans, as they relate to natural resources issues, have been incorporated and referenced throughout this INRMP.

5.1.1 Navy Region Hawai‘i Regional Integration Plan

In an effort to reduce redundant land uses and streamline master planning, all of Navy Region Hawai‘i has been combined into a single Navy Region Hawai‘i Regional Integration Plan (Commander Navy Region Hawai‘i 2012). Planned and recommended projects and renovations are identified in this plan, which must be assessed for impacts to natural resources as identified in this INRMP.

5.1.2 Integrated Cultural Resources Management Plan

The PMRF ICRMP (DoN 2012) is intended to provide procedural guidance for identifying, evaluating, and managing historic properties located at the base. The ICRMP is a management resource tool to achieve compliance with Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966, as amended, and other federal preservation laws. The NHPA charges federal agencies to identify and evaluate historic and archaeological resources under their stewardship and to nominate eligible properties to the NRHP. In addition, the Act calls for federal agencies to consider the effects of planned activities on NRHP-listed or eligible properties. Cultural resources are those resources that represent a culture or society, either past or present, and may include landscapes, structures, traditional cultural properties, and/or archaeological sites. Historic properties are those cultural resources determined eligible for listing in the NRHP.

5.1.3 Environmental Restoration Program

PMRF recognizes that adverse impacts to natural resources addressed in this INRMP may result from the release of hazardous substances, pollutants, and contaminants into the environment or from the actual restoration of contaminated sites. The Navy Environmental Restoration (ER) program is responsible for identifying Comprehensive Environmental Response, Compensation, and Liability Act

(CERCLA) releases, Resource Conservation and Recovery Act (RCRA) releases, and releases under related provisions and reporting such releases to the EPA and SOH Department of Health.

When appropriate, the IEPD will help the ER program Remedial Project Manager (RPM) identify potential impacts to natural resources caused by the release of these contaminants. Also, when appropriate, the IEPD will make recommendations to the ER program RPM regarding cleanup strategies and site restoration. During initial monitoring protocols, the NRM may suggest sampling and testing be accomplished so as to not impact sensitive or critical areas. Also during site restoration, the IEPD has the opportunity to recommend site restoration practices that are outlined within this INRMP.

5.2 Relationship to Regional Conservation Planning Efforts

PMRF Barking Sands and several of its secondary facilities support federally and regionally significant natural resources and as such, are integral components to a variety of regional and conservation efforts. Therefore, in addition to coordinating natural resources management with other installation and range planning documents, this INRMP must consider natural resources conservation matters of national or regional significance. Regional conservation planning efforts relevant to the natural resources present on PMRF are summarized in the following subsections.

5.2.1 State Wildlife Action Plan

In 2005, the Department of Land and Natural Resources took the lead in developing a Comprehensive Wildlife Conservation Strategy (CWCS) to address the conservation needs of native fauna and flora across all islands, elevations, and habitat in the SOH (SOH DLNR 2005). The CWCS was developed through the assistance and participation of numerous organizations and interested citizens in part, to identify and generate an all-taxa list of species of greatest conservation need (SOH DLNR 2005). The list includes indigenous species of concern, over 10,000 of which are endemic to the State, federal candidate species, and species that are federally listed as threatened or endangered and are protected under the ESA.

In 2015, the CWCS was updated and renamed the State Wildlife Action Plan (SWAP) and a final edition became effective in October 2015 (SOH DLNR 2015). State-wide conservation needs, marine conservation needs, threats to specific species and communities, and island-specific conservation strategies are outlined in the SWAP. Seven primary statewide conservation objectives identified are:

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive;
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication;
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs;
- Strengthen existing and create new partnerships and cooperative efforts;
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai‘i;

- Support policy changes aimed at improving and protecting native species and habitats; and
- Enhance funding opportunities to implement needed conservation actions.

Management recommendations in this INRMP are consistent with and support conservation strategies identified in the SWAP to the greatest extent practicable.

5.2.2 Hawaiian Bird Conservation Action Plan

The Hawaiian Bird Conservation Action Plan (VanderWerf 2012) identifies research needs, primary threats, and conservation goals for Hawaiian birds that are in critical need of conservation and the Hawaiian Hoary Bat. PMRF conservation measures are consistent with and support the plans conservation recommendations for:

- Endangered seabirds (Hawaiian Petrel, Newell's Shearwater, Band-rumped Storm-petrel)
- Nēnē
- Hawaiian Waterbirds (Hawaiian Coot, Hawaiian Duck, Hawaiian Stilt, Hawaiian Gallinule)
- Laysan Albatross
- Hawaiian Hoary Bat
- Scarlet Honeycreeper

Specific PMRF activities identified in the Hawaiian Bird Conservation Action Plan includes the Navy's participation in establishing a breeding colony of Laysan Albatrosses at James Campbell National Wildlife Refuge (NWR), O'ahu, by translocating chicks hatched from excess eggs removed from PMRF as part of a BASH reduction program. Predator control at PMRF is also identified in the plan.

5.2.3 Regional Biosecurity Plan for Micronesia and Hawai'i

Invasive species pose a constant and costly threat to Pacific islands' native ecosystems, ecosystem functions, biodiversity, watersheds, economies, public health, cultures, and the quality of life of residents and visitors (U.S. Navy 2015). In response to this threat, the Regional Biosecurity Plan for Micronesia and Hawai'i (RBP) was developed by the University of Guam and the Secretariat of the Pacific Community with funding from the U.S. Navy and in full consultation with RBP Jurisdictions. The purpose of the regional biosecurity plan is to act as a tool to help enhance the coordination of current management efforts, identify remaining problem areas and gaps, and recommend additional actions that are needed to effectively address invasive non-native species issues within jurisdictions as well as regionally.

Recommendations specific to DoD entities that are applicable to PMRF and should be considered for implementation include, but are not limited to:

- INRMPs should depict invasive non-native species monitoring and surveillance, detection, rapid response actions for all taxa to ensure biosecurity efforts are planned and funding is requested.
- The military should have at least one invasive species biologist, in addition to a supporting pest control shop or equivalent contract team at each DoD facility working in conjunction with local authorities to monitor for pests, to conduct biosecurity inspections, to respond to incursions,

and to implement management efforts as needed. Improvements to existing systems, communications, and partnerships with local civilian agencies should continue to be advanced.

- The military should include biosecurity requirements and provisions in contracts to reduce the risk of introduction of animal and plant pests and diseases.
- Military aircraft and other military vehicles arriving as maritime cargo should be inspected, cleaned, and washed down at a retrograde wash facility before entry. Wash down procedures for military vehicles should target soil, plants, insects, and other wildlife. Tracked vehicles can be cleaned on shore only if they can be reloaded without recontamination of the treads; otherwise they should be cleaned on the ship's well-deck. They should be cleaned to USDA-APHIS standards (USDA-APHIS-PPQ Treatment Manual 2008) prior to shipment from the port of departure. Vehicles may be cleaned at the port of entry provided wastewater soil is collected and drained fully into an approved collection system.
- The military should establish appropriate decontamination sites for cleaning both military and civilian equipment associated with military activities.
- The military should enhance training for military personnel and their dependents about phytosanitary and general sanitary regulations and the risks of sending or receiving agricultural and wildlife materials in the mail.
- New plantings should be locally sourced, non-invasive, and preferably native species, with a minimum of 50 percent native species planted for an individual project. Existing plant species, which are either known to be invasive or at least thought to have invasive potential, should be removed or managed.

5.2.4 Kawai'ele Bird Sanctuary

The Kawai'ele Bird Sanctuary is located on the west side of Kaua'i, Hawai'i, just south of PMRF Barking Sands. The sanctuary is part of an overall effort to restore wetland habitat at the Mānā Plain, which once contained expansive wetland habitats. Prior to its drainage and conversion to agricultural lands during the early 1900s, approximately 1,700 acres ([ac]; 688 hectares [ha]) of permanent, semi-permanent, and seasonal wetlands were present on the Mānā Plain. The 36-ac (14.5-ha) sanctuary supports wetland habitat that was created in the 1990s by mining sand down to the ground water level. The Kawai'ele site is an important feeding and nesting area for endemic and endangered waterbird species and is home to all four of Hawai'i's endangered endemic waterbirds: the Hawaiian Stilt, Hawaiian Gallinule, Hawaiian Coot, and Hawaiian Duck. Smaller numbers of Nēnē are also known to visit and nest in the sanctuary (SOH DOFAW 2014). During the winter months, migratory birds frequent the sanctuary. In addition, many native species of plants can be found within Kawai'ele (SOH DAR 2009).

5.2.5 Mānā Plain Forest Reserve Wetland Restoration

The Mānā Plain Wetland Restoration Project will involve 105 ac (42.5 ha) immediately north of the Kawai'ele Waterbird Sanctuary. This project, expected to be completed in 2022, will further help restore a portion of these historic wetlands, by nearly doubling the area's wetland habitat. The restored wetlands would help to re-establish native Hawaiian plants, once common to the area, and provide an opportunity for the public to experience the endangered Hawaiian birds in their traditional habitat

(SOH DOFAW 2014). The wetland enhancement boundary is planned to lie approximately 2,000 ft (610 meters [m]) from the PMRF runway. During the NEPA process, DOFAW acknowledged and understood the Navy's concern that a breeding population of Nēnē in the vicinity of the PMRF runway poses a risk to the safe operation of an aircraft. To address this concern, the wetland restoration plan for the Mānā Plain Wetland Restoration Project was designed to provide habitat for obligate wetland species (Hawaiian Gallinule, Hawaiian Coot, Hawaiian Stilt, and Hawaiian Duck) rather than for Nēnē (SOH DOFAW 2014). Hawaiian waterbird species, which frequent the sanctuary, pose a lower BASH risk because of their restricted habitat use and sedentary terrestrial habits. Nēnē, which are considered high risk BASH threat, are currently abundant throughout the agricultural fields of the Mānā Plain and on base, and are not anticipated to increase due to the implementation of the proposed project (SOH DOFAW 2014).

5.3 Integrating Natural Resources and Mission Sustainability

5.3.1 Natural Resources Support of the Military Mission

A primary goal of natural resources management at PMRF is to preserve and sustain conditions that are compatible with the military mission. The Sikes Act states that an INRMP shall provide for "no net loss" in the capability of military installation lands to support the military mission of the installation. Therefore, mission requirements and considerations have been integrated into this INRMP and the capability to support the mission is a natural resources priority. This INRMP provides management recommendations for natural resource actions that protect federally protected species, prevent designation of additional critical habitat, reduce soil erosion, protect and restore land and waterways from invasive non-native species infestation, and promote the protection and enhancement of wetlands and floodplains. These and other natural resources management activities help achieve no net loss of the PMRF mission.

5.3.2 Sustainability Challenges

5.3.2.1 Encroachment

Per OPNAVINST 11010.40, Encroachment Management Program, encroachment is "any non-Navy or Navy action planned or executed in the vicinity of a naval activity or operational area which inhibits, curtails, or possesses the potential to impede the performance of the mission of the naval activity." An installation Encroachment Action Plan (EAP) finalized in 2014 (DoN) identified a number of encroachment issues at PMRF. The highest priority issues were identified as:

- Urban development adjacent to the base,
- Restrictive use easements,
- Lease renewal issues.

The Navy Region Hawai‘i Regional Integration Plan (Commander Navy Region Hawai‘i 2012) and the EAP recommend that the Navy proactively pursue continued real estate agreements for adjacent lands to provide buffers for mission activities and minimize encroachment issues and communicate

Navy buffer requirements to Mānā Plain landowners, the Kekaha Agriculture Association, and tenants to ensure continued PMRF training and RDT&E operations.

Encroachment issues with the greatest relevance to natural resources management are:

- Competition for air, land, and sea space,
- Threatened and endangered species and critical habitat,
- Interpretation of historical and environmental regulations, and
- Maritime issues.

Strategies for resolving the natural resource-related encroachment issues primarily include implementing the INRMP; maintaining a good working relationship with federal, state and other agencies; and informing the public and regulatory agencies of Navy efforts regarding protected species, marine mammals and their habitats.

Lease Agreements

As part of their encroachment management program, the Navy has entered into an API with the SOH and Kauaʻi County to permanently preserve approximately 5,000 ac (2,023 ha) of land in the Mānā Plain for agricultural purposes (**Figure 5-1**). The API, which is in effect until 2029, ensures that the Navy can continue to safely conduct important research and training operations at Barking Sands in the future. Portions of the lands are encumbered by exclusive use and non-exclusive restrictive use easements. The API's common infrastructure is managed by the Kekaha Agriculture Association (DoN 2014a).

The Navy also leases an approximately 200-ac (81-ha) strip of land along Barking Sands' eastern border in the area of the U.S. Highway 50. The lease of this narrow strip of land allows the Navy to repair and maintain the drainage pumps that help to minimize flooding onto PMRF property and roadways during periods of heavy rainfall. In addition, the lease of this land is required because federal law forbids using public funds to maintain infrastructure on land that is not owned or leased by the federal government. In addition, the leased area supports Antiterrorism/Force Protection (AT/FP) setback requirements. Leasing this small area provides a buffer for PMRF allowing new construction within a larger area of the original installation boundary.

Figure 5-1. Agricultural Preservation Initiative Leased Lands

Restrictive Use Agreements

Missile flight safety procedures require that the public and nonessential mission personnel be excluded from hazardous areas to protect them in the unlikely event of an early flight termination. The U.S. Government is required by DoD policy to be able to exclude nonparticipants from hazardous areas. The off-base portion of the respective missile ground hazard areas is located adjacent to Barking Sands within a restrictive easement that was acquired from the SOH by the U.S. Government. PMRF holds this restrictive easement on 2,110 ac (854 ha) of land for safety purposes. The restrictive easement allows PMRF to clear the area up to 30 times per year.

Cooperative Agreement for Federally Listed Seabird Conservation

In 2002, the U.S Government implemented the Readiness and Environmental Protection Integration (REPI) program under USC 2684a. This program provides a process for agreements to be developed with eligible entities such as State, local, and private partners that ultimately aims to limit constraints on military training, testing, and operations and encroachments on mission success. In 2018, a REPI proposal submitted by CNRH, PMRF, and NAVFAC HI with the goal of addressing anticipated endangered seabird conservation encroachment issues at PMRF was validated and identified as a priority project for the Navy. REPI funding has been transferred to the National Fish and Wildlife Foundation for undertaking the management of conservation actions in areas off-site of PMRF for the conservation benefit of the Newell's Shearwater, Band-rumped Storm-petrel, and Hawaiian Petrel with implementation likely to occur in late 2019.

5.3.2.2 Climate Change

DoD recognizes climate change will play a significant role in its ability to fulfill its mission and undermine the capacity of our military installations to support training activities. As climate change

will affect both built and natural infrastructure, which will impact readiness and environmental stewardship responsibilities at installations across the nation, the DoD must employ creative ways to address the impact of climate change. In response to this need, DoD has developed a guide, *Climate Adaptation for DoD Natural Resource Managers,* to help installation managers address climate change considerations in INRMP (Stein et al. 2019).).

Potential climate change impacts to the DoD mission and operations are identified as various forms of extreme weather such as heat waves, drought, increasing wildland fire, excessive precipitation, flooding, storm surges, increases in storm frequency and intensity, and rises in sea levels and associated storm surge (Stein et al. 2019). However, more comprehensive and region or base-specific vulnerability assessments are needed to determine what adaptive responses are the most appropriate at individual bases. Climate change vulnerability assessments are a means of preparing for and coping with the effects of climate change (Glick et al. 2011). A vulnerability assessment is a key element in identifying which species or systems are likely to be the most strongly affected by projected changes in climate and provides a framework for understanding why particular species or systems are likely to be vulnerable, often depending on factors such as exposure, sensitivity, and adaptive capacity (Stein et al. 2019). This assessment allows for informed conservation planning by identifying climate-related threats and resulting stresses that become part of the decision-making process undertaken to identify and prioritize conservation strategies. Projecting future conditions and assessing the vulnerability of target natural resources are critical steps in assessing climate vulnerabilities and developing strategies to reduce climate risks (Stein et al. 2019).

Current research shows that in the Hawai‘ian Islands, air temperatures have risen rapidly in the past thirty years, rainfall and stream flow have steadily declined, and rainfall during the heaviest downpours has intensified (Codiga and Wager 2014). Sea levels in Hawai‘i are rising because of climate change and Hawai‘i is expected to experience sea-level rise of 1 ft (30.5 centimeter [cm]) by 2050 and 3 ft (91.4 cm) by the end of the century (Codiga and Wager 2014).

In the coastal area of Kaua‘i where Barking Sands is located, the key impacts associated with sea level rise will be coastal flooding and wave inundation, erosion, and inland flooding (Codiga and Wager 2014). The extensive shoreline at several of the PMRF facilities will also be susceptible to tsunami inundation (Commander Navy Region Hawai‘i 2012). **Figure 5-2** illustrates scenarios in which sea level rises by 1 and 3-foot (30.5 and 91.4-cm) intervals at PMRF Barking Sands. Although little land loss or threats to infrastructure at PMRF are expected, other impacts from inland flooding, saltwater intrusion, and some loss of sea birds and sea turtles nesting sites will be experienced. Drainage issues from increases in inundation of adjacent wetlands are expected. Access into Barking Sands may be restricted at times if Mānā Plain and the roads leading to the base are flooded.

Climate change is identified as an issue of concern for several natural resource management elements as well a specific threat to a number of the threatened and endangered species known to occur on or in the vicinity of PMRF that are addressed in this INRMP. Multiple projects and actions identified in **Appendix D** are focused on mitigating climate risk to these resources and the base’s military mission.

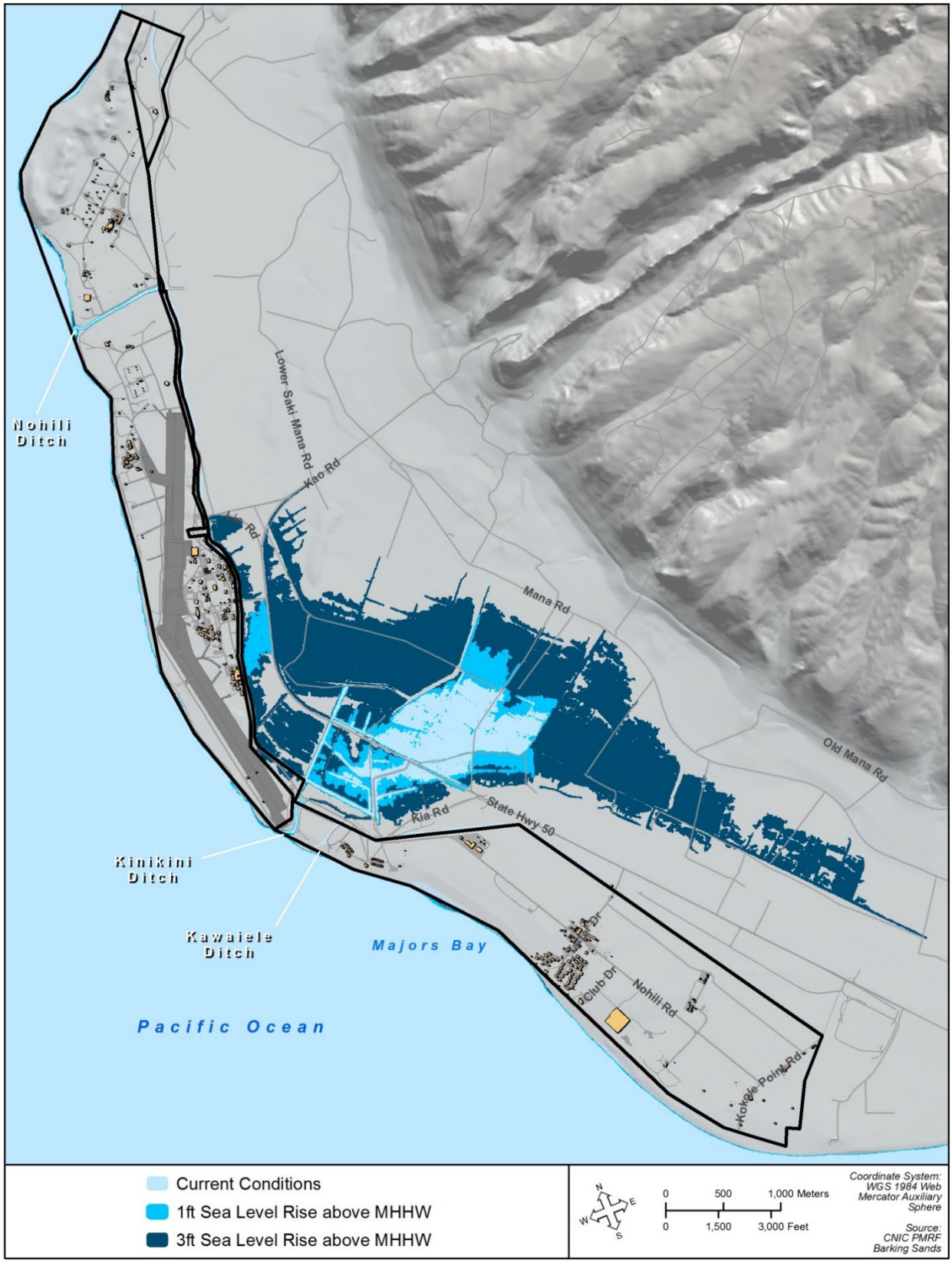
5.3.2.3 Energy Security

DoD's Energy Policy Directive, Department of Defense Directive (DoDD) 4180.01 of April 2014, which is aimed at improving DoD's energy security through increasing efficiency and diversifying energy resources will result in a major reduction in the use of fossil fuels and thereby reduce greenhouse gas emissions to help mitigate the effects of climate change greatly. The DoN's energy policy specifically requires the Navy to use all measures to minimize energy consumption, reduce energy expenditures, and utilize alternative energy resources and environmentally sustainable technologies where it is reasonable, affordable, and practical to do so (SECNAVINST 4101.3). In order to improve energy security, increase energy independence, and help lead the nation towards a clean energy economy, the DoN established energy goals that will move the Navy and Marine Corps away from a reliance on petroleum and will dramatically increase its use of alternative energy. In accordance with the Office of the Secretary of the Navy (2019), a number of goals were set and are being met:

- Energy Efficient Acquisition: DoN has issued policy guidance concerning the use of energy-related factors in acquisition planning, technology development, and source selections for platforms and weapons systems.
- Sail the "Great Green Fleet": DoN demonstrated alternative fuel blends on all ships and aircraft that participated in the 2012 Rim of the Pacific (RIMPAC) exercise. Ship and air systems operating with alternative fuel blends performed at full capability during the exercise.
- Reduce Non-Tactical Petroleum Use: DoN has significantly grown its fleet of alternative fuels-capable vehicles, is expanding its use of telematics to improve fleet performance and is working to deploy zero-emissions vehicles.
- Increase Alternative Energy Ashore: By 2020, DoN will produce at least 50 percent of shore-based energy requirements from alternative sources; 50 percent of DoN installations will be net-zero.
- Increase Alternative Energy Use DoN-Wide: The DoN has demonstrated certain alternative fuels to be effective drop-in replacements for conventional fossil fuels and qualified them to compete to supply fuel to the DoN through the Defense Logistics Agency Energy.

Preliminary site assessments being conducted for viability of regional Navy installations to be Net Zero, which means the amount of energy produced is equivalent to that which is utilized, indicate the potential for PMRF to become a Net Zero energy installation. At PMRF the two main initiatives are the Landfill Gas project and photovoltaic arrays. The Landfill Gas project will capture combustible gases from the adjacent County Kekaha Landfill and use them as fuel for energy production, whereas the photovoltaic array would use solar photovoltaic panels to produce solar electricity. These projects support Navy renewable energy goals at PMRF (Commander Navy Region Hawai‘i 2012). To ensure compliance with environmental statutes, the absence of impacts on sensitive resources, and cost effectiveness over the course of its lifetime, NEPA analysis must be conducted during the planning phase of any future projects. Natural resources personnel will have input in the site selection and review of potential impacts of any such project.

1


Nohili Ditch
Lower Saki Mana Rd
Kao Rd
Mana Rd
Old Mana Rd
Kia Rd
State Hwy 50
Kinikini Ditch
Kawaiele Ditch
Majors Bay
Pacific Ocean
Club Dr
Nohili Rd
Kokole Point Rd
Current Conditions
1ft Sea Level Rise above MHHW
3ft Sea Level Rise above MHHW
0 500 1,000 Meters
0 1,500 3,000 Feet
Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Source: CNIC PMRF Barking Sands

2

Figure 5-2. Predicted One and Three-Foot Sea Level Rise at Barking Sands

5.4 INRMP Review and Revision

This INRMP is a long-term planning document that requires periodic reviews of management goals and practices in order to provide the opportunity to incorporate new science and information as well as assess the performance of management actions. The Sikes Act requires that INRMPs be reviewed for operation and effect regularly by the installation, the USFWS, and appropriate state fish and wildlife agency (in this case, the SOH DOFAW) on a regular basis, but not less often than every five years. NOAA Fisheries is included in the five-year review if it participated in the INRMP development, if listed species are included in its jurisdiction or the near-shore environment is involved, or if the INRMP will benefit from its participation and review (DoDM 4715.03). The review for operation and effect is conducted to determine whether the installation is implementing the existing INRMP to meet Sikes Act requirements and are contributing to the conservation and rehabilitation of natural resources on military installations.

The decision on whether to update or revise the INRMP is based on the results of these reviews. An INRMP revision would be required if the current INRMP no longer provides adequately for the conservation and rehabilitation of the natural resources on the base, the installation mission or physical features have changed significantly, or there are substantial natural resources effects anticipated from base realignment and closure, such as: a new species listing, new construction, new training, changes to training type or tempo, or other factors that were not addressed in the existing INRMP. An INRMP may be simply updated to accommodate changes to the information contained in the INRMP that do not require substantial changes in the way natural resources on the base are to be managed.

5.4.1 Streamlined INRMP Review

A tripartite Memorandum of Understanding (MOU) between the DoD, USFWS, and the Association of Fish and Wildlife Agencies was signed in July 2013 that streamlines the review process for INRMP updates and DoD provided guidelines on the streamlined INRMP review process.

Per the MOU and DoD *Guidelines for Streamlined INRMP Review* (Office of the Assistant Secretary of Defense 2015), procedures for the streamlined review process are as follows:

1. Once the DoD component or installation determines that an INMRP update is appropriate, personnel will notify the USFWS and/or state offices with which they coordinate regarding their INRMP.This notification should be initiated by the DoD component or installation as soon as possible, and no less than 30 days prior to submitting the draft update for review.
2. The installation will submit a draft update to the appropriate state and USFWS field offices.
   a) The USFWS staff will review the draft update and respond to the installation within 15 calendar days of receipt.
   b) The USFWS field offices and states will provide comments (if any) on the draft update to the submitting installation a maximum of 60 calendar days, but preferably within 30 days, of receipt, unless the affected parties (i.e., the DoD component or installation and the states and/or USFWS offices) agree to a longer timeline for review.

c) If either state or federal review of a draft INRMP cannot be completed in the timeframe described above, then the USFWS and/or state office will notify the DoD component or installation, and provide an alternate timeline for the INRMP update review. If the parties cannot agree to a review timeline, the field office and/or installation may contact the Regional Sikes Act Coordinator who may help the field office(s) complete its review.

d) If there is disagreement concerning the conservation, protection, and management of fish and wildlife resources proposed in an INRMP update, all efforts will be made by the DoD component or installation, involved agencies, and Regional Sikes Act Coordinator to resolve those issues within the stated review timelines.

e) If USFWS and/or the states do not provide notification that an alternative timeline is needed within 60 days, the installation may, at its discretion, finalize the update.

3. Once complete, the installation shall submit a final update to the appropriate USFWS and state field offices, and to the Sikes Coordinator.

a) The states and USFWS field offices will respond and provide signature on the final update within a maximum of 60 calendar days, but preferably within 30 days, of receipt, unless the affected parties (i.e., the DoD component or installation and the states and/or USFWS offices) agree that a longer timeline for review is acceptable.

b) If the states and/or USFWS are unable to provide signature coordination within the applicable timelines, that agency will advise the DoD component or installation and the Regional Sikes Act Coordinator, explaining why the review and signature process cannot be completed within the designated timeframe, and offering an alternate date by which the review and signature can be completed. This notification will be given to the installation and the Regional Sikes Act Coordinator within 10 days of receipt of a final update. The Regional Sikes Act Coordinator will then coordinate with the states and the USFWS field office to ensure review and comment on the final update, discuss comments with the Regional Director, and prepare the Regional Director's response to DoD, if needed.

c) Once finalized, the updated INRMP will be considered reviewed for operation and effect, and will restart the five-year window for being compliant.

4. The USFWS field office will return the original concurrence letter or signature page to the DoD component or installation, and provide a copy of such (by mail, facsimile or electronic mail) to the Regional Sikes Act Coordinator and to the states.

INRMPS are considered compliant when all Navy endorsements, documentation of mutual agreement with USFWS and appropriate state fish and wildlife agency, and a documented review of operation and effect occur at least once every five years. A Navy-endorsed INRMP may be implemented (i.e., operational) without mutual agreement from USFWS or the State fish and wildlife agency only if: (1) a delay in the cooperative preparation process is documented as outlined in reference (e), or (2) the agency has objections based on the military mission of the installation and the Sikes Act's provision for no net loss to capability of the installation lands to support the installation's military mission. As operational INRMPs are technically not compliant INRMPs, all efforts must continue to obtain mutual agreement or endorsement from the other agencies (OPNAV-M 5090.1).

5.4.2 Annual Conservation Program Metrics Review

In addition to review of the INRMP review for operation and effect, DoD and Navy policy state that INRMPs must be reviewed annually by the installation with the cooperation of the statutory partners. Annual reviews are conducted to assess the INRMP goals and objectives, establish a realistic schedule for undertaking proposed actions, and determine adjustments needed to keep INRMPs current. It is recommended that the review for operation and effect be conducted during the annual INRMP metrics review.

Metrics have been developed to assess INRMP review and implementation, measure conservation efforts, ensure no net loss of military testing and training lands, understand the conservation program's installation mission support, and indicate the success of partnerships with the USFWS and SOH DLNR. This evaluation is facilitated by the web-based Metrics tool on the Navy Conservation Website: https://conservation.dandp.com. The metrics provide the means to evaluate performance in seven focus areas:

- Natural Resources Management
- Listed species and critical habitat
- Recreational use and access
- Sikes Act cooperation
- Team adequacy
- INRMP implementation
- INRMP support of the installation mission

The Installation Commanding Officer is required to participate in the annual natural resources program and INRMP metrics review. The Commanding Officer must further send a written report to USFWS and the appropriate state fish and wildlife agency following the annual INRMP metric review no later than 31 January of each year. The report must include the following:

- A copy of the invitation to the annual INRMP metric meeting, including a list of participants,
- An explanation and summary of INRMP metric results for the previous fiscal year,
- Description of INRMP actions implemented in the previous fiscal year,
- Description of benefits INRMP implementation provided to federally threatened and endangered species and/or benefits provided by the INRMPs Ecosystem Management for species that are proposed for listing or are candidates for listing under the ESA,
- Description of changes to be made to the INRMP as a result of the annual review, if any, and whether agreement was obtained with the USFWS to recognize the annual meeting as a review of the INRMP.

Annual reviews must also be documented and signed by these parties (DoDI 4715.03). Additionally, DoD produces an end-of-year Environmental Management Review, the Defense Environmental Programs Annual Report to Congress (DEPARC), to meet Congressional and in-house requirements from data derived from the annual metrics review. The report describes DoD's accomplishments during the past year in its restoration, conservation, compliance, and pollution prevention programs.

5.5 NEPA Analysis on INRMPs

Implementation of an INRMP is considered a major federal action requiring NEPA analysis. As a result, the Navy Office of General Counsel has determined that Sikes Act requirements for INRMP implementation necessitate the preparation of NEPA documentation prior to INRMP approval. It is expected that annual updates would be covered under the original NEPA documentation and therefore neither additional NEPA analysis nor an opportunity for public comment should be necessary unless there has been a major change in installation mission or program scope. However, a Memorandum for the Record or updated FONSI may be required to identify the previous NEPA document being relied on. An INRMP revision, however; which addresses management of any changes to listed species status, change in management of listed species, or may result in a significant environmental impact, including those not anticipated by the parties to the INRMP when the plan was last approved and/or reviewed does require new or supplemental NEPA analysis (OPNAV M-5090.1).

The NEPA process may be used to meet DoD's INRMP public review requirements and to document the decision to formally implement the INRMP. The NEPA process, however, will satisfy Sikes Act public comment requirements only if the public is provided a meaningful opportunity to comment upon the draft INRMP as part of the NEPA process. Absent some extraordinary circumstance, the public should be afforded a minimum of 30 days to review and comment upon the draft INRMP, whether as part of the NEPA process or through some other process.

Because of changes in protected species status and the proposed implementation of several protected species management plans, NEPA analysis and public comment were conducted in the development of this INRMP revision. An EA analyzing the potential effects of implementation of this INRMP was developed, provided for public review in local libraries and via the PMRF base website. The EA and comments received are in **Appendix G.**

5.5.1 Environmental Planning Library and Reporting Requirements

The OPNAV (N45) Environmental Planning Library website is an online, searchable electronic repository of completed Navy environmental planning documents covering Navy actions worldwide. The library also serves as a tool for the submission of required annual environmental planning and cooperating agency reports to the Navy Secretariat and other authority. Any Navy action proponent must upload environmental planning and associated compliance documents to the OPNAV (N45) Environmental Planning Library website as per OPNAV M-5090.1. In addition, the action proponent must input mitigation it has committed to implement in environmental planning decision documents to the mitigation reporting tool in the required reporting module of the Environmental Planning Library website.

5.5.2 Navy Conservation Website

The Navy Conservation Website is the Navy's official repository of natural resources information to track INRMP status and implementation measures for regulatory review; generate official reports; record DoN measures of merit and metrics; and centralize and track other documentation. It is a web-based tool used to submit, compile, and retrieve information about the Natural Resources Conservation Program to obtain and maintain the most current information possible to track the status of various

natural resources programs, have current data to respond to various program inquiries, and generate accurate reports.

5.6 Funding Priority and Strategy

This INRMP identifies a number of strategies to meet the natural resource objectives of PMRF. These actions include compliance requirements that must be performed to maintain compliance with laws and regulations, EOs, MOAs, and MOUs, as well as conservation actions that are necessary to ensure effective stewardship of public land entrusted to the U.S. Navy. Proactive management that focuses on efforts to prevent the listing of species at risk, which, if listed under the ESA, could adversely impact military readiness, and species protected by the MBTA and MMPA, is considered a priority funding by the Navy. Although funding priority is generally given to compliance-driven actions, stewardship actions will be carried out as funding and personnel become available. Actions that rely on volunteer labor and enjoy the support of the military community or have available alternate funding sources are also likely to be implemented. Funding is routinely programmed seven years in advance of project implementation. All projects and activities in the Implementation Table in **Appendix D** are assigned an Environmental Readiness Level (ERL), but many actions are completed using on-site personnel and are not part of the program budget.

5.6.1 Environmental Readiness Levels

Four levels of Navy environmental readiness have been established, which identify the specific types and scope of the capabilities required to provide each level. These ERLs enable capability-based programming and budgeting of environmental funding and facilitate required capability. The four ERLs are summarized from OPNAV M-5090.1 as defined below:

ERL 4. Environmental Readiness Level 4 are "must fund" conservation requirements that meet recurring natural and cultural resources conservation management or current legal compliance needs. ERL 4 supports all actions specifically required by law, regulation, or EO. Implementation of the INRMP anticipates the execution of all must fund projects and activities in accordance with specific timeframes indentified in the INRMP.

ERL 3. Supports requirements derived from DoD policy, Navy policy, or proactive initiatives that could result in obvious returns on investment and support critical readiness activities by decreasing encumbrances of statutory compliance. These EPRs/proposed efforts are not mandated by law or other federal, state, or local regulations or EOs but would minimize current or future impacts (including costs) to the Navy mission.

ERL 2. Supports proactive initiatives that result in speculative returns on investments and uncertain benefits to the Navy mission. These EPRs/proposed efforts are not mandatory by law or other Federal, state or local regulators, or EOs and should be based on best available scientific or commercial data; or pending Federal, state or local regulations.

ERL 1. Supports investments in environmental leadership and general proactive environmental stewardship.

5.6.2 Funding Sources

Operations and Maintenance, Navy (O&M, N) environmental funds are the primary source of resources to support reoccurring and non-reoccurring natural resources projects. Other environmental funding may be provided from the Naval Working Capital Fund (NWCF); military construction (MILCONs); Qualified Recycling Program revenues; and the Defense Logistics Agency Energy funds. PMRF does not hold any agricultural outleases and does not have a commercial forestry program; however, limited reimbursable funds from Fish and Wildlife Access Fees could be available for stewardship activities, if a base hunting program were established. Revenue collected from access fees may be used for the protection, conservation, and management of installation wildlife habitats and the hunting, fishing, and trapping programs.

Other special DoD initiatives to fund natural resources projects also may become available on a limited basis. In addition, alternate funding sources for special projects and initiatives may be sought from cooperative grants and partnership programs such as the DoD Legacy Program, National Public Lands Day grants, and Readiness and Environmental Protection Integration program. Application for these funds require a written proposal, are competitive, and often are cost-sharing opportunities.

5.6.3 Federal Anti-Deficiency Act

All actions contemplated in this INRMP are subject to the availability of funds as authorized and appropriated under federal law. Nothing in this INRMP is intended to be, nor must beconstrued to be a violation of the Anti-Deficiency Act (31 USC §1341 et seq.).

5.7 Staffing Needs

The Sikes Act requires, to the extent practicable using available resources, the Navy ensure that sufficient numbers of professionally trained natural resources management personnel and natural resources law enforcement personnel are available and assigned responsibility to perform tasks necessary to carry out natural resources management programs.

5.7.1 Professional Development and Natural Resources Training

OPNAV M-5090.1, Chapter 3 establishes Navy implementing policy guidance regarding environmental training and identifies required training for Navy personnel (including military, civilian, active duty, and reserve) to accomplish all Navy missions in an environmentally responsible manner, and to comply with federal, state, and local laws and regulations.

The Navy Environmental Readiness Training Program (NERTP) was developed to support the ability of the U.S. naval forces to effectively operate in an environmentally responsible manner. NERTP requirements are documented in the NERTP Navy Training System Plan (NTSP). NTSP lists formal courses, electronic learning, and other training vehicles authorized within NERTP.

A variety of formal Navy environmental training courses are available through the Civil Engineer Corps Officer School (CECOS) at Port Hueneme, California and Naval Safety and Environmental Training Center at Norfolk, Virginia. Any requirement submitted for training outside of these two venues requires detailed justification as to why it cannot be accommodated within these programs. A

list of courses offered and billet-specific environmental training requirements are identified in OPNAV M-5090.1, Table 2-1.

Required courses for PMRF Environmental Program personnel include:

EIPM: (1) Basic Environmental Law (A-4A-0058) and (2) Management of multiple environmental media (completion of CECOS Advanced Environmental Management (A-4A-0063) will satisfy this requirement).

Personnel with Co-Lateral Environmental Duties: Navy environmental program orientation training (completion of CECOS Environmental Protection (A-4A-0036) will satisfy this requirement).

Other courses that may be pertinent to natural resources management at PMRF include:

- Advanced Environmental Management (A-4A-0063)
- Environmental Negotiation Workshop (A-4A-0067)
- Environmental Protection (A-4A-0036)
- Natural Resources Compliance (A-4A-0087)

Participation in the annual National Military Fish and Wildlife Associate training session, held in March in various locations across the nation, provides additional training and opportunity to interact with other natural resources managers from installations worldwide. Workshops and training sessions on emerging issues, successful management techniques, and application of new technologies and procedures are typical offerings. Other course options are also available such as DoD online training and the USFWS National Conservation Training Center.

This page left blank.

6.0 REFERENCES

AECOM. 2013. Draft Environmental Assessment Kekaha Landfill Phase II Vertical Expansion Kekaha, Kauaʻi, Hawaiʻi. Prepared for County of Kauaʻi Department of Public Works, Līhuʻe, Hawaiʻi.

Ampela, K. J.R. Mobley Jr., M.W. Richie, J.A. Rivers, and R.K. Uyeyama. 2015. Aerial and Ground-based Shoreline Surveys for Marine Mammals and Sea Turtles in the Hawaiʻi Range Complex: SCC 12-13 August 2013. Final Field Report. Prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command, Pacific, Pearl Harbor Hawaiʻi, under Contract No. N62470-10-D-3011. CTO KB22 issued to HDR, Inc. Honolulu, Hawaiʻi.

Anders, A.D., Burger, J.R., and V.E. Pepi. 2009. Barking Sands, PMRF, proposed Laysan albatross management plan to reduce birdaircraft strike hazard potential. NAVFAC Pacific.

Bailey, R. 1995. Description of the Ecoregions of the United States. USDA Forest Service Miscellaneous Publication No. 1391.

Baird, R. W. 2005. Sightings of dwarf (*Kogia sima*) and pygmy (*K. breviceps*) sperm whales from the main Hawaiian Islands. Pacific Science 59(3):461-466. https://doi.org/10.1353/psc.2005.0031

Baird, R., D. Webster, R. Morris, B. Rone, S. Mahaffy, a. Gorone, D. Anderson, E. Henderson, S. Martin, D. Moretti. 2017. Odontocete Studies on the PMRF in February 2016: Satellite-Tagging, Photo-Identification, and Passive Acoustic Monitoring. Final Report. Prepared for Commander, Pacific Fleet. Submitted to Naval Facilities Engineering Command Pacific, Pearl Harbor, Hawaiʻi, under Contract No. N62470-15-D-8006, Task Order KB08 issued to HDR Inc., Honolulu, Hawaiʻi.

Baird, R.W., D.L. Webster, S.M. Jarvis, K.A. Wood, C.J. Cornforth, S.D. Mahaffy, K.K. Martien, K.M. Robertson, D.B. Anderson, and D.J. Moretti. 2018. Odontocete studies on the Pacific Missile Range Facility in August 2017: satellite-tagging, photo-identification, and passive acoustic monitoring. Prepared for Commander, Pacific Fleet, Pearl Harbor, HI.

Baird, R.W., D.L. Webster, S.M. Jarvis, E.E. Henderson, S.L. Watwood, S.D. Mahaffy, B.D. Guenther, J.K. Lerma, C.J. Cornforth, A.W. Vanderzee and D.B. Anderson. 2019. Odontocete studies on the Pacific Missile Range Facility in August 2018: satellite tagging, photo-identification, and passive acoustic monitoring. Final report. Prepared for Commander, Pacific Fleet, Environmental Readiness Division, Pearl Harbor, HI. Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, EV2 Environmental Planning, Pearl Harbor, HI, under Contract No. N62470-15-D-8006 Task Order 6274218F0107 issued to HDR Inc., Honolulu, HI. June 2019.

Baird, R.W., S.D. Mahaffy, and J.K. Lerma. 2021a. Site Fidelity, Spatial Use, and Behavior of Dwarf Sperm Whales in Hawaiian Waters: Using Small-Boat Surveys, Photo-Identification, and Unmanned Aerial Systems to Study a Difficult-to-Study Species. *Marine Mammal Science 38*(1), 326-348. doi: 10.1111/mms.12861

Baird, R. W., C. J. Cornforth, S. M. Jarvis, N. A. DiMarzio, K. Dolan, E. E. Henderson, S. W. Martin, S. L. Watwood, S. D. Mahaffy, B. D. Guenther, J. K. Lerma, A. E. Harnish, and M. A. Kratofil.

2021b. Odontocete Studies on the Pacific Missile Range Facility in February 2020: Satellite-Tagging, Photo-Identification, and Passive Acoustic Monitoring. Prepared for Commander, Pacific Fleet, under Contract No. N62470-15-D-8006 Task Order N6274219F0101 issued to HDR Inc., Honolulu, HI.

Baird, R.W., C.J. Cornforth, K.A. Wood, S.E. Vasquez, A.E. Harnish, and M.A. Kratofil. 2022. Small-boat surveys and satellite tagging of odontocetes on the Pacific Missile Range Facility , Kauaʻi, in August 2021. Field survey report to U.S. Pacific Fleet by HDR, under Federal contract number N6247020D0016, Task Order No. N6274221F0107

Barbieri, M.M., L. Kashinsky, D.S. Rotstein, K.M. Colegrove, K.H. Haman, S.L. Magargal, A.R. Sweeny, A.C. Kaufman, M.E. Grigg, C.L. Littnan. Protozoal-related mortalities in endangered Hawaiian monk seals Neomonachus schauinslandi. Dis Aquat Organ. 1016 Sep 26; 121(2):85-95. https://doi.org/10.3354/dao03047.

Belt Collins. 2014. Draft Environmental Assessment ICSD Radio Facility Upgrade at Mauna Kapu. Prepared for Department of Accounting and General Services Information and Communication Services Division. Prepared by Belt Collins Haii LLC, Honolulu, Hawaiʻi.

Bird, C. and R. Toonen. 2014. The State of ʻOpihi Populations at the PMRF, Kauaʻi, Hawaiʻi. Under USACE SWF Cooperative Agreement No. W9126G-12-2-0066.

Bishop Museum. 2015. Offshore Islet Project. <http://www2.bishopmuseum.org/HBS/islets/index.asp?isl=Kaua\%27i%20and%20Ni\%27ihau&id=-21495405>. Accessed 20 July 2016.

Bonaccorso, F. and C. Pinzari. 2011. Hawaiian Hoary Bat Occupancy at the PMRF and Satellite Facilities. U.S. Geological Survey, Pacific Island Ecosystems Research Center and Hawaiʻi Cooperative Studies Unit, University of Hawaiʻi.

Bonfil, R., S. Clarke, and H. Nakano. 2008. The Biology and Ecology of the Oceanic Whitetip Shark, *Carcharhinus longimanus*. In M.D. Camhi, E. K. Pikitch, and E. A. Babcock (Eds.), Sharks of the Open Ocean: Biology, Fisheries, and Conservation. Oxford, U.K.: Blackwell Publishing Ltd.https://www.researchgate.net/publication/230013365.

Bruland, G. 2009. Soil Survey and LUCCs. University of Hawaiʻi at Mānoa, College of Tropical Agriculture and Human Resources. <http://www.ctahr.Hawaiʻi.edu/brulandg/teaching/46120%20Soil%20Survey%20LUCC.pdf>. Accesssed 20 July 2016.

Bruner, P. 2000. Survey of Avifauna and Feral Mammals for the INRMP PMRF, Barking Sands, Kauaʻi, Hawaiʻi.

Burger, J.R., Pepi, V.E., and A.D. Anders. 2009. Barking Sands, PMRF Threatened and Endangered Seabird Tower Strike and Fallout Monitoring, October-December 2008.

Carretta, J.V., K.A. Forney, E. M. Oleson, D.W. Weller, A.R. Lang, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2018. U.S. Pacific Marine Mammal Stock Assessments: 2017. US Department of Commerce. NOAA Technical Memorandum NMFS-SWFSC-602. https://doi.org/10.7289/V5/TM-SWFSC-602

Char, W.P. 2000a. Botanical Survey of Barking Sands, for the INRMP, PMRF, Barking Sands, Kaua‘i, Hawai‘i.

Char, W.P. 2000b. Botanical Survey of Mākaha Ridge for the INRMP PMRF, Barking Sands, Kaua‘i, Hawai‘i. June 2000.

Char, W.P. 2000c. Botanical Survey of Kokee Sites for the INRMP for PMRF, Barking Sands, Kaua‘i, Hawai‘i. June 2000.

Char, W.P. 2000d. Botanical Survey of Kamokala for the INRMP PMRF, Barking Sands, Kaua‘i, Hawai‘i. June 2000.

City Data. 2015. Kehaka, Hawai‘i. <http://www.city-data.com/city/Kekaha-Hawai‘i.html>. Accessed 8 August 2016.

Codiga D. and K. Wager. 2014. Sea-Level Rise and Coastal Land Use in Hawai‘i: A Policy Tool Kit for State and Local Governments. 2011. Center for Island Climate Adaptation and Policy. University of Hawai‘i Sea Grant College Program Honolulu, HI. < https://seagrant.soest.hawaii.edu/hawaii-slr-policy-tool-kit/>. Accessed 6 July 2022.

College of Tropical Agriculture. 2010. Weeds of Hawai‘i. <https://www.ctahr.Hawai‘i. edu/invweed/weedsHi.html>. Accessed 20 September 2017.

Commander, Navy Installation Command (CNIC). 2015. PMRF Barking Sands. <http://cnic.navy.mil/regions/cnrh/installations/pacific_missile_range_facility_barking_sands/om /beach-access.html>.

Currents. Summer 2016. PMRF Establishing New Hives to Protect Honey Bee Populatins and Minimize Interference with Base Activities. <http://greenfleet.dodlive.mil/currents-magazine/currents-magazine-2016/summer-2016/>. Accessed 19 January 2017.

Deakos, M.H., K. West and J.R. Mobley, Jr. 2017. Aerial Shoreline Surveys for Marine Mammals and Sea Turtles in the Hawaii Range Complex, Conducted after Navy Training Events. Five-Year Summary Report 2010–2014. Final Report. Prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command Pacific, Pearl Harbor, Hawai‘i under Contract No. N62470-10-D-3011, CTO KB28 issued to HDR Inc., Honolulu, Hawai‘i. June 2017.

Department of Defense (DoD). 2000. DoD Coral Reef Protection Implementation Plan. Office of the Assistant Secretary of the Navy (Installations and Environment) Legacy Resource Management Program Grant DACA87-00-H-0021.

Department of the Navy (DoN). 1976. Environmental Impact Assessment, Ka‘ula Island Target, Hawai‘i, in Pepi et al. 2009.

Department of the Navy (DoN). 1998. PMRF Enhanced Capability Biological Assessment. Prepared for Commander, PMRF, Kekaha, Hawai‘i.

Department of the Navy (DoN). 2001. PMRF INRMP. Prepared by Belt Collins. October 2001.

Department of the Navy (DoN). 2005. Marine Resources Assessment for the Hawaiian Islands Operating Area. Prepared by Geo-Marine, Inc. Hampton, Virginia for NAVFAC PAC. December 2005.

Department of the Navy (DoN). 2008a. Hawai‘i Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement. May 2008.

Department of the Navy (DoN). 2008b. Hawai‘i Range Complex Monitoring Plan. December 2008.

Department of the Navy (DoN). 2010. Integrated Natural Resource Management Plan Update, PMRF, Kaua‘i, O‘ahu, Ni‘ihau, Ka‘ula Islands, State of Hawai‘i.

Department of the Navy (DoN). 2012a. Integrated Cultural Resources Management Plan for the PMRF, Kaua‘i Island, State of Hawai‘i FY 2012 – 2017.

Department of the Navy (DoN). 2012b. Integrated Natural Resources Management Plan Ni‘ihau Addendum. Commander, Navy Region Hawaii.

Department of the Navy (DoN). 2014a. Encroachment Action Plan, PMRF Island of Kaua‘i, Ni‘ihau, O‘ahu, and Ka‘ula, State of Hawai‘i.

Department of the Navy (DoN). 2014b. Marine Species Monitoring for the U.S. Navy’s Hawai‘i Range Complex, 2013 Annual Report. March 2014.

Department of the Navy (DoN). 2014c. Revised Biological Assessment; Effects of Base Infrastructure and Maintenance of Federally Threatened and endangered Species at PMRF Kaua‘i, Hawai‘i. Prepared for USFWS, Pacific Islands Fish and Wildlife Office, Prepared by NAVFAC Pacific, Pearl Harbor, Hawai‘i.

Dollar, S. and R. Brock. 2000. Survey of Marine and Fishery Resources, for the INRMP for PMRF, Barking Sands, Kaua‘i, Hawai‘i. Prepared for Belt Collins Hawai‘i.

Dollar, S. and R. Brock. 2007. Marine and Fishery Resources, for the INRMP for PMRF, Barking Sands, Kaua‘i, Hawai‘i, Phase II-2006. Prepared for Commander, Navy Region Hawai‘i Navy Regional Environmental Department.

eBird. (2021). eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. Accessed: June 3, 2021.

Fisher, H. 1951. The Avifauna of Ni‘ihau Island, Hawaiian Archipelago. *The Condor* Vol. 53.

Fletcher, C.H. and E. Fiersten. 2009. Hawai‘i, *In*: The Worlds Coastal Landforms, Bird, E.C.F. (ed.), Chapter 1.16, Springer Verlag, Heidelberg.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte. 2013: Online Rainfall Atlas of Hawai‘i. Bull. Amer. Meteor. Soc. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.

Glick, P., B.A. Stein, and M.A. Edelson, eds. 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington D.C. http://www.nwf.org/~/media /PDFs/Global-Warming/Climate-Smart-Conservation/NWF ScanningtheConservationHorizonFINAL92311.pdf?dmc=1&ts=20130329T0843048750.

Google Earth. 2018. Data SOEST/UHM© 2018 Google.

Hamer Environmental, L.P. 2016. Study of Nocturnal Seabird Activity at PMRF, Kauaʻi. Using Ornithological Radar, Thermal Imagery, and Auitory Survey Techniques. Prepared for NAVFAC Hawaiʻi.

Harting, A.L., M.M. Barbieri, J.D. Baker, T.A. Mercer, T.C. Johanos, S.J. Robinson, C.L. Littnan, K.M. Colegrove, D.S. Rotstein. 2021. Population-level impacts of natural and anthropogenic causes-of-death for Hawaiian monk seals in the main Hawaiian Islands. Mar Mam Sci. 37(1): 235-250. 2021. https://doi.org/10.1111/mms.12742.

Hawaiʻi Invasive Species Council. 2015a. Official Designation of Invasive Species. <http://dlnr.Hawaiʻi.gov/hisc/info/policy/>.

Hawaiʻi Invasive Species Council. 2015b. Strategic Plan 2015 – 2020. <http://dlnr.Hawaiʻi.gov/hisc/plans/>.

Hawaiʻi Invasive Species Council. 2016. <http://dlnr.Hawaiʻi.gov/hisc/info/coconut-rhinoceros-beetle-response-updates/>.

Hawaiʻi Wildfire Management Organization (HWMO). 2017. Communities at Risk from Wildfire, State of Hawaiʻi Map. <http://www.hawaiiwildfire.org/fire-resource-library/>.

Hebshi, A. 2007 PMRF Wedge-Tailed Shearwater Population Survey Project Summary. Prepared for NAVFAC Pacific.

Herring, R. and R. Johnson. 2017. PMRF FY17 Second Quarter Report. Prepared by University of Hawaiʻi, Office of Research Services for NAVFAC HA under Contract # W9126G-16-2-004.

Hunt, C.D. 1996. Geohydrology of the island of Oʻahu, Hawaiʻi. Regional Aquifer-System Analysis Oʻahu, Hawaiʻi. U.S. Geological Survey Professional Paper 1412-B.

Interagency Marine Debris Coordinating Committee. 2014. 2012-2013 Progress Report on the Implementation of the Marine Debris Act. <http://marinedebris.noaa.gov/sites/default/files/imdccreport_2013_0.pdf>.

Juvik, S.P. and J.O. Juvik (Eds.) 1998. Atlas of Hawaiʻi. Third Edition. University of Hawaiʻi Press, Honolulu, Hawaiʻi.

Kauaʻi Invasive Species Council (KISC). 2015. KISC Pests. <http://www.kauaiisc.org/kiscpests/>.

Kauaʻi Invasive Species Committee (KISC). 2017. Draft KISC Strategic Plan 2017 to 2022. <http://www.kauaiisc.org/wp-content/uploads/KISC_Strategic_Plan_2017_2022.pdf>. Accessed 20 September 2017.

Kōkeʻe Resource Conservation Program. 2015. KRCP's Most Wanted List. <https://sites.google.com/site/krcpmostwanted/home>.

Kleidosty, K. 2011. Surveys of Nocturnal Seabird Collisions with Communications Towers at Multiple PMRF Sites on Kauaʻi: 2010 Results. Prepared for: NAVFAC Pacific, Pearl Harbor, Hawaiʻi.

Kleidosty. K. 2016. Surveys of Nocturnal Seabird Collisions with Communications Towers at Multiple PMRF Sites on Kauaʻi: 2016 Results. Prepared for: NAVFAC Pacific, Pearl Harbor, Hawaiʻi.

Lopez, J. T. Wurth, and C. Littnan. 2014. Report on Hawaiian Monk Seals Surveys on Niʻihau Island, 2014. Protected Species Division, Pacific Islands Fisheries Science Center, NOAA Fisheries Hawaiian Monk Seal Research Program, Honolulu, Hawaiʻi.

Manu Kai. 2010. Integrated Pest Management Plan for PMRF with Contractors Work Plan. Prepared by Manu Kai under Contract No. N00604-09-D-0001.

Miller, J., M. Ericksen, A. Agustin, S. Dollar, A. Millan. 2022. Fieldwork Plan for Biological and Benthic Habitat Surveys in Support of the Pacific Missile Range Facility Barking Sands Integrated Natural Resources Management Plan, January 2022. Prepared by CARDNO GS-AECOM PACIFIC JV. Submitted to NAVFAC Pacific for Commander, Navy Region Hawaii. 74 pp.

Mink, J.F. and L.S. Lau. 1992. Aquifer Identification and Classification for Kauaʻi: Groundwater Protection Strategy for Hawaiʻi. Technical Report No. 186. Water Resources Research Center, University of Hawaiʻi at Manoa, Honolulu, Hawaiʻi.

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. Hawaiʻi's Comprehensive Wildlife Conservation Strategy. Department of Land and Natural Resources. Honolulu, Hawaiʻi.

Mobley, J.R. Jr., S.W. Martin, R. Manzano-Roth, and M.H. Deakos. 2017. Aerial Survey Monitoring for Marine Mammals and Sea Turtles in the Hawaiʻi Range Complex in Conjunction with Navy Training Events: Submarine Commanders Course 17-18 February 2015 & 2016. Final Report. Prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command, Pacific, Pearl Harbor Hawaiʻi, under Contract No. N62470-10-D-3011. CTO KB28 issued to HDR, Inc. Honolulu, Hawaiʻi.

National Marine Fisheries Service (NMFS). 2007. Recovery Plan for the Hawaiian Monk Seal *(Monachus schauinslandi)*. August 2007.

National Marine Fisheries Service (NMFS). 2008. Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaiʻi Range Complex 2008-2013. December 2008.

National Marine Fisheries Service (NMFS). 2009. Final Biological Opinion on 2009 Letter of Authorization for U.S. Navy Activities in the Hawaiʻi Range Complex. January 2009.

National Marine Fisheries Service (NMFS). 2014a. False Killer Whale (*Pseudorca crassidens*): Hawaiian Islands Stock Complex – Main Hawaiian Islands Insular, Northwestern Hawaiian Islands, and Hawaiʻi Pelagic Stocks. http://www.nmfs.noaa.gov/pr/sars/2013/po2013_falsekillerwhale-hi.pdf.

National Marine Fisheries Service (NMFS). 2014b. Hawaiian Monk Seal (*Monachus schauinslandi*) Stock Report. http://www.nmfs.noaa.gov/pr/sars/2013/po2013_monkseal-hi.pdf.

National Marine Fisheries Service (NMFS). 2014c. Spinner Dolphin (*Stenella longirostris*). https://www.fisheries.noaa.gov/species/spinner-dolphin.

National Marine Fisheries Service (NMFS). 2015. Endangered and Threatened Species: Final Rulemaking To Revise Critical Habitat for Hawaiian Monk Seals. Federal Register, Vol. 80, No. 162, (21 AUG 2015), 80 FR 50926-50988.

National Marine Fisheries Service (NMFS). 2016a. Corals. https://www.fisheries.noaa.gov/corals.

National Marine Fisheries Service (NMFS). 2016b. Endangerd Species Act Status Review Report: Giant Manta Ray (*Manta birostris*), Reef Manta Ray (*Manta alfredi*). Report to National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. September 2017.

National Marine Fisheries Service (NMFS). 2016c. Green Turtle (*Chelonia mydas*). <http://www.nmfs.noaa.gov/pr/species/turtles/green.html>.

National Marine Fisheries Service (NMFS). 2016d. Humpback Whale (*Megaptera novaeangliae*). <http://www.fisheries.noaa.gov/pr/species/mammals/whales/humpback-whale.html>.

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2018. <https://www.fisheries.noaa.gov/species-directory>.

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2019. About Us. <https://www.fisheries.noaa.gov/about-us>.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1998. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service (NMFS). Hawaiian Monk Seal Research Program, Pacific Islands Fisheries Science Center. 2019. Population Summary for Hawaiian Monk Seals in 2019. PIFSC Internal Report IR-20-001.

National Weather Service (NWS) Forecast Office – Honolulu, HI. 2007. Climate of Hawai‘i. <http://www.prh.noaa.gov/hnl/pages/climate_summary.php>.

National Weather Service (NWS). 2009. Hydrology of Hawai‘i. <http://www.prh.noaa.gov/hnl/hydro/pages/Hawai‘i-hydrology.php>.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2005. PMRF Conservation Mapping.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006a. PMRF Barking Sands INRMP Bird Survey. May 2006.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006b. PMRF Barking Sands INRMP Botanical Survey. May 2006.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006c. Herpetological and Mammal Surveys at PMRF. April 2006.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006d. PMRF Bird Surveys. October 2006.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006e. PMRF Mākaha Ridge INRMP Botanical Survey.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006f. PMRF Kokee INRMP Botanical Survey.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2006g. PMRF Kamokala Ridge Magazine INRMP Botanical Survey.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2008. Wedge-Tailed Shearwater Conservation at Barking Sands, PMRF, Kaua‘i, Hawai‘i. Prepared by V. Pepi.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2009. Wedge-Tailed Shearwater Conservation at Barking Sands, PMRF, Kaua‘i, Hawai‘i. Prepared by V. Pepi.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2014. Revised Biological Assessment on the Effects of Base Infrastructure Operations and Maintenance on Federally Threatened and Endangered Species at PMRF, Kaua‘i, Hawai‘i.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2016a. Surveys for *Panicum niihauense* and Long-thorn Kiawe Monitoring at Pacific Missile Range Facility. Prepared by NAVFAC Pacific, Natural Resources for NAVFAC Hawaii and Pacific Missile Range Facility.

Naval Facility Engineering Command Pacific (NAVFAC PAC). 2016b. Aerial Survey of Seabirds and Marine Mammals at Ka‘ula Island, Hawai‘i. Prepared for NAVFAC PAC by Normandeau Associates, Inc. and APEM, Ltd. Joint Venture.

Ni‘ihau Cultural Heritage Foundation. 2009a. Ni‘ihau Today. Kalāheo, HI. <http://www.niihauheritage.org/niihau_today.html>.

Ni‘ihau Cultural Heritage Foundation, 2009b. Ni‘ihau History. Kalāheo, HI. <http://www.niihauheritage.org/niihau_history.html>.

Nyberg, B. 2019. Endangered Plant Surveys using Unmanned Aerial Vehicle Makaha Ridge Facility. Prepared for Naval Facilities Engineering Command Hawai‘i, by Ben Nyberg - GIS Consultant, Kapaa, HI.

Office of the Secretary of the Navy. 2019. U.S. Navy Energy, Environment, and Climate Change. < https://navysustainability.dodlive.mil/energy/#Shore>.

Office of the Assistant Secretary of Defense. 2015. Guidelines for Streamlined INRMP Review.

Oki, D.S. 2003. Surface Water in Hawai‘i. U.S. Geological Survey Fact Sheet 045-03. <http://pubs.usgs.gov/fs/fs04503/>.

Oki, D.S., S.B Gingerich, and R.L Whitehead. 1999. Hawai‘i. In Ground Water Atlas of the United States, Segment 13, Alaska, Hawai‘i, Puerto Rico, and the U.S. Virgin Islands: U.S. Geological Survey Hydrologic Investigations Atlas 730-N, p. N12–N22, N36. <http://pubs.usgs.gov/ha/730n/report.pdf>.

Pepi, V.E., A. Kumar, M.E. Laut, J. Hallman, J. Kim, and A.D. Anders. 2009. Ka‘ula Island ship-based seabird and marine mammal surveys, 21-22 July 2009. Prepared for Commander, Pacific Fleet. NAVFAC Pacific.

Pacific Missile Range Facility (PMRF). 2018. Audubon Christmas Bird Count Survey. 4 Janyary 2018.

Pyle, R.L., and P. Pyle. 2017. The Birds of the Hawaiian Islands: Occurrence, History, Distribution, and Status. B.P. Bishop Museum, Honolulu, HI. Version 2 (1 January 2017) <http://hbs.bishopmuseum.org/birds/rlp-monograph>.

Raine, A. 2012. Summary of Song Meter work undertaken at PMRF in 2012 by the Kauai Endangered Seabird Recovery Project. Prepared for PMRF.

Raine, A., N. Holmes, M. Travers, B. Cooper, and R. Day. 2017. Declining population trends of Hawaiian Petrel and Newell's Shearwater on the island of Kauaʻi, Hawaii, USA. The Condor 119(3):405-415. 2017. https://doi.org/10.1650/CONDOR-16-223.1

Richie, M., R. Uyeyama, J. Fujimoto. 2012. Kaʻula Ship-Based Marine Mammal Surveys, July 6, 2012, Hawaiʻi Range Complex Field Report. Prepared for Commander, U.S. Pacific Fleet.

Rubin, K. 2013. The Formation of the Hawaiian Islands. Hawaiʻi Center for Volcanology. <https://www.soest.Hawaiʻi.edu/GG/HCV/haw_formation.html>.

Santos, R.G., R. Andrades, M.A. Boldrini, and A.S. Martin. 2015. Debris ingestion by juvenile marine turtles: An underestimated problem. Marine Pollution Bulletin 93(1-2), 37-43.

Smith, C.W. and J.T. Tunison. 1992. Fire and Alien Plants in Hawaiʻi: Research and Management Implecatins for Native Ecosystems. Pgs 384 – 408. In Stone, C. P., C. W. Smith, and J. T. Tunison (eds.), Alien plant invasions in native ecosystems of Hawaiʻi: Management and research. University of Hawaiʻi Cooperative National Park Resources Studies Unit. Honolulu, Hawaiʻi.

Smith, L.W. 2019. Status Review Report: Pocillopora meandrina. National Marine Fisheries Service, Pacific Islands Regional Office, Honolulu

State of Hawaiʻi (SOH). 2013. 2013 State of Hawaiʻi Data Book: Geography and Environment. <http://dbedt.Hawaiʻi.gov/economic/databook/db2013/>.

State of Hawaiʻi Division of Forestry and Wildlife (SOH DLNR). 2005. Hawaiʻi's Comprehensive Wildlife Conservation Strategy.

State of Hawaiʻi Department of Land and Natural Resources (SOH DLNR) and Department of Navy (DoN). 1998. Pacific Missile Range Facility Enhanced Capability, Final Environmental Impact Statement. December 1998.

State of Hawaiʻi Department of Land and Natural Resources (SOH DLNR). 2009. Honouliuli Forest Reserve Acquisition Fact Sheet. <http://dlnr.Hawaiʻi.gov/ecosystems/files/2013/09/llcp-info-sheet_FY09-Honouliuli.pdf>.

State of Hawaiʻi Department of Land and Natural Resources (SOH DLNR). 2014. Kōkeʻe and Waimea Canyon State Parks Master Plan. Prepared by the Division of State parks and R.M. Towill Corporation. <http://dlnr.Hawaiʻi.gov/dsp/files/2015/03/hsp_Kokee_master_plan_final.pdf>.

State of Hawaiʻi Department of Land and Natural Resources (SOH DLNR). 2015. Hawaiʻi's State Wildlife Action Plan. Prepared by H. T. Harvey and Associates, Honolulu, Hawaiʻi.

State of Hawaiʻi Department of Land and Natural Resources Division of Aquatic Resources (SOH DLNR DAR). 2009. Invasive Fish Control and Eradication: A Preliminary Plan for the Kawaile Bird Sanctuary, Mānā Plain Conservation Area, Kauaʻi, Hawaiʻi.

State of Hawai‘i Division of Forestry and Wildlife (SOH DOFAW). 2013. Hawai‘i’s Comprehensive Wildlife Conservation Strategy. State of Hawai‘i Department of Land and Natural Resources. Lo‘ulu *Pritchardia aylmer*-robinsonii Fact Sheet. <http://dlnr.Hawai‘i.gov/wildlife/files/2013/09/Fact-Sheet-Pritchardia-aylmer-robinsonii.pdf>.

State of Hawai‘i Division of Forestry and Wildlife (SOH DOFAW). 2015. Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance Document. Prepared by A. Amlin and A. Siddiqi.

State of Hawai‘i Division of Aquatic Resources (SOH DLNR DAR). 2015. Regulated Areas. <http://dlnr.Hawai‘i.gov/dar/fishing/fishing-regulations/regulated-areas/>.

State of Hawai‘i Division of Forestry and Wildlife (SOH DOFAW). 2013. Partnerships Bring Hope for Hawaiian Tree Snail. <http://dlnr.Hawai‘i.gov/ecosystems/featured/hope-for-hawaiian-tree-snails/>.

State of Hawai‘i Division of Forestry and Wildlife (SOH DOFAW). 2014. Final Environmental Assessment, Mānā Plain Wetland Restoration Project at the Mānā Plains Forest Reserve, Island of Kaua‘i. <http://oeqc.doh.Hawai‘i.gov/Shared%20Documents/EA_and_EIS_Online_Library/Kauai/2010s/2014-02-08-KA-5B-FEA-Mana-Plain-Wetland-Restoration-Project.pdf>.

State of Hawai‘i Division of Forestry and Wildlife (SOH DOFAW). 2019. Welcome to Division of Forestry & Wildlife. https://dlnr.hawaii.gov/dofaw/

State of Hawai‘i Land Use Commission (SOH LUC). 2012. Land Use Maps of Hawai‘i. <http://luc.Hawai‘i.gov/maps/land-use-district-boundary-maps/>.

Stein, B. A., D. M. Lawson, P. Glick, C. M. Wolf, and C. Enquist. 2019. Climate Adaptation for DoD Natural Resource Managers: A Guide to Incorporating Climate Considerations into Integrated Natural Resource Management Plans. Washington, D.C.: National Wildlife Federation.

Telfer, T. 1998. Ka‘ula Rock survey trip report, November 16-17, 1998. U.S. Fish and Wildlife Service, Hawai‘i Dept. of Land and Natural Resources, and the U.S. Navy, Ka‘ula Island, Hawai‘i.

The Nature Conservancy (TNC). 2007. The Hawaiian High Island Ecoregion. <http://www.hawaiiecoregionplan.info/ecoregion.html>.

Tilling, R.I., Heliker, C., and Swanson D.A. 2010. Eruptions of Hawaiian volcanoes-Past, present, and future: U.S. Geological Survey General Information Product 117. <http://pubs.usgs.gov/gip/117/gip117.pdf>.

University of Hawai‘i. 2009. Native Plants Hawai‘i, *Spermolepis hawaiiensis.* <http://www.nativeplants.hawaii.edu/plant/index>.

University of Hawai‘i. 2013a. Coastal Geology Group – Kaua‘i. <http://www.soest.Hawai‘i.edu/coasts/publications/hawaiiCoastline/kauai.html>.

University of Hawai‘i. 2013b. Coastal Geology Group – O‘ahu. <http://www.soest.Hawai‘i.edu/coasts/publications/hawaiiCoastline/oahu.html>.

University of Hawai‘i. 2013c. Geology Group School of Ocean and Earth Sciences and Technology. Barking Sands Shoreline Change Rate. <http://www.soest.Hawai‘i.edu/coasts/kauaicounty/poster/BarkingSands_STposter_tmks.pdf>.

U.S. Army Corps of Engineers (USACE). 2012. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Hawai‘i and Pacific Islands Region (Version 2.0). USACE Research and Development Center, Vicksburg, MS.

U.S. Coral Reef Task Force. 2000. The National Action Plan to Conserve Coral Reefs. Washington, DC.

U.S. Department of Agriculture (USDA). 2018. Invasive Species Information Center. <https://www.invasivespeciesinfo.gov/index.shtml>.

U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS). 1972. Soil Survey of the Islands of Kaua‘i, O‘ahu, Maui, Molokai, and Lanai, State of Hawai‘i.

U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). 2015. Web Soil Survey Data. <https://websoilsurvey.nrcs.usda.gov/app/>.

U.S. Department of Navy (U.S. Navy). 2006. Integrated Natural Resources Management Program Guidance, and INRMP Guidance. April 10, 2006.

U.S. Department of Navy (U.S. Navy). 2015. Regional Biosecurity Plan for Micronesia and Hawai‘i, Eds. University of Guam and the Secretariat of the Pacific Community.

U.S. Department of Navy, PMRF. 2010. PMRF, Barking Sands. Intercept Test Support. Environmental Assessment/Overseas Environmental Assessment.

U.S. Fish and Wildlife Service (USFWS). 1996. Final Listing, Endangered ETWP; Endangered Status for the Hawaiian Plant *Pritchardia aylmer-robinsonii* (wahane); Federal Register, Vol. 61, No. 153.

U.S. Fish and Wildlife Service (USFWS). 2003. Endangered and Threatened Wildlife and Plants; Final Designations or Nondesignations of Critical Habitat for 95 Plant Species from the Islands of Kauai and Niihau, Hawaii; Final Rule. Federal Register, Vol. 68, No. 39.

U.S. Fish and Wildlife Service (USFWS). 2008a. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for 12 Species of Picture-Wing Flies from the Hawaiian Islands; Federal Register, Vol. 73, No. 234.

U.S. Fish and Wildlife Service (USFWS). 2008b. *Panicum niihauense* (Lau‘ehu) 5-Year Review: Summary and Evaluation. <http://ecos.fws.gov/docs/five_year_review/doc1856.pdf>.

U.S. Fish and Wildlife Service (USFWS). 2008c. Birds of Conservation Concern. Division of Migratory Bird Management. December.

U.S. Fish and Wildlife Service (USFWS). 2009. Informal Section 7 Consultation Regarding the Advanced Detection Radar Laboratory, PMRF, Kaua‘i, Service File 2009-F-0269.

U.S. Fish and Wildlife Service (USFWS). 2010. *Wilkesia hobdyi* (Dwarf iliau) 5-Year Review, Short Form Summary. Pacific Island Fish and Wildlife Office, Honolulu, Hawai‘i.

U.S. Fish and Wildlife Service (USFWS). 2011a. *Pritchardia aylmer-robinsonii* (wahane) 5-Year Review. <http://ecos.fws.gov/docs/five_year_review/doc3843.pdf>.

U.S. Fish and Wildlife Service (USFWS). 2011b. Recovery Plan for Hawaiian Waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon. <http://ecos.fws.gov/docs/recovery_plan/Hawaiian%20Waterbirds%20RP%202nd%20Revision.pdf>.

U.S. Fish and Wildlife Service (USFWS). 2014. Biological and Conference Opinions on the Proposed PMRF Base-wide Infrastructure, Operations, and Maintenance, located on the island of Kaua‘i. Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

U.S. Fish and Wildlife service (USFWS). 2016. Final Rule to List Eleven Distinct Population Segments of the Green Sea Turtle (*Chelonia mydas*) as Endangered or Threatened and Revision of Current Listings Under the ESA. Federal Register / Vol. 81, No. 66.

U.S. Fish and Wildlife Service (USFWS). 2018a. Biological Opinion of the U.S. Fish and Wildlife Service for the Proposed Base-wide Infrastructure, Operations, and Maintenance Activities at the Pacific Missile Range Facility, Island of Kaua‘i, Hawai‘I (01EPIF00-2015-F-0227). Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

U.S. Fish and Wildlife Service (USFWS). 2018b. U.S. Fish and Wildlife Service Guidelines for Coordination on Integrated Natural Resource Management Plans. https://www.fws.gov/fisheries/sikes_act/index.html#policy.

U.S. Fish and Wildlife Service (USFWS). 2019a. About the U.S. Fish and Wildlife Service. https://www.fws.gov/help/about_us.html.

U.S. Fish and Wildlife Service (USFWS). 2019b. USFWS Threatened & Endangered Species Active Critical Habitat Report. <https://ecos.fws.gov/ecp/report/table/critical-habitat.html>.

U.S. Fish and Wildlife Service (USFWS). 2019c. White-tailed Tropicbird *Phaethon lepturus dorotheae* / Koa‘e ‘ula https://www.fws.gov/refuge/Kilauea_Point/wildlife_and_habitat/White-tailed_tropicbird.html.

U.S. Geological Survey (USGS). 1986. National Water Summary 1985. Hydrologic Events and Surface-Water Resources. Water Supply Paper 2300.

U.S. Geological Survey (USGS). 2004. Atlas of Natural Hazards in the Hawaiian Coastal Zone. U.S. Geological Survey, Geologic Investigations Series I-2761. <http://pubs.usgs.gov/imap/i2761/>.

U.S. Geological Survey (USGS). 2013. Hawai‘i Volcanic – Rock Aquifer Study. <http://hi.water.usgs.gov/studies/GWRP/hydrogeology.html>.

Uyeyama, R. and S. Hanser. 2010. Ka‘ula Island Ship-Based Marine Mammal Survey – Hawai‘i Range Complex. Draft submission to NMFS, October 2010.

Uyeyama R.K., Richie M.W., Winters K., Fujimoto J. 2011. Ka‘ula Island ship-based marine mammal survey June 30, 2011 Field Report. Pearl Harbor, HI, Naval Facilites Engineering Command Pacific for Commander, U.S. Pacific Fleet.

VanderWerf, E.A. 2012. Hawaiian Bird Conservation Action Plan. Pacific Rim Conservation, Honolulu, HI. <https://www.pacificrimconservation. org/wp-content/uploads/ 2013/10/HBCAP_complete1.pdf>.

VanderWerf, E.A. and A. Talpas. 2017. Rodent Control and O`ahu `Elepaio Monitoring in Pia Valley-2017 Report. Pacific Rim Conservation

Western Pacific Regional Fishery Management Council (WPRFMC). 2009a. Fishery Ecosystem Plan for the Hawai‘i Archipelago. <http://www.wpcouncil.org/fep/ WPRFMC%20Hawaii%20FEP%20%282009-09-21%29.pdf>.

Western Pacific Regional Fishery Management Council (WPRFMC). 2009b. Fishery Ecosystem Plan for Pacific Pelagic Fisheries of the Western Pacific Region. WPRFMC, Honolulu, Hawai‘i. <http://www.wpcouncil.org/fep/WPRFMC%20Pelagic%20FEP%20%282009-09-21%29.pdf>.

Western Regional Climate Center (WRCC). 2015. Climate of Hawai‘i. <http://www.wrcc.dri.edu/narratives/Hawai‘i/>.

Wood, K. R. 2006. The Status of *Wilkesia hobdyi* (Asteraceae) U.S. Navy PMRF, Mākaha Ridge, Kōke‘e, Kaua‘i, Hawai‘i.

World Wildlife Fund. 2015. Terrestrial Ecoregions. <http://www.worldwildlife.org/biome-categories/terrestrial-ecoregions>.

Young, L.C., E.A. VanderWerf, M. McKown, P. Roberts, J. Schlueter, A. Vorsino, and D. Sischo. 2019. Evidence of Newell’s Shearwaters and Hawaiian Petrels on Oahu, Hawaii. The Condor: Ornithological Applications. 121(1):1-7. 2019. https://doi.org/10.1093/condor/duy004