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Hawaii-Southern California Training and Testing Activities Final Environmental Impact Statement/ Overseas Environmental Impact Statement

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Appendix C: Air Quality Emissions Calculations and Record of Non-Applicability

APPENDIX C

AIR QUALITY EMISSIONS CALCULATIONS
AND
RECORD OF NON-APPLICABILITY

Final
Environmental Impact Statement/Overseas Environmental Impact Statement
Hawaii-Southern California Training and Testing

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APPENDIX C AIR QUALITY EMISSIONS CALCULATIONS AND RECORD OF NON-APPLICABILITY

This appendix discusses emission factor development, calculations, and assumptions used in the air quality analyses presented in the Air Quality section of Chapter 3 (see Section 3.1).

C.1 SURFACE ACTIVITIES EMISSIONS

Surface activities are associated with vessel movements. Fleet training activities use a variety of marine vessels, including cruisers, destroyers, frigates, carriers, submarines, amphibious vessels, and small boats. Testing activities use a variety of marine vessels, including various testing support vessels, work boats, torpedo recovery vessels, unmanned surface vehicles, and small boats. These vessels use a variety of propulsion methods, including marine outboard engines, diesel engines, and gas turbines.

Marine Outboard Engines:

Emission factors for small surface craft involved in amphibious training and testing activities were obtained from the Navy and Military Sealift Command (MSC) Marine Engine Fuel Consumption & Emission Calculator database. Emissions for surface craft using outboard engines were calculated using Navy and MSC emission factors which are provided in terms of emissions per hour, and multiplied by the hours of operation.

$$Emissions = HR/YR \times EF \times ENG$$

Where:

Emissions = surface craft emissions
HR/YR = hours per year
EF = emission factor for specific engine type
ENG = number of engines

To obtain the total criteria pollutant emissions for the Proposed Action, emissions were calculated for each training or testing activity, type of surface vessel, and criteria pollutant. These individual estimates of emissions, in units of tons per year, were then summed by criteria pollutant to obtain the aggregate emissions for surface vessel emissions activities.

Diesel Engines:

Emission factors for small surface craft involved in amphibious training and testing activities were obtained from the Navy and MSC Marine Engine Fuel Consumption & Emission Calculator database. Diesel was assumed to be the primary fuel to ensure a conservative estimate. Calculation methods similar to those described for Marine Outboard Engines were used to obtain emissions estimates for diesel engines.

$$Emissions = HR/YR \times EF \times ENG$$

Where:

Emissions = surface craft emissions
HR/YR = hours per year
EF = emission factor for specific engine type
ENG = number of engines

Diesel engine emission factors were multiplied by the annual hours of operation to calculate the pollutant emissions per year.

C.2 AIR ACTIVITIES EMISSIONS

Fleet training and Naval Air Systems Command testing consists of the activities of various aircraft, including the F/A-18, P-8, SH-60B, MH-53, MH-60S, and Lear jet. RDT&E air activities consist of various aircraft, including the 1UH-1N, SH-60B, MH-53, MH-60S, and Cessna-172. Aircraft activities of concern are those that occur from ground level up to 3,000 feet (ft.) above ground level (AGL). The 3,000 ft. AGL ceiling was assumed to be the atmospheric mixing height above which any pollutant generated would not contribute to increased pollutant concentrations at ground level (known as the mixing zone). All criteria pollutant emissions from aircraft generated above 3,000 ft. AGL are excluded from analysis of compliance with National Ambient Air Quality Standards. The pollutant emission rate is a function of the aircraft engine's fuel flow rate and efficiency. Emissions for one complete training activity for a particular aircraft are calculated by knowing the specific engine pollutant emission factors for each mode of operation.

For this EIS/OEIS, emission factors for most military engines were obtained from Navy's Aircraft Environmental Support Office (AESO) memoranda and previous Navy EIS/OEIS documentation (primarily citing the Federal Aviation Administration's EDMS model). For those aircraft for which engine data were unavailable, an applicable surrogate was used. Pollutant emissions for each aircraft/organization were calculated by applying the equation below.

$$Emissions = TIM \times FF \times EF \times ENG \times CF$$

Where:

Emissions = aircraft emissions (pounds [lb.]) (for EF in lb./1,000 gallons [gal.] fuel)
TIM = time-in-mode at a specified power setting (hours [hr.]/operation).
FF = fuel flow at a specified power setting (gal./hr./engine)
EF = emission factor for specific engine type and power setting (lb./1,000 gal. of fuel used)
ENG = number of engines on aircraft
CF = conversion factor (0.001)

C.3 MUNITIONS EMISSIONS

Available emissions factors (AP-42, *Compilation of Air Pollutant Emission Factors*) were used. These factors were then multiplied by the net weight of the explosive and the number of items that were used per year. This calculation provides estimates of annual emissions.

$$Emissions = EXP/YR \times EF \times Net\ Wt$$

Where:

Emissions = munitions emissions
EXP/YR = explosives, propellants, and pyrotechnics used per year
EF = emissions factor
Net Wt = net weight of explosive

C.4 EMISSIONS ESTIMATES SPREADSHEETS

The following spreadsheets show the emissions calculations for ships, aircraft, and munitions, involved in training and testing activities. These spreadsheets were developed for each range complex and testing area. The spreadsheets show the calculations developed for each alternative analyzed in this EIS/OEIS.

Table C-1: Summary of Emissions by Air Basin

Source	*Emissions by Air Pollutant (TPY)*					
	CO	*NO_X*	*VOC*	*SO_X*	*PM_{10}*	*$PM_{2.5}$*
Hawaii (Baseline Emissions)	25	60	3	19	6	6
Hawaii (Alternative 1 – Preferred Alternative)	18	58	3	18	9	9
Hawaii (Alternative 2)	20	75	3	25	9	9
South Coast Air Basin (Baseline Emissions)	98	155	23	34	21	21
South Coast Air Basin (Alternative 1 – Preferred Alternative)	72	95	27	21	19	19
South Coast Air Basin (Alternative 2)	72	96	27	21	19	19
San Diego Air Basin (Baseline Emissions)	146	855	456	332	39	39
San Diego Air Basin (Alternative 1 – Preferred Alternative)	138	835	445	330	39	39
San Diego Air Basin (Alternative 2)	139	849	445	340	40	40

[1] Table includes criteria pollutant precursors (e.g., volatile organic compounds). Individual values may not add exactly to total values due to rounding.

Notes: CO = carbon monoxide, NO_X = nitrogen oxides, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, PM_{10} = particulate matter≤ 10 microns in diameter, SO_X = sulfur oxides, TPY = tons per year, VOC = volatile organic compounds.

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Air Emission Calculations

Summary Tables

Hawaii-Southern California Training and Testing Activities

Table C-2: Surface Ship Emission Factors

Ship/Boat Type	Vessel Mode	Emissions Factors (lb/hr) Propulsion Engines + Generators						
		CO	NOx	HC	SOx	PM10	PM2.5	CO2
CG-3	Under Way	61.51	79.58	4.32	77.63	2.79	2.79	24191.08
	Restricted Waters	27.73	285.54	2.46	156.68	12.45	12.45	69,839.523
DDG-3	Under Way	60.16	114.52	4.01	88.53	3.64	3.64	27564.11
	Restricted Waters	30.57	374.80	2.39	191.63	15.22	15.22	85,141.652
FFG-3	Under Way	32.94	47.16	3.00	34.92	2.31	2.31	10425.55
	Restricted Waters	13.97	143.41	1.79	74.63	6.19	6.19	31,993
TRB-3	Under Way	6.47	56.22	1.55	7.40	1.18	1.18	294.76
	Restricted Waters	6.47	56.22	1.55	7.40	1.18	1.18	294.76
AOE-2	Under Way	109.76	311.31	10.60	119.99	10.41	10.41	67943.57
	Restricted Waters	35.08	445.24	5.85	191.00	15.15	15.15	81,478
USCG Cutter WHEC715, 378 feet - Hamilton Class	Under Way	5.74	57.91	0.88	11.55	0.21	0.21	1389.56
Amphibious Assault Ship - Tarawa	Under Way	7.96	47.09	5.67	133.29	28.11	28.11	46858.77
	Restricted Waters	7.54	44.39	5.62	132.95	28.08	28.08	46,715
LHD-2	Under Way	8.08	47.83	5.77	135.50	28.58	28.58	35921.75
	Restricted Waters	7.66	45.12	5.72	135.15	28.55	28.55	47,489
LPD-2	Under Way	3.48	21.00	2.58	60.82	12.85	12.85	21367.78
	Restricted Waters	28.08	263.75	14.95	46.99	3.54	3.54	15,027
LCAC	Under Way	18.32	114.53	3.49	54.61	5.14	5.14	20694.11
LCU	Under Way	5.06	15.70	1.27	2.91	0.75	0.75	923.73
AAV-2	Under Way	0.76	6.22	0.82	1.25	0.26	0.26	1389.56
PC-2	Under Way	37.36	74.17	6.02	23.42	2.60	2.60	7675.42
	Restricted Waters	43.15	78.36	7.22	24.95	2.75	2.75	8,055
MK V-2	Under Way	3.86	29.49	0.99	4.73	0.40	0.40	5205.49
RIB-4	Under Way	0.34	9.14	0.06	1.44	0.15	0.15	1070.71
CRRC-5	Under Way		0.15	12.90				1070.71
AE-2	Under Way	2.61	15.84	1.94	45.83	9.67	9.67	16133.84
	Restricted Waters	2.58	15.57	1.93	45.73	9.66	9.66	16,072
BW-3	Under Way	111.75	1.60	45.89	0.31	0.08	0.08	98.68
MCM	Under Way	25.62	30.81	6.09	5.13	0.56	0.56	1260.26
	Restricted Waters	60.48	50.26	12.20	8.20	0.90	0.90	2,104
WT	Under Way	5.36	16.63	1.35	3.08	0.80	0.80	1065.29

SSN	Under Way	3.24	2.39	0.17	0.26	0.02	0.02	112.62
	Restricted Waters	0.32	0.23	0.02	0.03	0.00	0.00	11.06
LCS	Under Way	37.98	171.04	2.82	67.28	6.94	6.94	24363.03
	Restricted Waters	70.97	136.87	5.75	29.73	7.10	7.10	9,967
LSD	Under Way	21.25	334.51	10.84	35.04	2.71	2.71	16265.54
	Restricted Waters	40.02	604.27	20.43	64.65	5.00	5.00	21,124
AS	Under Way	3.38	21.34	2.53	59.59	12.57	12.57	20947.49
	Restricted Waters	3.35	20.97	2.52	59.51	12.57	12.57	20,910
TAKE	Under Way	10.28	302.32	29.73	52.35	5.48	5.48	17234.51
	Restricted Waters	5.31	86.45	12.00	16.00	1.24	1.24	5,369
TAO	Under Way	54.35	752.77	27.71	72.89	5.68	5.68	22935.81
	Restricted Waters	38.40	579.94	22.97	61.23	4.81	4.81	17,479
TARS	Under Way	0.32	3.22	0.13	0.96	0.11	0.11	341.09
	Restricted Waters	0.34	3.81	0.08	1.16	0.08	0.08	398
TATF	Under Way	16.41	104.32	2.11	11.14	1.08	1.08	3594.62
	Restricted Waters	13.35	139.75	2.59	14.59	1.29	1.29	4,846
TAGM	Under Way	2.88	17.14	2.12	49.71	10.51	10.51	17464.00
	Restricted Waters	2.80	16.85	2.10	49.64	10.49	10.49	17,441
PW	Under Way	136.52	0.17	0.02	0.09	0.12	0.12	182.25
OUB	Under Way	36.21	44.95	0.52	3.11	1.57	1.57	2095.87
CVN	Under Way	0.68	9.23	0.17	1.09	0.08	0.08	376.99
	Restricted Waters	0.07	0.91	0.02	0.11	0.01	0.01	37.26

Notes:

1. AOE-1 assumed 2 boilers operating and heavy displacement
2. AOE, LHA, LHD, and LPD class ships – Steam ship emissions are calculated based on ship's fuel consumption.
3. Steam ship emission factors were calculated using U.S. Environmental Protection Agency AP-42 Steam Ship Emission Factors for Distillate Oil.
4. All SO_x emission factors were based upon 0.5% sulfur content of the fuel.
5. PM_{10} is based on 95% of total PM based on information provided by the EPA.
6. $PM_{2.5}$ emissions are assumed to be the same as PM_{10} emissions

Table C-3: Aircraft Engine Emissions Indices/Factors and Sources

Aircraft	Engine Model	Engines (#)	Fuel Flow (lb/hr) /Engine	Mode	Emission Indices, lb/1,000 lb fuel							Emissions Factors (lb/hr)							References
					CO	NOx	VOC	SOx	PM10	PM2.5	CO2	CO	NOx	VOC	SOx	PM10	PM2.5	CO2	Source of Emissions Indices Information
AH-1W	T700-GE-401C (2)	2	406		11.21	5.44	0.57	0.40	4.20	4.20	3214.50	9.10	4.42	0.46	0.32	3.41	3.41	2610.17	AESO Memorandum Report No. 9961, Revision A, November 2009.
AV-8B	F402-RR-408 (1)	1	6000	approach	7.70	8.60	0.54	0.40	3.80	3.80	3144.00	46.20	51.60	3.24	2.40	22.80	22.80	18864.00	AESO Memorandum Report No. 9913, Revision D, July 2009.
C-130 F/R/T	T56-A-16 Turboprop	4	1125	circle	2.07	8.16	0.47	0.40	3.97	3.97	3213.00	9.32	36.72	2.12	1.80	17.87	17.87	14458.50	AESO Memorandum Report No. 2000-09D, December 2015.
CH-46	T58-GE-5	2	600	circle	17.04	4.12	2.64	0.40	1.78	1.78	3200.00	20.45	4.94	3.17	0.48	2.14	2.14	3840.00	AESO Memorandum Report No. 9959 Revision B, January 2001.
CH-53	T64-GE-415 (3)	3	1488		2.13	8.08	0.15	0.40	2.21	2.21	3221.35	9.51	36.07	0.67	1.79	9.87	9.87	14380.11	AESO Memorandum Report No. 9822, Revision D, November 2009.
E-2 / E-2C	T56-A-425, -427 (2)	2	1100		2.54	10.04	0.36	0.40	0.94	0.94	3251.78	5.59	22.09	0.79	0.88	2.07	2.07	7153.92	AESO Memorandum Report No. 9943E, September 2015
EA-18G	F414-GE-400 (2)	2	5169	approach	0.72	14.75	0.12	0.40	6.56	6.56	3191.28	7.44	152.49	1.24	4.14	67.82	67.82	32991.45	F/A-18A/F and EA-18G Emissions Calculator
EA-6B	J52-P-408A (2)	2	3195	circle	7.99	5.71	1.09	0.40	12.12	12.12	3168.84	51.06	36.49	6.97	2.56	77.45	77.45	20248.89	AESO Memorandum Report No. 9917, Revision C, December 2009.
EP-3	T56-A-7 (4)	4	1053		2.51	7.73	0.58	0.40	3.97	3.97	3207.70	10.57	32.56	2.44	1.68	16.72	16.72	13510.83	AESO Memorandum Report No. 9948, Revision C, March 2010.
F-15E	F100-PW-229 (2)	2	3098		3.62	46.72	0.65	0.40	8.15	8.15	3200.00	22.43	289.48	4.03	2.48	50.50	50.50	19827.20	USAF Institute for Environment, Safety and Occupational Health Risk Analysis,
FA-18C/D	F404-GE-400 (2)	2	3318	approach	2.44	6.74	0.44	0.40	6.36	6.36	3154.00	16.19	44.73	2.92	2.65	42.20	42.20	20929.94	F/A-18A/F and EA-18G Emissions Calculator
FA-18E/F	F414-GE-400 (2)	2	5169		0.72	14.75	0.12	0.40	6.56	6.56	3191.28	7.44	152.49	1.24	4.14	67.82	67.82	32991.45	F/A-18A/F and EA-18G Emissions Calculator
F-35											3117.10	0.39	3.53	0.01	0.35	0.03	0.03	1134.00	F-35 calcualtion spreadsheet
HH-60	T700-GE-401C (2)	2	600	approach	6.25	6.40	0.55	0.40	4.20	4.20	3221.36	7.50	7.68	0.66	0.48	5.04	5.04	3865.63	AESO Memorandum Report No. 9929, Revision B, January 2014.
Learjet	TFE731-2-2B	2	532		22.38	5.90	4.26	0.40	1.27	1.27	3200.00	23.81	6.28	4.53	0.43	1.35	1.35	3404.80	USAF Institute for Environment, Safety and Occupational Health Risk Analysis,
MH-60R/S	T700-GE-401C (2)	2	600	approach	6.25	6.40	0.55	0.40	4.20	4.20	3221.36	7.50	7.68	0.66	0.48	5.04	5.04	3865.63	AESO Memorandum Report No. 9929, Revision B, January 2014.
MV-22					0.52	14.09	0.01	0.40	1.58	1.58	3820.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	AESO Memorandum Report No. 9946E, January 2001.
P-3C	T56-A-14 (4)	4	1200	ASUW	2.51	7.73	0.58	0.40	3.97	3.97	3207.70	12.05	37.10	2.78	1.92	19.06	19.06	15396.96	AESO Memorandum Report No. 9948, Revision C, March 2010.
P-8 MMA	Boeing 737-800 Series CFM56-7B26	2	1631	climbout	1.24	9.26	0.28	0.40	0.56	0.56	3200.00	4.05	30.21	0.91	1.31	1.83	1.83	10440.32	ICAO, 2007, Cited in DoN 2008 (EIS for Introduction of the P-8A).
S-3	TF34-GE-400 (2)	2	1145		14.10	4.07	1.86	0.40	3.62	3.62	3200.00	32.29	9.32	4.26	0.92	8.29	8.29	7328.00	AESO Memorandum Report No. 9915B, May 2010.
S-3B	TF34-GE-400 (2)	2	1145		14.10	4.07	1.86	0.40	3.62	3.62	3200.00	32.29	9.32	4.26	0.92	8.29	8.29	7328.00	AESO Memorandum Report No. 9915B, May 2010.
SH-60	T700-GE-401C (2)	2	600	approach	6.25	6.40	0.55	0.40	4.20	4.20	3221.36	7.50	7.68	0.66	0.48	5.04	5.04	3865.63	AESO Memorandum Report No. 9929, Revision B, January 2014.
SH-60B	T700-GE-401C (2)	2	600	approach	6.25	6.40	0.55	0.40	4.20	4.20	3221.36	7.50	7.68	0.66	0.48	5.04	5.04	3865.63	AESO Memorandum Report No. 9929, Revision B, January 2014.
SH-60B/F	T700-GE-401C (2)	2	600	approach	6.25	6.40	0.55	0.40	4.20	4.20	3221.36	7.50	7.68	0.66	0.48	5.04	5.04	3865.63	AESO Memorandum Report No. 9929, Revision B, January 2014.
SH-60F	T700-GE-401C (2)	2	600	approach	6.25	6.40	0.55	0.40	4.20	4.20	3221.36	7.50	7.68	0.66	0.48	5.04	5.04	3865.63	AESO Memorandum Report No. 9929, Revision B, January 2014.
UH-1N	T400-CP-400 (2)	2	270		3.34	4.72	0.17	0.40	4.20	4.20	3200.00	1.80	2.55	0.09	0.22	2.27	2.27	1728.00	AESO Memorandum Report No. 9962, Revision A, November 2009.

Notes:

1. AESO MR refers to AESO Memorandum Reports.
2. The ICAO, 2007 report was cited in DoN 2008 (EIS for Introduction of the P-8A).
3. SOHRA stands for Safety and Occupational Health Risk Analysis
4. $PM_{2.5}$ emissions are assumed to be the same as PM_{10} emissions.

Table C-4: Total Annual Criteria Pollutant Emissions within 3 NM from Training and Testing Activities - Baseline (tons/year [tpy])

Hawaii						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	3	30	1	11	1	1
Amphibious Craft	5	22	2	7	1	1
Aircraft	11	8	1	1	4	4
Munitions	7	0	0	0	0	0
Total - Training Activities	**25**	**60**	**3**	**19**	**6**	**6**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	0	0	0	0	0
Aircraft	0	0	0	0	0	0
Munitions	0	0	0	0	0	0
Total - Testing Activities	**0**	**0**	**0**	**0**	**0**	**0**
Total - Hawaii	**25**	**60**	**3**	**19**	**6**	**6**
South Coast Air Basin						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	0	2	0	1	0	0
Amphibious Craft	44	122	19	30	3	3
Aircraft	30	25	3	2	15	15
Munitions	17	1	0	0	1	1
Total - Training Activities	**92**	**150**	**22**	**33**	**20**	**20**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	5	4	1	1	0	0
Aircraft	1	1	0	0	1	1
Munitions	0	0	0	0	0	0
Total - Testing Activities	**6**	**6**	**1**	**1**	**1**	**1**
Total - SCAB	**98**	**155**	**23**	**34**	**21**	**21**
San Diego Air Basin						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	8	81	2	28	3	3
Amphibious Craft	130	768	453	304	33	33
Aircraft	8	6	1	0	3	3
Munitions	0	0	0	0	0	0
Total - Training Activities	**146**	**855**	**456**	**332**	**39**	**39**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	0	0	0	0	0
Aircraft	0	0	0	0	0	0
Munitions	0	0	0	0	0	0
Total - Testing Activities	**0**	**0**	**0**	**0**	**0**	**0**
Total - SDAB	**146**	**855**	**456**	**332**	**39**	**39**

Table C-5: Total Annual Greenhouse Gas Emissions from Training and Testing Activities - Baseline (metric tons per year)

Training Activities	CO2	N2O	CH4	CO2E
Vessels	718,528	24	20	725,982
Amphibious Craft	191,493	6	0	193,344
Aircraft	407,583	13	12	411,811
Ordnance	67	0	0	67
Total - Training Activities	**1,317,671**	**43**	**32**	**1,331,204**
Testing Activities	CO2	N2O	CH4	CO2E
Amphibious Craft	304	0	0	307
Aircraft	42,433	1	1	42,873
Ordnance	24	0	0	24
Total - Testing Activities	**42,761**	**1**	**1**	**43,204**
Total - HSTT	**1,360,432**	**44**	**33**	**1,374,408**

Table C-6: Total Annual Criteria Pollutant Emissions within 3 NM from Training and Testing Activities – Alternative 1 (tpy)

Hawaii						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	3	30	1	11	1	1
Amphibious Craft	5	17	1	6	1	1
Aircraft	10	10	1	1	7	7
Munitions	0	0	0	0	0	0
Total	**17**	**57**	**3**	**17**	**8**	**8**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	1	0	0	0	0
Aircraft	1	1	0	0	0	0
Munitions	0	0	0	0	0	0
Total	**1**	**1**	**0**	**0**	**0**	**0**
Total - Hawaii	**17**	**58**	**3**	**18**	**9**	**9**
South Coast Air Basin						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	0	2	0	1	0	0
Amphibious Craft	37	74	26	19	2	2
Aircraft	11	11	1	1	7	7
Munitions	21	0	0	0	9	9
Total - Training Activities	**70**	**88**	**27**	**20**	**18**	**18**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	5	0	1	0	0
Aircraft	2	2	0	0	1	1
Munitions	0	0	0	0	0	0
Total - Testing Activities	**2**	**7**	**0**	**1**	**1**	**1**
Total - SCAB	**71**	**95**	**27**	**21**	**19**	**19**
San Diego Air Basin						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	8	81	2	28	3	3
Amphibious Craft	125	749	442	301	33	33
Aircraft	5	5	0	0	3	3
Munitions	0	0	0	0	0	0
Total - Training Activities	**138**	**835**	**445**	**330**	**39**	**39**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	0	0	0	0	0
Aircraft	0	0	0	0	0	0
Munitions	0	0	0	0	0	0
Total - Testing Activities	**0**	**0**	**0**	**0**	**0**	**0**

Table C-7: Total Annual Criteria Pollutant Emissions from Training and Testing Activities – Alternative 1 (tpy)

Hawaii						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	465	2,147	92	650	37	37
Amphibious Craft	14	88	3	21	3	3
Aircraft	39	54	4	3	31	31
Ordnance	22	0	0	0	0	0
Total Training Activities	**540**	**2,289**	**99**	**674**	**71**	**71**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	1	18	0	3	0	0
Aircraft	11	31	2	1	7	7
Ordnance	12	0	0	0	5	5
Total Testing Activities	**23**	**49**	**2**	**4**	**12**	**12**
Total - Hawaii	**563**	**2,338**	**101**	**678**	**83**	**83**
Southern California						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	1,106	5,257	215	1,837	157	157
Amphibious Craft	176	921	471	341	37	37
Aircraft	89	115	8	7	69	69
Ordnance	45	0	0	0	9	9
Total Training Activities	**1,416**	**6,294**	**694**	**2,184**	**271**	**271**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	3	52	0	8	1	1
Aircraft	43	79	7	4	16	16
Ordnance	12	0	0	0	5	5
Total Testing Activities	**57**	**130**	**8**	**12**	**22**	**22**
Total - Southern California	**1,473**	**6,424**	**702**	**2,195**	**294**	**294**

Table C-8: Total Annual Greenhouse Gas Emissions from Training and Testing Activities – Alternative 1 (metric tons per year)

Training Activities	**CO2**	**N2O**	**CH4**	**CO2E**
Vessels	768,268	25	22	776,238
Amphibious Craft	182,781	6	0	184,548
Aircraft	422,852	14	12	427,239
Ordnance	67	0	0	67
Total - Training Activities	**1,373,968**	**45**	**34**	**1,388,091**
Testing Activities	**CO2**	**N2O**	**CH4**	**CO2E**
Amphibious Craft	7,062	0	0	7,130
Aircraft	129,053	4	4	130,392
Ordnance	24	0	0	24
Total - Testing Activities	**136,139**	**4**	**4**	**137,546**
Total - HSTT	**1,510,107**	**49**	**37**	**1,525,637**

Table C-9: Total Annual Criteria Pollutant Emissions within 3 NM from Training and Testing Activities – Alternative 2 (tpy)

Hawaii						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	5	47	1	19	2	2
Amphibious Craft	5	17	1	6	1	1
Aircraft	10	10	1	1	7	7
Ordnance	0	0	0	0	0	0
Total	**19**	**74**	**3**	**25**	**9**	**9**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	1	0	0	0	0
Aircraft	1	1	0	0	0	0
Ordnance	0	0	0	0	0	0
Total	**1**	**1**	**0**	**0**	**0**	**0**
Total - Hawaii	**20**	**75**	**3**	**25**	**9**	**9**
South Coast Air Basin						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	0	3	0	1	0	0
Amphibious Craft	37	74	26	19	2	2
Aircraft	11	11	1	1	7	7
Ordnance	21	0	0	0	9	9
Total	**70**	**88**	**27**	**21**	**18**	**18**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	5	0	1	0	0
Aircraft	2	3	0	0	1	1
Ordnance	0	0	0	0	0	0
Total	**2**	**7**	**0**	**1**	**1**	**1**
Total - SCAB	**72**	**96**	**27**	**21**	**19**	**19**
San Diego Air Basin						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Vessels	9	94	2	38	3	3
Amphibious Craft	125	749	442	301	33	33
Aircraft	5	5	0	0	3	3
Ordnance	0	0	0	0	0	0
Total	**139**	**849**	**445**	**340**	**40**	**40**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM2.5**
Amphibious Craft	0	0	0	0	0	0
Aircraft	0	0	0	0	0	0
Ordnance	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Total - SDAB	**139**	**849**	**445**	**340**	**40**	**40**

Table C-10: Total Annual Criteria Pollutant Emissions from Training and Testing Activities – Alternative 2 (tpy)

Hawaii						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM11**
Vessels	748	3,012	128	1,102	79	79
Amphibious Craft	14	88	3	21	3	3
Aircraft	39	55	4	3	31	31
Ordnance	22	0	0	0	0	0
Total - Training Activities	**822**	**3,155**	**135**	**1,126**	**112**	**112**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM11**
Amphibious Craft	1	18	0	3	0	0
Aircraft	11	32	2	1	7	7
Ordnance	12	0	0	0	5	5
Total - Testing Activities	**24**	**50**	**2**	**4**	**13**	**13**
Total - Hawaii	**846**	**3,205**	**137**	**1,130**	**125**	**125**
Southern California						
Training Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM11**
Vessels	1,394	5,120	221	2,293	183	183
Amphibious Craft	176	921	471	341	37	37
Aircraft	89	115	8	7	69	69
Ordnance	45	0	0	0	9	9
Total	**1,705**	**6,157**	**700**	**2,641**	**298**	**298**
Testing Activities	**CO**	**NOx**	**HC**	**SOx**	**PM10**	**PM11**
Amphibious Craft	3	54	1	8	1	1
Aircraft	44	81	7	4	18	18
Ordnance	12	0	0	0	5	5
Total	**59**	**135**	**8**	**12**	**24**	**24**
Total - Southern California	**1,764**	**6,292**	**708**	**2,653**	**322**	**322**

Table C-11: Total Annual Greenhouse Gas Emissions from Training and Testing Activities – Alternative 2 (metric tons per year)

Training Activities	**CO2**	**N2O**	**CH4**	**CO2E**
Vessels	949,077	31	27	958,923
Amphibious Craft	165,816	5	0	167,419
Aircraft	398,673	13	11	402,808
Ordnance	61	0	0	61
Total - Training Activities	**1,513,627**	**49**	**38**	**1,529,211**
Testing Activities	**CO2**	**N2O**	**CH4**	**CO2E**
Amphibious Craft	6,420	0	0	6,482
Aircraft	118,365	4	3	119,593
Ordnance	21	0	0	21
Total - Testing Activities	**124,807**	**4**	**3**	**126,097**
Total - HSTT	**1,638,433**	**53**	**41**	**1,655,307**

Air Emission Calculations

Baseline

Table C-12: Baseline Ship Emissions – SCAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																															
SHIPS																															
guided missile cruiser			CG	1	5,741	5568.6	55.7	111.4	5401.5	1,544	15,901	137	8,725	693	693	6,851	8,862	481	8,646	311	311	332,250	429,826	23,316	419,335	15,064	15,064	61,104,385	1,362	1,727	61,738,267
guided missile destroyer			DDG	1	17,611	17062.9	170.6	341.7	16570.4	5,222	64,027	409	32,736	2,600	2,600	20,553	39,125	1,369	30,248	1,243	1,243	396,823	1,897,569	66,377	1,467,014	60,276	60,276	213,588,450	6,329	6,036	215,804,164
aircraft carrier, nuclear powered			CVN	1	3,418	3315.1	33.2	66.3	3215.6	2	30	1	4	0	0	45	612	11	72	6	6	2,176	29,668	546	3,509	269	269	566,881	18	16	572,762
Frigate			FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered			SSN	1	4060.8	3939.0	39.4	78.8	3820.8	13	9	1	1	0	0	255	188	13	21	2	2	12,365	9,114	649	1,011	76	76	201,212	7	6	203,233
littoral combat ship			LCS	1	1440	1396.8	14.0	27.9	1354.9	991	1,912	80	415	99	99	1,061	4,778	79	1,880	194	194	51,460	231,738	3,826	31,157	3,409	3,409	15,436,138	501	436	15,596,269
amphibious assault ship, general purpose			LHA	1	379.2	343.8	3.5	19.0	321.3	72	422	53	1,263	267	267	151	895	108	2,532	534	534	7,332	43,384	5,226	122,808	25,899	25,899	20,188,642	655	571	20,398,074
amphibious assault ship, multi-			LHD	1	2836.8	2751.7	27.5	55.0	2669.1	211	1,242	157	3,719	786	786	445	2,632	317	7,457	1,573	1,573	21,572	127,674	15,394	361,661	76,274	76,274	44,836,429	1,455	1,267	45,301,551
amphibious transport dock ship			LPD	1	3820.8	3706.2	37.1	74.1	3595.0	1,041	9,775	554	1,741	131	131	258	1,557	191	4,508	953	953	12,499	75,506	3,265	218,641	46,206	46,206	35,321,828	1,165	1,015	36,294,472
dock landing ship			LSD	1	3168.0	3073.0	30.7	61.5	2980.8	1,230	18,569	628	1,987	154	154	1,306	20,559	666	2,153	167	167	63,335	997,099	32,318	104,439	8,089	8,089	22,672,448	736	641	22,907,646
patrol craft			PC	1	648.0	628.6	6.3	12.6	609.7	271	433	45	157	17	17	470	932	76	294	33	33	22,777	45,224	3,670	14,280	1,586	1,586	2,188,376	71	62	2,211,077
submarine tender			AS	1	3.6	3.3	0.1	0.2	3.0	0	2	0	6	1	1	1	4	0	11	2	2	31	193	23	538	114	114	88,481	3	3	89,336
dray cargo ship			TAKE	1	326.4	316.6	3.2	6.3	307.1	17	274	38	51	4	4	65	1,914	188	331	35	35	3,156	32,844	9,131	16,077	1,682	1,682	2,475,106	80	70	2,500,782
replenishment oiler			TAO	1	7804.8	7570.7	75.7	151.4	7343.5	2,907	43,905	1,739	4,635	365	365	8,229	113,979	4,195	11,036	860	860	339,105	5,527,958	203,470	535,243	41,720	41,720	78,762,632	2,555	2,226	79,573,757
rescue and salvage ship			TARS	1	172.8	167.6	1.7	3.4	162.6	1	6	0	2	0	0	1	11	0	3	0	0	52	524	21	157	17	17	25,933	1	1	26,202
fleet ocean tug			TATF	1	705.6	684.4	6.8	13.7	663.9	91	956	18	100	9	9	225	1,428	29	153	15	15	10,835	69,253	1,401	7,397	714	714	1,115,380	36	32	1,127,557
TAE			TAE	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fast combat support ship			TADE	1	456.0	442.3	4.4	8.8	429.1	155	1,969	26	845	67	67	971	2,754	94	1,061	92	92	47,092	133,569	4,548	51,481	4,466	4,466	13,631,950	442	385	13,773,364
mine countermeasure ship			MCM	1	4252.8	4125.2	41.3	82.5	4001.5	2,495	2,074	503	338	37	37	2,114	2,542	503	424	47	47	102,534	123,273	24,383	20,546	2,258	2,258	2,358,187	77	67	2,382,650
Intrumentation ship			TAGM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			TEFP	1	105.6	102.4	1.0	2.0	99.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL							558	1,117	54,155	16,262	161,564	4,330	56,724	5,230	5,230	42,393	202,772	8,321	70,831	6,064	6,064	2,085,455	3,834,423	403,563	3,435,295	294,121	294,121	515,163,115	16,712	14,559	520,507,230

EMISSIONS / YEAR (tons) BY JURISDICTION																													
State (0-3 nm offshore)							Waters of U S (3-12 nm)							Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
8	81	2	28	3	3	21	101	4	35	3	3	1,043	4,917	202	1,718	147	147	515,163	17	15	520,507

Table C-13: Baseline Ship Emissions – SDAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						GHG Emissions (kg/yr)			
		Ship / Vessel / Boat			Range Time (hr		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}
SHIP STEAMING																															
SHIPS																															
guided missile cruiser			CG	1	5,741	172.2	1.7	3.4	167.1	48	432	4	270	21	21	212	274	15	267	10	10	10,276	13,294	721	12,363	466	466	1,883,826	61	53	1,909,431
guided missile destroyer			DDG	1	17,611	528.3	5.3	10.6	512.5	162	1,380	13	1,012	80	80	636	1,210	42	335	38	38	30,830	58,688	2,053	45,372	1,864	1,864	6,605,828	214	187	6,674,356
aircraft carrier, nuclear powered			CVN	1	3,418	102.5	1.0	2.1	99.5	0	1	0	0	0	0	1	13	0	2	0	0	67	318	17	103	8	8	17,532	1	0	17,714
Frigate			FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered			SSN	1	4060.8	121.8	1.2	2.4	118.2	0	0	0	0	0	0	8	6	0	1	0	0	382	282	20	31	2	2	6,223	0	0	6,288
littoral combat ship			LCS	1	1440	43.2	0.4	0.9	41.9	31	59	2	13	3	3	33	148	2	58	6	6	1,532	7,167	118	2,813	231	231	477,406	15	13	482,359
amphibious assault ship, general purpose			LHA	1	979.2	29.4	0.3	0.6	28.5	2	13	2	39	8	8	5	28	3	78	17	17	227	1,342	162	3,798	801	801	624,391	20	18	630,868
amphibious assault ship, multi-			LHD	1	2836.8	85.1	0.9	1.7	82.6	7	38	5	115	24	24	14	81	10	231	49	49	667	3,949	476	11,185	2,359	2,359	1,386,634	45	39	1,401,079
amphibious transport dock ship			LPD	1	3820.8	114.6	1.1	2.3	111.2	32	302	17	54	4	4	8	48	6	139	29	29	387	2,335	287	6,762	1,429	1,429	1,110,384	36	31	1,122,509
dock landing ship			LSD	1	3168.0	95.0	1.0	1.9	92.2	38	574	19	61	5	5	40	636	21	67	5	5	1,353	30,838	1,000	3,230	250	250	701,210	23	20	708,484
patrol craft			PC	1	648.0	19.4	0.2	0.4	18.9	8	15	1	5	1	1	15	29	2	9	1	1	704	1,393	113	442	43	43	67,682	2	2	68,384
submarine tender			AS	1	9.6	0.3	0.0	0.0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	1	6	1	17	4	4	2,737	0	0	2,765
dray cargo ship			TAKE	1	326.4	9.8	0.1	0.2	9.5	1	8	1	2	0	0	2	59	6	10	1	1	38	2,871	282	497	52	52	76,550	2	2	77,344
replenishment oiler			TAO	1	7804.8	234.1	2.3	4.7	227.1	90	1,358	54	143	11	11	255	3,525	130	341	27	27	12,343	170,968	6,293	16,554	1,290	1,290	2,435,960	79	69	2,461,230
rescue and salvage ship			TARS	1	172.8	5.2	0.1	0.1	5.0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	1	5	1	1	802	0	0	810
fleet ocean tug			TATF	1	705.6	21.2	0.2	0.4	20.5	3	30	1	3	0	0	7	44	1	5	0	0	337	2,142	43	229	22	22	34,515	1	1	34,873
			TAE	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fast combat support ship			TAOE	1	456.0	13.7	0.1	0.3	13.3	5	61	1	26	2	2	30	85	3	33	3	3	1,456	4,131	141	1,532	138	138	421,607	14	12	425,980
mine countermeasure ship			MCM	1	4252.8	127.6	1.3	2.6	123.8	77	64	16	10	1	1	65	79	16	13	1	1	3,171	3,813	754	635	70	70	72,334	2	2	73,690
Intrumentation ship			TAGM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			TEFP	1	105.6	3.2	0.0	0.1	3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL							17	35	1,675	503	4,997	136	1,754	162	162	1,330	6,271	257	2,191	188	188	64,499	304,157	12,481	106,246	9,097	9,097	15,932,880	517	450	16,098,164

EMISSIONS / YEAR (tons) BY JURISDICTION																													
State (0-3 nm offshore)								Waters of U S (3-12 nm)								Int Waters (> 12 nm)												GHG Emissions (Metric tons/year)			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}								
0	2	0	1	0	0	1	3	0	1	0	0	32	152	6	53	5	5	15,333	1	0	16,098								

Table C-14: Baseline Ship Emissions – Hawaii

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						ANNUAL EMISSIONS (lb/yr) BY JURISDICTION						GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																															
SHIPS																															
guided missile cruiser			CG	1	2,656	2656.0	28.6	57.1	2770.3	792	8,155	70	4,475	355	355	3,513	4,545	247	4,434	159	159	170,404	220,448	11,958	215,068	7,726	7,726	31,339,094	1,017	866	31,664,193
guided missile destroyer			DDG	1	7,464	7464.0	74.6	143.3	7240.1	2,282	27,375	179	14,303	1,136	1,136	8,380	17,095	538	13,216	543	543	435,541	829,103	29,002	640,981	26,336	26,336	93,323,004	3,027	2,637	94,231,116
aircraft carrier, nuclear powered			CVN	1	238	237.6	3.0	6.0	228.7	0	3	0	0	0	0	4	55	1	6	0	0	195	2,663	43	315	24	24	50,890	2	1	51,418
Frigate			FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered			SSN	1	#####	13123.2	131.2	262.5	12729.5	42	31	2	3	0	0	849	626	45	69	5	5	41,197	30,365	2,161	3,368	253	253	670,364	22	19	677,318
littoral combat ship			LCS	1	288	288.0	2.9	5.8	279.4	204	394	17	86	20	20	219	985	16	388	40	40	10,610	47,781	789	18,795	1,940	1,940	3,182,709	103	90	3,215,726
amphibious assault ship, general purpose			LHA	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
amphibious assault ship, multi-			LHD	1	28.8	28.8	0.3	0.6	27.9	2	13	2	39	8	8	5	28	3	78	16	16	226	1,336	161	3,785	798	798	469,270	15	13	474,138
amphibious transport dock ship			LPD	1	9.6	9.6	0.1	0.2	9.3	3	25	1	5	0	0	1	4	0	12	2	2	32	196	24	566	120	120	93,047	3	3	94,013
dock landing ship			LSD	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
patrol craft			PC	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
submarine tender			AS	1	96.0	96.0	1.0	1.9	93.1	3	20	2	57	12	12	6	41	5	114	24	24	315	1,987	236	5,549	1,171	1,171	912,171	30	26	921,634
dray cargo ship			TAKE	1	1660.8	1660.8	16.6	33.2	1611.0	88	1,436	199	266	21	21	341	10,042	988	1,739	182	182	16,557	487,025	47,900	84,335	8,826	8,826	12,983,424	421	367	13,118,111
replenishment oiler			TAO	1	2865.6	2865.6	28.7	57.3	2779.6	1,100	16,619	658	1,754	138	138	3,115	43,142	1,588	4,177	326	326	151,067	2,092,410	77,016	202,597	15,792	15,792	29,812,789	967	843	30,122,059
rescue and salvage ship			TARS	1	1234	1233.6	12.3	24.7	1196.6	4	47	1	14	1	1	8	79	3	24	3	3	383	3,854	153	1,153	127	127	190,859	6	5	192,833
fleet ocean tug			TATF	1	3576.0	3576.0	35.8	71.5	3468.7	477	4,997	93	522	46	46	1,174	7,461	151	797	77	77	56,925	361,863	7,318	38,649	3,732	3,732	5,830,738	189	165	5,891,225
tanker			TAE	1	225.6	225.6	2.3	4.5	218.8	6	35	4	103	22	22	12	71	9	207	44	44	571	3,466	425	10,030	2,116	2,116	1,651,011	54	47	1,668,138
fast combat support ship			TADE	1	216.0	216.0	2.2	4.3	209.5	76	362	13	413	33	33	474	1,345	46	518	45	45	22,997	65,226	2,221	25,140	2,181	2,181	6,656,948	216	188	6,726,005
mine countermeasure ship			MCM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intrumentation ship			TAGM	1	33.6	33.6	0.3	0.7	32.6	1	6	1	17	4	4	2	12	1	33	7	7	94	559	69	1,620	343	343	266,168	9	8	268,329
			TEFP	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL							**340**	**679**	**32,355**	**5,081**	**60,717**	**1,242**	**22,057**	**1,797**	**1,797**	**18,703**	**85,532**	**3,701**	**25,813**	**1,474**	**1,474**	**907,114**	**4,148,282**	**179,482**	**1,251,351**	**71,484**	**71,484**	**187,432,486**	**6,080**	**5,237**	**189,376,864**

EMISSIONS / YEAR (tons) BY JURISDICTION

State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
3	30	1	11	1	1	9	43	2	13	1	1	454	2,074	90	626	36	36	187,432	6	5	189,377

Table C-15: Baseline Amphibious Vessel Emissions – SCAB Training Activities

OPERATIONAL INFORMATION - VESSELS										EMISSIONS/YEAR (lb) BY JURISDICTION																			
Type Training	Training Ops (#)	Vessel / Boat		Range Time (hr)			Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
		Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}
AMPHIBIOUS WARFARE																													
Amphibious Assault	36																												
		144.0	LCAC	4.0	8.0	1152.0	432.0	432.0	288.0	7,914	49,478	1,507	23,590	2,220	2,220	7,914	49,478	1,507	23,590	2,220	2,220	5,276	32,986	1,004	15,726	1,480	1,480	23,839,610	773.37	0.02	24,070,074
		144.0	LCU	4.0	8.0	1152.0	432.0	432.0	288.0	2,186	6,784	550	1,255	326	326	2,186	6,784	550	1,255	326	326	1,457	4,523	367	837	217	217	1,064,134	34.52	0.00	1,074,421
Battalion Landing	6																												
		36.0	LCU	6.0	3.0	108.0	10.8	32.4	64.8	55	170	14	31	8	8	164	509	41	94	24	24	328	1,018	83	188	49	49	99,763	3.24	0.00	100,727
		84.0	AAV/EFV	14.0	6.0	504.0	50.4	151.2	302.4	38	313	41	63	13	13	115	940	124	189	39	39	230	1,881	248	378	79	79	700,340	22.72	0.00	707,111
		30.0	LCAC	5.0	3.0	90.0	9.0	27.0	54.0	165	1,031	31	491	46	46	495	3,092	94	1,474	139	139	989	6,185	188	2,949	278	278	1,862,470	60.42	0.00	1,880,475
		0.0	CRRC	0.0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0																												
		0.0	CRRC	13.0	2.0	0.0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCU	2.0	2.0	0.0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCAC	2.0	2.0	0.0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	EFV	6.0	2.0	0.0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	2																												
		8.0	LCAC	4.0	8.0	64.0	24.0	24.0	16.0	440	2,749	84	1,311	123	123	440	2,749	84	1,311	123	123	293	1,833	56	874	82	82	1,324,423	42.96	0.00	1,337,226
		8.0	LCU	4.0	8.0	64.0	24.0	24.0	16.0	121	377	31	70	18	18	121	377	31	70	18	18	81	251	20	46	12	12	59,119	1.92	0.00	59,690
ANTI-SURFACE WARFARE																													
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	200																												
		200.0	BW	1.0	2.0	400.0	400.0	0.0	0.0	44,699	638	18,357	123	32	32	0	0	0	0	0	0	0	0	0	0	0	0	39,472	1.28	0.00	39,854
		200	Bayliner	1	2.0	400.0	400.0	0.0	0.0	14,943	29,670	2,407	9,369	1,041	1,041	0	0	0	0	0	0	0	0	0	0	0	0	3,070,167	99.60	0.00	3,099,848
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	14																												
		14.0	BW	1.0	2.0	28.0	28.0	0.0	0.0	3,129	45	1,285	9	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2,763	0.09	0.00	2,790
		14	Bayliner	1	2.0	28.0	28.0	0.0	0.0	1,046	2,077	169	656	73	73	0	0	0	0	0	0	0	0	0	0	0	0	214,912	6.97	0.00	216,989
ANTI-SUBMARINE WARFARE																													
Tracking / Torpedo Exercise-Submarine	63																												
		63.0	TRB	1.0	3.6	226.8	2.3	22.7	201.9	15	128	4	17	3	3	147	1,275	35	168	27	27	1,306	11,348	313	1,494	238	238	66,851	2.17	0.00	67,497
Tracking / Torpedo Exercise-Surface	540																												
		170.5	TRB	0.316	3.6	613.9	6.1	61.4	546.4	40	345	10	45	7	7	397	3,451	95	454	72	72	3,535	30,717	847	4,043	645	645	180,949	5.87	0.00	182,698
Tracking / Torpedo Exercise-Helo	628																												
		188.4	TRB	0.300	3.6	678.2	6.8	67.8	603.6	44	381	11	50	8	8	439	3,813	105	502	80	80	3,906	33,936	936	4,467	712	712	199,915	6.49	0.00	201,848
Tracking / Torpedo Exercise-MPA	116																												
		70.6	TRB	0.609	2.0	141.2	7.1	14.1	120.0	46	397	11	52	8	8	91	794	22	105	17	17	777	6,748	186	888	142	142	41,625	1.35	0.00	42,027
Tracking / Torpedo Exercise - MPA-EER	48																												
		29.2	TRB	0.609	2.0	58.4	2.9	5.8	49.7	19	164	5	22	3	3	38	329	9	43	7	7	321	2,792	77	368	59	59	17,224	0.56	0.00	17,391

MINE WARFARE																															
Mine Neutralization - EOD	354																														
		1062.0	RHIB	3.0	12.0	12744.0	12744.0	0.0	0.0	4,333	116,480	765	18,351	1,912	1,912	0	0	0	0	0	0	0	0	0	0	0	0	13,645,181	442.66	0.01	13,777,092
Mine Neutralization - ROV	248																														
		248.0	RHIB	1.0	12.0	2976.0	2976.0	0.0	0.0	1,012	27,201	179	4,285	446	446	0	0	0	0	0	0	0	0	0	0	0	0	3,186,445	103.37	0.00	3,217,249
MK8 MM Ops	0																														
		0.0	RHIB	4.0	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Shock Wave Generator	90																														
		90.0	CRRC	1.0	4.0	360.0	360.0	0.0	0.0	0	53	4,645	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	385,457	12.50	0.00	389,183
		90.0	LCM8	1.0	4.0	360.0	360.0	0.0	0.0	1,821	5,653	459	1,046	271	271	0	0	0	0	0	0	0	0	0	0	0	0	332,542	10.79	0.00	335,757
Surf Zone Test	0																														
		0.0	CRRC	2.0	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Airborne Mine Neutralization Test AMNS	0																														
		0.0	RHIB	1.0	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
NAVAL SPECIAL WARFARE																															
Underwater Demo - Mat Weave	18																														
		36.0	CRRC	2.0	4.0	144.0	144.0	0.0	0.0	0	21	1,858	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	154,183	5.00	0.00	155,673
Underwater Demo Qual	24																														
		48.0	CRRC	2.0	6.0	288.0	288.0	0.0	0.0	0	43	3,716	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	308,366	10.00	0.00	311,347
OTHER																															
Precision Anchoring	0																														
		0.0	RHIB	1.0	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	18																														
		18.0	BW	1.0	2.0	36.0	36.0	0.0	0.0	4,023	57	1,652	11	3	3	0	0	0	0	0	0	0	0	0	0	0	0	3,552	0.12	0.00	3,587
Offshore Petroleum Discharge System	0																														
		0.0	OUB	2.0	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Elevated Causeway	2																														
		4.0	WT	2.0	4.0	16.0	16.0	0.0	0.0	86	266	22	49	13	13	0	0	0	0	0	0	0	0	0	0	0	0	17,045	0.55	0.00	17,209
		4.0	PW	2.0	4.0	16.0	16.0	0.0	0.0	2,184	3	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2,916	0.09	0.00	2,944
		2.0	LCM	1.0	4.0	8.0	8.0	0.0	0.0	40	126	10	23	6	6	0	0	0	0	0	0	0	0	0	0	0	0	7,390	0.24	0.00	7,461
Salvage Operations	0																														
		0.0	CRRC	2.0	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
LIFECYCLE ACTIVITIES																															
Combat System Ship Qual - USW	0																														
		0.0	TRB	0.31579	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
SHIPBOARD PROTECTION																															
Shipboard Protection	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																							
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)										
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}
44	122	19	30	3	3	6	37	1	15	2	2	9	67	2	16	2	2	25,413	1	0	25,659

Table C-16: Baseline Amphibious Vessel Emissions – SDAB Training Activities

OPERATIONAL INFORMATION - VESSELS											EMISSIONS/YEAR (lb) BY JURISDICTION																					
		/ Vessel / Boat		Range Time (hr)			Distribution (hr)				State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emixxions			
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																																
Amphibious Assault	0																															
		0.0	LCAC	4.0	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCU	4.0	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Battalion Landing	0																															
		0.0	LCU	6.0	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	AAV/EFV	14.0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCAC	5.0	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	CRRC	0.0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	2426																															
		31538.0	CRRC	13.0	2.0	63076.0	63,076	0.0	0.0	0	9,370	813,772	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58,265,029	1890.14	0.05	58,828,293
		4852.0	LCU	2.0	2.0	9704.0	9,704	0.0	0.0	49,098	152,385	12,365	28,197	7,317	7,317	0	0	0	0	0	0	0	0	0	0	0	0	8,963,851	290.79	0.01	9,050,507
		4852.0	LCAC	2.0	2.0	9704.0	9,704	0.0	0.0	177,779	1,111,432	33,844	529,894	49,868	49,868	0	0	0	0	0	0	0	0	0	0	0	0	200,815,607	6514.54	0.18	202,756,943
		14556.0	EFV	6.0	2.0	29112.0	29,112	0.0	0.0	22,125	181,077	23,872	36,390	7,569	7,569	0	0	0	0	0	0	0	0	0	0	0	0	40,452,987	1312.31	0.04	40,844,057
Humanitarian Assistance	0																															
		0.0	LCAC	4.0	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCU	4.0	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SURFACE WARFARE																																
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																															
		0.0	BW	1.0	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	0																															
		0.0	BW	1.0	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SUBMARINE WARFARE																																
Tracking / Torpedo Exercise-Submarine	0																															
		0.0	TRB	1.0	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Surface	0																															
		0.0	TRB	0.316	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Helo	0																															
		0.0	TRB	0.300	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-MPA	0																															
		0.0	TRB	0.609	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise - MPA-EER	0																															
		0.0	TRB	0.609	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

MINE WARFARE																															
Mine Neutralization - EOD	0																														
		0.0	RHIB	3.0	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - ROV	0																														
		0.0	RHIB	1.0	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
MK8 MM Ops	175																														
		700.0	RHIB	4.0	12.0	8400.0	8400.0	0.0	0.0	2,856	76,776	504	12,096	1,260	1,260	0	0	0	0	0	0	0	0	0	0	0	0	8,993,999	291.77	0.01	9,080,946
Shock Wave Generator	0																														
		0.0	CRRC	1.0	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCM8	1.0	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test	200																														
		400.0	CRRC	2.0	4.0	1600.0	1600.0	0.0	0.0	0	238	20,642	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,713,143	55.58	0.00	1,729,704
Airborne Mine Neutralization Test AMNS	0																														
		0.0	RHIB	1.0	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
NAVAL SPECIAL WARFARE																															
Underwater Demo - Mat Weave	0																														
		0.0	CRRC	2.0	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demo Qual	0																														
		0.0	CRRC	2.0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Precision Anchoring	72																														
		72.0	RHIB	1.0	4.0	288.0	288.0	0.0	0.0	98	2,632	17	415	43	43	0	0	0	0	0	0	0	0	0	0	0	0	308,366	10.00	0.00	311,347
Small Boat Attack	18																														
		18.0	BW	1.0	2.0	36.0	36.0	0.0	0.0	4,023	57	1,652	11	3	3	0	0	0	0	0	0	0	0	0	0	0	0	3,552	0.12	0.00	3,587
Offshore Petroleum Discharge System	6																														
		12.0	OUB	2.0	4.0	48.0	48.0	0.0	0.0	1,738	2,158	25	149	75	75	0	0	0	0	0	0	0	0	0	0	0	0	100,602	3.26	0.00	101,574
Elevated Causeway	2																														
		4.0	WT	2.0	4.0	16.0	16.0	0.0	0.0	86	266	22	49	13	13	0	0	0	0	0	0	0	0	0	0	0	0	17,045	0.55	0.00	17,209
		4.0	PW	2.0	4.0	16.0	16.0	0.0	0.0	2,184	3	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2,916	0.09	0.00	2,944
		2.0	LCM	1.0	4.0	8.0	8.0	0.0	0.0	40	126	10	23	6	6	0	0	0	0	0	0	0	0	0	0	0	0	7,390	0.24	0.00	7,461
Salvage Operations	0																														
		0.0	CRRC	2.0	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Combat System Ship Qual - USW	0																														
		0.0	TRB	0.315789	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
SHIPBOARD PROTECTION																															
Shipboard Protection	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0		1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																					
State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
130	768	453	304	33	33	0	0	0	0	0	0	0	0	0	0	0	0	159,822	5	0	161,367

Table C-17: Baseline Amphibious Vessel Emissions – Hawaii Training Activities

OPERATIONAL INFORMATION - VESSELS										EMISSIONS/YEAR (lb) BY JURISDICTION																				
Type Training	Training Ops (#)	Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emixxions			
		Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																														
Amphibious Assault	12																													
		48.0	LCAC	4.0	8.0	384.0	144.0	144.0	96.0	2,638	16,493	502	7,863	740	740	2,638	16,493	502	7,863	740	740	1,759	10,995	335	5,242	493	493	7,946,537	257.79	0.01	8,023,358
		48.0	LCU	4.0	8.0	384.0	144.0	144.0	96.0	729	2,261	183	418	109	109	729	2,261	183	418	109	109	486	1,508	122	279	72	72	354,711	11.51	0.00	358,140
Battalion Landing	0																													
		0.0	LCU	6.0	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	AAV/EFV	14.0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	LCAC	5.0	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0.0	CRRC	0.0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	6																													
		78.0	CRRC	13.0	2.0	156.0	156	0.0	0.0	789	2,450	199	453	118	118	0	0	0	0	0	0	0	0	0	0	0	0	144,101	4.67	0.00	145,495
		12.0	LCU	2.0	2.0	24.0	24	0.0	0.0	121	377	31	70	18	18	0	0	0	0	0	0	0	0	0	0	0	0	22,169	0.72	0.00	22,384
		12.0	LCAC	2.0	2.0	24.0	24	0.0	0.0	440	2,749	84	1,311	123	123	0	0	0	0	0	0	0	0	0	0	0	0	496,659	16.11	0.00	501,460
		36.0	EFV	6.0	2.0	72.0	72	0.0	0.0	55	448	59	90	19	19	0	0	0	0	0	0	0	0	0	0	0	0	100,049	3.25	0.00	101,016
Humanitarian Assistance	2																													
		8.0	LCAC	4.0	8.0	64.0	24.0	24.0	16.0	440	2,749	84	1,311	123	123	440	2,749	84	1,311	123	123	293	1,833	56	874	82	82	1,324,423	42.96	0.00	1,337,226
		8.0	LCU	4.0	8.0	64.0	24.0	24.0	16.0	121	377	31	70	18	18	121	377	31	70	18	18	81	251	20	46	12	12	59,119	1.92	0.00	59,690
ANTI-SURFACE WARFARE																														
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																													
		0.0	BW	1.0	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	10																													
		10.0	BW	1.0	2.0	20.0	20.0	0.0	0.0	2,235	32	918	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1,974	0.06	0.00	1,993
		10	Bayliner	1	2.0	20.0	20.0	0.0	0.0	747	1,483	120	468	52	52	0	0	0	0	0	0	0	0	0	0	0	0	153,508	4.98	0.00	154,992
ANTI-SUBMARINE WARFARE																														
Tracking / Torpedo Exercise-Submarine	127																													
		127.0	TRB	1.0	3.6	457.2	4.6	45.7	406.9	30	257	7	34	5	5	296	2,570	71	338	54	54	2,633	22,876	631	3,011	480	480	134,762	4.37	0.00	136,065
Tracking / Torpedo Exercise-Surface	274																													
		86.5	TRB	0.316	3.6	311.5	3.1	31.1	277.2	20	175	5	23	4	4	202	1,751	48	231	37	37	1,794	15,586	430	2,052	327	327	91,815	2.98	0.00	92,703
Tracking / Torpedo Exercise-Helo	165																													
		49.5	TRB	0.300	3.6	178.2	1.8	17.8	158.6	12	100	3	13	2	2	115	1,002	28	132	21	21	1,026	8,916	246	1,174	187	187	52,526	1.70	0.00	53,033
Tracking / Torpedo Exercise-MPA	296																													
		180.2	TRB	0.609	2.0	360.3	18.0	36.0	306.3	117	1,013	28	133	21	21	233	2,026	56	267	43	43	1,982	17,220	475	2,267	361	361	106,215	3.45	0.00	107,241
Tracking / Torpedo Exercise - MPA-EER	96																													
		58.4	TRB	0.609	2.0	116.9	5.8	11.7	99.3	38	329	9	43	7	7	76	657	18	86	14	14	643	5,585	154	735	117	117	34,448	1.12	0.00	34,781

Table C-18: Baseline Amphibious Vessel Emissions – SCAB Testing Activities

		OPERATIONAL INFORMATION - VESSELS								EMISSIONS/YEAR (lb) BY JURISDICTION																					
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	0																														
		0	LCAC	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Battalion Landing	0																														
		0	LCU	6	3.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0	0	CRRC	13	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	0																														
		0	LCAC	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																														
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0		1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	0																														
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0		1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Submarine	0																														
		0	TRB	1	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Surface	0																														
		0.0	TRB	0.31579	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Helo	188																														
		56.4	TRB	0.3	3.6	203.04	2.0	20.3	180.7	13	114	3	15	2	2	131	1,141	31	150	24	24	1,169	10,159	280	1,337	213	213	59,847	1.94	0.00	60,426
Tracking / Torpedo Exercise-MPA	33																														
		20.1	TRB	0.6087	2.0	40.17	2.0	4.0	34.1	13	113	3	15	2	2	26	226	6	30	5	5	221	1,920	53	253	40	40	11,842	0.38	0.00	11,956
Tracking / Torpedo Exercise - MPA-EER	0																														
		0.0	TRB	0.6087	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

MINE WARFARE																															
Mine Countermeasure Exercise - Surface	0	0	MCM	1	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - EOD	0	0	RHIB	3	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasure Exercise - Towed	0	0	MCM	1	15.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasure Exercise - Mine Detection	0	0	MCM	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - ROV	0	0	RHIB	1	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
MK8 MM Ops	0	0	RHIB	4	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Shock Wave Generator	0	0	CRRC	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM8	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test	0	0	CRRC	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Airborne Mine Neutralization Test AMNS	17	17	RHIB	1	12.0	204.00	204.0	0.0	0.0	69	1,865	12	294	31	31	0	0	0	0	0	0	0	0	0	0	0	0	0	218,426	7.09	0.00	220,537
Mine Countermeasures Test	14	14	MCM	1	15.0	210.00	210.0	0.0	0.0	5,381	6,469	1,280	1,078	119	119	0	0	0	0	0	0	0	0	0	0	0	0	0	264,654	8.59	0.00	267,212
NAVAL SPECIAL WARFARE																															
Underwater Demo - Mat Weave	0	0	CRRC	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demo Qual	0	0	CRRC	2	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Precision Anchoring	0	0	RHIB	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	0	0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	0	0	OUB	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Elevated Causeway	0	0	WT	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	PW	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Salvage Operations	0	0	CRRC	2	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
LIFECYCLE ACTIVITIES																															
Combat System Ship Qual - USW	8	2.5	TRB	0.31579	3.6	3.09	0.1	0.9	8.1	1	5	0	1	0	0	6	51	1	7	1	1	52	455	13	60	10	10	2,681	0.09	0.00	2,707
SHIPBOARD PROTECTION																															
Shipboard Protection	8	8	BW	1	2.0	16.00	16.0	0.0	0.0	1,788	26	734	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1,579	0.05	0.00	1,594
		8		1	2.0	16.00	16.0	0.0	0.0	2,184	3	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2,916	0.09	0.00	2,944

EMISSIONS / YEAR (tons) BY JURISDICTION																															
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)																		
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e									
5	4	1	1	0	0	0	1	0	0	0	0	1	6	0	1	0	0	281	0	0	284									

Table C-19: Baseline Amphibious Vessel Emissions – SDAB Testing Activities

Type Training	Training Ops (#)	OPERATIONAL INFORMATION - VESSELS								EMISSIONS/YEAR (lb) BY JURISDICTION																			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
		Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																													
Amphibious Assault	0																												
		0	LCAC	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Battalion Landing	0																												
		0	LCU	6	3.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0																												
		0	CRRC	13	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	0																												
		0	LCAC	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SURFACE WARFARE																													
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																												
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	0																												
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SUBMARINE WARFARE																													
Tracking / Torpedo Exercise-Submarine	0																												
		0	TRB	1	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Surface	0																												
		0.0	TRB	0.315789	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Helo	0																												
		0	TRB	0.3	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-MPA	0																												
		0.0	TRB	0.608696	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise - MPA-EER	0																												
		0.0	TRB	0.608696	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

MINE WARFARE																																
Mine Countermeasure Exercise - Surface	0																															
		0	MCM	1	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - EOD	0																															
		0	RHIB	3	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasure Exercise - Towed	0																															
		0	MCM	1	15.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasure Exercise - Mine Detection	0																															
		0	MCM	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - ROV	0																															
		0	RHIB	1	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
MK8 MM Ops	0																															
		0	RHIB	4	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Shock Wave Generator	0																															
		0	CRRC	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM8	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test	0																															
		0	CRRC	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Airborne Mine Neutralization Test AMNS	0																															
		0	RHIB	1	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasures Test	0																															
		0	MCM	1	15.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
NAVAL SPECIAL WARFARE																																
Underwater Demo - Mat Weave	0																															
		0	CRRC	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demo Qual	0																															
		0	CRRC	2	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																																
Precision Anchoring	0																															
		0	RHIB	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	0																															
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	0																															
		0	OUB	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Elevated Causeway	0																															
		0	WT	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	PW	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Salvage Operations	0																															
		0	CRRC	2	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
LIFECYCLE ACTIVITIES																																
Combat System Ship Qual - USW	0																															
		0.0	TRB	0.3158	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
SHIPBOARD PROTECTION																																
Shipboard Protection	0																															
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)												
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C-20: Baseline Amphibious Vessel Emissions – Hawaii Testing Activities

Type Training	Training Ops (#)	OPERATIONAL INFORMATION - VESSELS								EMISSIONS/YEAR (lb) BY JURISDICTION																			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
		Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																													
Amphibious Assault	0																												
		0	LCAC	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Battalion Landing	0																												
		0	LCU	6	3.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0	0	CRRC	13	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.00	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	0																												
		0	LCAC	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SURFACE WARFARE																													
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																												
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0		1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	0																												
		0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0		1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SUBMARINE WARFARE																													
Tracking / Torpedo Exercise-Submarine	0																												
		0	TRB	1	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Surface	0																												
		0.0	TRB	0.315789	3.6	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Helo	122																												
		36.6	TRB	0.3	3.6	131.76	1.3	13.2	117.3	9	74	2	10	2	2	85	741	20	98	16	16	759	6,593	182	868	138	138	38,837	1.26	0.00	39,212
Tracking / Torpedo Exercise-MPA	14																												
		8.5	TRB	0.608696	2.0	17.04	0.9	1.7	14.5	6	48	1	6	1	1	11	96	3	13	2	2	94	814	22	107	17	17	5,024	0.16	0.00	5,072
Tracking / Torpedo Exercise - MPA-EER	0																												
		0.0	TRB	0.608696	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

MINE WARFARE																															
Mine Countermeasure Exercise - Surface	0																														
	0	MCM	1	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - EOD	0																														
	0	RHIB	3	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasure Exercise - Towed	0																														
	0	MCM	1	15.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasure Exercise - Mine Detection	0																														
	0	MCM	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - ROV	0																														
	0	RHIB	1	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
MK8 MM Ops	0																														
	0	RHIB	4	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Shock Wave Generator	0																														
	0	CRRC	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
	0	LCM8	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test	0																														
	0	CRRC	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Airborne Mine Neutralization Test AMNS	0																														
	0	RHIB	1	12.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Countermeasures Test	0																														
	0	MCM	1	15.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
NAVAL SPECIAL WARFARE																															
Underwater Demo - Mat Weave	0																														
	0	CRRC	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demo Qual	0																														
	0	CRRC	2	6.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Precision Anchoring	0																														
	0	RHIB	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	0																														
	0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	0																														
	0	OUB	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Elevated Causeway	0																														
	0	WT	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
	0	PW	2	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
	0	LCM	1	4.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Salvage Operations	0																														
	0	CRRC	2	8.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
LIFECYCLE ACTIVITIES																															
Combat System Ship Qual - USW	8																														
	2.5	TRB	0.3158	3.6	9.09	0.1	0.9	8.1	1	5	0	1	0	0	6	51	1	7	1	1	52	455	13	60	10	10	2,681	0.09	0.00	2,707
SHIPBOARD PROTECTION																															
Shipboard Protection	0																														
	0	BW	1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
	0		1	2.0	0.00	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																													
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)																
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e								
0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	23	0	0	23								

Table C-21: Baseline Aircraft Emissions – SCAB Training Activities

GENERAL INFO					EMISSIONS (lb/yr)																							
		Aircraft			State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-AIR WARFARE																												
Air Combat Maneuvers	1985																											
		2.83	5618	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58074231.9	8540328	179808070	5833	5081	181,723,025
		0.17	337	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2024700	297750	6268829	203	177	6,335,591
Air Defense Exercise	275																											
		0.21	58	E-2	0	0	0	0	0	0	0	0	0	0	0	0	161	638	23	25	60	60	127050	18684	393369	13	11	397,559
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	352	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	1310	26837	218	728	11936	11936	3638976	535144	11266912	366	318	11,386,904
Gunnery Exercise, A-A	1.5																											
		2.83	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43884.81	6454	135875	4	4	137,322
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1530	225	4737	0	0	4,788
A-A MISSILEX	12.5																											
		4	50	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	663600	97588	2054623	67	58	2,076,504
		6	75	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1550700	228044	4801241	156	136	4,852,374
		1	13	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110000	16176	340579	11	10	344,207
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	13	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	225000	33088	696640	23	20	704,059
Gunnery Exercise	80	12																										
		1	80	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2857	753	544	51	162	162	255360	37553	790640	26	22	799,060
Gunnery Exercise	95																											
		1	95	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	3393	895	646	61	193	193	303240	44594	938885	30	27	948884
S-A MISSILEX	10																											
		1	10	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	225	230	20	14	151	151	36000	5294	111462	4	3	112,649
		1	10	P-8	0	0	0	0	0	0	0	0	0	0	0	0	241	742	56	38	381	381	144000	21176	445849	14	13	450,598
		1	10	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	476	126	91	9	27	27	31920	4694	98830	3	3	99,882
		0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intell, Surveill, Recon	0																											
		0	1	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																													
Amphibious Assault	36																												
		8	288	AH-1	7865	3817	400	281	2947	2947	0	0	0	0	0	0	0	0	0	0	0	0	701568	103172	2172178	70	61	2,195,312
		0	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	144	UH-1	3932	1908	200	140	1473	1473	0	0	0	0	0	0	0	0	0	0	0	0	233280	34306	722276	23	20	729,968
USMC Battalion Landing	6																												
		8	48.0	FA-18A/C	12	32	2	2	30	30	29	81	5	5	76	76	17	48	3	3	46	46	159264	23421	493109	16	14	498,361
		8	48.0	FA-18E/F	5	110	1	3	49	49	13	274	2	7	122	122	8	165	1	4	73	73	248112	36487	768199	25	22	776,380
		6	36.0	AV-8B	187	209	13	10	92	92	10	12	1	1	5	5	10	12	1	1	5	5	108000	15882	334387	11	9	337,948
		4	24.0	AH-1	197	95	10	7	74	74	11	5	1	0	4	4	11	5	1	0	4	4	19488	2866	60338	2	2	60,981
		2	12.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75600	11118	234071	8	7	236,564
		4	24.0	H-53	308	1169	22	58	320	320	17	65	1	3	18	18	17	65	1	3	18	18	160704	23633	497568	16	14	502,867
		12	72.0	H-46	1988	110	308	47	208	208	110	27	17	3	12	12	110	27	17	3	12	12	129600	19059	401264	13	11	405,538
		3	18.0	UH-1	147	72	7	5	55	55	8	4	0	0	3	3	8	4	0	0	3	3	9720	1429	30095	1	1	30,415
Amphibious Raid	0	47																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	9																												
		0.17	2	FA-18E/F	0	0	0	0	0	0	34	700	6	19	311	311	0	0	0	0	0	0	47451.42	6978	146918	5	4	148,483
		0.17	2	AH-1	0	0	0	0	0	0	42	20	2	1	16	16	0	0	0	0	0	0	3727.08	548	11540	0	0	11,663
		0.17	2	AV-8B	0	0	0	0	0	0	212	237	15	11	105	105	0	0	0	0	0	0	27540	4050	85269	3	2	86,177
Humanitarian Assistance	2																												
		90	180.0	AH-1	4915	2385	250	175	1842	1842	0	0	0	0	0	0	0	0	0	0	0	0	438480	64482	1357611	44	38	1,372,070
		58	116.0	CH-46	7116	0	1102	167	743	743	0	0	0	0	0	0	0	0	0	0	0	0	417600	61412	1292963	42	37	1,306,733
		32	64.0	CH-53	1826	6925	129	343	1894	1894	0	0	0	0	0	0	0	0	0	0	0	0	857088	126042	2653696	86	75	2,681,958
		38	76.0	AV-8B	0	0	0	0	0	0	10534	11765	739	547	5198	5198	0	0	0	0	0	0	1368000	201176	4235569	137	120	4,280,678
		48	96.0	UH-1	2622	1272	133	94	982	982	0	0	0	0	0	0	0	0	0	0	0	0	155520	22871	481517	16	14	486,646
STRIKE WARFARE																													
A-S BOMBEX	0																												
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-S GUNEX	0																												
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SURFACE WARFARE																											
Maritime Security Operations	192																										
		0.74	142	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	4262	4365	375	273	2864	2864	681984	100292	2111543	68	60	2,134,031
		0.25	48	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	1440	1475	127	92	968	968	230400	33882	713359	23	20	720,956
GUNEX, A-S (Small Caliber)	131																										
		1.62	212	SH-60B	0	0	0	0	0	0	796	815	70	51	535	535	796	815	70	51	535	535	254664	37451	788485	26	22	796,882
		0.55	212	SH-60F	0	0	0	0	0	0	796	815	70	51	535	535	796	815	70	51	535	535	254664	37451	788485	26	22	796,882
		0.02	212	MH-60R/S	0	0	0	0	0	0	796	815	70	51	535	535	796	815	70	51	535	535	254664	37451	788485	26	22	796,882
GUNEX, A-S (Medium Caliber)	100																										
		1.62	162.0	SH-60B	0	0	0	0	0	0	608	622	53	39	408	408	608	622	53	39	408	408	194400	28588	601897	20	17	608,307
		0.55	55.0	SH-60F	0	0	0	0	0	0	206	211	18	13	139	139	206	211	18	13	139	139	66000	9706	204348	7	6	206,524
		0.02	2.0	MH-60R/S	0	0	0	0	0	0	8	8	1	0	5	5	8	8	1	0	5	5	2400	353	7431	0	0	7,510
MISSILEX, A-S (Rocket)	130																										
		0.55	71.5	SH-60B	0	0	0	0	0	0	804	824	71	51	541	541	804	824	71	51	541	541	257400	37853	796956	26	23	805,443
		0.28	36.4	SH-60F	0	0	0	0	0	0	410	419	36	26	275	275	410	419	36	26	275	275	131040	19271	405723	13	11	410,044
		0.3	39.0	FA-	0	0	0	0	0	0	63	174	11	10	165	165	63	174	11	10	165	165	517608	76119	1602606	52	45	1,619,673
		0.3	39.0	FA-	0	0	0	0	0	0	29	595	5	16	264	264	29	595	5	16	264	264	806364	118583	2496645	81	71	2,523,235
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S	214																										
		0.55	72	SH-60B	0	0	0	0	0	0	804	824	71	51	541	541	804	824	71	51	541	541	257400	37853	796956	26	23	805,443
		0.28	36	SH-60F	0	0	0	0	0	0	410	419	36	26	275	275	410	419	36	26	275	275	131040	19271	405723	13	11	410,044
		0.3	39	FA-	0	0	0	0	0	0	63	174	11	10	165	165	63	174	11	10	165	165	517608	76119	1602606	52	45	1,619,673
		0.3	39	FA-	0	0	0	0	0	0	29	595	5	16	264	264	29	595	5	16	264	264	806364	118583	2496645	81	71	2,523,235
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOMBEX, A-S	120																										
		0.53	64	FA-18A/C	0	0	0	0	0	0	51	142	9	8	134	134	51	142	9	8	134	134	422049.6	62066	1306740	42	37	1,320,657
		0.53	64	FA-18E/F	0	0	0	0	0	0	24	485	4	13	216	216	24	485	4	13	216	216	657496.8	96691	2035726	66	58	2,057,407
		0.28	34	P-8	0	0	0	0	0	0	20	62	5	3	32	32	20	62	5	3	32	32	161280	23718	499351	16	14	504,669
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	250																										
		0.55	138	SH-60B	0	0	0	0	0	0	516	528	45	33	347	347	516	528	45	33	347	347	165000	24265	510869	17	14	516,310
		0.28	70	SH-60F	0	0	0	0	0	0	263	269	23	17	176	176	263	269	23	17	176	176	84000	12353	260079	8	7	262,849
		0.3	75	FA-	0	0	0	0	0	0	61	168	11	10	158	158	61	168	11	10	158	158	497700	73191	1540967	50	44	1,557,378
		0.3	75	FA-	0	0	0	0	0	0	28	572	5	16	254	254	28	572	5	16	254	254	775350	114022	2400620	78	68	2,426,187
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINKEX	2																						0	0	0	0.00	0.00	0
		2	4	E-2	0	0	0	0	0	0	0	0	0	0	0	0	36	141	5	6	13	13	140800	20706	435942	14	12	440,584
		8	16	FA-	0	0	0	0	0	0	0	0	0	0	0	0	191	3904	32	106	1736	1736	2646528	389195	8194118	266	232	8,281,385
		1	2	P-8	0	0	0	0	0	0	0	0	0	0	0	0	39	119	9	6	61	61	153600	22588	475573	15	13	480,638
		2	4	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	480	492	42	31	323	323	76800	11294	237786	8	7	240,319
Missile Testing	0																										
		1.2	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.8	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Warfare Testing	0																										
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo Testing	0																										
		0.14	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.68	0	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.09	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SUBMARINE WARFARE																												
TRACKEX-Helo	628																											
		0.17	107	SH-60B	0	0	0	0	0	0	680	697	60	44	457	457	2202	2255	194	141	1480	1480	461203.2	67824	1427366	46	40	1,443,174
		0.83	521	SH-60F	0	0	0	0	0	0	3321	3401	292	213	2232	2232	10752	11010	946	688	7225	7225	2251756.8	331141	6971836	226	197	7,046,086
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA	116																											
		1	116	P-8	314	368	73	50	437	437	629	1937	145	100	395	395	5346	16463	1235	852	8455	8455	3340800	491294	10343706	336	292	10,453,867
					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX MPA-IEER	48																											
		1	48	P-8	0	0	0	0	0	0	0	0	0	0	0	0	2602	8014	601	415	4116	4116	1382400	203294	4280154	139	121	4,325,738
					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASW Torpedo Test	0																											
		0.5	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.5	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELECTRONIC WARFARE																												
Electronic Warfare	350																											
		0.08	28	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	441	452	33	28	296	296	70560	10376	218466	7	6	220,793
		0.05	18	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	276	282	24	18	185	185	44100	6485	136541	4	4	137,396
		0.004	1	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	22	23	2	1	15	15	3528	513	10323	0	0	11,040
		0.04	14	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	134400	19765	416126	13	12	420,558
		0.29	102	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1347108	138104	4170884	135	118	4,215,304
		0.29	102	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2038614	308620	6437679	211	184	6,566,880
		0.02	7	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30800	4529	95362	3	3	96,378
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	70	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148960	21306	461206	15	13	466,118
		0.01	4	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7448	1095	23060	1	1	23,306
FLAREX	25		344.4																									
		2	50	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1421475	209040	4401137	143	124	4,448,010
		2	50	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	312450	134184	2825106	32	80	2,855,194
		2	50	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660000	37053	2043476	66	58	2,065,239
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	50	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660000	37053	2043476	66	58	2,065,239
		1	25	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53200	7824	164717	5	5	166,471
CHAFFEX	125																											
																							0	0	0	0.00	0.00	0
		2	250	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7107375	1045202	22005687	714	622	22,240,048
		2	250	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4562250	670313	14125531	458	399	14,275,368
		2	250	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3300000	485294	10217382	331	289	10,326,197
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	250	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3300000	485294	10217382	331	289	10,326,197
		1	125	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	266000	33118	823583	27	23	832,354
Electronic Systems Evaluation	0																											
		1	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	250	384	57	48	479	479	180000	26471	557312	18	16	563,247
		2	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	36000	14118	237233	10	8	300,338

MINE WARFARE																												
Mine Neutralization - EOD	354																											
		1	354	SH-60B	5576	5709	491	357	3747	3747	0	0	0	0	0	0	0	0	0	0	0	0	892080	131188	2762037	90	78	2,791,453
Mine Countermeasure Exercise - Towed	340																											
		1	340	SH-60B	5355	5484	471	343	3599	3599	0	0	0	0	0	0	0	0	0	0	0	0	856800	126000	2652804	86	75	2,681,056
Mine Countermeasure Exercise - Mine Detection	668																											
		1	668	SH-60B	10521	10774	926	673	7070	7070	0	0	0	0	0	0	0	0	0	0	0	0	1683360	247553	5211980	169	147	5,267,487
Mine Countermeasure Exercise - Mine Neutralization	36																											
		1	36	SH-60B	567	581	50	36	381	381	0	0	0	0	0	0	0	0	0	0	0	0	90720	13341	280885	9	8	283,877
Mine Neutralization - ROV	248																											
		1	248	SH-60B	3906	4000	344	250	2625	2625	0	0	0	0	0	0	0	0	0	0	0	0	624960	91906	1934986	63	55	1,955,594
Mine Laying	18																											
		0.29	5.22	P-8	19	58	4	3	30	30	15	46	3	2	24	24	4	12	1	1	6	6	22550.4	3316	69820	2	2	70,564
		0.65	11.7	FA-18A/C	3	9	1	1	8	8	3	7	0	0	7	7	1	2	0	0	2	2	38820.6	5709	120195	4	3	121,476
		0.59	10.62	FA-18E/F	1	27	0	1	12	12	1	22	0	1	10	10	0	5	0	0	2	2	54894.78	8073	169964	6	5	171,774
Airborne Mine Neutralization Test AMNS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - AN/AQS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test OASIS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - ALMDS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasures Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NAVAL SPECIAL WARFARE																												
Personnel I&E	204.5																											
		1	204.5	SH-60B	3221	3298	283	206	2164	2164	0	0	0	0	0	0	0	0	0	0	0	0	515340	75785	1595584	52	45	1,612,577
OTHER																												
Air Platform Ship Integration Test	0																											
		1	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398
		1	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS (lb/yr)																											
State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
60,602	49,012	5,220	3,251	30,842	30,842	22,453	28,835	1,921	1,471	15,557	15,557	45,173	91,308	6,047	4,237	48,067	48,067	122,251,493	17,978,161	378,512,197	12,279	10,697	382,543,350
30	25	3	2	15	15	11	14	1	1	8	8	23	46	3	2	24	24			189,256	6	5	191,272

Table C-22: Baseline Aircraft Emissions – SDAB Training Activities

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-AIR WARFARE																												
Air Combat Maneuvers	1985																											
		2.83	5618	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58074231.9	8540328	179808070	5833	5081	181,723,025
		0.17	337	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2024700	297750	6268829	203	177	6,335,591
Air Defense Exercise	275																											
		0.21	58	E-2	0	0	0	0	0	0	0	0	0	0	0	0	161	638	23	25	60	60	127050	18684	393369	13	11	397,559
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	352	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	1310	26837	218	728	11936	11936	3638976	535144	11266912	366	318	11,386,904
Gunnery Exercise, A-A	1.5																											
		2.83	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43884.81	6454	135875	4	4	137,322
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1530	225	4737	0	0	4,788
A-A MISSILEX	12.5																											
		4	50	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	663600	97588	2054623	67	58	2,076,504
		6	75	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1550700	228044	4801241	156	136	4,852,374
		1	13	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110000	16176	340579	11	10	344,207
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	13	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	225000	33088	696640	23	20	704,059
Gunnery Exercise	80																											
		1	80	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2857	753	544	51	162	162	255360	37553	790640	26	22	799,060
Gunnery Exercise	95																											
		1	95	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	3393	895	646	61	193	193	303240	44594	938885	30	27	948884
S-A MISSILEX	10																											
		1	10	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	225	230	20	14	151	151	36000	5294	111462	4	3	112,649
		1	10	P-8	0	0	0	0	0	0	0	0	0	0	0	0	241	742	56	38	381	381	144000	21176	445849	14	13	450,598
		1	10	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	476	126	91	9	27	27	31920	4694	98830	3	3	99,882
		0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intell, Surveill, Recon	0																											
		0	1	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																												
Amphibious Assault	0																											
		8	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USMC Battalion Landing	0																											
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	H-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	2426																											
		0.053	128	AH-1	3498	1697	178	125	1311	1311	0	0	0	0	0	0	0	0	0	0	0	0	312034.0608	45887	966113	31	27	976,402
		0.035	84	CH-46	5149	0	798	121	538	538	0	0	0	0	0	0	0	0	0	0	0	0	302182.56	44439	935611	30	26	945,575
		0.020	48	CH-53	1370	5198	96	257	1422	1422	0	0	0	0	0	0	0	0	0	0	0	0	643282.0416	94600	1991715	65	56	2,012,926
		0.023	56	AV-8B	0	0	0	0	0	0	5156	5758	362	268	2544	2544	0	0	0	0	0	0	669576	98467	2073125	67	59	2,095,204
		0.030	72	UH-1	1968	955	100	70	737	737	0	0	0	0	0	0	0	0	0	0	0	0	116724.564	17165	361400	12	10	365,249
Expeditionary Fires Exercise	0																											
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	0																											
		90	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		58	0.0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		32	0.0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		38	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		48	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STRIKE WARFARE																												
A-S BOMBEX	0																											
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-S GUNEX	0																						0	0	0	0.00	0.00	0
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SURFACE WARFARE																													
Maritime Security Operations	0																												
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Small Caliber)	0																												
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Medium Caliber)	0																												
		1.62	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0.0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S (Rocket)	0																												
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOMBEX, A-S	0																												
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINKEX	0																												
		2	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Testing	0																												
		1.2	0	18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.8	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Warfare Testing	0																												
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo Testing	0																												
		0.14	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.68	0	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.09	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SUBMARINE WARFARE																												
TRACKEX-Helo	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA	0																						0	0	0	0.00	0.00	0
		1	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA-IEER	0																						0	0	0	0.00	0.00	0
		1	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kip Dip-Helo	1,060																											
		0.17	180	SH-60B	0	0	0	0	0	0	80	82	7	5	54	54	258	264	23	17	173	173	54060	7950	167379	5	5	169,162
		0.83	880	SH-60F	0	0	0	0	0	0	389	399	34	25	262	262	1260	1291	111	81	847	847	263940	38815	817205	27	23	825,908
ASW Torpedo Test	0																											
		0.5	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.5	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELECTRONIC WARFARE																												
Electronic Warfare	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLAREX	0		0																									
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAFFEX	0																											
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																											
		1	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	250	984	57	48	479	479	180000	26471	557312	18	16	563,247
		2	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398

MINE WARFARE																												
Mine Neutralization - EOD	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Towed	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying	0																											
		0.29	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.65	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.59	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test AMNS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - ANAQS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test OASIS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - ALMDS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasures Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NAVAL SPECIAL WARFARE																												
Personnel I&E	204.5																											
		1	204.5	SH-60B	3221	3298	283	206	2164	2164	0	0	0	0	0	0	0	0	0	0	0	0	515340	75785	1595584	52	45	1,612,577
OTHER																												
Air Platform Ship Integration Test	0																											
		1	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398
		1	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS (lb/yr)																							
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
15,206	11,148	1,456	779	6,172	6,172	5,625	6,239	403	298	2,860	2,860	11,633	33,989	1,893	1,148	15,215	15,215	70,479,332	10,364,608	218,216,449	7,079	6,167	220,540,453
8	6	1	0	3	3	3	3	0	0	1	1	6	17	1	1	8	8			109,108	4	3	110,270

Table C-23: Baseline Aircraft Emissions – Hawaii Training Activities

GENERAL INFO					EMISSIONS (lb/yr)																						
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-AIR WARFARE																												
Air Combat Maneuvers	814																											
		2.83	2304	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23814823.6	3502180	73734896	2392	2084	74,520,173
		0.17	138	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	830280	122100	2570693	83	73	2,598,071
Air Defense Exercise	185																											
		0.21	39	E-2	0	0	0	0	0	0	0	0	0	0	0	0	109	429	15	17	40	40	85470	12569	264630	9	7	267,449
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	237	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	881	18054	147	490	8030	8030	2448038.4	360006	7579559	246	214	7,660,281
Gunnery Exercise, A-A	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-A MISSILEX	27																											
		4	108	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1433376	210791	4437985	144	125	4,485,250
		6	162	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3349512	492575	10370680	336	293	10,481,128
		1	27	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	237600	34941	735652	24	21	743,486
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	27	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	486000	71471	1504742	49	43	1,520,767
Gunnery Exercise	50																											
		1	50	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	1786	471	340	32	101	101	159600	23471	494150	16	14	499,412
Gunnery Exercise	70																											
		1	70	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2500	659	476	45	142	142	223440	32859	691810	22	20	699177
S-A MISSILEX	30																											
		1	30	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	675	691	59	43	454	454	108000	15882	334387	11	9	337,948
		1	30	P-8	0	0	0	0	0	0	0	0	0	0	0	0	723	2227	167	115	1144	1144	432000	63529	1337548	43	38	1,351,793
		1	30	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	1429	377	272	26	81	81	95760	14082	296490	10	8	299,647
		0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intell, Surveill, Recon	0																						0	0	0	0.00	0.00	0
		0	1	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																											
Amphibious Assault	12																										
		8	96	AH-1	2622	1272	133	94	982	982	0	0	0	0	0	0	0	0	0	0	0	0	233856	34391	724059	23	20	731,771
		0	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	48	UH-1	1311	636	67	47	491	491	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240759	8	7	243,323
USMC Battalion Landing	0																										
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	H-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	6																										
		0.053	0	AH-1	9	4	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	771.7248	113	2389	0	0	2,415
		0.035	0	CH-46	13	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	747.36	110	2314	0	0	2,339
		0.020	0	CH-53	3	13	0	1	4	4	0	0	0	0	0	0	0	0	0	0	0	0	1590.9696	234	4926	0	0	4,978
		0.023	0	AV-8B	0	0	0	0	0	0	13	14	1	1	6	6	0	0	0	0	0	0	1656	244	5127	0	0	5,182
		0.030	0	UH-1	5	2	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	288.684	42	894	0	0	903
Expeditionary Fires Exercise	0																										
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	2																										
		90	180.0	AH-1	4915	2385	250	175	1842	1842	0	0	0	0	0	0	0	0	0	0	0	0	438480	64482	1357611	44	38	1,372,070
		58	116.0	CH-46	7116	0	1102	167	743	743	0	0	0	0	0	0	0	0	0	0	0	0	417600	61412	1292963	42	37	1,306,733
		32	64.0	CH-53	1826	6925	129	343	1894	1894	0	0	0	0	0	0	0	0	0	0	0	0	857088	126042	2653696	86	75	2,681,958
		38	76.0	AV-8B	0	0	0	0	0	0	10534	11765	739	547	5198	5198	0	0	0	0	0	0	1368000	201176	4235569	137	120	4,280,678
		48	96.0	UH-1	2622	1272	133	94	982	982	0	0	0	0	0	0	0	0	0	0	0	0	155520	22871	481517	16	14	486,646
STRIKE WARFARE																											
A-S BOMBEX	60																										
		0.3	18	FA-18A/C	0	0	0	0	0	0	15	40	3	2	38	38	15	40	3	2	38	38	119448	17566	369832	12	10	373,771
		0.3	18	FA-18E/F	0	0	0	0	0	0	7	137	1	4	61	61	7	137	1	4	61	61	186084	27365	576149	19	16	582,285
		0.2	12	P-8	0	0	0	0	0	0	7	22	2	1	11	11	7	22	2	1	11	11	57600	8471	178340	6	5	180,239
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-S GUNEX	307																										
		1.62	497	SH-60B	0	0	0	0	0	0	1865	1910	164	119	1253	1253	1865	1910	164	119	1253	1253	596808	87766	1847823	60	52	1,867,502
		0.55	169	SH-60F	0	0	0	0	0	0	633	648	56	41	426	426	633	648	56	41	426	426	202620	29797	627347	20	18	634,029
		0.02	6	MH-60R/S	0	0	0	0	0	0	23	24	2	1	15	15	23	24	2	1	15	15	7368	1084	22813	1	1	23,056

ANTI-SURFACE WARFARE																											
Maritime Security Operations	70																										
		0.74	52	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1554	1591	137	99	1044	1044	248640	36565	769833	25	22	778,032
		0.25	18	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	525	538	46	34	353	353	84000	12353	260079	8	7	262,849
GUNEX, A-S (Small Caliber)	275																										
		1.62	446	SH-60B	0	0	0	0	0	0	1671	1711	147	107	1123	1123	1671	1711	147	107	1123	1123	534600	78618	1655216	54	47	1,672,844
		0.55	446	SH-60F	0	0	0	0	0	0	1671	1711	147	107	1123	1123	1671	1711	147	107	1123	1123	534600	78618	1655216	54	47	1,672,844
		0.02	446	MH-60R/S	0	0	0	0	0	0	1671	1711	147	107	1123	1123	1671	1711	147	107	1123	1123	534600	78618	1655216	54	47	1,672,844
GUNEX, A-S (Medium Caliber)	130																										
		1.62	210.6	SH-60B	0	0	0	0	0	0	790	809	69	51	531	531	790	809	69	51	531	531	252720	37165	782466	25	22	790,799
		0.55	71.5	SH-60F	0	0	0	0	0	0	268	275	24	17	180	180	268	275	24	17	180	180	85800	12618	265652	9	8	268,481
		0.02	2.6	MH-60R/S	0	0	0	0	0	0	10	10	1	1	7	7	10	10	1	1	7	7	3120	459	9660	0	0	9,763
MISSILEX, A-S (Rocket)	20																										
		0.55	11.0	SH-60B	0	0	0	0	0	0	124	127	11	8	83	83	124	127	11	8	83	83	39600	5824	122609	4	3	123,916
		0.28	5.6	SH-60F	0	0	0	0	0	0	63	65	6	4	42	42	63	65	6	4	42	42	20160	2965	62419	2	2	63,084
		0.3	6.0	FA-	0	0	0	0	0	0	10	27	2	2	25	25	10	27	2	2	25	25	79632	11711	246555	8	7	249,181
		0.3	6.0	FA-18E/F	0	0	0	0	0	0	4	91	1	2	41	41	4	91	1	2	41	41	124056	18244	384099	12	11	388,190
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S	57																										
		0.55	11	SH-60B	0	0	0	0	0	0	124	127	11	8	83	83	124	127	11	8	83	83	39600	5824	122609	4	3	123,916
		0.28	6	SH-60F	0	0	0	0	0	0	63	65	6	4	42	42	63	65	6	4	42	42	20160	2965	62419	2	2	63,084
		0.3	6	FA-	0	0	0	0	0	0	10	27	2	2	25	25	10	27	2	2	25	25	79632	11711	246555	8	7	249,181
		0.3	6	FA-18E/F	0	0	0	0	0	0	4	91	1	2	41	41	4	91	1	2	41	41	124056	18244	384099	12	11	388,190
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOMBEX, A-S	28																										
		0.53	15	FA-18A/C	0	0	0	0	0	0	12	33	2	2	31	31	12	33	2	2	31	31	98478.24	14482	304906	10	9	308,153
		0.53	15	FA-18E/F	0	0	0	0	0	0	6	113	1	3	50	50	6	113	1	3	50	50	153415.92	22561	475003	15	13	480,062
		0.28	8	P-8	0	0	0	0	0	0	5	15	1	1	7	7	5	15	1	1	7	7	37632	5534	116515	4	3	117,756
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	50																										
		0.55	28	SH-60B	0	0	0	0	0	0	103	106	9	7	69	69	103	106	9	7	69	69	33000	4853	102174	3	3	103,262
		0.28	14	SH-60F	0	0	0	0	0	0	53	54	5	3	35	35	53	54	5	3	35	35	16800	2471	52016	2	1	52,570
		0.3	15	FA-	0	0	0	0	0	0	12	34	2	2	32	32	12	34	2	2	32	32	99540	14638	308193	10	9	311,476
		0.3	15	FA-18E/F	0	0	0	0	0	0	6	114	1	3	51	51	6	114	1	3	51	51	155070	22804	480124	16	14	485,237
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINKEX	6																										
		2	12	E-2	0	0	0	0	0	0	0	0	0	0	0	0	107	424	15	17	40	40	422400	62118	1307825	42	37	1,321,753
		8	48	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	572	11711	95	318	5208	5208	7939584	1167586	24582353	797	695	24,844,155
		1	6	P-8	0	0	0	0	0	0	0	0	0	0	0	0	116	356	27	18	183	183	460800	67765	1426718	46	40	1,441,913
		2	12	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1440	1475	127	92	968	968	230400	33882	713359	23	20	720,956
Missile Testing	0																										
		1.2	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.8	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Warfare Testing	0																										
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo Testing	0																										
		0.14	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.68	0	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.09	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SUBMARINE WARFARE																												
TRACKEX-Helo	165																											
		0.17	28	SH-60B	0	0	0	0	0	0	179	183	16	11	120	120	579	593	51	37	389	389	121176	17820	375182	12	11	379,178
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA	296																						0	0	0	0.00	0.00	0
					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA-IEER	96																						0	0	0	0.00	0.00	0
					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	2																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	15	316	0	0	319
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASW Torpedo Test	0																											
		0.5	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.5	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELECTRONIC WARFARE																												
Electronic Warfare	33																											
		0.08	3	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	42	43	4	3	28	28	6652.8	978	20598	1	1	20,818
		0.05	2	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	26	27	2	2	17	17	4158	611	12874	0	0	13,011
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1	332.64	49	1030	0	0	1,041
		0.04	1	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12672	1864	39235	1	1	39,653
		0.29	10	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127013.04	18678	393255	13	11	397,443
		0.29	10	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	197869.32	29098	612638	20	17	619,163
		0.02	1	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2904	427	8991	0	0	9,087
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	7	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14044.8	2065	43485	1	1	43,948
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	702.24	103	2174	0	0	2,197
FLAREX	8																											
		2	16	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	454872	66893	1408364	46	40	1,423,363
		2	16	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	291984	42939	904034	29	26	913,662
		2	16	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	211200	31059	653912	21	18	660,877
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	16	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	211200	31059	653912	21	18	660,877
		1	8	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17024	2504	52709	2	1	53,271
CHAFFEX	37																											
		2	74	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2103783	309380	6513683	211	184	6,583,054
		2	74	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1350426	198592	4181157	136	118	4,225,687
		2	74	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	976800	143647	3024345	98	85	3,056,554
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
		2	74	P-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	976800	143647	3024345	98	85	3,056,554
		1	37	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78736	11579	243781	8	7	246,377
Electronic Systems Evaluation	0																											
		1	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	250	984	57	48	479	479	180000	26471	557312	18	16	563,247
		2	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398

MINE WARFARE																												
Mine Neutralization - EOD	22																											
		1	22	SH-60B	347	355	30	22	233	233	0	0	0	0	0	0	0	0	0	0	0	0	55440	8153	171652	6	5	173,480
Mine Countermeasure Exercise - Towed	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying	32																											
		0.29	9.28	P-8	34	103	8	5	53	53	27	83	6	4	42	42	7	21	2	1	11	11	40089.6	5896	124124	4	4	125,446
		0.65	20.8	FA-18A/C	6	16	1	1	15	15	4	12	1	1	12	12	1	3	0	0	3	3	69014.4	10149	213681	7	6	215,956
		0.59	18.88	FA-18E/F	2	48	0	1	21	21	2	38	0	1	17	17	0	10	0	0	4	4	97590.72	14352	302158	10	9	305,376
Airborne Mine Neutralization Test AMNS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - AMAGIS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test OASIS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - ALMDS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasures Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NAVAL SPECIAL WARFARE																												
Personnel I&E	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Ship Integration Test	0																											
		1	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398
		1	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS (lb/yr)																											
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
21,631	15,503	2,042	1,078	8,536	8,536	22,463	28,026	2,031	1,488	15,071	15,071	45,424	112,941	7,570	5,308	57,783	57,783	70,555,591	10,375,822	218,452,562	7,087	6,174	220,779,081
11	8	1	1	4	4	11	14	1	1	8	8	23	56	4	3	29	29			109,226	4	3	110,390

Table C-24: Baseline Aircraft Emissions – SCAB Testing Activities

GENERAL INFO					EMISSIONS (lb/yr)																					
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-AIR WARFARE																												
Air Combat Maneuvers	55																											
		2.83	156	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1609109.7	236634	4982088	162	141	5,035,147
		0.17	9	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56100	8250	173696	6	5	175,545
Air Defense Exercise	0																											
		0.21	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise A-A	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-A MISSILEX	0																											
		4	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise	0	12																										
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise	0																											
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S-A MISSILEX	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Platform, Vehicle Test	385																											
		0.33	127	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	946	19373	158	525	8616	8616	5253771.6	772613	16266604	528	460	16,439,843
		0.33	127	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	1156	561	59	41	433	433	274428	40357	849678	28	24	858,727
		0.33	127	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	710	2806	101	112	263	263	1118040	164418	3461649	112	98	3,498,516
Air Platform, Weapons Test	165																											
		0.33	54	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	203	4151	34	113	1846	1846	1125808.2	165560	3485701	113	99	3,522,824
		0.33	54	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	204	209	18	13	137	137	130680	19218	404608	13	11	408,917
		0.33	54	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	152	601	22	24	56	56	239580	35232	741782	24	21	749,682
Intell, Surveill, Recon	50																						0	0	0	0.00	0.00	0
		50	1	P-3c	0	0	0	0	0	0	0	0	0	0	0	0	2169	6679	501	346	3430	3430	1440000	211765	4458494	145	126	4,505,977

AMPHIBIOUS WARFARE																												
Amphibious Assault	0																											
		8	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USMC Battalion Landing	0																											
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	H-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	0																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	0																											
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	0																											
		90	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		58	0.0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		32	0.0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		38	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		48	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STRIKE WARFARE																												
A-S BOMBEX	0																											
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-S GUNEX	0																											
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SURFACE WARFARE																												
Maritime Security Operations	0																											
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Small Caliber)	25																											
		1.62	41	SH-60B	0	0	0	0	0	0	152	156	13	10	102	102	152	156	13	10	102	102	48600	7147	150474	5	4	152,077
		0.55	41	SH-60F	0	0	0	0	0	0	152	156	13	10	102	102	152	156	13	10	102	102	48600	7147	150474	5	4	152,077
		0.02	41	MH-60R/S	0	0	0	0	0	0	152	156	13	10	102	102	152	156	13	10	102	102	48600	7147	150474	5	4	152,077
GUNEX, A-S (Medium Caliber)	30																											
		1.62	48.6	SH-60B	0	0	0	0	0	0	182	187	16	12	122	122	182	187	16	12	122	122	58320	8576	180569	6	5	182,492
		0.55	16.5	SH-60F	0	0	0	0	0	0	62	63	5	4	42	42	62	63	5	4	42	42	19800	2912	61304	2	2	61,957
		0.02	0.6	MH-60R/S	0	0	0	0	0	0	2	2	0	0	2	2	2	2	0	0	2	2	720	106	2229	0	0	2,253
MISSILEX, A-S (Rocket)	66																											
		0.55	36.3	SH-60B	0	0	0	0	0	0	408	418	36	26	274	274	408	418	36	26	274	274	130680	19218	404608	13	11	408,917
		0.28	18.5	SH-60F	0	0	0	0	0	0	208	213	18	13	140	140	208	213	18	13	140	140	66528	9784	205982	7	6	208,176
		0.3	19.8	FA-18A/C	0	0	0	0	0	0	32	89	6	5	84	84	32	89	6	5	84	84	262785.6	38645	813631	26	23	822,296
		0.3	19.8	FA-18E/F	0	0	0	0	0	0	15	302	2	8	134	134	15	302	2	8	134	134	409384.8	60204	1267528	41	36	1,281,027
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S	100																											
		0.55	36	SH-60B	0	0	0	0	0	0	408	418	36	26	274	274	408	418	36	26	274	274	130680	19218	404608	13	11	408,917
		0.28	18	SH-60F	0	0	0	0	0	0	208	213	18	13	140	140	208	213	18	13	140	140	66528	9784	205982	7	6	208,176
		0.3	20	FA-18A/C	0	0	0	0	0	0	32	89	6	5	84	84	32	89	6	5	84	84	262785.6	38645	813631	26	23	822,296
		0.3	20	FA-18E/F	0	0	0	0	0	0	15	302	2	8	134	134	15	302	2	8	134	134	409384.8	60204	1267528	41	36	1,281,027
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOMBEX, A-S	0																											
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	6																											
		0.55	3	SH-60B	0	0	0	0	0	0	12	13	1	1	8	8	12	13	1	1	8	8	3960	582	12261	0	0	12,391
		0.28	2	SH-60F	0	0	0	0	0	0	6	6	1	0	4	4	6	6	1	0	4	4	2016	296	6242	0	0	6,308
		0.3	2	FA-18A/C	0	0	0	0	0	0	1	4	0	0	4	4	1	4	0	0	4	4	11944.8	1757	36983	1	1	37,377
		0.3	2	FA-18E/F	0	0	0	0	0	0	1	14	0	0	6	6	1	14	0	0	6	6	18608.4	2737	57615	2	2	58,228
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINKEX	0									0						0						0	0	0	0.00	0.00	0
		2	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Testing	12																											
		1.2	14	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	23	64	4	4	61	61	95558.4	14053	295866	10	8	299,017
		0.6	7	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	5	110	1	3	49	49	74433.6	10946	230460	7	7	232,914
		0.8	10	P-3	0	0	0	0	0	0	0	0	0	0	0	0	185	570	43	29	293	293	737280	108424	2282749	74	65	2,307,060
		0.2	2	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	288	295	25	18	194	194	46080	6776	142672	5	4	144,191
		0.6	7	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	34	9	7	1	2	2	15322	2253	47438	2	1	47,946
		0.2	2	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	232	67	31	7	60	60	16488	2425	51050	2	1	51,593
Electronic Warfare Testing	54																											
		0.08	4.32	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	68	70	6	4	46	46	10886.4	1601	33706	1	1	34,065
		0.05	2.7	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	43	44	4	3	29	29	6804	1001	21066	1	1	21,291
		0.004	0.216	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	2.16	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20736	3049	64202	2	2	64,886
		0.29	15.66	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	207839.52	30565	643508	21	18	650,361
		0.29	15.66	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	323786.16	47616	1002499	33	28	1,013,176
		0.02	1.08	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4752	699	14713	0	0	14,870
		0.02	1.08	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	10.8	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22982	3380	71158	2	2	71,915
		0.01	0.54	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo Testing	17									0						0						0					
		0.14	2.38	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	54	55	5	3	36	36	8568	1260	26528	1	1	26,811
		0.68	11.56	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	260	266	23	17	175	175	41616	6120	128850	4	4	130,223
		0.09	1.53	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	148	43	20	4	38	38	5508	810	17054	1	0	17,235

ANTI-SUBMARINE WARFARE																											
TRACKEX-Helo	188																										
		0.17	32	SH-60B	0	0	0	0	0	0	204	209	18	13	137	137	659	675	58	42	443	443	138067.2	20304	427480	14	12	432,033
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA	33																						0	0	0	0.00	0.00	0
		1	33	P-3	89	275	21	14	141	141	179	551	41	29	283	283	1521	4683	351	242	2405	2405	950400	139765	2942606	95	83	2,973,945
				P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA-IEER	0																						0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	0																										
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASW Torpedo Test	36																										
		0.5	18	P-3	49	150	11	8	77	77	98	301	23	16	154	154	830	2555	192	132	1312	1312	518400	76235	1605058	52	45	1,622,152
		0.5	18	SH-60B	0	0	0	0	0	0	8	8	1	1	5	5	26	26	2	2	17	17	5400	794	16719	1	0	16,897
Sonobuoy Lot Acceptance Test	36																										
		1	36	P-3	1659	5109	383	264	2624	2624	195	601	45	31	309	309	98	301	23	16	154	154	1036800	152471	3210116	104	91	3,244,303
ELECTRONIC WARFARE																											
Electronic Warfare	0																										
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLAREX	0		0																								
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAFFEX	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	670																										
		1	670	C-130	0	0	0	0	0	0	0	0	0	0	0	0	250	984	57	48	479	479	180000	26471	557312	18	16	563,247
		2	1340	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398

MINE WARFARE																												
Mine Neutralization - EOD	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Towed	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying	0																											
		0.29	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.65	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.59	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test AMNS	17																											
		1	17	SH-60B	268	274	24	17	180	180	0	0	0	0	0	0	0	0	0	0	0	0	42840	6300	132640	4	4	134,053
Airborne Mine Hunting Test - AMAQS	17																											
		1	17	SH-60B	268	274	24	17	180	180	0	0	0	0	0	0	0	0	0	0	0	0	42840	6300	132640	4	4	134,053
Airborne Mine Neutralization Test OASIS	17																											
		1	17	SH-60B	268	274	24	17	180	180	0	0	0	0	0	0	0	0	0	0	0	0	42840	6300	132640	4	4	134,053
Airborne Mine Hunting Test - ALMDS	17																											
		1	17	SH-60B	268	274	24	17	180	180	0	0	0	0	0	0	0	0	0	0	0	0	42840	6300	132640	4	4	134,053
Airborne Mine Countermeasures	17																											
		1	17	SH-60B	268	274	24	17	180	180	0	0	0	0	0	0	0	0	0	0	0	0	42840	6300	132640	4	4	134,053
Mine Detection Testing	10																											
		1	10	SH-60B	158	161	14	10	106	106	0	0	0	0	0	0	0	0	0	0	0	0	25200	3706	78024	3	2	78,855
Mine Countermeasures Test	14																											
		1	14	SH-60B	221	226	19	14	148	148	0	0	0	0	0	0	0	0	0	0	0	0	35280	5188	109233	4	3	110,396
NAVAL SPECIAL WARFARE																												
Personnel I&E	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Ship Integration Test	136																											
		1	136	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398
		1	136	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	34	692	6	19	308	308	702984	103380	2176563	71	62	2,199,743

EMISSIONS (lb/yr)																											
State (0-3 nm)							**U.S. (3-12 nm)**						**International (>12 nm)**						**Annual Fuel Use (total)**		**GHG Emissions (lb)**			
CO	**NOx**	**HC**	**SOx**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NOx**	**HC**	**SOx**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NOx**	**HC**	**SOx**	**PM_{10}**	**$PM_{2.5}$**	**Pounds**	**Gallons**	**CO_2**	**N_2O**	**CH_4**	**CO_2e**
3,514	7,293	566	396	3,996	3,996	3,727	5,486	404	305	3,315	3,315	16,765	53,213	2,325	2,203	25,609	25,609	19,558,908	2,876,310	60,557,829	1,965	1,711	61,202,770
2	4	0	0	2	2	2	3	0	0	2	2	8	27	1	1	13	13			30,279	1	1	30,601

Table C-25: Baseline Aircraft Emissions – SDAB Testing Activities

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_{2-e}
ANIT-AIR WARFARE																												
Air Combat Maneuvers																												
		2.83	156	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1609109.7	236634	4982088	162	141	5,035,147
	55	0.17	9	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56100	8250	173696	6	5	175,545
Air Defense Exercise																												
		0.21	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	1.28	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise A-A																												
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-A MISSILEX																												
		4	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise		12																										
	0	1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise																												
	0	1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S-A MISSILEX																												
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Missile																			0	0	0	0	0	0
	0			BQM-74																			0	0	0	0	0	0
Air Platform, Vehicle Test																												
		0.33	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.33	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.33	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Platform, Weapons Test																												
		0.33	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.33	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.33	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intell, Surveill, Recon																												
	0	0	1	P-3c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																												
Amphibious Assault	0																											
		8	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USMC Battalion Landing	0																											
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	H-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	0																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	0																											
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	0																											
		90	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		58	0.0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		32	0.0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		38	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		48	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STRIKE WARFARE																												
A-S BOMBEX	0																											
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-S GUNEX	0																											
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SURFACE WARFARE																													
Maritime Security Operations	0																												
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Small Caliber)	0																												
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Medium Caliber)	0																												
		1.62	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0.0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S (Rocket)	0																												
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOMBEX, A-S	0																												
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINKEX	0								0						0							0	0	0	0.00	0.00	0		
		2	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Testing	0																												
		1.2	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.8	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.6	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Warfare Testing	0																												
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo Testing	0								0						0							0							
		0.14	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.68	0	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.09	0	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SUBMARINE WARFARE																												
TRACKEX-Helo	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA	0																						0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA-IEER	0																						0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	5																											
		0.17	1	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	255	38	790	0	0	798
		0.83	4	SH-60F	0	0	0	0	0	0	2	2	0	0	1	1	6	6	1	0	4	4	1245	183	3855	0	0	3,896
ASW Torpedo Test	0																											
		0.5	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.5	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELECTRONIC WARFARE																												
Electronic Warfare	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLAREX	0		0																									
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAFFEX	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																						0	0	0	0.00	0.00	0
		1	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	250	984	57	48	479	479	180000	26471	557312	18	16	563,247
		2	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398

					EMISSIONS (lb/yr)																							
					State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use		GHG Emissions (lb)			
					CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
MINE WARFARE																												
Mine Neutralization - EOD	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Towed	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying	0																											
		0.29	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.65	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.59	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test AMNS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - AN/AQS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test OASIS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - ALMDS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasures Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NAVAL SPECIAL WARFARE																												
Personnel I&E	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Ship Integration Test	0																											
		1	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398
		1	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	2	2	0	0	1	1	1,457	2,220	163	125	1,290	1,290	2,038,710	299,810	6,312,205	205	178	6,379,430
					0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1			3,156	0	0	3,190

Table C-26: Baseline Aircraft Emissions – Hawaii Testing Activities

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-AIR WARFARE																												
Air Combat Maneuvers	11																											
		2.83	31	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	321821.94	47327	996418	32	28	1,007,029
		0.17	2	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11220	1650	34739	1	1	35,109
Air Defense Exercise	0																											
		0.21	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise A-A	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-A MISSILEX	0																											
		4	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise	0																											
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise	0																											
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S-A MISSILEX	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Missile																			0	0	0	0	0	0
				BQM-74																			0	0	0	0	0	0
Air Platform, Vehicle Test	50																											
		0.33	17	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	123	2516	20	68	1119	1119	682308	100339	2112546	69	60	2,135,045
		0.33	17	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	150	73	8	5	56	56	35640	5241	110348	4	3	111,523
		0.33	17	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	92	364	13	15	34	34	145200	21353	449565	15	13	454,353
Air Platform, Weapons Test	44																											
		0.33	15	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	54	1107	9	30	492	492	300215.52	44149	929520	30	26	939,420
		0.33	15	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	54	56	5	3	37	37	34848	5125	107896	4	3	109,045
		0.33	15	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	41	160	6	6	15	15	63888	9395	197809	6	6	199,915
Intell, Surveill, Recon	11																											
		11	1	P-3c	0	0	0	0	0	0	0	0	0	0	0	0	477	1469	110	76	755	755	316800	46588	980869	32	28	991,315

AMPHIBIOUS WARFARE																												
Amphibious Assault	0																											
		8	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USMC Battalion Landing	0																											
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	H-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	0																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	0																											
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	0																											
		90	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		58	0.0	CH-46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		32	0.0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		38	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		48	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STRIKE WARFARE																												
A-S BOMBEX	0																											
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-S GUNEX	0																								0	0	0	0.00	0.00	0
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANTI-SURFACE WARFARE																												
Maritime Security Operations	0																											
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Small Caliber)	0																											
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUNEX, A-S (Medium Caliber)	0																											
		1.62	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0.0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S (Rocket)	0																											
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSILEX, A-S	10																											
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOMBEX, A-S	0																											
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	0																											
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINKEX	0									0					0						0	0	0	0	0.00	0.00	0
		2	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Testing	12																											
		1.2	14	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	23	64	4	4	61	61	35558.4	14053	295866	10	8	299,017
		0.6	7	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	5	110	1	3	49	49	74433.6	10946	230460	7	7	232,914
		0.8	10	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	185	570	43	29	293	293	737280	108424	2282749	74	65	2,307,060
		0.2	2	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	288	295	25	18	134	134	46080	6776	142672	5	4	144,191
		0.6	7	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	34	3	7	1	2	2	15322	2253	47438	2	1	47,944
		0.2	2	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	232	67	31	7	60	60	16488	2425	51050	2	1	51,593
Electronic Warfare Testing	122																											
		0.08	3.76	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	154	157	14	10	103	103	24595.2	3617	76151	2	2	76,362
		0.05	6.1	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	36	38	8	6	65	65	15372	2261	47534	2	1	48,101
		0.004	0.488	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	4.88	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46848	6889	145050	5	4	146,594
		0.29	35.38	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	463563.4	63053	1453851	47	41	1,463,335
		0.29	35.38	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	731516.3	107576	2264905	73	64	2,289,027
		0.02	2.44	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10736	1579	33241	1	1	33,595
		0.02	2.44	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	24.4	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51923	7636	160763	5	5	162,476
		0.01	1.22	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo Testing	21									0					0						0							
		0.14	2.94	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	66	68	6	4	44	44	10584	1556	32770	1	1	33,119
		0.68	14.28	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	321	329	28	21	216	216	51408	7560	159168	5	4	160,863
		0.09	1.89	SH-3	0	0	0	0	0	0	0	0	0	0	0	0	0	183	53	24	5	47	47	6804	1001	21066	1	1	21,291

ANTI-SUBMARINE WARFARE																											
TRACKEX-Helo	122																										
		0.17	21	SH-60B	0	0	0	0	0	0	132	135	12	8	89	89	428	438	38	27	287	287	89596.8	13176	277408	9	8	280,362
		0.83	101	SH-60F	0	0	0	0	0	0	645	661	57	41	434	434	2089	2139	184	134	1404	1404	437443.2	64330	1354401	44	38	1,368,826
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA	14																						0	0	0	0.00	0.00	0
		1	14	P-3	38	117	9	6	60	60	76	234	18	12	120	120	645	1987	149	103	1020	1020	403200	59294	1248378	40	35	1,261,674
				P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRACKEX-MPA-IEER	0																						0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	5																											
		0.17	1	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	255	38	790	0	0	798
		0.83	4	SH-60F	0	0	0	0	0	0	2	2	0	0	1	1	6	6	1	0	4	4	1245	183	3855	0	0	3,896
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASW Torpedo Test	12																											
		0.5	6	P-3	16	50	4	3	26	26	33	100	8	5	51	51	277	852	64	44	437	437	172800	25412	535019	17	15	540,717
		0.5	6	SH-60B	0	0	0	0	0	0	3	3	0	0	2	2	9	9	1	1	6	6	1800	265	5573	0	0	5,632
Sonobuoy Lot Acceptance Test	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELECTRONIC WARFARE																												
Electronic Warfare	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLAREX	0		0																									
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHAFFEX	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																						0	0	0	0.00	0.00	0
		1	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	250	984	57	48	479	479	180000	26471	557312	18	16	563,247
		2	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398

					EMISSIONS (lb/yr)																					
					State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
					CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
MINE WARFARE																												
Mine Neutralization - EOD	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Towed	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying	0																											
		0.29	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.65	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.59	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test AMNS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - AMAGS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization Test OASIS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Hunting Test - ALMDS	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection Testing	7																											
		1	7	SH-60B	110	113	10	7	74	74	0	0	0	0	0	0	0	0	0	0	0	0	17640	2594	54617	2	2	55,198
Mine Countermeasures Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NAVAL SPECIAL WARFARE																												
Personnel I&E	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Ship Integration Test	0																											
		1	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	600	614	53	38	403	403	96000	14118	297233	10	8	300,398
		1	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					164	280	22	16	160	160	891	1,135	94	67	697	697	7,484	15,211	960	746	8,085	8,085	5,812,434	854,770	17,996,320	584	509	18,187,981
					0	0	0	0	0	0	0	1	0	0	0	0	4	8	0	0	4	4			8,998	0	0	9,094

Table C-27: Baseline Munitions Emissions

MUNITIONS EMISSIONS ESTIMATES - BASELINE															
MEM Category	Location – Range Complex	Training MEM	Testing MEM	Emissions (lb/year) Training						Emissions (lb/year) Testing					
		#/yr	#/yr	CO	NOx	VOC	SOx	PM10	PM2.5	CO	NOx	VOC	SOx	PM10	PM2.5
Bombs															
Bombs (H-E)	HRC	74	0	4,524	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	166	0	10,148	0	0	0	0	0	0	0	0	0	0	0
	Total	240	0	14,672	0	0	0	0	0	0	0	0	0	0	0
Bombs (N-E)	HRC	399	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	1,120	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1,519	0	0	0	0	0	0	0	0	0	0	0	0	0
Projectiles															
Small Caliber	HRC	422,000	8,250	971	41	0	0	22	16	19	1	0	0	0	0
	SOCAL	2,559,800	15,550	5,888	248	0	0	131	97	36	2	0	0	1	1
	Total	2,981,800	23,800	6,858	289	0	0	152	113	55	2	0	0	1	1
Medium Caliber (H-E)	HRC	6,640	0	219	3	0	0	4	3	0	0	0	0	0	0
	SOCAL	13,920	16,500	459	6	0	0	9	6	545	7	0	0	11	8
	Total	20,560	16,500	678	9	0	0	14	9	545	7	0	0	11	8
Medium Caliber (N-E)	HRC	195,360	24,000	6,447	84	0	0	129	90	792	10	0	0	16	11
	SOCAL	435,160	63,500	14,360	187	0	0	287	200	2,096	27	0	0	42	29
	Total	630,520	87,500	20,807	271	0	0	416	290	2,888	38	0	0	58	40
Large Caliber (H-E)	HRC	1894	678	242	303	0	0	18	14	87	108	0	0	7	5
	SOCAL	4244	791	543	679	0	0	41	32	101	127	0	0	8	6
	Total	6138	1469	786	982	0	0	59	46	188	235	0	0	14	11
Large Caliber (N-E)	HRC	1464	8590	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	5596	1457	0	0	0	0	0	0	0	0	0	0	0	0
	Total	7060	10047	0	0	0	0	0	0	0	0	0	0	0	0
Missiles (H-E)	HRC	146	52	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	330	62	0	0	0	0	0	0	0	0	0	0	0	0
	Total	476	114	0	0	0	0	0	0	0	0	0	0	0	0
Missiles (N-E)	HRC	64	74	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	30	152	0	0	0	0	0	0	0	0	0	0	0	0
	Total	94	226	0	0	0	0	0	0	0	0	0	0	0	0
Rockets (H-E)	HRC	760	0	707	4	0	0	304	220	0	0	0	0	0	0
	SOCAL	3800	297	3,534	21	0	0	1,520	1,102	276	2	0	0	119	86
	Total	4560	297	4,241	26	0	0	1,824	1,322	276	2	0	0	119	86
Rockets (N-E)	HRC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	0	781	0	0	0	0	0	0	726	4	0	0	312	226
	Total	0	781	0	0	0	0	0	0	726	4	0	0	312	226
Countermeasures															
Chaff	HRC	2600	300	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	20,750	254	0	0	0	0	0	0	0	0	0	0	0	0
	Total	23350	554	0	0	0	0	0	0	0	0	0	0	0	0
Flares	HRC	1750	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	8300	110	0	1	0	0	2	2	0	0	0	0	0	0
	Total	10050	110	1	2	0	0	3	3	0	0	0	0	0	0
Targets															
Airborne targets	HRC	26	52	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	45	22	0	0	0	0	0	0	0	0	0	0	0	0
	Total	71	74	0	0	0	0	0	0	0	0	0	0	0	0
Surface targets	HRC	450	43	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	1150	191	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1600	234	0	0	0	0	0	0	0	0	0	0	0	0
Expendable sub-surface targets	HRC	405	177	0	0	0	0	0	0	0	0	0	0	0	0
	SOCAL	550	243	0	0	0	0	0	0	0	0	0	0	0	0
	Total	955	420	0	0	0	0	0	0	0	0	0	0	0	0
				CO	NOx	VOC	SOx	PM10	PM2.5	CO	NOx	VOC	SOx	PM10	PM2.5
	Total for HRC			13,110	435	0	0	478	344	898	120	0	0	23	16
	Total for SOCAL			34,933	1,143	0	0	1,990	1,440	3,780	169	0	0	492	356
	TOTAL for Activity	pounds		96,086	3,157	0	0	4,935	3,567	9,355	576	0	0	1,030	745
		tons		48.0	1.6	0.0	0.0	2.5	1.8	4.7	0.3	0.0	0.0	0.5	0.4
	Total for Study Area	pounds		105,440	3,733	0	0	5,965	4,312						
		tons		52.7	1.9	0.0	0.0	3.0	2.2						

Air Emission Calculations

Alternative 1

Table C-28: Alternative 1 Ship Emissions - SCAB

ACTIVITY								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																	
Type Training	Ship Type		Range Time (hr)		Distribution (hr)			State (0-3 nm off-shore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
	Ship Type	Participation	Total Hours	In Region	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																													
SHIPS																													
guided missile cruiser	CG	1	5,741	172.2	1.7	3.4	167.1	48	492	4	270	21	21	212	274	15	267	10	10	10,276	13,294	721	12,969	466	466	4,041,295	131	114	4,083,219
guided missile destroyer	DDG	1	17,611	528.3	5.3	10.6	512.5	162	1,980	13	1,012	80	80	636	1,210	42	935	38	38	30,830	58,688	2,053	45,372	1,864	1,864	14,126,220	458	399	14,272,762
aircraft carrier, nulear powered	CVN	1	3,418	102.5	1.0	2.1	99.5	0	1	0	0	0	0	1	19	0	2	0	0	67	918	17	109	8	8	37,492	1	1	37,881
Frigate	FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered	SSN	1	4060.8	121.8	1.2	2.4	118.2	0	0	0	0	0	0	8	6	0	1	0	0	382	282	20	31	2	2	13,308	0	0	13,446
littoral combat ship	LCS	1	1440	43.2	0.4	0.9	41.9	31	59	2	13	3	3	33	148	2	58	6	6	1,592	7,167	118	2,819	291	291	1,020,909	33	29	1,031,499
amphibious assault ship, general purpose	LHA	1	979.2	29.4	0.3	0.6	28.5	2	13	2	39	8	8	5	28	3	78	17	17	227	1,342	162	3,798	801	801	1,335,228	43	38	1,349,079
amphibious assault ship, multi-purpose	LHD	1	2836.8	85.1	0.9	1.7	82.6	7	38	5	115	24	24	14	81	10	231	49	49	667	3,949	476	11,185	2,359	2,359	2,965,372	96	84	2,996,134
amphibious transport dock ship	LPD	1	3820.8	114.6	1.1	2.3	111.2	32	302	17	54	4	4	8	48	6	139	29	29	387	2,335	287	6,762	1,429	1,429	2,375,782	77	67	2,400,428
dock landing ship	LSD	1	3168.0	95.0	1.0	1.9	92.2	38	574	19	61	5	5	40	636	21	67	5	5	1,959	30,838	1,000	3,230	250	250	1,499,501	49	42	1,515,056
patrol craft	PC	1	648.0	19.4	0.2	0.4	18.9	8	15	1	5	1	1	15	29	2	9	1	1	704	1,399	113	442	49	49	144,734	5	4	146,235
submarine tender	AS	1	9.6	0.3	0.0	0.0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	1	6	1	17	4	4	5,852	0	0	5,913
dray cargo ship	TAKE	1	326.4	9.8	0.1	0.2	9.5	1	8	1	2	0	0	2	59	6	10	1	1	98	2,871	282	497	52	52	163,697	5	5	165,396
replenishment oiler	TAO	1	7804.8	234.1	2.3	4.7	227.1	90	1,358	54	143	11	11	255	3,525	130	341	27	27	12,343	170,968	6,293	16,554	1,290	1,290	5,209,173	169	147	5,263,211
rescue and salvage ship	TARS	1	172.8	5.2	0.1	0.1	5.0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	1	5	1	1	1,715	0	0	1,733
fleet ocean tug	TATF	1	705.6	21.2	0.2	0.4	20.5	3	30	1	3	0	0	7	44	1	5	0	0	337	2,142	43	229	22	22	73,808	2	2	74,574
	TAE	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fast combat support ship	TAOE	1	456.0	13.7	0.1	0.3	13.3	5	61	1	26	2	2	30	85	3	33	3	3	1,456	4,131	141	1,592	138	138	901,584	29	25	910,937
mine countermeasure ship	MCM	1	4252.8	127.6	1.3	2.6	123.8	77	64	16	10	1	1	65	79	16	13	1	1	3,171	3,813	754	635	70	70	155,965	5	4	157,583
Intrumentation ship	TAGM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TEFP	1	105.6	3.2	0.0	0.1	3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm off-shore)							Waters of U S (3-12 nm)							Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	2	0	1	0	0	1	3	0	1	0	0	32	152	6	53	5	5	17,036	1	0	17,213

Table C-29: Alternative 1 Ship Emissions - SDAB

ACTIVITY								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																			
Type Training	Ship Type		Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
	Ship Type	Participation	Total Hours	In Region	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																													
SHIPS																													
guided missile cruiser	CG	1	5,741	5568.6	55.7	111.4	5401.5	1,544	15,901	137	8,725	693	693	6,851	8,862	481	8,646	311	311	332,250	429,826	23,316	419,335	15,064	15,064	130,668,549	4,239	3,693	132,024,072
guided missile destroyer	DDG	1	17,611	17082.9	170.8	341.7	16570.4	5,222	64,027	409	32,736	2,600	2,600	20,553	39,125	1,369	30,248	1,243	1,243	996,823	1,897,569	66,377	1,467,014	60,276	60,276	456,747,787	14,817	12,908	461,485,976
aircraft carrier, nuclear powered	CVN	1	3,418	3315.1	33.2	66.3	3215.6	2	30	1	4	0	0	45	612	11	72	6	6	2,176	29,668	546	3,509	269	269	1,212,246	33	34	1,224,821
Frigate	FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered	SSN	1	4060.8	3939.0	39.4	78.8	3820.8	13	9	1	1	0	0	255	188	13	21	2	2	12,365	9,114	649	1,011	76	76	430,282	14	12	434,745
littoral combat ship	LCS	1	1440	1396.8	14.0	27.9	1354.9	991	1,912	80	415	99	99	1,061	4,778	79	1,880	194	194	51,460	231,738	3,826	91,157	9,409	9,409	33,009,378	1,071	933	33,351,803
amphibious assault ship, general purpose	LHA	1	973.2	943.8	9.5	19.0	921.3	72	422	53	1,263	267	267	151	895	108	2,532	534	534	7,332	43,384	5,226	122,808	25,899	25,899	43,172,360	1,401	1,220	43,620,219
amphibious assault ship, multi-	LHD	1	2836.8	2751.7	27.5	55.0	2669.1	211	1,242	157	3,719	786	786	445	2,632	317	7,457	1,573	1,573	21,572	127,674	15,394	361,661	76,274	76,274	95,880,370	3,110	2,710	96,875,003
amphibious transport dock ship	LPD	1	3820.8	3706.2	37.1	74.1	3535.0	1,041	9,775	554	1,741	131	131	258	1,557	191	4,508	953	953	12,499	75,506	9,265	218,641	46,206	46,206	76,816,960	2,432	2,171	77,613,640
dock landing ship	LSD	1	3168.0	3073.0	30.7	61.5	2380.8	1,230	18,569	628	1,987	154	154	1,306	20,559	666	2,153	167	167	63,335	997,099	32,318	104,439	8,089	8,089	48,483,850	1,573	1,370	48,986,809
patrol craft	PC	1	648.0	628.6	6.3	12.6	609.7	271	493	45	157	17	17	470	932	76	294	33	33	22,777	45,224	3,670	14,280	1,586	1,586	4,679,727	152	132	4,728,274
submarine tender	AS	1	9.6	9.3	0.1	0.2	9.0	0	2	0	6	1	1	1	4	0	11	2	2	31	193	23	538	114	114	189,211	6	5	191,174
dray cargo ship	TAKE	1	326.4	316.6	3.2	6.3	307.1	17	274	38	51	4	4	65	1,914	188	331	35	35	3,156	92,844	9,131	16,077	1,682	1,682	5,292,885	172	150	5,347,732
replenishment oiler	TAO	1	7804.8	7570.7	75.7	151.4	7343.5	2,907	43,905	1,739	4,635	365	365	8,229	113,979	4,195	11,036	860	860	399,105	5,527,958	203,470	535,243	41,720	41,720	168,429,919	5,464	4,760	170,177,163
rescue and salvage ship	TARS	1	172.8	167.6	1.7	3.4	162.6	1	6	0	2	0	0	1	11	0	3	0	0	52	524	21	157	17	17	55,456	2	2	56,032
fleet ocean tug	TATF	1	705.6	684.4	6.8	13.7	663.9	91	956	18	100	9	9	225	1,428	29	153	15	15	10,895	69,259	1,401	7,397	714	714	2,386,465	77	67	2,411,221
	TAE	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fast combat support ship	TAOE	1	456.0	442.3	4.4	8.8	429.1	155	1,969	26	845	67	67	971	2,754	94	1,061	92	92	47,092	133,569	4,548	51,481	4,466	4,466	29,151,215	946	824	29,453,622
mine countermeasure ship	MCM	1	4252.8	4125.2	41.3	82.5	4001.5	2,495	2,074	503	338	37	37	2,114	2,542	503	424	47	47	102,534	123,273	24,383	20,546	2,258	2,258	5,042,860	164	143	5,095,173
Intrumentation ship	TAGM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TEFP	1	105.6	102.4	1.0	2.0	99.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION																											
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions								
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e						
8	81	2	28	3	3	21	101	4	35	3	3	1,043	4,917	202	1,718	147	147	550,825	18	16	556,539						

Table C-30: Alternative 1 Ship Emissions - Hawaii

ACTIVITY								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																			
Type Training	Ship Type		Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
	Ship Type	Participation	Total Hours	In Region	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}
SHIP STEAMING																													
SHIPS																													
guided missile cruiser	CG	1	2,856	2856.0	28.6	57.1	2770.3	732	8,155	70	4,475	355	355	3,513	4,545	247	4,434	159	159	170,404	220,448	11,958	215,068	7,726	7,726	67,017,021	2,174	1,894	67,712,233
guided missile destroyer	DDG	1	7,464	7464.0	74.6	149.3	7240.1	2,282	27,975	179	14,303	1,136	1,136	8,980	17,095	598	13,216	543	543	435,541	829,103	29,002	640,981	26,336	26,336	199,566,389	6,474	5,640	201,636,642
aircraft carrier, nulear powered	CVN	1	236	237.6	3.0	6.0	288.7	0	3	0	0	0	0	4	55	1	6	0	0	195	2,663	49	315	24	24	108,825	4	3	109,354
Frigate	FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered	SSN	1	13123.2	13123.2	131.2	262.5	12729.5	42	31	2	3	0	0	849	626	45	69	5	5	41,197	30,365	2,161	3,368	253	253	1,433,538	47	41	1,448,409
littoral combat ship	LCS	1	288	288.0	2.9	5.8	279.4	204	394	17	86	20	20	219	985	16	388	40	40	10,610	47,781	789	18,795	1,940	1,940	6,806,057	221	192	6,876,662
amphibious assault ship, general purpose	LHA	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
amphibious assault ship, multi-	LHD	1	28.8	28.8	0.3	0.6	27.9	2	13	2	39	8	8	5	28	3	78	16	16	226	1,336	161	3,785	798	798	1,003,510	33	28	1,013,920
amphibious transport dock ship	LPD	1	9.6	9.6	0.1	0.2	9.3	3	25	1	5	0	0	1	4	0	12	2	2	32	196	24	566	120	120	198,977	6	5	201,041
dock landing ship	LSD	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
patrol craft	PC	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
submarine tender	AS	1	96.0	96.0	1.0	1.9	93.1	3	20	2	57	12	12	6	41	5	114	24	24	315	1,987	236	5,549	1,171	1,171	1,950,630	63	55	1,970,866
dray cargo ship	TAKE	1	1660.8	1660.8	16.6	33.2	1611.0	88	1,436	199	266	21	21	341	10,042	988	1,739	182	182	16,557	487,025	47,900	84,335	8,826	8,826	27,764,377	901	795	28,052,338
replenishment oiler	TAO	1	2865.6	2865.6	28.7	57.3	2779.6	1,100	16,619	658	1,754	138	138	3,115	43,142	1,588	4,177	326	326	151,067	2,092,410	77,016	202,597	15,792	15,792	63,753,098	2,068	1,802	64,414,457
rescue and salvage ship	TARS	1	1233.6	1233.6	12.3	24.7	1196.6	4	47	1	14	1	1	8	79	3	24	3	3	383	3,854	153	1,153	127	127	408,142	13	12	412,376
fleet ocean tug	TATF	1	3576.0	3576.0	35.8	71.5	3468.7	477	4,397	93	522	46	46	1,174	7,461	151	797	77	77	56,925	361,863	7,318	38,649	3,732	3,732	12,468,731	404	352	12,538,078
TAE	TAE	1	225.6	225.6	2.3	4.5	218.8	6	35	4	103	22	22	12	71	9	207	44	44	571	3,486	425	10,030	2,116	2,116	3,530,601	115	100	3,567,226
fast combat support ship	TAOE	1	216.0	216.0	2.2	4.3	209.5	76	962	13	413	33	33	474	1,345	46	518	45	45	22,997	65,226	2,221	25,140	2,181	2,181	14,235,536	462	402	14,383,212
mine countermeasure ship	MCM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intrumentation ship	TAGM	1	33.6	33.6	0.3	0.7	32.6	1	6	1	17	4	4	2	12	1	33	7	7	94	559	69	1,620	343	343	569,187	18	16	575,031
	TEFP	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION																											
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}
3	30	1	11	1	1	9	43	2	13	1	1	454	2,074	90	626	36	36	200,407	7	6	202,486

Table C-31: Alternative 1 Amphibious Vessel Training Emissions - SCAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GREENHOUSE GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U.S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation Per Ship	Total		0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	18																														
		72	LCAC	4	8.0	576.0	216.0	216.0	144.0	3,957	24,739	753	11,795	1,110	1,110	3,957	24,739	753	11,795	1,110	1,110	2,638	16,493	502	7,863	740	740	11,919,805	386.68	0.01	12,035,037
		72	LCU	4	8.0	576.0	216.0	216.0	144.0	1,093	3,392	275	628	163	163	1,093	3,392	275	628	163	163	729	2,261	183	418	109	109	532,067	17.26	0.00	537,211
Battalion Landing	2																														
		12	LCU	6	3.0	36.0	3.6	10.8	21.6	18	57	5	10	3	3	55	170	14	31	8	8	109	339	28	63	16	16	33,254	1.08	0.00	33,576
		28	AAV/EFV	14	6.0	168.0	16.8	50.4	100.8	13	104	14	21	4	4	38	313	41	63	13	13	77	627	83	126	26	26	233,447	7.57	0.00	235,704
		10	LCAC	5	3.0	30.0	3.0	9.0	18.0	55	344	10	164	15	15	165	1,031	31	491	46	46	330	2,062	63	983	93	93	620,823	20.14	0.00	626,625
		0	CRRC	0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0																														
		0	CRRC	13	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	1																														
		4	LCAC	4	8.0	32.0	0.0	16.0	16.0	0	0	0	0	0	0	293	1,833	56	874	82	82	293	1,833	56	874	82	82	662,211	21.48	0.00	668,613
		4	LCU	4	8.0	32.0	0.0	16.0	16.0	0	0	0	0	0	0	81	251	20	46	12	12	81	251	20	46	12	12	23,559	0.36	0.00	23,645
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Submarine (TRACKEX-Sub)	50																														
		50	TRB	1	3.6	180.0	0.0	18.0	162.0	0	0	0	0	0	0	116	1,012	28	133	21	21	1,048	9,108	251	1,199	191	191	53,056	1.72	0.00	53,569
Tracking / Torpedo Exercise-Submarine (TORPEX-Sub)	13																														
		13	TRB	1	3.6	46.8	0.0	4.7	42.1	0	0	0	0	0	0	30	263	7	35	6	6	273	2,368	65	312	50	50	13,795	0.45	0.00	13,928
Tracking / Torpedo Exercise-Surface (TRACKEX-Surface)	423																														
		133.6	TRB	0.32	3.6	480.9	0.0	48.1	432.8	0	0	0	0	0	0	311	2,704	75	356	57	57	2,800	24,332	671	3,203	511	511	141,744	4.60	0.00	143,114
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	117																														
		133.6	TRB	0.32	3.6	480.9	0.0	48.1	432.8	0	0	0	0	0	0	311	2,704	75	356	57	57	2,800	24,332	671	3,203	511	511	141,744	4.60	0.00	143,114
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	524																														
		157.2	TRB	0.3	3.6	565.9	0.0	56.6	509.3	0	0	0	0	0	0	366	3,182	88	419	67	67	3,295	28,634	789	3,769	601	601	166,808	5.41	0.00	168,421
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	104																														
		157.2	TRB	0.3	3.6	565.9	0.0	56.6	509.3	0	0	0	0	0	0	366	3,182	88	419	67	67	3,295	28,634	789	3,769	601	601	166,808	5.41	0.00	168,421
Service Weapons Test (SWT)	1																														
		1	TRB	1	3.6	3.6	0.0	0.4	3.2	0	0	0	0	0	0	2	20	1	3	0	0	21	182	5	24	4	4	1,061	0.03	0.00	1,071
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	50																														
		30.4	TRB	0.61	2.0	60.9	0.0	6.1	54.8	0	0	0	0	0	0	39	342	9	45	7	7	354	3,080	85	405	65	65	17,942	0.58	0.00	18,115
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	25																														
		30.4	TRB	0.61	2.0	60.9	0.0	6.1	54.8	0	0	0	0	0	0	39	342	9	45	7	7	354	3,080	85	405	65	65	17,942	0.58	0.00	18,115
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																														
		3.7	TRB	0.61	2.0	7.3	0.0	0.7	6.6	0	0	0	0	0	0	5	41	1	5	1	1	43	370	10	49	8	8	2,153	0.07	0.00	2,174
Expeditionary Warfare																															
Dive and Salvage Operations	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	57.5																														
		57.5	RHIB	1	2.0	115.0	35.7	39.7	39.7	12	326	2	51	5	5	13	363	2	57	6	6	13	363	2	57	6	6	123,132	3.99	0.00	124,322

MINE WARFARE																															
Civilian Port Defense - Homeland Security																															
		0	RHIB	1	24.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Limpet Mine Neutralization System	90																														
		180	RHIB	2	2.0	360.0	360.0	0.0	0.0	122	3,290	22	518	54	54	0	0	0	0	0	0	0	0	0	0	0	0	385,457	12.50	0.00	389,183
Marine Mammal System	0																														
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - EOD	170																														
		510	RHIB	3	12.0	6120.0	6120.0	0.0	0.0	2,081	55,937	367	8,813	918	918	0	0	0	0	0	0	0	0	0	0	0	0	6,552,771	212.57	0.01	6,616,119
Mine Neutralization - ROV	60																														
		60	RHIB	1	12.0	720.0	720.0	0.0	0.0	245	6,581	43	1,037	108	108	0	0	0	0	0	0	0	0	0	0	0	0	770,914	25.01	0.00	778,967
SLMM (Sub-mobile) Mine Exercise for Training and Certification	5																														
		5	Bayliner	1	8.0	40.0	40.0	0.0	0.0	1,494	2,967	241	937	104	104	0	0	0	0	0	0	0	0	0	0	0	0	307,017	9.86	0.00	309,985
Underwater Demolition - Multiple Charge - Mat Weave and Obstacle Loading	18																														
		36	CRRC	2	8.0	288.0	288.0	0.0	0.0	0	43	3,716	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	308,366	10.00	0.00	311,347
Underwater Demo Qual	120									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		240	CRRC	2	8.0	1920.0	1920.0	0.0	0.0	0	285	24,771	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,055,771	66.69	0.00	2,075,645
SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	14																														
		14	BW	1	2.0	28.0	28.0	0.0	0.0	3,129	45	1,285	9	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2,763	0.09	0.00	2,790
		14	Bayliner	1	2.0	28.0	28.0	0.0	0.0	1,046	2,077	169	656	73	73	0	0	0	0	0	0	0	0	0	0	0	0	214,912	6.97	0.00	216,989
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	200																														
		200	BW	1	2.0	400.0	400.0	0.0	0.0	44,699	638	18,357	123	32	32	0	0	0	0	0	0	0	0	0	0	0	0	39,472	1.28	0.00	39,854
		200	Bayliner	1	2.0	400.0	400.0	0.0	0.0	14,943	29,670	2,407	9,369	1,041	1,041	0	0	0	0	0	0	0	0	0	0	0	0	3,070,167	99.60	0.00	3,093,848
OTHER																															
Elevated Causeway	1																														
		2	WT	2	4.0	8.0	8.0	0.0	0.0	43	133	11	25	6	6	0	0	0	0	0	0	0	0	0	0	0	0	8,522	0.28	0.00	8,605
		2	PW	2	4.0	8.0	8.0	0.0	0.0	1,092	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	7,390	0.24	0.00	7,461
		1	LCM	1	4.0	4.0	4.0	0.0	0.0	20	63	5	12	3	3	0	0	0	0	0	0	0	0	0	0	0	0	3,695	0.12	0.00	3,731
Offshore Petroleum Discharge System	0																														
		0	OUB	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Precision Anchoring	0																														
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test Detachment/Equipment Test and Evaluation	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Waterborne Training	500																														
		500	RHIB	1	4.0	2000.0	2000.0	0.0	0.0	680	18,280	120	2,880	300	300	0	0	0	0	0	0	0	0	0	0	0	0	2,141,428	69.47	0.00	2,162,130

EMISSIONS / YEAR (tons) BY JURISDICTION																							
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
37	74	26	19	2	2	4	23	1	8	1	1	9	74	2	13	2	2	15,373	0	0	15521.6126

Table C-32: Alternative 1 Amphibious Vessel Training Emissions - SDAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																GREENHOUS GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	0																														
		0	LCAC	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Battalion Landing	0																														
		0	LCU	6	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	2426																														
		31538	CRRC	13	2.0	63,076.0	63076.0	0.0	0.0	0	9,370	813,772	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67,536,365	2190.91	0.06	68,189,256
		4852	LCU	2	2.0	9,704.0	9704.0	0.0	0.0	49,098	152,385	12,365	28,197	7,317	7,317	0	0	0	0	0	0	0	0	0	0	0	0	8,963,851	290.79	0.01	9,050,507
		4852	LCAC	2	2.0	9,704.0	9704.0	0.0	0.0	177,779	1,111,432	33,844	529,894	49,868	49,868	0	0	0	0	0	0	0	0	0	0	0	0	200,815,607	6514.54	0.18	202,756,343
		14556	EFV	6	2.0	29,112.0	29112.0	0.0	0.0	22,125	181,077	23,872	36,390	7,569	7,569	0	0	0	0	0	0	0	0	0	0	0	0	40,452,987	1312.31	0.04	40,844,057
Humanitarian Assistance	0																														
		0	LCAC	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SUBMARINE WARFARE																															
Tracking/Torpedo Exercise-Submarine (TRACKEX-Sub)		0	TRB	1	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-Submarine (TORPEX-Sub)		0	TRB	1	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-Surface (TRACKEX-Surface)		0.0	TRB	0.32	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-Surface (TORPEX-Surface)		0.0	TRB	0.32	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)		0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-Helo (TORPEX-Helo)		0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Service Weapons Test (SWT)		0	TRB	1	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)		0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise-MPA (TORPEX-MPA)		0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking/Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys		0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Expeditionary Warfare																															
Dive and Salvage Operations	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	57.5																														
		57.5	RHIB	1	2.0	115.0	35.7	39.7	39.7	12	326	2	51	5	5	13	363	2	57	6	6	13	363	2	57	6	6	123,132	3.99	0.00	124,322

MINE WARFARE																															
Civilian Port Defense - Homeland Security	3																														
		3	RHIB	1	24.0	72.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Limpet Mine Neutralization System	90																														
		180	RHIB	2	2.0	360.0	360.0	0.0	0.0	122	3,290	22	518	54	54	0	0	0	0	0	0	0	0	0	0	0	0	385,457	12.50	0.00	389,183
Marine Mammal System	175																														
		175	RHIB	1	4.0	700.0	700.0	0.0	0.0	238	6,398	42	1,008	105	105	0	0	0	0	0	0	0	0	0	0	0	0	749,500	24.31	0.00	756,746
Mine Neutralization - EOD	0																														
		0	RHIB	3	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - ROV	312																														
		312	RHIB	1	12.0	3744.0	3744.0	0.0	0.0	1,273	34,220	225	5,391	562	562	0	0	0	0	0	0	0	0	0	0	0	0	4,008,754	130.05	0.00	4,047,507
SLMM (Sub-mobile) Mine Exercise for Training and Certification																															
		0	Bayliner	1	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demolition - Multiple Charge - Mat Weave and Obstacle Loading																															
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demo Qual										0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber																															
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber																															
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Elevated Causeway	1																														
		0	WT	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	PW	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	6																														
		12	OUB	2	4.0	48.0	48.0	0.0	0.0	1,738	2,158	25	149	75	75	0	0	0	0	0	0	0	0	0	0	0	0	100,602	3.26	0.00	101,574
Precision Anchoring	75																														
		75	RHIB	1	4.0	300.0	300.0	0.0	0.0	102	2,742	18	432	45	45	0	0	0	0	0	0	0	0	0	0	0	0	321,214	10.42	0.00	324,320
Surf Zone Test Detachment/Equipment Test and Evaluation	200																														
		400	CRRC	2	8.0	3200.0	3200.0	0.0	0.0	0	475	41,285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,426,285	111.15	0.00	3,459,468
Waterborne Training																															
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)												
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
125	743	442	301	33	33	0	0	0	0	0	0	0	0	0	0	0	0	161,518	5	0	163079.261

Table C-33: Alternative 1 Amphibious Vessel Training Emissions - Hawaii

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	12																														
		48	LCAC	4	8.0	384.0	144.0	144.0	96.0	2,638	16,493	502	7,863	740	740	2,638	16,493	502	7,863	740	740	1,759	10,995	335	5,242	493	493	7,946,537	257.79	0.01	8,023,358
		48	LCU	4	8.0	384.0	144.0	144.0	96.0	723	2,261	183	418	109	109	723	2,261	183	418	109	109	486	1,508	122	279	72	72	354,711	11.51	0.00	358,140
Battalion Landing	0																														
		0	LCU	6	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0																														
		0	CRRC	13	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	2																														
		8	LCAC	4	8.0	64.0	0.0	32.0	32.0	0	0	0	0	0	0	586	3,665	112	1,747	164	164	586	3,665	112	1,747	164	164	1,324,423	42.96	0.00	1,337,226
		8	LCU	4	8.0	64.0	0.0	32.0	32.0	0	0	0	0	0	0	162	503	41	93	24	24	162	503	41	93	24	24	53,113	1.92	0.00	53,630
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Submarine (TRACKEX-Sub)	200																														
		200	TRB	1	3.6	720.0	0.0	72.0	648.0	0	0	0	0	0	0	466	4,048	112	533	85	85	4,193	36,431	1,004	4,795	765	765	212,224	6.88	0.00	214,276
Tracking / Torpedo Exercise-Submarine (TORPEX-Sub)	48																														
		48	TRB	1	3.6	172.8	0.0	17.3	155.5	0	0	0	0	0	0	112	971	27	128	20	20	1,006	8,743	241	1,151	184	184	50,934	1.65	0.00	51,426
Tracking / Torpedo Exercise-Surface (TRACKEX-Surface)	224																														
		70.7	TRB	0.32	3.6	254.7	0.0	25.5	229.2	0	0	0	0	0	0	165	1,432	39	188	30	30	1,483	12,885	355	1,696	270	270	75,060	2.43	0.00	75,786
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	50																														
		70.7	TRB	0.32	3.6	254.7	0.0	25.5	229.2	0	0	0	0	0	0	165	1,432	39	188	30	30	1,483	12,885	355	1,696	270	270	75,060	2.43	0.00	75,786
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	159																														
		47.7	TRB	0.3	3.6	171.7	0.0	17.2	154.5	0	0	0	0	0	0	111	965	27	127	20	20	1,000	8,689	240	1,144	182	182	50,616	1.64	0.00	51,105
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	6																														
		47.7	TRB	0.3	3.6	171.7	0.0	17.2	154.5	0	0	0	0	0	0	111	965	27	127	20	20	1,000	8,689	240	1,144	182	182	50,616	1.64	0.00	51,105
Service Weapons Test (SWT)	2																														
		2	TRB	1	3.6	7.2	0.0	0.7	6.5	0	0	0	0	0	0	5	40	1	5	1	1	42	364	10	48	8	8	2,122	0.07	0.00	2,143
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	26																														
		15.8	TRB	0.61	2.0	31.7	0.0	3.2	28.5	0	0	0	0	0	0	20	178	5	23	4	4	184	1,602	44	211	34	34	9,330	0.30	0.00	9,420
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	10																														
		15.8	TRB	0.61	2.0	31.7	0.0	3.2	28.5	0	0	0	0	0	0	20	178	5	23	4	4	184	1,602	44	211	34	34	9,330	0.30	0.00	9,420
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																														
		3.7	TRB	0.61	2.0	7.3	0.0	0.7	6.6	0	0	0	0	0	0	5	41	1	5	1	1	43	370	10	49	8	8	2,153	0.07	0.00	2,174
Expeditionary Warfare																															
Dive and Salvage Operations	3																														
		6	CRRC	2	8.0	48.0	48.0	0.0	0.0	0	7	619	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51,394	1.67	0.00	51,831
Small Boat Attack	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

MINE WARFARE																															
Civilian Port Defense - Homeland Security	1																														
		1	RHIB	1	24.0	24.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	RHIB	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Marine Mammal System	10																														
		10	RHIB	1	4.0	40.0	40.0	0.0	0.0	14	366	2	58	6	6	0	0	0	0	0	0	0	0	0	0	0	0	42,823	1.39	0.00	43,243
Mine Neutralization - EOD	20																														
		60	RHIB	3	12.0	720.0	720.0	0.0	0.0	245	6,581	43	1,037	108	108	0	0	0	0	0	0	0	0	0	0	0	0	770,914	25.01	0.00	778,367
Mine Neutralization - ROV	6																														
		6	RHIB	1	12.0	72.0	72.0	0.0	0.0	24	658	4	104	11	11	0	0	0	0	0	0	0	0	0	0	0	0	77,091	2.50	0.00	77,837
SLMM (Sub-mobile) Mine Exercise for Training and Certification	5																														
		5	Bayliner	1	8.0	40.0	40.0	0.0	0.0	1,494	2,967	241	337	104	104	0	0	0	0	0	0	0	0	0	0	0	0	307,017	9.96	0.00	309,365
Underwater Demo Qual	25																														
		50	CRRC	2	8.0	400.0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	10																														
		10	BW	1	2.0	20.0	20.0	0.0	0.0	2,235	32	918	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1,974	0.06	0.00	1,993
		10	Bayliner	1	2.0	20.0	20.0	0.0	0.0	747	1,483	120	468	52	52	0	0	0	0	0	0	0	0	0	0	0	0	153,508	4.38	0.00	154,932
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Elevated Causeway	0																														
		0	WT	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	PW	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	4																														
		8	OUB	2	4.0	32.0	32.0	0.0	0.0	1,159	1,438	17	100	50	50	0	0	0	0	0	0	0	0	0	0	0	0	67,068	2.18	0.00	67,716
Precision Anchoring	20																														
		20	RHIB	1	4.0	80.0	80.0	0.0	0.0	27	731	5	115	12	12	0	0	0	0	0	0	0	0	0	0	0	0	85,657	2.78	0.00	86,485
Underwater Demolition - Multiple Charge - Mat Weave and Obstacle Loading	0																														
		0	CRRC	2	8.0	0.0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
UUV Training, Certification, and Development Operations	25																														
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test Detachment/Equipment Test and Evaluation	0																														
		0	CRRC	2	8.0	0.0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm offshore)							Waters of U.S (3-12 nm)						Int Waters (> 12 nm)												
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N2O	CH4	CO_2e
5	17	1	6	1	1	3	17	1	6	1	1	7	54	2	10	1	1	5,890	0	0	5946.78163

Table C-34: Alternative 1 Amphibious Vessel Testing Emissions - SCAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GREENHOUSE GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
ANTI-SUBMARINE WARFARE																															
Tracking/Torpedo Exercise-Surface (TORPEX-Surface)	53																														
		16.7	TRB	0.32	3.6	60.3	0.0	6.0	54.2	0.0	0.0	0.0	0.0	0.0	0.0	39.0	338.7	9.3	44.6	7.1	7.1	350.9	3048.7	84.1	401.3	64.0	64.0	17759.8	1	0	17,932
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	81																														
		24.3	TRB	0.3	3.6	87.5	0.0	8.7	78.7	0.0	0.0	0.0	0.0	0.0	0.0	56.6	491.8	13.6	64.7	10.3	10.3	509.4	4426.3	122.0	582.6	92.9	92.9	25785.3	1	0	26,035
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	63																														
		38.3	TRB	0.61	2.0	76.7	0.0	7.7	69.0	0.0	0.0	0.0	0.0	0.0	0.0	49.6	431.2	11.9	56.8	9.1	9.1	446.6	3880.6	107.0	510.8	81.5	81.5	22606.5	1	0	22,825
Countermeasure Testing	17																														
		34	RHIB	2	12.0	408.0	0.0	253.0	155.0	0.0	0.0	0.0	0.0	0.0	0.0	86.0	2312.1	15.2	364.3	37.9	37.9	52.7	1417.1	9.3	223.3	23.3	23.3	436851.4	14	0	441,075
Torpedo (Explosive) Testing	11																														
		66	RHIB	6	12.0	792.0	0.0	79.2	712.8	0.0	0.0	0.0	0.0	0.0	0.0	26.9	723.9	4.8	114.0	11.9	11.9	242.4	6515.0	42.8	1026.4	106.9	106.9	848005.6	28	0	856,203
Torpedo (Non-Explosive) Testing	18																														
		36	RHIB	2	12.0	432.0	0.0	43.2	388.8	0.0	0.0	0.0	0.0	0.0	0.0	14.7	394.8	2.6	62.2	6.5	6.5	132.2	3553.6	23.3	559.9	58.3	58.3	462548.5	15	0	467,020
MINE WARFARE																															
Mine Countermeasure and Neutralization Testing	11																														
		22	RHIB	2	8.0	176.0	0.0	0.0	176.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.8	1608.6	10.6	253.4	26.4	26.4	188445.7	6	0	190,267
Mine Detection and Classification Testing	16																														
		64	RHIB	4	12.0	768.0	0.0	0.0	768.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	261.1	7019.5	46.1	1105.9	115.2	115.2	822308.5	27	0	830,258
OTHER																															
Personnel Insertion/Extraction - Non Submarine	0.5																														
		0.5	Bayliner	1	8.0	4.0	4.0	0.0	0.0	149.4	296.7	24.1	93.7	10.4	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Non-Acoustic Component Testing	17																														
		34	RHIB	2	6.0	204.0	0.0	0.0	204.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	69.4	1864.6	12.2	293.8	30.6	30.6	218425.7	7	0	220,537
		0.5	Bayliner	1	8.0	4.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	149.4	296.7	24.1	93.7	10.4	10.4	30701.7	1	0	30,988
Signature Analysis Operations	1																														
		2	RHIB	2	8.0	16.0	16.0	0.0	0.0	5.4	146.2	1.0	23.0	2.4	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17131.4	1	0	17,287
UNMANNED SYSTEMS																															
Unmanned Surface Vehicle System Testing	4																														
		4	RHIB	1	12.0	48.0	0.0	0.0	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	438.7	2.9	69.1	7.2	7.2	51394.3	2	0	51,831
Unmanned Underwater Vehicle Testing	231																														
		231	RHIB	1	12.0	3492.0	0.0	0.0	3492.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1187.3	31916.9	209.5	5028.5	523.8	523.8	3738933.8	121	0	3,775,079
Air Defense Testing	9																														
		9	RHIB	1	10.0	90.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.6	822.6	5.4	129.6	13.5	13.5	96364.3	3	0	97,296
Surface Warfare Testing	58																														
		58	RHIB	1	12.0	696.0	0.0	0.0	696.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	236.6	6361.4	41.8	1002.2	104.4	104.4	745217.0	24	0	752,421
VESSEL EVALUATION																															
Undersea Warfare Training	16																														
		32	RHIB	2	12.0	384.0	0.0	0.0	384.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	130.6	3509.8	23.0	553.0	57.6	57.6	411154.2	13	0	415,129
Submarine Sea Trials - Weapons System Testing	1																														
		1	RHIB	1	24.0	24.0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	219.4	1.4	34.6	3.6	3.6	25697.1	1	0	25,946
SPAWAR																															
Vehicle Testing	166																														
		166	RHIB	1	6.0	996.0	996.0	0.0	0.0	338.6	9103.4	59.6	1434.2	149.4	149.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1066431.3	35	0	1,076,741
Communications	10																														
		10	RHIB	1	8.0	80.0	0.0	0.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2	731.2	4.8	115.2	12.0	12.0	85657.1	3	0	86,465

EMISSIONS / YEAR (tons) BY JURISDICTION																															
										State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
										CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
										0	5	0	1	0	0	0	2	0	0	0	0	2	39	0	6	1	1	4,656	0	0	4,701

Table C-35: Alternative 1 Amphibious Vessel Testing Emissions - SDAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GREENHOUSE GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
ANTI-SUBMARINE WARFARE																														
Tracking/Torpedo Exercise-Surface (TORPEX-Surface)	0	0.0	TRB	0.32	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	0	0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	0	0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Countermeasure Testing	0	0	RHIB	2	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Torpedo (Explosive) Testing	11	66	RHIB	6	12.0	792.0	0.0	79.2	712.8	0.0	0.0	0.0	0.0	0.0	0.0	26.9	723.9	4.8	114.0	11.9	11.9	242.4	6515.0	42.8	1026.4	106.9	106.9	848005.6	28	0	856,203
Torpedo (Non-Explosive) Testing	18	36	RHIB	2	12.0	432.0	0.0	43.2	388.8	0.0	0.0	0.0	0.0	0.0	0.0	14.7	394.8	2.6	62.2	6.5	6.5	132.2	3553.6	23.3	559.9	58.3	58.3	462548.5	15	0	467,020
MINE WARFARE																														
Mine Countermeasure and Neutralization Testing	0	0	RHIB	2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Mine Detection and Classification Testing	0	0	RHIB	4	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
OTHER																														
Personnel Insertion/Extraction - Non Submarine	0	0	Bayliner	1	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Non-Acoustic Component Testing	0	0	RHIB	2	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
		0	Bayliner	1	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Signature Analysis Operations	0	0	RHIB	2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
UNMANNED SYSTEMS																														
Unmanned Surface Vehicle System Testing	0	0	RHIB	1	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Unmanned Underwater Vehicle Testing	0	0	RHIB	1	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Air Defense Testing	0	0	RHIB	1	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Surface Warfare Testing	0	0	RHIB	1	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
VESSEL EVALUATION																														
Undersea Warfare Training	0	0	RHIB	2	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Submarine Sea Trials - Weapons System Testing	0	0	RHIB	1	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
SPAWAR																														
Vehicle Testing	0	0	RHIB	1	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Communications	0	0	RHIB	1	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION

State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	0	0	0	0	0	0	1	0	0	0	0	0	5	0	1	0	0	655	0	0	662

Table C-36: Alternative 1 Amphibious Vessel Testing Emissions - Hawaii

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																GREENHOUSE GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
ANTI-SUBMARINE WARFARE																														
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	20	6.3	TRB	0.32	3.6	22.7	0.0	2.3	20.5	0.0	0.0	0.0	0.0	0.0	0.0	14.7	127.8	3.5	16.8	2.7	2.7	132.4	1150.4	31.7	151.4	24.1	24.1	6701.8	0	0	6,767
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	0	0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	58	35.3	TRB	0.61	2.0	70.6	0.0	7.1	63.5	0.0	0.0	0.0	0.0	0.0	0.0	45.7	397.0	10.9	52.3	8.3	8.3	411.2	3572.7	98.5	470.3	75.0	75.0	20812.3	1	0	21,014
Countermeasure Testing	15	30	RHIB	2	12.0	360.0	0.0	223.2	136.8	0.0	0.0	0.0	0.0	0.0	0.0	75.9	2040.0	13.4	321.4	33.5	33.5	46.5	1250.4	8.2	197.0	20.5	20.5	385457.1	13	0	389,183
Torpedo (Explosive) Testing	12	72	RHIB	6	12.0	864.0	0.0	86.4	777.6	0.0	0.0	0.0	0.0	0.0	0.0	29.4	789.7	5.2	124.4	13.0	13.0	264.4	7107.3	46.7	1119.7	116.6	116.6	325097.0	30	0	324,040
Torpedo (Non-Explosive) Testing	18	36	RHIB	2	12.0	432.0	0.0	43.2	388.8	0.0	0.0	0.0	0.0	0.0	0.0	14.7	394.8	2.6	62.2	6.5	6.5	132.2	3553.6	23.3	559.9	58.3	58.3	462548.5	15	0	467,020
MINE WARFARE																														
Mine Countermeasure and Neutralization Testing	0	0	RHIB	2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Mine Detection and Classification Testing	7	28	RHIB	4	12.0	336.0	0.0	0.0	336.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.2	3071.0	20.2	483.8	50.4	50.4	359759.9	12	0	363,236
OTHER																														
Personnel Insertion/Extraction - Non Submarine	1	1	Bayliner	1	8.0	8.0	8.0	0.0	0.0	298.9	593.4	48.1	187.4	20.8	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Non-Acoustic Component Testing	8	16	RHIB	2	6.0	96.0	0.0	0.0	96.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.6	877.4	5.8	138.2	14.4	14.4	102788.6	3	0	103,782
		1	Bayliner	1	8.0	8.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	298.9	593.4	48.1	187.4	20.8	20.8	61403.3	2	0	61,997
Signature Analysis Operations	2	4	RHIB	2	8.0	32.0	32.0	0.0	0.0	10.9	292.5	1.9	46.1	4.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34262.9	1	0	34,594
UNMANNED SYSTEMS																														
Unmanned Surface Vehicle System Testing	3	3	RHIB	1	12.0	36.0	0.0	0.0	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	329.0	2.2	51.8	5.4	5.4	38545.7	1	0	38,918
Unmanned Underwater Vehicle Testing	3	3	RHIB	1	12.0	36.0	0.0	0.0	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	329.0	2.2	51.8	5.4	5.4	38545.7	1	0	38,918
Air Defense Testing	4	4	RHIB	1	10.0	40.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	365.6	2.4	57.6	6.0	6.0	42828.6	1	0	43,243
Surface Warfare Testing	45	45	RHIB	1	12.0	540.0	0.0	0.0	540.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	183.6	4935.6	32.4	777.6	81.0	81.0	578185.6	19	0	583,775
VESSEL EVALUATION																														
Undersea Warfare Training	15	30	RHIB	2	12.0	360.0	0.0	0.0	360.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	122.4	3290.4	21.6	518.4	54.0	54.0	385457.1	13	0	389,183
Submarine Sea Trials - Weapons System Testing	1	1	RHIB	1	24.0	24.0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	219.4	1.4	34.6	3.6	3.6	25697.1	1	0	25,946
SPAWAR																														
Vehicle Testing	4	4	RHIB	1	6.0	24.0	24.0	0.0	0.0	8.2	219.4	1.4	34.6	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25697.1	1	0	25,946
Communications	1	1	RHIB	1	8.0	8.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	73.1	0.5	11.5	1.2	1.2	8565.7	0	0	8,649

EMISSIONS / YEAR (tons) BY JURISDICTION																								
State (0-3 nm offshore)							Waters of U S (3-12 nm)							Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	1	0	0	0	0	0	2	0	0	0	0	1	15	0	2	0	0	1,751	0	0	1,768

Table C-37: Alternative 1 Aircraft Training Emissions - SCAB

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers	3000																											
		2.83	8490	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87769620	12907297	271750232	8816	7680	274,569,302
		0.17	510	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3254310	478575	10075918	327	285	10,180,443
Air Defense Exercise	275																											
		0.21	58	E-2	0	0	0	0	0	0	0	0	0	0	0	0	166	657	24	26	62	62	130861.5	19244	405170	13	11	409,373
		0.00	0.00	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	352	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	1310	26837	218	728	11936	11936	3638976	535144	11266912	366	318	11,383,792
Gunnery ExerciseA-A	2.5																											
		2.83	7	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73141.35	10756	226459	7	6	228,808
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2711.925	399	8397	0	0	8,484
Gunnery Exercise, SA Large Caliber	82.5																											
		1	83	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2947	777	561	53	167	167	263340	38726	815347	26	23	823,805
Gunnery Exercise, SA Medium Caliber	97.5																											
		1	38	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	3483	918	663	62	198	198	311220	45768	963592	31	27	973,588
Missile Exercise, AAb	2																											
		4	8	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106176	15614	328740	11	9	332,150
		6	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	248112	36487	768199	25	22	776,168
		1	2	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18128	2666	56127	2	2	56,710
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	2	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36000	5294	111462	4	3	112,619
Missile Exercise, SA	12.5									0						0						0						
		1	13	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	281	288	25	18	189	189	45000	6618	139328	5	4	140,773
		1	13	P-3	0	0	0	0	0	0	0	0	0	0	0	0	257	793	59	41	407	407	153750	22610	476037	15	13	480,975
		0.5	6	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	238	79	57	5	17	17	13950	2934	61769	2	2	62,409
		0.0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																												
Amphibious Assault	18																											
		8	144	AH-1	3932	1908	200	140	1473	1473	0	0	0	0	0	0	0	0	0	0	0	0	350784	51586	1086089	35	31	1,097,356
		0.00	0.00	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	72	UH-1	390	551	20	47	490	490	0	0	0	0	0	0	0	0	0	0	0	0	116640	17153	361138	12	10	364,884
USMC Battalion Landing	2																											
		8	16.0	FA-18A/C	4	11	1	1	10	10	10	27	2	2	25	25	6	16	1	1	15	15	53088	7807	164370	5	5	166,075
		8	16.0	FA-18E/F	2	37	0	1	16	16	4	91	1	2	41	41	3	55	0	1	24	24	82704	12162	256066	8	7	258,723
		6	12.0	AV-8B	66	74	5	3	33	33	4	4	0	0	2	2	4	4	0	0	2	2	38286	5630	118540	4	3	119,770
		4	8.0	AH-1	66	32	3	2	25	25	4	2	0	0	1	1	4	2	0	0	1	1	6496	955	20113	1	1	20,321
		2	4.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25200	3706	78024	3	2	78,833
		4	8.0	H-53	103	390	7	19	107	107	6	22	0	1	6	6	6	22	0	1	6	6	53568	7878	165856	5	5	167,577
		12	24.0	MV-22	64	4	1	50	196	196	4	97	0	3	11	11	4	97	0	3	11	11	43200	6353	133755	4	4	135,142
		3	6.0	UH-1	10	14	0	1	12	12	1	1	0	0	1	1	1	1	0	0	1	1	3240	476	10032	0	0	10,136
Amphibious Raid	0																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	8																											
		0.17	1	FA-18E/F	0	0	0	0	0	0	30	622	5	17	277	277	0	0	0	0	0	0	42179.04	6203	130594	4	4	131,948
		0.17	1	AH-1	0	0	0	0	0	0	37	18	2	1	14	14	0	0	0	0	0	0	3312.96	487	10258	0	0	10,364
		0.17	1	AV-8B	0	0	0	0	0	0	200	224	14	10	99	99	0	0	0	0	0	0	26034.48	3829	80607	3	2	81,444
Humanitarian Assistance	1																											
		90	90.0	AH-1	2458	1193	125	88	921	921	0	0	0	0	0	0	0	0	0	0	0	0	219240	32241	678806	22	19	685,847
		58	58.0	MV-22	346	0	7	266	1050	1050	0	0	0	0	0	0	0	0	0	0	0	0	208800	30706	646482	21	18	653,188
		32	32.0	CH-53	913	3463	64	171	947	947	0	0	0	0	0	0	0	0	0	0	0	0	428544	63021	1326848	43	37	1,340,612
		38	38.0	AV-8B	0	0	0	0	0	0	5601	6256	393	291	2764	2764	0	0	0	0	0	0	727434	106976	2252264	73	64	2,275,628
		48	48.0	UH-1	260	367	13	31	327	327	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240759	8	7	243,256
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise–Helo (TRACKEX-Helo)	524																											
		0.17	89	SH-60B	0	0	0	0	0	0	568	581	50	36	381	381	1838	1882	162	118	1235	1235	384825.6	56592	1191488	39	34	1,203,848
		0.83	435	SH-60F	0	0	0	0	0	0	2771	2838	244	177	1862	1862	8972	9187	789	574	6029	6029	1878854.4	276302	5817265	189	164	5,877,612
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise–Helo (TORPEX-Helo)	104																									0.00	0.00	0
		0.17	18	SH-60B	0	0	0	0	0	0	113	115	10	7	76	76	365	373	32	23	245	245	76377.6	11232	236479	8	7	238,932
		0.83	86	SH-60F	0	0	0	0	0	0	550	563	48	35	370	370	1781	1823	157	114	1197	1197	372902.4	54839	1154572	37	33	1,166,549
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise–MPA (TRACKEX-MPA)	50																											
		1	50	P-3	116	357	27	18	183	183	232	713	54	37	366	366	1968	6061	455	314	3113	3113	1230000	180882	3808297	124	108	3,847,803
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise–MPA (TORPEX-MPA)	25																											
		1	25	P-3	58	178	13	9	92	92	116	357	27	18	183	183	984	3031	227	157	1556	1556	615000	90441	1904143	62	54	1,923,902
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise – MPA–Multi-Static Active Coherent Sonobuoys	6																											
		1	6	P-3	0	0	0	0	0	0	0	0	0	0	0	0	278	856	64	44	439	439	147600	21706	456396	15	13	461,736
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																												
Electronic Warfare	350																											
		0.08	28	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	441	452	39	28	296	296	70560	10376	218466	7	6	220,733
		0.05	18	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	276	282	24	18	185	185	44100	6485	136541	4	4	137,958
		0.004	1	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	22	23	2	1	15	15	3528	519	10923	0	0	11,037
		0.04	14	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114800	16882	355441	12	10	359,128
		0.29	102	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1347108	198104	4170884	135	118	4,214,152
		0.29	102	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2038614	308620	6437679	211	184	6,565,085
		0.02	7	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31724	4665	98223	3	3	99,242
		0.02	7	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89460	13156	276984	9	8	279,857
		0.2	70	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148960	21906	461206	15	13	465,991
		0.01	4	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7448	1095	23060	1	1	23,300
Counter Targeting Flare Exercise	130																											
		2	260	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7391670	1087010	22885915	742	647	23,123,328
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	260	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931500	431103	9076441	294	257	9,170,598
		2	260	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1465750	215551	4538221	147	128	4,585,299
		2	260	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931500	431103	9076441	294	257	9,170,598
		1	130	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276640	40682	856526	28	24	865,412
Counter Targeting Chaff Exercise – Aircraft	140																											
		2	280	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7960260	1170626	24646370	800	697	24,902,045
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	280	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3157000	464265	9774629	317	276	9,876,029
		2	280	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1578500	232132	4887315	159	138	4,938,014
		2	280	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3157000	464265	9774629	317	276	9,876,029
		1	140	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	297920	43812	922413	30	26	931,982
Expeditionary Warfare																												
Personnel Insertion/Extraction – Swimmer/Diver	165																											
		1	165	SH-60B	2599	2661	229	166	1746	1746	0	0	0	0	0	0	0	0	0	0	0	0	415800	61147	1287390	42	36	1,300,745
MINE WARFARE																												
Mine Neutralization - EOD	170																											
		1	170	SH-60B	2678	2742	236	171	1799	1799	0	0	0	0	0	0	0	0	0	0	0	0	428400	63000	1326402	43	37	1,340,162
Mine Countermeasure Exercise - Mine Neutralization Small-Medium Caliber	36																											
		1	36	SH-60B	567	581	50	36	381	381	0	0	0	0	0	0	0	0	0	0	0	0	90720	13341	280885	9	8	283,799
Mine Neutralization - ROV	60																											
		1	60	SH-60B	945	968	83	60	635	635	0	0	0	0	0	0	0	0	0	0	0	0	151200	22235	468142	15	13	472,998
Mine Laying	18																											
		0.29	5.22	P-3	16	50	4	3	25	25	13	40	3	2	20	20	3	10	1	1	5	5	19261.8	2833	59638	2	2	60,257
		0.65	11.7	FA-18A/C	3	9	1	1	8	8	3	7	0	0	7	7	1	2	0	0	2	2	38820.6	5709	120195	4	3	121,442
		0.59	10.62	FA-18E/F	1	27	0	1	12	12	1	22	0	1	10	10	0	5	0	0	2	2	54894.78	8073	169964	6	5	171,727

ANTI-SURFACE WARFARE																												
Bombex, Air to Surface	640																											
		0.53	339	FA-18A/C	0	0	0	0	0	0	275	759	50	45	716	716	275	759	50	45	716	716	2250931.2	331019	6969280	226	197	7,041,578
		0.53	339	FA-18E/F	0	0	0	0	0	0	126	2586	21	70	1150	1150	126	2586	21	70	1150	1150	3506643.6	515684	10857206	352	307	10,969,836
		0.28	179	P-3	0	0	0	0	0	0	92	284	21	15	146	146	92	284	21	15	146	146	734720	108047	2274823	74	64	2,298,421
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Medium Caliber	363																											
		1.62	588.1	SH-60B	0	0	0	0	0	0	2205	2258	194	141	1482	1482	2205	2258	194	141	1482	1482	705672	103775	2184885	71	62	2,207,551
		0.55	199.7	SH-60F	0	0	0	0	0	0	749	767	66	48	503	503	749	767	66	48	503	503	239580	35232	741782	24	21	749,477
		0.02	7.3	MH-60R/S	0	0	0	0	0	0	27	28	2	2	18	18	27	28	2	2	18	18	8712	1281	26974	1	1	27,254
Gunnery Exercise, Air to Surface, Small Caliber	2040																											
		1.62	3305	SH-60B	0	0	0	0	0	0	12393	12690	1091	793	8328	8328	12393	12690	1091	793	8328	8328	3965760	583200	12278693	398	347	12,406,069
		0.55	3305	SH-60F	0	0	0	0	0	0	12393	12690	1091	793	8328	8328	12393	12690	1091	793	8328	8328	3965760	583200	12278693	398	347	12,406,069
		0.02	3305	MH-60R/S	0	0	0	0	0	0	12393	12690	1091	793	8328	8328	12393	12690	1091	793	8328	8328	3965760	583200	12278693	398	347	12,406,069
Laser Targeting	910																											
		0.55	501	SH-60B	0	0	0	0	0	0	1877	1922	165	120	1261	1261	1877	1922	165	120	1261	1261	600600	88324	1859564	60	53	1,878,854
		0.28	255	SH-60F	0	0	0	0	0	0	956	978	84	61	642	642	956	978	84	61	642	642	305760	44965	946687	31	27	956,508
		0.3	273	FA-18A/C	0	0	0	0	0	0	221	611	40	36	576	576	221	611	40	36	576	576	1811628	266416	5609120	182	159	5,667,308
		0.3	273	FA-18E/F	0	0	0	0	0	0	102	2081	17	56	926	926	102	2081	17	56	926	926	2822274	415040	8738258	283	247	8,828,907
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maritime Security Ops	250																											
		0.74	185	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	5550	5683	488	355	3730	3730	888000	130588	2749405	89	78	2,777,926
		0.25	63	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	1875	1920	165	120	1260	1260	300000	44118	928853	30	26	938,489
Missile Exercise, Air to Surface	117																											
		0.55	64	SH-60B	0	0	0	0	0	0	724	741	64	46	486	486	724	741	64	46	486	486	231660	34068	717260	23	20	724,701
		0.28	33	SH-60F	0	0	0	0	0	0	369	377	32	24	248	248	369	377	32	24	248	248	117936	17344	365151	12	10	368,939
		0.3	35	FA-18A/C	0	0	0	0	0	0	57	157	10	9	148	148	57	157	10	9	148	148	465847.2	68507	1442345	47	41	1,457,308
		0.3	35	FA-18E/F	0	0	0	0	0	0	26	535	4	15	238	238	26	535	4	15	238	238	725727.6	106725	2246981	73	64	2,270,290
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface, Rocket	246																											
		0.55	135.3	SH-60B	0	0	0	0	0	0	1522	1559	134	97	1023	1023	1522	1559	134	97	1023	1023	487080	71629	1508086	49	43	1,523,730
		0.28	68.9	SH-60F	0	0	0	0	0	0	775	793	68	50	521	521	775	793	68	50	521	521	247968	36466	767753	25	22	775,717
		0.3	73.8	FA-18A/C	0	0	0	0	0	0	119	330	22	20	311	311	119	330	22	20	311	311	979473.6	144040	3032623	98	86	3,064,083
		0.3	73.8	FA-18E/F	0	0	0	0	0	0	55	1125	9	31	500	500	55	1125	9	31	500	500	1525888.8	224395	4724421	153	134	4,773,431
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinking Exercise	1																											
		2	2	E-2	0	0	0	0	0	0	0	0	0	0	0	0	18	73	3	3	7	7	72512	10664	224510	7	6	226,839
		8	8	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	95	1952	16	53	868	868	1323264	194598	4097059	133	116	4,139,561
		1	1	P-3	0	0	0	0	0	0	0	0	0	0	0	0	16	51	4	3	26	26	65600	9647	203109	7	6	205,216
		2	2	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	240	246	21	15	161	161	38400	5647	118893	4	3	120,127
OTHER																												
Kilo Dip-Helo	2400																											
		0.83	1992	SH-60F	0	0	0	0	0	0	881	903	78	56	592	592	2854	2922	251	183	1918	1918	597600	87882	1850275	60	52	1,869,469
		0.83	1992	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	597600	87882	1850275	60	52	1,869,469

EMISSIONS (lb/yr)																											
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
21,107	21,257	1,574	1,639	14,192	14,192	58,603	69,465	5,206	3,964	42,988	42,988	83,799	123,341	8,785	6,328	71,205	71,205	174,016,870	25,590,716	538,786,940	17,478	15,226	544,376,182
11	11	1	1	7	7	29	35	3	2	21	21	42	62	4	3	36	36			269,393	9	8	272,188

Table C-38: Alternative 1 Aircraft Training Emissions – SDAB

GENERAL INFO					EMISSIONS (lb/yr)																					
			Aircraft		State (0–3 nm)						U.S. (3–12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Defense Exercise	0																											
		0.21	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, SA Large Caliber	0																											
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, AAb	0																											
		4	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, SA	0	12								0						0						0			0			
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.5	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																												
Amphibious Assault	0																											
		8	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USMC Battalion Landing	0																											
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	0																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	0																											
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	1																											
		90	90.0	AH-1	2458	1193	125	88	321	321	0	0	0	0	0	0	0	0	0	0	0	0	219240	32241	678806	22	19	685,847
		58	58.0	MV-22	346	0	7	266	1050	1050	0	0	0	0	0	0	0	0	0	0	0	0	208800	30706	646482	21	18	653,188
		32	32.0	CH-53	913	3463	64	171	947	947	0	0	0	0	0	0	0	0	0	0	0	0	428544	63021	1326848	43	37	1,340,612
		38	38.0	AV-8B	0	0	0	0	0	0	5601	6256	393	291	0	0	0	0	0	0	0	0	727434	106976	2252264	73	64	2,275,628
		48	48.0	UH-1	260	367	13	31	327	327	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240759	8	7	243,256
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																												
Electronic Warfare	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counter Targeting Flare Exercise	130																								0			
		2	260	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7391670	1087010	22885315	742	647	23,123,328
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	260	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931500	431103	9076441	294	257	9,170,598
		2	260	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1465750	215551	4538221	147	128	4,585,239
		2	260	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931500	431103	9076441	294	257	9,170,598
		1	130	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276640	40682	856526	28	24	865,412
Counter Targeting Chaff Exercise - Aircraft	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Warfare																												
Personnel Insertion/Extraction - Swimmer/Diver	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINE WARFARE																												
Airborne Mine Countermeasures - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures - Towed Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Civilian Port Defense - Homeland Security	3																											
		1	3	SH-60B	270	276	24	17	181	181	0	0	0	0	0	0	0	0	0	0	0	0	43200	6353	133755	4	4	135,142
Mine Neutralization - EOD	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization Small-Medium Caliber																												
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	312																											
		1	312	SH-60B	4914	5032	432	314	3302	3302	0	0	0	0	0	0	0	0	0	0	0	0	786240	115624	2434338	79	69	2,459,591
Mine Laying	18																											
		0.29	5.22	P-3	16	50	4	3	25	25	13	40	3	2	0	0	3	10	1	1	0	0	19261.8	2833	59638	2	2	60,257
		0.65	11.7	FA-18A/C	3	9	1	1	8	8	3	7	0	0	0	0	1	2	0	0	0	0	38820.6	5709	120195	4	3	121,442
		0.59	10.62	FA-18E/F	1	27	0	1	12	12	1	22	0	1	0	0	0	5	0	0	0	0	54894.78	8073	169964	6	5	171,727

ANTI-SURFACE WARFARE																													
Bombex, Air to Surface	0																												
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Medium Caliber	0																												
		1.62	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0.0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Small Caliber	0																												
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maritime Security Ops	0																												
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface, Rocket	0																												
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinking Exercise	0																												
		2	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS (lb/yr)																													
State (0-3 nm)							U.S. (3-12 nm)						International (> 12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)							
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e						
9,180	10,416	670	892	6,774	6,774	5,618	6,324	396	294	0	0	4	17	1	1	0	0	17,601,255	2,588,420	54,496,592	1,768	1,540	55,061,926						
5	5	0	0	3	3	3	3	0	0	0	0	0	0	0	0	0	0			27,248	1	1	27,531						

Table C-39: Alternative 1 Aircraft Training Emissions - Hawaii

GENERAL INFO					EMISSIONS (lb/yr)																					
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers	814																											
		2.83	2304	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23814823.56	3502180	73734896	2392	2084	74,499,804
		0.17	138	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	883002.78	129853	2733932	89	77	2,762,294
Air Defense Exercise	185																											
		0.21	39	E-2	0	0	0	0	0	0	0	0	0	0	0	0	112	442	16	18	41	41	88034.1	12946	272569	9	8	275,397
		0.00	0.00	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	237	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	881	18054	147	490	8030	8030	2448038.4	360006	7579559	246	214	7,658,187
Gunnery Exercise A-A	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, SA Large Caliber	51																											
		1	51	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	1822	480	347	33	103	103	162792	23940	504033	16	14	509,261
Gunnery Exercise, SA Medium Caliber	72																											
		1	72	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2572	678	490	46	146	146	229824	33798	711576	23	20	718,957
Missile Exercise, AAb	64																											
		4	256	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3397632	499652	10519668	341	297	10,628,797
		6	384	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7939584	1167586	24582353	797	695	24,837,364
		1	64	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	580096	85308	1796080	58	51	1,814,712
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	64	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1152000	169412	3566795	116	101	3,603,796
Missile Exercise, SA	30									0						0						0						
		1	30	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	675	691	59	43	454	454	108000	15882	334387	11	9	337,856
		1	30	P-3	0	0	0	0	0	0	0	0	0	0	0	0	618	1903	143	98	977	977	369000	54265	1142489	37	32	1,154,341
		0.5	15	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	715	188	136	13	41	41	47880	7041	148245	5	4	149,783
		0.0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																											
Amphibious Assault	12																										
		8	36	AH-1	2622	1272	133	34	382	382	0	0	0	0	0	0	0	0	0	0	0	0	233856	34331	724059	23	20	731,571
		0.00	0.00	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	48	UH-1	260	367	13	31	327	327	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240753	8	7	243,256
USMC Battalion Landing	0																										
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	0																										
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	0																										
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	2																										
		30	160.0	AH-1	4315	2385	250	175	1842	1842	0	0	0	0	0	0	0	0	0	0	0	0	438480	64482	1357611	44	38	1,371,635
		58	116.0	MV-22	631	0	13	532	2100	2100	0	0	0	0	0	0	0	0	0	0	0	0	417600	61412	1292363	42	37	1,306,376
		32	64.0	CH-53	1826	6325	123	343	1834	1834	0	0	0	0	0	0	0	0	0	0	0	0	857088	126042	2653636	86	75	2,681,224
		38	76.0	AV-8B	0	0	0	0	0	0	11202	12512	786	582	5528	5528	0	0	0	0	0	0	1454868	213951	4504528	146	127	4,551,257
		48	96.0	UH-1	519	734	26	62	653	653	0	0	0	0	0	0	0	0	0	0	0	0	155520	22871	481517	16	14	486,513
ANTI-SUBMARINE WARFARE																											
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	153																										
		0.17	27	SH-60B	0	0	0	0	0	0	172	176	15	11	116	116	558	571	43	36	375	375	116769.6	17172	361539	12	10	365,290
		0.83	132	SH-60F	0	0	0	0	0	0	841	861	74	54	565	565	2722	2788	240	174	1829	1829	570110.4	83840	1765162	57	50	1,783,474
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	6																						0	0	0	0.00	0.00	0
		0.17	1	SH-60B	0	0	0	0	0	0	6	7	1	0	4	4	21	22	2	1	14	14	4406.4	648	13643	0	0	13,785
		0.83	5	SH-60F	0	0	0	0	0	0	32	32	3	2	21	21	103	105	9	7	69	69	21513.6	3164	66610	2	2	67,301
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	26																										
		1	26	P-3	60	185	14	10	35	35	120	371	28	19	130	130	1023	3152	236	163	1619	1619	633600	94053	1360314	64	56	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	10																						0	0	0	0.00	0.00	0
		1	10	P-3	23	71	5	4	37	37	46	143	11	7	73	73	334	1212	91	63	623	623	246000	36176	761659	25	22	763,561
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																						0	0	0	0.00	0.00	0
		1	6	P-3	0	0	0	0	0	0	0	0	0	0	0	0	278	856	64	44	433	433	147600	21706	456396	15	13	461,736
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																												
Electronic Warfare	33																											
		0.08	3	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	42	43	4	3	28	28	6652.8	978	20598	1	1	20,812
		0.05	2	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	26	27	2	2	17	17	4158	611	12874	0	0	13,007
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1	332.64	49	1030	0	0	1,041
		0.04	1	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10824	1592	33513	1	1	33,861
		0.29	10	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127013.04	18678	393255	13	11	397,334
		0.29	10	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	197869.32	29098	612638	20	17	618,994
		0.02	1	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2991.12	440	9261	0	0	9,357
		0.02	1	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8434.8	1240	26116	1	1	26,387
		0.2	7	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14044.8	2065	43485	1	1	43,936
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	702.24	103	2174	0	0	2,197
Counter Targeting Flare Exercise	159																											
		2	318	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9040581	1329497	27991234	908	791	28,281,608
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	318	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3585450	527272	11101186	360	314	11,216,347
		2	318	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1792725	263636	5550593	180	157	5,608,173
		2	318	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3585450	527272	11101186	360	314	11,216,347
		1	159	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	338352	49758	1047598	34	30	1,058,465
Counter Targeting Chaff Exercise - Aircraft	19																											
		2	38	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1080321	158871	3344864	109	95	3,379,563
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	38	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	428450	63007	1326557	43	37	1,340,318
		2	38	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	214225	31504	663278	22	19	670,159
		2	38	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	428450	63007	1326557	43	37	1,340,318
		1	19	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40432	5946	125185	4	4	126,483
Expeditionary Warfare																												
Personnel Insertion/Extraction - Swimmer/Diver	495																											
		1	495	SH-60B	7796	7983	686	499	5239	5239	0	0	0	0	0	0	0	0	0	0	0	0	1247400	183441	3862171	125	109	3,902,236
MINE WARFARE																												
Airborne Mine Countermeasures - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures - Towed Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Civilian Port Defense - Homeland Security	1																											
		1	1	SH-60B	90	92	8	6	60	60	0	0	0	0	0	0	0	0	0	0	0	0	14400	2118	44585	1	1	45,047
Mine Neutralization - EOD	20																											
		1	20	SH-60B	315	323	28	20	212	212	0	0	0	0	0	0	0	0	0	0	0	0	50400	7412	156047	5	4	157,666
Mine Countermeasure Exercise - Mine Neutralization Small-Medium Caliber	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	6																											
		1	6	SH-60B	95	97	8	6	64	64	0	0	0	0	0	0	0	0	0	0	0	0	15120	2224	46814	2	1	47,300
Mine Laying	6																											
		0.29	1.74	P-3	5	17	1	1	8	8	4	13	1	1	7	7	1	3	0	0	2	2	6420.6	944	19879	1	1	20,086
		0.65	3.9	FA-18A/C	1	3	0	0	3	3	1	2	0	0	2	2	0	1	0	0	1	1	12940.2	1903	40065	1	1	40,481
		0.59	3.54	FA-18E/F	0	9	0	0	4	4	0	7	0	0	3	3	0	2	0	0	1	1	18298.26	2691	56655	2	2	57,242

ANTI-SURFACE WARFARE																												
Bombex, Air to Surface	187																											
		0.53	99	FA-18A/C	0	0	0	0	0	0	80	222	14	13	209	209	80	222	14	13	209	209	657633.36	36720	2036337	66	58	2,057,461
		0.53	99	FA-18E/F	0	0	0	0	0	0	37	756	6	20	336	336	37	756	6	20	336	336	1024539.18	150676	3172340	103	90	0
		0.28	52	P-3	0	0	0	0	0	0	27	83	6	4	43	43	27	83	6	4	43	43	214676	31570	664675	22	19	671,570
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Medium Caliber	217																											
		1.62	351.5	SH-60B	0	0	0	0	0	0	1318	1350	116	84	886	886	1318	1350	116	84	886	886	421848	62036	1306116	42	37	1,319,665
		0.55	119.4	SH-60F	0	0	0	0	0	0	448	458	39	29	301	301	448	458	39	29	301	301	143220	21062	443434	14	13	448,034
		0.02	4.3	MH-60R/S	0	0	0	0	0	0	16	17	1	1	11	11	16	17	1	1	11	11	5208	766	16125	1	0	16,232
Gunnery Exercise, Air to Surface, Small Caliber	585																											
		1.62	948	SH-60B	0	0	0	0	0	0	3554	3639	313	227	2388	2388	3554	3639	313	227	2388	2388	1137240	167241	3521096	114	100	3,557,623
		0.55	948	SH-60F	0	0	0	0	0	0	3554	3639	313	227	2388	2388	3554	3639	313	227	2388	2388	1137240	167241	3521096	114	100	3,557,623
		0.02	948	MH-60R/S	0	0	0	0	0	0	3554	3639	313	227	2388	2388	3554	3639	313	227	2388	2388	1137240	167241	3521096	114	100	3,557,623
Laser Targeting	50																											
		0.55	28	SH-60B	0	0	0	0	0	0	103	106	9	7	69	69	103	106	9	7	69	69	33000	4853	102174	3	3	103,234
		0.28	14	SH-60F	0	0	0	0	0	0	53	54	5	3	35	35	53	54	5	3	35	35	16800	2471	52016	2	1	52,555
		0.3	15	FA-18A/C	0	0	0	0	0	0	12	34	2	2	32	32	12	34	2	2	32	32	39540	14638	308193	10	9	311,331
		0.3	15	FA-18E/F	0	0	0	0	0	0	6	114	1	3	51	51	6	114	1	3	51	51	155070	22804	480124	16	14	485,105
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maritime Security Ops	70																											
		0.74	52	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1554	1531	137	33	1044	1044	248640	36565	763833	25	22	777,819
		0.25	18	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	525	538	46	34	353	353	84000	12353	260079	8	7	262,777
Missile Exercise, Air to Surface	10																											
		0.55	6	SH-60B	0	0	0	0	0	0	62	63	5	4	42	42	62	63	5	4	42	42	19800	2912	61304	2	2	61,340
		0.28	3	SH-60F	0	0	0	0	0	0	32	32	3	2	21	21	32	32	3	2	21	21	10080	1482	31209	1	1	31,533
		0.3	3	FA-18A/C	0	0	0	0	0	0	5	13	1	1	13	13	5	13	1	1	13	13	39816	5855	123277	4	3	124,556
		0.3	3	FA-18E/F	0	0	0	0	0	0	2	46	0	1	20	20	2	46	0	1	20	20	62028	9122	192050	6	5	134,042
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface, Rocket	227																											
		0.55	124.3	SH-60B	0	0	0	0	0	0	1405	1438	124	90	944	944	1405	1438	124	90	944	944	443460	66097	1391607	45	39	1,406,044
		0.28	63.6	SH-60F	0	0	0	0	0	0	715	732	63	46	481	481	715	732	63	46	481	481	226816	33643	708455	23	20	715,804
		0.3	68.1	FA-18A/C	0	0	0	0	0	0	110	305	20	18	287	287	110	305	20	18	287	287	303823.2	132315	2736396	91	79	2,827,426
		0.3	68.1	FA-18E/F	0	0	0	0	0	0	51	1038	8	28	462	462	51	1038	8	28	462	462	1408035.6	207064	4359527	141	123	4,404,751
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinking Exercise	2																											
		2	4	E-2	0	0	0	0	0	0	0	0	0	0	0	0	37	146	5	6	14	14	145024	21327	449020	15	13	453,678
		8	16	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	131	3904	32	106	1736	1736	2646528	389195	8194118	266	232	8,273,121
		1	2	P-3	0	0	0	0	0	0	0	0	0	0	0	0	33	101	8	5	52	52	131200	19294	406218	13	11	410,432
		2	4	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	480	492	42	31	323	323	76800	11294	237786	8	7	240,253
OTHER																												
Kilo Dip-Helo	60																											
		0.83	50	SH-60F	0	0	0	0	0	0	22	23	2	1	15	15	71	73	6	5	48	48	14340	2197	46257	2	1	46,750
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	EMISSIONS (lb/yr)																											
	State (0-3 nm)						U.S. (3-12 nm)						International (> 12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
	13,219	20,464	1,316	1,782	13,520	13,520	27,530	31,325	2,283	1,718	17,332	17,332	30,536	55,841	3,674	2,557	23,785	23,785	81,526,683	11,983,218	252,420,396	8,183	7,134	249,833,456
	10	10	1	1	7	7	14	16	1	1	9	9	15	28	2	1	15	15			126,210	4	4	124,317

Table C-40: Alternative 1 Aircraft Testing Emissions - SCAB

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuver	110																											
		2.83	311	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3218213.4	473268	3364175	323	282	10,067,541
		0.17	19	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119324.7	17548	363450	12	10	373,263
Air Platform Weapons Integration Test	10																											
		0.3	3	P8-MMA	0	2	0	0	0	0	1	5	0	0	0	0	6	45	1	2	3	3	39151.2	5758	121219	4	3	122,477
		0.4	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	15	305	2	8	136	136	82704	12162	256066	8	7	258,723
		0.3	3	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	3	34	1	1	3	3	13536	1399	42096	1	1	42,532
Air Platform - Vehicle Test	35																											
		0.3143	11	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	20	28	1	2	25	25	23760	3434	73565	2	2	74,328
		0.3429	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	63	1830	15	50	814	814	436224	72374	1536397	50	43	1,552,335
		0.3143	11	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	53	250	3	10	23	23	99704	14562	308701	10	9	311,304
Intelligence, Surveillance, and Reconnaissance Test	254																											
		1	254	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	3693	27626	835	1193	1671	1671	3944404.8	1462412	30789632	993	870	31,103,036
ANTI-SUBMARINE WARFARE																												
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	81																											
		0.17	14	SH-60B	0	0	0	0	0	0	88	90	8	6	59	59	284	231	25	18	191	191	59486.4	8748	184180	6	5	186,091
		0.83	67	SH-60F	0	0	0	0	0	0	428	439	38	27	288	288	1387	1420	122	89	932	932	290433.6	42711	899234	29	25	908,562
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	63																											
		1	63	P-3	146	443	34	23	231	231	292	886	67	46	461	461	2480	7637	573	395	3922	3922	1543800	227312	4736454	156	136	4,848,232
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	3																											
		0.83	2	SH-60B	0	0	0	0	0	0	1	1	0	0	1	1	4	4	0	0	2	2	747	110	2313	0	0	2,337
Sonobuoy Lot Acceptance Test	160																											
		1	160	P8-MMA	2476	18430	559	793	1118	1118	231	2175	66	94	132	132	146	1088	33	47	66	66	6264192	921205	19395044	623	548	19,596,243
Anti-Submarine Warfare Mission Package Testing	27																											
		0.83	22	SH-60B	0	0	0	0	0	0	143	146	13	9	96	96	462	473	41	30	311	311	96811.2	14237	299745	10	8	302,854
At-Sea Sonar Testing	22																											
		1	22	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1650	1690	145	106	1103	1103	264000	38824	817391	27	23	825,870
		1	22	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	890	6647	201	287	402	402	1435544	211109	4444638	144	126	4,430,806
Torpedo (Explosive) Testing	11																											
		1	11	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	660	676	58	42	444	444	105600	15529	326956	11	9	330,348
		1	11	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	356	2659	80	115	161	161	574217.6	84444	1777879	58	50	1,796,322
Torpedo (Non-Explosive) Testing	18																											
		1	18	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1080	1106	95	69	726	726	172800	25412	535019	17	15	540,569
		1	18	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	583	4350	132	188	263	263	939628.8	138181	2903257	94	82	2,939,436

ELECTRONIC WARFARE																												
Counter Targeting Flare Exercise	15	2	30	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	852885	125424	2640682	86	75	2,668,076
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	30	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	338250	49743	1047282	34	30	1,058,146
		2	30	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	527175	77526	1632227	53	46	1,649,159
		2	30	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	338250	49743	1047282	34	30	1,058,146
		1	15	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31920	4694	98830	3	3	99,855
Counter Targeting Chaff Exercise - Aircraft	0	2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																							0	0	0	0.00	0.00	0
Electronic Systems Evaluation	4	0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	3	3	806.4	119	2497	0	0	2,523
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	2	2	504	74	1560	0	0	1,577
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40.32	6	125	0	0	126
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1312	193	4062	0	0	4,104
		0.29	1	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15395.52	2264	47667	2	1	48,162
		0.29	1	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23984.16	3527	74259	2	2	75,030
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	362.56	53	1123	0	0	1,134
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1022.4	150	3166	0	0	3,198
		0.2	1	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1702.4	250	5271	0	0	5,326
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85.12	13	264	0	0	266
Radar and Other System Testing	52	3	156	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	44577	11752	8485	797	2530	2530	1991808	292913	6166989	200	174	6,230,964
		1	52	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6450912	948664	19973162	648	564	20,180,359
		1	52	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	4680	4792	412	300	3145	3145	748800	110118	2318417	75	66	2,342,468
MINE WARFARE																												
Mine Countermeasure Mission Package Testing	58	1	58	SH-60B	1088	1114	96	70	731	731	653	668	57	42	438	438	435	445	38	28	292	292	348000	51176	1077469	35	30	1,088,647
Mine Countermeasure and Neutralization Testing	11	2	22	SH-60B	660	676	58	42	444	444	396	406	35	25	266	266	264	270	23	17	177	177	211200	31059	653912	21	18	660,696
Mine Detection and Classification Testing	16	2	32	SH-60B	960	983	84	61	645	645	576	590	51	37	387	387	384	393	34	25	258	258	307200	45176	951145	31	27	961,012
Airborne Dipping Sonar Minehunting Test	6	1	6	SH-60B	56	58	5	4	38	38	34	35	3	2	23	23	23	23	2	1	15	15	18000	2647	55731	2	2	56,309
Airborne Laser-Based Mine Detection System Test	20	1	20	SH-60B	150	154	13	10	101	101	90	92	8	6	60	60	60	61	5	4	40	40	48000	7059	148616	5	4	150,158
Airborne Mine Neutralization System Test	21	1	21	SH-60B	158	161	14	10	106	106	95	97	8	6	64	64	63	65	6	4	42	42	50400	7412	156047	5	4	157,666
Airborne Sonobuoy Minehunting Test	6	1	6	SH-60B	45	46	4	3	30	30	27	28	2	2	18	18	18	18	2	1	12	12	14400	2118	44585	1	1	45,047
Mine Laying Test	2	1	2	P8-MMA	4	30	1	1	2	2	2	18	1	1	1	1	2	12	0	1	1	1	13050.4	1919	40406	1	1	40,826

ANTI-SURFACE WARFARE																													
Bombing Test, Air to Surface	14																												
		0.53	7	18A/C	0	0	0	0	0	0	6	17	1	1	16	16	6	17	1	1	16	16	49239.12	7241	152453	5	4	154,035
		0.53	7	FA-18E/F	0	0	0	0	0	0	3	57	0	2	25	25	3	57	0	2	25	25	76707.96	11281	237501	8	7	239,965
		0.28	4	P-3	0	0	0	0	0	0	2	6	0	0	3	3	2	6	0	0	3	3	16072	2364	49762	2	1	50,278
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Test, Air to Surface	45																												
		1.62	73	SH-60B	0	0	0	0	0	0	273	280	24	17	184	184	273	280	24	17	184	184	87480	12865	270854	9	8	273,663
		0.55	73	SH-60F	0	0	0	0	0	0	273	280	24	17	184	184	273	280	24	17	184	184	87480	12865	270854	9	8	273,663
		0.02	73	60R/S	0	0	0	0	0	0	273	280	24	17	184	184	273	280	24	17	184	184	87480	12865	270854	9	8	273,663
Gun Testing - Large Caliber	43																												
		0.74	32	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	955	978	84	61	641	641	152736	22461	472898	15	13	477,803
		0.25	11	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	323	330	28	21	217	217	51600	7588	159763	5	5	161,420
High Energy Laser Weapons Test	54																												
		1	54	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	810	829	71	52	544	544	129600	19059	401264	13	11	405,427
Laser Targeting Test	5																												
		0.55	3	SH-60B	0	0	0	0	0	0	10	11	1	1	7	7	10	11	1	1	7	7	3300	485	10217	0	0	10,323
		0.28	1	SH-60F	0	0	0	0	0	0	5	5	0	0	4	4	5	5	0	0	4	4	1680	247	5202	0	0	5,256
		0.3	2	FA-18A/C	0	0	0	0	0	0	1	3	0	0	3	3	1	3	0	0	3	3	9954	1464	30819	1	1	31,139
		0.3	2	FA-18E/F	0	0	0	0	0	0	1	11	0	0	5	5	1	11	0	0	5	5	15507	2280	48012	2	1	48,510
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile and Rocket Testing	32																												
		0.55	17.6	SH-60B	0	0	0	0	0	0	198	203	17	13	133	133	198	203	17	13	133	133	63360	9318	196174	6	6	198,209
		0.28	9.0	SH-60F	0	0	0	0	0	0	101	103	9	6	68	68	101	103	9	6	68	68	32256	4744	99870	3	3	100,906
		0.3	9.6	FA-18A/C	0	0	0	0	0	0	16	43	3	3	41	41	16	43	3	3	41	41	127411.2	18737	394488	13	11	398,580
		0.3	9.6	FA-18E/F	0	0	0	0	0	0	7	146	1	4	65	65	7	146	1	4	65	65	198489.6	29190	614559	20	17	620,934
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocket Test	20																												
		0.55	11.0	SH-60B	0	0	0	0	0	0	124	127	11	8	83	83	124	127	11	8	83	83	39600	5824	122609	4	3	123,880
		0.28	5.6	SH-60F	0	0	0	0	0	0	63	65	6	4	42	42	63	65	6	4	42	42	20160	2965	62419	2	2	63,066
		0.3	6.0	FA-18A/C	0	0	0	0	0	0	10	27	2	2	25	25	10	27	2	2	25	25	79632	11711	246555	8	7	249,112
		0.3	6.0	FA-18E/F	0	0	0	0	0	0	4	91	1	2	41	41	4	91	1	2	41	41	124056	18244	384099	12	11	388,084
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																													
Air Platform Shipboard Integration Test	110																												
		1	110	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	437	11841	8	336	1328	1328	840400	123588	2602027	84	74	2,629,019
		1	110	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	445	3323	100	144	201	201	717772	105555	2222349	72	63	2,245,403
Shipboard Electronic Systems Evaluation	0																												
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical and Biological Simulant Testing	220																												
		1	220	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2706000	397941	8378254	272	237	8,465,167
Non-Acoustic Component Testing	17																												
		1	17	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	418200	61500	1294821	42	37	1,308,253
		1	17	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1020	1044	90	65	685	685	163200	24000	505296	16	14	510,538
UNMANNED SYSTEMS																													
Air Defense Testing	9																												
		1	9	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	675	691	59	43	454	454	108000	15882	334387	11	9	337,856
Propulsion Testing	17																												
		1	17	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	217056	31920	672044	22	19	679,015
VESSEL EVALUATION																													
Undersea Warfare Training	16																												
		1	16	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1200	1229	106	77	806	806	192000	28235	594466	19	17	600,633
Vessel Signature Evaluation	42																												
		1	17	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1672800	246000	5179284	168	146	5,233,013
		2	34	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	6120	6267	539	392	4113	4113	979200	144000	3031776	98	86	3,063,227
SPAWAR																													
Intelligence, Surveillance, and Reconnaissance Sensor Systems	52																												
		1	52	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	1262	9426	285	407	570	570	2035862.4	299392	6303389	204	178	6,368,779

EMISSIONS (lb/yr)																													
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
5,742	22,162	868	1,023	3,445	3,445	4,487	7,442	482	402	3,406	3,406	70,430	96,791	11,945	4,650	22,903	22,903	44,750,243	6,580,918	138,554,649	4,495	3,916	139,991,981
3	11	0	1	2	2	2	4	0	0	2	2	35	48	6	2	11	11			69,277	2	2	69,996

Table C-41: Alternative 1 Aircraft Testing Emissions - SDAB

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0–3 nm)						U.S. (3–12 nm)						International (> 12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuver	110																											
		2.83	311	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3218219.4	473268	9964175	323	282	10,067,541
		0.17	19	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119324.7	17548	369450	12	10	373,283
Air Platform Weapons Integration Test	10																											
		0.3	3	P8-MMA	0	2	0	0	0	0	1	5	0	0	0	0	6	45	1	2	3	3	39151.2	5758	121219	4	3	122,477
		0.4	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	15	305	2	8	136	136	82704	12162	256066	8	7	258,723
		0.3	3	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	9	34	1	1	3	3	13596	1999	42096	1	1	42,532
Air Platform – Vehicle Test	35																											
		0.314	11	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	20	28	1	2	25	25	23760	3494	73565	2	2	74,328
		0.343	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	89	1830	15	50	814	814	496224	72974	1536397	50	43	1,552,335
		0.314	11	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	63	250	9	10	23	23	99704	14662	308701	10	9	311,904
Intelligence, Surveillance, and Reconnaissance Test	254																											
		1	254	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	3699	27626	835	1193	1671	1671	3944404.8	1462412	30789632	999	870	31,109,036
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise–Helo (TRACKEX–Helo)	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise–MPA (TRACKEX–MPA)	0																						0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip–Helo	0																						0	0	0	0.00	0.00	0
		0.83	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anti-Submarine Warfare Mission Package Testing	0																											
		0.83	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
At-Sea Sonar Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo (Explosive) Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo (Non-Explosive) Testing	0																								0			
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																												
Counter Targeting Flare Exercise	0																											
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counter Targeting Chaff Exercise – Aircraft	0																											
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radar and Other System Testing	1																											
		3	3	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	857	226	163	15	49	49	38304	5633	118596	4	3	119,826
		1	1	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124056	18244	384099	12	11	388,084
		1	1	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	90	92	8	6	60	60	14400	2118	44585	1	1	45,047
MINE WARFARE																												
Mine Countermeasure Mission Package Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure and Neutralization Testing	0																											
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection and Classification Testing	0																											
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Dipping Sonar Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Laser-Based Mine Detection System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Sonobuoy Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying Test	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

					EMISSIONS (lb/yr)																							
					State (0–3 nm)						U.S. (3–12 nm)						International (> 12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
					CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-SURFACE WARFARE																												
Bombing Test, Air to Surface	0																											
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Test, Air to Surface	0																											
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gun Testing – Large Caliber	0																											
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
High Energy Laser Weapons Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting Test	0																											
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile and Rocket Testing	0																											
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocket Test	0																											
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Shipboard Integration Test	0																											
		1	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shipboard Electronic Systems Evaluation	26																											
		1	26	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	195	200	17	12	131	131	31200	4588	96601	3	3	97,603
Chemical and Biological Simulant Testing	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-Acoustic Component Testing	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNMANNED SYSTEMS																												
Air Defense Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Propulsion Testing	0																											
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VESSEL EVALUATION																												0
Undersea Warfare Training	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vessel Signature Evaluation	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPAWAR																												
Intelligence, Surveillance, and Reconnaissance Sensor Systems		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C-42: Alternative 1 Aircraft Testing Emissions - Hawaii

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0–3 nm)						U.S. (3–12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuver	110																											
		2.83	311	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3218219.4	473268	3964175	323	282	10,067,541
		0.17	19	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119324.7	17548	369450	12	10	373,283
Air Platform Weapons Integration Test	10																											
		0.3	3	P8-MMA	0	2	0	0	0	0	1	5	0	0	0	0	6	45	1	2	3	3	39151.2	5758	121219	4	3	122,477
		0.4	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	15	305	2	8	136	136	82704	12162	256066	8	7	258,723
		0.3	3	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	9	34	1	1	3	3	13596	1999	42096	1	1	42,532
Air Platform – Vehicle Test	35																											
		0.314	11	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	20	28	1	2	25	25	23760	3494	73565	2	2	74,328
		0.343	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	89	1830	15	50	814	814	496224	72974	1536397	50	43	1,552,335
		0.314	11	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	63	250	9	10	23	23	99704	14662	308701	10	9	311,904
Intelligence, Surveillance, and Reconnaissance Test	254																											
		1	254	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	3699	27626	835	1193	1671	1671	3944404.8	1462412	30789632	999	870	31,109,036
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise–Helo (TRACKEX–Helo)	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise–MPA (TRACKEX–MPA)	58																						0	0	0	0.00	0.00	0
		1	58	P-3	134	414	31	21	212	212	269	827	62	43	425	425	2283	7031	528	364	3611	3611	1426800	209824	4417625	143	125	4,463,452
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	0																						0	0	0	0.00	0.00	0
		0.83	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anti-Submarine Warfare Mission Package Testing	27																											
		0.83	22	SH-60B	0	0	0	0	0	0	143	146	13	9	96	96	462	473	41	30	311	311	96811.2	14237	299745	10	8	302,854
At-Sea Sonar Testing	16																											
		1	16	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1200	1229	106	77	806	806	192000	28235	594466	19	17	600,633
		1	16	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	647	4834	146	209	292	292	1044032	153534	3232507	105	91	3,266,041
Torpedo (Explosive) Testing	12																											
		1	12	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	720	737	63	46	484	484	115200	16941	356680	12	10	360,380
		1	12	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	388	2900	88	125	175	175	626419.2	92120	1939504	63	55	1,959,624
Torpedo (Non-Explosive) Testing	18																								0			
		1	18	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1080	1106	95	69	726	726	172800	25412	535019	17	15	540,569
		1	18	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	583	4350	132	188	263	263	939628.8	138181	2909257	94	82	2,939,436

ELECTRONIC WARFARE																												
Counter Targeting Flare Exercise	5																											
		2	10	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	284295	41808	880227	29	25	889,359
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	10	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112750	16581	349094	11	10	352,715
		2	10	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	175725	25842	544076	18	15	549,720
		2	10	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112750	16581	349094	11	10	352,715
		1	5	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10640	1565	32943	1	1	33,285
Counter Targeting Chaff Exercise – Aircraft	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radar and Other System Testing	4																											
		3	12	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	3429	904	653	61	195	195	153216	22532	474384	15	13	479,305
		1	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	496224	72974	1536397	50	43	1,552,335
		1	4	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	360	369	32	23	242	242	57600	8471	178340	6	5	180,190
MINE WARFARE																												
Mine Countermeasure Mission Package Testing	24																											
		1	24	SH-60B	450	461	40	29	302	302	270	276	24	17	181	181	180	184	16	12	121	121	144000	21176	445849	14	13	450,475
Mine Countermeasure and Neutralization Testing	0																											
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection and Classification Testing	7																											
		2	14	SH-60B	420	430	37	27	282	282	252	258	22	16	169	169	168	172	15	11	113	113	134400	19765	416126	13	12	420,443
Airborne Dipping Sonar Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Laser-Based Mine Detection System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Sonobuoy Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying Test	1																											
		1	1	P8-MMA	2	15	0	1	1	1	1	9	0	0	1	1	1	6	0	0	0	0	6525.2	960	20203	1	1	20,413

					EMISSIONS (lb/yr)																							
					State (0–3 nm)						U.S. (3–12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
					CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
					1,007	1,322	108	78	798	798	1,304	2,078	156	115	1,217	1,217	18,695	58,872	3,072	2,724	12,383	12,383	24,367,709	3,583,487	75,446,729	2,448	2,132	76,229,394
					1	1	0	0	0	0	1	1	0	0	1	1	9	29	2	1	6	6			37,723	1	1	38,115
ANTI-SURFACE WARFARE																												
Bombing Test, Air to Surface	8																											
		0.53	4	FA-18A/C	0	0	0	0	0	0	3	9	1	1	9	9	3	9	1	1	9	9	28136.64	4138	87116	3	2	88,020
		0.53	4	FA-18E/F	0	0	0	0	0	0	2	32	0	1	14	14	2	32	0	1	14	14	43833.12	6446	135715	4	4	137,123
		0.28	2	P-3	0	0	0	0	0	0	1	4	0	0	2	2	1	4	0	0	2	2	9184	1351	28435	1	1	28,730
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Test, Air to Surface	5																											
		1.62	8	SH-60B	0	0	0	0	0	0	30	31	3	2	20	20	30	31	3	2	20	20	9720	1429	30095	1	1	30,407
		0.55	8	SH-60F	0	0	0	0	0	0	30	31	3	2	20	20	30	31	3	2	20	20	9720	1429	30095	1	1	30,407
		0.02	8	MH-60R/S	0	0	0	0	0	0	30	31	3	2	20	20	30	31	3	2	20	20	9720	1429	30095	1	1	30,407
Gun Testing – Large Caliber	43																											
		0.74	32	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	955	978	84	61	641	641	152736	22461	472898	15	13	477,803
		0.25	11	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	323	330	28	21	217	217	51600	7588	159763	5	5	161,420
High Energy Laser Weapons Test	54																											
		1	54	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	810	829	71	52	544	544	129600	19059	401264	13	11	405,427
Laser Targeting Test	0																											
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile and Rocket Testing	25																											
		0.55	13.8	SH-60B	0	0	0	0	0	0	155	158	14	10	104	104	155	158	14	10	104	104	49500	7279	153261	5	4	154,851
		0.28	7.0	SH-60F	0	0	0	0	0	0	79	81	7	5	53	53	79	81	7	5	53	53	25200	3706	78024	3	2	78,833
		0.3	7.5	FA-18A/C	0	0	0	0	0	0	12	34	2	2	32	32	12	34	2	2	32	32	99540	14638	308193	10	9	311,391
		0.3	7.5	FA-18E/F	0	0	0	0	0	0	6	114	1	3	51	51	6	114	1	3	51	51	155070	22804	480124	16	14	485,105
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocket Test	2																											
		0.55	1.1	SH-60B	0	0	0	0	0	0	12	13	1	1	8	8	12	13	1	1	8	8	3960	582	12261	0	0	12,388
		0.28	0.6	SH-60F	0	0	0	0	0	0	6	6	1	0	4	4	6	6	1	0	4	4	2016	296	6242	0	0	6,307
		0.3	0.6	FA-18A/C	0	0	0	0	0	0	1	3	0	0	3	3	1	3	0	0	3	3	7963.2	1171	24655	1	1	24,911
		0.3	0.6	FA-18E/F	0	0	0	0	0	0	0	9	0	0	4	4	0	9	0	0	4	4	12405.6	1824	38410	1	1	38,808
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Shipboard Integration Test	7																											
		1	7	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	28	754	1	21	84	84	53480	7865	165584	5	5	167,301
		1	7	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	28	211	6	9	13	13	45676.4	6717	141422	5	4	142,889
Shipboard Electronic Systems Evaluation	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical and Biological Simulant Testing	220																											
		1	220	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2706000	397941	8378254	272	237	8,465,167
Non-Acoustic Component Testing	8																											
		1	8	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	196800	28941	609328	20	17	615,649
		1	8	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	480	492	42	31	323	323	76800	11294	237786	8	7	240,253
UNMANNED SYSTEMS																												
Air Defense Testing	4																											
		1	4	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	300	307	26	19	202	202	48000	7059	148616	5	4	150,158
Propulsion Testing	8																											
		1	8	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102144	15021	316256	10	9	319,537
VESSEL EVALUATION																												
Undersea Warfare Training	15																											
		1	15	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1125	1152	99	72	756	756	180000	26471	557312	18	16	563,093
Vessel Signature Evaluation	22																											
		1	8	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	787200	115765	2437310	79	69	2,462,594
		2	16	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	2880	2949	253	184	1935	1935	460800	67765	1426718	46	40	1,441,519
SPAWAR																												
Intelligence, Surveillance, and Reconnaissance Sensor Systems	13																											
		1	13	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	316	2357	71	102	143	143	508965.6	74848	1575847	51	45	1,592,195

Table C-43: Alternative 1 Munitions Training Emissions

MEM Category	Location – Range Complex	Training MEM #/yr	Emissions (lb/year) Training CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Bombs									
Bombs (1000 lb MK83)	HRC	12	0	740	0		0	0	0
	SOCAL	12	0	740	0		0	0	0
	Total	24	0						
Bombs (2000 lb MK84)	HRC	261	0	38,353	0		0	0	0
	SOCAL	320	0	44,816	0		0	0	0
	Total	581	0						
Bombs (2000 lb GB)	HRC	36	0	5,042	0		0	0	0
	SOCAL	0	0	0	0		0	0	0
	Total	36	0						
Projectiles									
20 MM Projectile	HRC	4,000	64	132	2	0	0	3	2
	SOCAL	4,000	64	132	2	0	0	3	2
	Transit			0	0	0	0	0	0
	Total	8,000							
25 MM Projectile	HRC	256	4	5	0	0	0	1	0
	SOCAL	256	4	5	0	0	0	1	0
	Total	512							
30 MM Projectile MK-238	HRC	1100	18	8	2	0	0	37	23
	SOCAL	1640	26	12	3	0	0	55	34
	Transit	200	3	1	0	0	0	7	4
	Total	2,940							
M1060 40 MM Projectile MK-3A	HRC	400	6	2	1	0	0	4	2
	SOCAL	1140	18	5	1	0	0	11	6
	Transit	200	3	1	0	0	0	2	1
	Total	1,740							
Rockets 2.75 in	HRC	327	5	304	2	0	0	131	95
	SOCAL	1874	30	1,743	10	0	0	750	543
	Total	2201							
	HRC	0	0	0	0	0	0	0	0
LG Caliber HE CPF	SOCAL	4,950	79	42,719	431	0	13	17,028	644
	Total	4,950							
	HRC	1,908	31	309	0	0	0	18	14
5 in 54 HE Surf	SOCAL	4,224	68	676	0	0	0	41	31
	Transit	32	1	5	0	0	0	0	0
	Total	6,164							
A-A Missiles (H-E)	HRC	62	1	0	0	0	0	0	0
	SOCAL	4	0	0	0	0	0	0	0
	Total	66							
Missiles Hellfire (propelled by solid propellant)	HRC	10	0	0	0	0	0	0	0
	SOCAL	25	0	0	0	0	0	0	0
	Total	35							
Missiles Griffin (note, fired by 5" caliber)	HRC	22	0	4	0	0	0	0	0
	SOCAL	29	0	5	0	0	0	0	0
	Total	51							
Missiles (H-E)	HRC	30	0	0	0	0	0	0	0
	SOCAL	25	0	0	0	0	0	0	0
	Total	55							
Missiles Maverick (Thiokol SR 109-TC-1 solid-propellant	HRC	20	0	0	0	0	0	0	0
	SOCAL	96	2	0	0	0	0	0	0
	Total	116							
Missiles Harpoon (turbojet solid propellant)	HRC	27	0	0	0	0	0	0	0
	SOCAL	6	0	0	0	0	0	0	0
	Total	33							

		CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Total for HRC		131	43,094	6	0	0	194	136
		0.1	21.5	0.0	0.0	0.0	0.1	0.1
Total for SOCAL		292	90,851	447	0	13	17,888	1,261
		0.1	45.4	0.2	0.0	0.0	8.9	0.6
Total for Transit		7	7	1	0	0	9	5
Area		0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL for Activity	pounds	430	133,472	454	0	13	18,091	1,403
	tons	0.2	66.2	0.2	0.0	0.0	9.0	0.7

Within 3 nm		CO	NOx	VOC	SOx	PM10	PM2.5
Total for HRC		0	0	0	0	0	0
		0.0	0.0	0.0	0.0	0.0	0.0
Total for SOCAL		42,719	431	0	13	17,028	644
		21.4	0.2	0.0	0.0	8.5	0.3
Total for Transit		0.0	0.0	0.0	0.0	0.0	0.0
TOTAL for Activity	pounds	42,719	431	0	13	17,028	644
	tons	21.4	0.2	0.0	0.0	8.5	0.3

Table C-44: Alternative 1 Ordnance Testing Emissions

MEM Category	Location – Range Complex	Testing MEM #/yr	Emissions (lb/year) Testing CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Bombs									
Bombs (1000 lb MK83)	HRC		0	0	0		0	0	0
	SOCAL		0	0	0		0	0	0
	Total	0	0						
Bombs (2000 lb MK84)	HRC		0	0	0		0	0	0
	SOCAL		0	0	0		0	0	0
	Total	0	0						
Bombs (500 lb LGB)	HRC	1	0	61	0		0	0	0
	SOCAL	1	0	61	0		0	0	0
	Total	2	0						
Bombs (2000 lb LGB)	HRC		0	0	0		0	0	0
	SOCAL		0	0	0		0	0	0
	Total	0	0						
Projectiles									
20 MM Projectile	HRC		0	0	0	0	0	0	0
	SOCAL	200	1	7	0	0	0	0	0
	Total	200							
25 MM Projectile	HRC		0	0	0	0	0	0	0
	SOCAL		0	0	0	0	0	0	0
	Total	0							
30 MM Projectile MK-238	HRC	1925	31	14	3	0	0	65	40
	SOCAL	7225	116	53	12	0	0	244	150
	Total	9,150							
30 MM Projectile NAVSEA	HRC	13440	215	98	22	0	0	454	280
	SOCAL	13916	223	101	23	0	0	470	289
	Total	27,356							
M1000 40 MM Projectile MK-3A	HRC		0	0	0	0	0	0	0
	SOCAL		0	0	0	0	0	0	0
	Total	0							
57 MM HE	HRC	636	10	38	3	0	0	39	19
	SOCAL	636	10	38	3	0	0	39	19
	Total	1,272							
Rockets 2.75 in	HRC	3	0	1	0	0	0	1	1
	SOCAL	103	2	96	1	0	0	41	30
	Total	106							
LG Caliber HE CPF	HRC	2,660	43	22,956	231	0	7	9,150	346
	SOCAL	2,720	44	23,474	237	0	7	9,357	354
	Total	5,380							
5 in 54 HE Surf	HRC	700	11	112	0	0	0	7	5
	SOCAL	700	11	112	0	0	0	7	5
	Total	1,400							
A-A Missiles (H-E)	HRC		0						
	SOCAL		0						
	Total	0							
Missiles Hellfire	HRC	8	0	0	0	0	0	0	0
	SOCAL	18	0	0	0	0	0	0	0
	Total	26							
Missiles Griffin	HRC		0						
	SOCAL		0						
	Total	0							
Missiles (H-E)	HRC	377	6	0	0	0	0	0	0
	SOCAL	404	6	0	0	0	0	0	0
	Total	781							
Missiles Maverick	HRC		0						
	SOCAL		0						
	Total	0							
Missiles Harpoon	HRC	10	0	0	0	0	0	0	0
	SOCAL	20	0	0	0	0	0	0	0
	Total	30							
JSOW	HRC	1	0	0	0	0	0	0	0
	SOCAL	1	0	0	0	0	0	0	0
	Total	2							
			CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Total for HRC			316	23,282	260	0	7	9,717	691
			0.2	11.6	0.1	0.0	0.0	4.9	0.3
Total for SOCAL			415	23,941	275	0	7	10,159	848
			0.2	12.0	0.1	0.0	0.0	5.1	0.4
TOTAL for Activity	pounds		731	47,223	535	0	15	19,876	1,538
	tons		0.4	23.6	0.3	0.0	0.0	9.9	0.8
Total for Study Area	pounds		731	47,223	535	0	15	19,876	1,538
	tons		0.4	23.6	0.3	0.0	0.0	9.9	0.8

Air Emission Calculations

Alternative 2

Table C-45: Alternative 2 Ship Emissions - SCAB

ACTIVITY								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																			
	Ship Type		Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
Type Training	Ship Type	Participation	Total Hours	In Region	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																													
SHIPS																													
guided missile cruiser	CG	1	8,184	245.5	2.5	4.9	238.2	68	701	6	385	31	31	302	391	21	381	14	14	14,649	18,951	1,028	18,489	664	664	5,761,211	167	163	5,820,977
guided missile destroyer	DDG	1	26,664	799.9	0.0	16.0	775.9	245	2,398	19	1,533	122	122	962	1,832	64	1,416	58	58	46,677	88,855	3,108	68,694	2,822	2,822	21,387,613	634	604	21,609,483
aircraft carrier, nulear powered	CVN	1	7,224	216.7	2.2	4.3	210.2	0	2	0	0	0	0	3	40	1	5	0	0	142	1,940	36	229	18	18	79,250	3	2	80,072
Frigate	FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered	SSN	1	8436.0	254.9	2.5	5.1	247.2	1	1	0	0	0	0	16	12	1	1	0	0	800	590	42	65	5	5	27,842	1	1	28,131
littoral combat ship	LCS	1	0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
amphibious assault ship, general purpose	LHA	1	1236.0	38.9	0.4	0.8	37.7	3	17	2	52	11	11	6	37	4	104	22	22	300	1,776	214	5,027	1,060	1,060	1,767,213	57	50	1,785,546
amphibious assault ship, multi-	LHD	1	3288.0	98.6	1.0	2.0	95.7	8	45	6	133	28	28	16	94	11	267	56	56	773	4,577	552	12,964	2,734	2,734	3,437,022	111	97	3,472,677
amphibious transport dock ship	LPD	1	4176.0	125.3	1.3	2.5	121.5	35	330	19	59	4	4	9	53	6	152	32	32	422	2,552	313	7,391	1,562	1,562	2,596,646	84	73	2,623,583
dock landing ship	LSD	1	2520.0	75.6	0.8	1.5	73.3	30	457	15	49	4	4	32	506	16	53	4	4	1,558	24,530	795	2,569	199	199	1,192,784	33	34	1,205,158
patrol craft	PC	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
submarine tender	AS	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dray cargo ship	TAKE	1	816.0	24.5	0.2	0.5	23.7	1	21	3	4	0	0	5	148	15	26	3	3	244	7,179	706	1,243	130	130	409,244	13	12	413,483
replenishment oiler	TAO	1	5904.0	177.1	1.8	3.5	171.8	68	1,027	41	108	9	9	193	2,667	98	258	20	20	3,337	129,330	4,760	12,522	976	976	3,340,518	128	111	3,381,396
rescue and salvage ship	TARS	1	0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fleet ocean tug	TATF	1	2112.0	63.4	0.6	1.3	61.5	8	89	2	9	1	1	21	132	3	14	1	1	1,009	6,412	130	685	66	66	220,922	7	6	223,214
	TAE	1	384.0	11.5	0.1	0.2	11.2	0	2	0	5	1	1	1	4	0	11	2	2	29	177	22	512	108	108	180,286	6	5	182,156
fast combat support ship	TAOE	1	360.0	10.8	0.1	0.2	10.5	4	48	1	21	2	2	24	67	2	26	2	2	1,150	3,261	111	1,257	109	109	711,777	23	20	719,161
mine countermeasure ship	MCM	1	5784.0	173.5	1.7	3.5	168.3	105	87	21	14	2	2	89	107	21	18	2	2	4,313	5,185	1,026	864	95	95	212,119	7	6	214,320
Intrumentation ship	TAGM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TEFP	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION																											
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	3	0	1	0	0	1	3	0	1	0	0	41	148	6	66	5	5	20,962	1	1	21,180

Table C-46: Alternative 2 Ship Emissions - SDAB

ACTIVITY								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																	
Type Training	Ship Type		Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
	Ship Type	Participa-tion	Total Hours	In Region	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																													
SHIPS																													
guided missile cruiser	CG	1	8,184	7338.5	79.4	158.8	7700.3	2,201	22,868	195	12,438	988	988	9,766	12,634	685	12,326	443	443	473,651	612,754	33,239	597,798	21,475	21,475	186,279,160	5,043	5,264	188,211,574
guided missile destroyer	DDG	1	26,664	25864.1	259.6	517.3	25888.2	7,307	36,338	619	49,564	3,937	3,937	31,118	53,237	2,072	45,796	1,882	1,882	1,509,226	2,872,989	100,497	2,221,113	91,260	91,260	631,532,831	22,434	19,543	638,706,622
aircraft carrier, nuclear powered	CVN	1	7,224	7007.3	70.1	140.1	6797.1	5	64	1	8	1	1	95	1,293	24	153	12	12	4,600	62,711	1,154	7,417	569	569	2,562,401	83	72	2,588,383
Frigate	FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered	SSN	1	8436.0	8241.1	82.4	164.8	7393.3	26	19	1	2	0	0	533	393	28	44	3	3	25,871	19,068	1,357	2,115	159	159	900,235	23	25	909,573
littoral combat ship	LCS	1	0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
amphibious assault ship, general purpose	LHA	1	1296.0	1257.1	12.6	25.1	1219.4	95	558	71	1,671	353	353	200	1,184	143	3,351	707	707	9,705	57,419	6,917	162,540	34,279	34,279	57,139,888	1,854	1,615	57,732,643
amphibious assault ship, multi-	LHD	1	3288.0	3189.4	31.9	63.8	3093.7	244	1,439	182	4,310	910	910	516	3,051	368	8,643	1,823	1,823	25,003	147,981	17,842	419,184	88,405	88,405	111,130,378	3,605	3,141	112,283,217
amphibious transport dock ship	LPD	1	4176.0	4050.7	40.5	81.0	3929.2	1,137	10,684	606	1,903	143	143	282	1,702	209	4,327	1,041	1,041	13,660	82,526	10,126	238,967	50,501	50,501	83,958,235	2,724	2,373	84,823,197
dock landing ship	LSD	1	2520.0	2444.4	24.4	48.9	2371.1	978	14,771	499	1,580	122	122	1,039	16,354	530	1,713	133	133	50,380	793,147	25,708	83,077	6,435	6,435	38,566,699	1,251	1,030	38,966,780
patrol craft	PC	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
submarine tender	AS	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dray cargo ship	TAKE	1	816.0	791.5	7.9	15.8	767.8	42	684	95	127	10	10	163	4,786	471	829	87	87	7,891	232,111	22,829	40,193	4,206	4,206	13,232,213	429	374	13,369,481
replenishment oiler	TAO	1	5904.0	5726.3	57.3	114.5	5555.1	2,139	33,212	1,316	3,506	276	276	6,225	86,220	3,174	8,348	651	651	301,906	4,181,665	153,917	404,889	31,560	31,560	127,410,086	4,133	3,601	128,731,807
rescue and salvage ship	TARS	1	0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fleet ocean tug	TATF	1	2112.0	2048.6	20.5	41.0	1967.2	273	2,863	53	299	26	26	672	4,274	86	457	44	44	32,612	207,306	4,193	22,141	2,138	2,138	7,143,160	232	202	7,217,262
	TAE	1	384.0	372.5	3.7	7.4	361.3	10	58	7	170	36	36	19	118	14	341	72	72	942	5,722	701	16,560	3,494	3,494	5,829,247	183	165	5,883,718
fast combat support ship	TAOE	1	360.0	349.2	3.5	7.0	338.7	122	1,555	20	667	53	53	767	2,174	74	838	73	73	37,178	105,443	3,590	40,643	3,526	3,526	23,014,117	747	650	23,252,860
mine countermeasure ship	MCM	1	5784.0	5610.5	56.1	112.2	5442.2	3,393	2,820	684	460	50	50	2,875	3,457	684	576	63	63	139,450	167,657	33,162	27,943	3,071	3,071	6,858,517	222	194	6,923,656
Intrumentation ship	TAGM	1	0.0	0.0	0.0	0.0	-7.4	0	0	0	0	0	0	0	0	0	0	0	0	-21	-128	-16	-370	-78	-78	-130,100	-4	-4	-131,443
	TEFP	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)						Greenhouse Gases			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
9	94	2	38	3	3	27	98	4	44	4	4	1,316	4,774	208	2,142	171	171	677,714	22	19	684,744

Table C-47: Alternative 2 Ship Emissions - Hawaii

ACTIVITY								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION																	
	Ship Type		Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
Type Training	Ship Type	Participation	Total Hours	In Region	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
SHIP STEAMING																													
SHIPS																													
guided missile cruiser	CG	1	4,728	4728.0	47.3	34.6	4586.2	1,311	13,500	116	7,408	589	589	5,816	7,525	408	7,341	264	264	282,097	364,944	19,797	356,036	12,790	12,790	110,344,144	3,539	3,135	112,095,051
guided missile destroyer	DDG	1	11,664	11664.0	116.6	233.3	11314.1	3,566	43,717	279	22,352	1,775	1,775	14,033	26,714	934	20,653	849	849	680,620	1,295,640	45,321	1,001,662	41,156	41,156	311,862,589	10,117	8,813	315,097,774
aircraft carrier, nulear powered	CVN	1	864	864.0	8.6	17.3	838.1	1	8	0	1	0	0	12	159	3	19	1	1	567	7,732	142	915	70	70	315,945	10	9	319,222
Frigate	FFG	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
attack submarine, nuclear powered	SSN	1	16440.0	16440.0	164.4	328.8	15946.8	52	38	3	4	0	0	1,064	784	56	87	7	7	51,609	38,039	2,707	4,219	316	316	1,795,855	58	51	1,814,485
littoral combat ship	LCS	1	0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
amphibious assault ship, general purpose	LHA	1	408.0	408.0	4.1	8.2	395.8	31	181	23	542	115	115	65	384	46	1,088	229	229	3,150	18,636	2,245	52,753	11,125	11,125	18,544,828	602	524	18,737,207
amphibious assault ship, multi-	LHD	1	636.0	636.0	7.0	13.9	675.1	53	314	40	941	193	193	113	666	80	1,886	398	398	5,456	32,293	3,894	91,477	19,232	19,232	24,251,433	787	685	24,503,072
amphibious transport dock ship	LPD	1	1104.0	1104.0	11.0	22.1	1070.9	310	2,312	165	519	39	39	77	464	57	1,343	284	284	3,723	22,492	2,760	65,129	13,764	13,764	22,882,325	742	647	23,119,700
dock landing ship	LSD	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
patrol craft	PC	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
submarine tender	AS	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dray cargo ship	TAKE	1	600.0	600.0	6.0	12.0	582.0	32	519	72	96	7	7	123	3,628	357	628	66	66	5,382	175,948	17,305	30,468	3,188	3,188	10,030,483	325	283	10,134,537
replenishment oiler	TAO	1	4680.0	4680.0	46.8	93.6	4539.6	1,797	27,141	1,075	2,865	225	225	5,087	70,459	2,593	6,822	532	532	246,717	3,417,252	125,781	330,875	25,791	25,791	104,119,381	3,378	2,942	105,139,430
rescue and salvage ship	TARS	1	1368	1368.0	13.7	27.4	1327.0	5	52	1	16	1	1	9	88	3	26	3	3	424	4,274	170	1,278	140	140	452,609	15	13	457,304
fleet ocean tug	TATF	1	360.0	360.0	3.6	7.2	349.2	48	503	9	53	5	5	118	751	15	80	8	8	5,731	36,429	737	3,891	376	376	1,255,241	41	35	1,268,263
	TAE	1	1224.0	1224.0	12.2	24.5	1187.3	32	191	24	560	118	118	64	388	47	1,122	237	237	3,096	18,804	2,303	54,417	11,483	11,483	19,155,386	621	541	19,354,033
fast combat support ship	TAOE	1	1008.0	1008.0	10.1	20.2	977.8	354	4,488	59	1,925	153	153	2,213	6,276	214	2,419	210	210	107,317	304,390	10,364	117,319	10,179	10,179	66,432,502	2,155	1,877	67,121,557
mine countermeasure ship	MCM	1	2424.0	2424.0	24.2	48.5	2351.3	1,466	1,218	296	199	22	22	1,242	1,494	295	249	27	27	60,249	72,436	14,328	12,073	1,327	1,327	2,963,213	96	84	2,993,952
Intrumentation ship	TAGM	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TEFP	1	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm offshore)							Waters of U S (3-12 nm)						Int Waters (> 12 nm)						Greenhouse Gases						
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e				
5	47	1	19	2	2	15	60	3	22	2	2	728	2,905	124	1,061	75	75	347,503	11	10	351,108				

Table C-48: Alternative 2 Amphibious Vessel Training Emissions - SCAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GREENHOUSE GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)								
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	18																														
		72	LCAC	4	8.0	576.0	216.0	216.0	144.0	3,957	24,739	753	11,795	1,110	1,110	3,957	24,739	753	11,795	1,110	1,110	2,638	16,493	502	7,863	740	740	11,319,805	386.66	0.01	12,035,037
		72	LCU	4	8.0	576.0	216.0	216.0	144.0	1,093	3,392	275	628	163	163	1,093	3,392	275	628	163	163	729	2,261	183	418	109	109	532,067	17.26	0.00	537,211
Battalion Landing	2																														
		12	LCU	6	3.0	36.0	3.6	10.8	21.6	18	57	5	10	3	3	55	170	14	31	8	8	109	339	28	63	16	16	33,254	1.08	0.00	33,576
		28	AAV/EFV	14	6.0	168.0	16.8	50.4	100.8	13	104	14	21	4	4	38	313	41	63	13	13	77	627	83	126	26	26	233,447	7.57	0.00	235,704
		10	LCAC	5	3.0	30.0	3.0	9.0	18.0	55	344	10	164	15	15	165	1,031	31	491	46	46	330	2,062	63	983	93	93	620,823	20.14	0.00	626,625
		0	CRRC	0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0																														
		0	CRRC	13	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	1																														
		4	LCAC	4	8.0	32.0	0.0	16.0	16.0	0	0	0	0	0	0	293	1,833	56	874	82	82	293	1,833	56	874	82	82	662,211	21.48	0.00	666,613
		4	LCU	4	8.0	32.0	0.0	16.0	16.0	0	0	0	0	0	0	81	251	20	46	12	12	81	251	20	46	12	12	29,559	0.96	0.00	29,645
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Submarine (TRACKEX-Sub)	50																														
		50	TRB	1	3.6	180.0	0.0	18.0	162.0	0	0	0	0	0	0	116	1,012	28	133	21	21	1,048	9,108	251	1,199	191	191	53,056	1.72	0.00	53,569
Tracking / Torpedo Exercise-Submarine (TORPEX-Sub)	13																														
		13	TRB	1	3.6	46.8	0.0	4.7	42.1	0	0	0	0	0	0	30	263	7	35	6	6	273	2,368	65	312	50	50	13,795	0.45	0.00	13,928
Tracking / Torpedo Exercise-Surface (TRACKEX-Surface)	423																														
		133.6	TRB	0.32	3.6	480.9	0.0	48.1	432.8	0	0	0	0	0	0	311	2,704	75	356	57	57	2,800	24,332	671	3,203	511	511	141,744	4.60	0.00	143,114
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	117																														
		133.6	TRB	0.32	3.6	480.9	0.0	48.1	432.8	0	0	0	0	0	0	311	2,704	75	356	57	57	2,800	24,332	671	3,203	511	511	141,744	4.60	0.00	143,114
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	524																														
		157.2	TRB	0.3	3.6	565.9	0.0	56.6	509.3	0	0	0	0	0	0	366	3,182	88	419	67	67	3,295	28,634	789	3,769	601	601	166,808	5.41	0.00	168,421
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	104																														
		157.2	TRB	0.3	3.6	565.9	0.0	56.6	509.3	0	0	0	0	0	0	366	3,182	88	419	67	67	3,295	28,634	789	3,769	601	601	166,808	5.41	0.00	168,421
Service Weapons Test (SWT)	1																														
		1	TRB	1	3.6	3.6	0.0	0.4	3.2	0	0	0	0	0	0	2	20	1	3	0	0	21	182	5	24	4	4	1,061	0.03	0.00	1,071
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	50																														
		30.4	TRB	0.61	2.0	60.9	0.0	6.1	54.8	0	0	0	0	0	0	39	342	9	45	7	7	354	3,080	85	405	65	65	17,942	0.58	0.00	18,115
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	25																														
		30.4	TRB	0.61	2.0	60.9	0.0	6.1	54.8	0	0	0	0	0	0	39	342	9	45	7	7	354	3,080	85	405	65	65	17,942	0.58	0.00	18,115
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																														
		3.7	TRB	0.61	2.0	7.3	0.0	0.7	6.6	0	0	0	0	0	0	5	41	1	5	1	1	43	370	10	49	8	8	2,153	0.07	0.00	2,174
Expeditionary Warfare																															
Dive and Salvage Operations	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	57.5																														
		57.5	RHIB	1	2.0	115.0	35.7	39.7	39.7	12	326	2	51	5	5	13	363	2	57	6	6	13	363	2	57	6	6	123,132	3.89	0.00	124,322
MINE WARFARE																															
Civilian Port Defense - Homeland Security																															
		0	RHIB	1	24.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Limpet Mine Neutralization System	90																														
		180	RHIB	2	2.0	360.0	360.0	0.0	0.0	122	3,290	22	518	54	54	0	0	0	0	0	0	0	0	0	0	0	0	385,457	12.50	0.00	383,183
Marine Mammal System	0																														
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - EOD	170																														
		510	RHIB	3	12.0	6120.0	6120.0	0.0	0.0	2,081	55,937	367	8,813	918	918	0	0	0	0	0	0	0	0	0	0	0	0	6,552,771	212.57	0.01	6,616,118
Mine Neutralization - ROV	60																														
		60	RHIB	1	12.0	720.0	720.0	0.0	0.0	245	6,581	43	1,037	108	108	0	0	0	0	0	0	0	0	0	0	0	0	770,914	25.01	0.00	778,367
SLMM (Sub-mobile) Mine Exercise for Training and Certification	5																														
		5	Bayliner	1	8.0	40.0	40.0	0.0	0.0	1,494	2,967	241	937	104	104	0	0	0	0	0	0	0	0	0	0	0	0	307,017	9.96	0.00	309,985
Underwater Demolition - Multiple Charge - Mat Weave and Obstacle Loading	18																														
		36	CRRC	2	8.0	288.0	288.0	0.0	0.0	0	43	3,716	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	308,366	10.00	0.00	311,047
Underwater Demo Qual	120									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		240	CRRC	2	8.0	1920.0	1920.0	0.0	0.0	0	285	24,771	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,055,771	66.69	0.00	2,075,645
SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	14																														
		14	BW	1	2.0	28.0	28.0	0.0	0.0	3,129	45	1,285	9	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2,763	0.09	0.00	2,790
		14	Bayliner	1	2.0	28.0	28.0	0.0	0.0	1,046	2,077	163	656	73	73	0	0	0	0	0	0	0	0	0	0	0	0	214,912	6.97	0.00	216,389
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	200																														
		200	BW	1	2.0	400.0	400.0	0.0	0.0	44,699	638	18,357	123	32	32	0	0	0	0	0	0	0	0	0	0	0	0	39,472	1.28	0.00	39,654
		200	Bayliner	1	2.0	400.0	400.0	0.0	0.0	14,943	29,670	2,407	9,369	1,041	1,041	0	0	0	0	0	0	0	0	0	0	0	0	3,070,167	99.60	0.00	3,099,648
OTHER																															
Elevated Causeway	1																														
		2	WT	2	4.0	8.0	8.0	0.0	0.0	43	133	11	25	6	6	0	0	0	0	0	0	0	0	0	0	0	0	8,522	0.28	0.00	8,605
		2	PW	2	4.0	8.0	8.0	0.0	0.0	1,092	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	7,390	0.24	0.00	7,461
		1	LCM	1	4.0	4.0	4.0	0.0	0.0	20	63	5	12	3	3	0	0	0	0	0	0	0	0	0	0	0	0	3,695	0.12	0.00	3,731
Offshore Petroleum Discharge System	0																														
		0	OUB	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Precision Anchoring	0																														
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test Detachment/Equipment Test and Evaluation	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Waterborne Training	500																														
		500	RHIB	1	4.0	2000.0	2000.0	0.0	0.0	680	18,280	120	2,880	300	300	0	0	0	0	0	0	0	0	0	0	0	0	2,141,428	69.47	0.00	2,162,130

EMISSIONS / YEAR (tons) BY JURISDICTION																									
State (0-3 nm offshore)							Waters of U S (3-12 nm)							Int Waters (> 12 nm)											
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
37	74	26	19	2	2	4	23	1	8	1	1	9	74	2	13	2	2	15,373	0	0	15521.6126

Table C-49: Alternative 2 Amphibious Vessel Training Emissions - SDAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GREENHOUS GAS EMISSIONS			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	0																														
		0	LCAC	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Battalion Landing	0																														
		0	LCU	6	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	2426																														
		31538	CRRC	13	2.0	63,076.0	63076.0	0.0	0.0	0	3,370	813,772	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67,536,365	2190.91	0.06	68,189,256
		4852	LCU	2	2.0	9,704.0	9704.0	0.0	0.0	49,098	152,385	12,365	28,197	7,317	7,317	0	0	0	0	0	0	0	0	0	0	0	0	8,363,851	290.73	0.01	8,050,507
		4852	LCAC	2	2.0	9,704.0	9704.0	0.0	0.0	177,779	1,111,432	33,844	529,894	49,868	49,868	0	0	0	0	0	0	0	0	0	0	0	0	200,815,607	6514.54	0.18	202,756,843
		14556	EFV	6	2.0	29,112.0	29112.0	0.0	0.0	22,125	181,077	23,872	36,390	7,569	7,569	0	0	0	0	0	0	0	0	0	0	0	0	40,452,387	1312.31	0.04	40,844,057
Humanitarian Assistance	0																														
		0	LCAC	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	4	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Submarine (TRACKEX-Sub)	0																														
		0	TRB	1	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Submarine (TORPEX-Sub)	0																														
		0	TRB	1	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Surface (TRACKEX-Surface)	0																														
		0.0	TRB	0.32	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	0																														
		0.0	TRB	0.32	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	0																														
		0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	0																														
		0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Service Weapons Test (SWT)	0																														
		0	TRB	1	3.6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	0																														
		0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	0																														
		0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	0																														
		0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Expeditionary Warfare																															
Dive and Salvage Operations	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Small Boat Attack	57.5																														
		57.5	RHIB	1	2.0	115.0	35.7	39.7	39.7	12	326	2	51	5	5	13	363	2	57	6	6	13	363	2	57	6	6	123,132	3.99	0.00	124,322
MINE WARFARE																															
Civilian Port Defense - Homeland Security	3																														
		3	RHIB	1	24.0	72.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Limpet Mine Neutralization System	30																														
		180	RHIB	2	2.0	360.0	360.0	0.0	0.0	122	3,290	22	518	54	54	0	0	0	0	0	0	0	0	0	0	0	0	385,457	12.50	0.00	389,193
Marine Mammal System	175																														
		175	RHIB	1	4.0	700.0	700.0	0.0	0.0	238	6,398	42	1,008	105	105	0	0	0	0	0	0	0	0	0	0	0	0	0	749,500	24.31	0.00	756,745
Mine Neutralization - EOD	0																														
		0	RHIB	3	12.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Mine Neutralization - ROV	312																														
		312	RHIB	1	12.0	3744.0	3744.0	0.0	0.0	1,273	34,220	225	5,391	562	562	0	0	0	0	0	0	0	0	0	0	0	0	4,008,754	130.05	0.00	4,047,597
SLMM (Sub-mobile) Mine Exercise for Training and Certification	0																														
		0	Bayliner	1	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demolition - Multiple Charge - Mat Weave and Obstacle Loading	0																														
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Underwater Demo Qual	0									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	2	8.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Elevated Causeway	1																														
		0	WT	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	PW	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	6																														
		12	OUB	2	4.0	48.0	48.0	0.0	0.0	1,738	2,158	25	149	75	75	0	0	0	0	0	0	0	0	0	0	0	0	100,602	3.26	0.00	101,574
Precision Anchoring	75																														
		75	RHIB	1	4.0	300.0	300.0	0.0	0.0	102	2,742	18	432	45	45	0	0	0	0	0	0	0	0	0	0	0	0	321,214	10.42	0.00	324,320
Surf Zone Test Detachment/Equipment Test and Evaluation	200																														
		400	CRRC	2	8.0	3200.0	3200.0	0.0	0.0	0	475	41,285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,426,285	111.15	0.00	3,453,408
Waterborne Training																															
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																							
State (0-3 nm offshore)							Waters of U S (3-12 nm)							Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
125	749	442	301	33	33	0	0	0	0	0	0	0	0	0	0	0	0	161,518	5	0	163073.261

Table C-50: Alternative 2 Amphibious Vessel Training Emissions - Hawaii

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
AMPHIBIOUS WARFARE																															
Amphibious Assault	12																														
		48	LCAC	4	8.0	384.0	144.0	144.0	96.0	2,638	16,493	502	7,863	740	740	2,638	16,493	502	7,863	740	740	1,759	10,995	335	5,242	493	493	7,946,537	257.73	0.01	8,023,358
		48	LCU	4	8.0	384.0	144.0	144.0	96.0	729	2,261	183	418	109	109	729	2,261	183	418	109	109	486	1,508	122	279	72	72	354,711	11.51	0.00	358,140
Battalion Landing	0																														
		0	LCU	6	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	AAV/EFV	14	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	5	3.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	CRRC	0	6.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Amphibious Raid	0																														
		0	CRRC	13	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCU	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCAC	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	EFV	6	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Humanitarian Assistance	2																														
		8	LCAC	4	8.0	64.0	0.0	32.0	32.0	0	0	0	0	0	0	586	3,665	112	1,747	164	164	586	3,665	112	1,747	164	164	1,324,423	42.96	0.00	1,337,226
		8	LCU	4	8.0	64.0	0.0	32.0	32.0	0	0	0	0	0	0	162	503	41	93	24	24	162	503	41	93	24	24	53,119	1.92	0.00	53,630
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Submarine (TRACKEX-Sub)	200																														
		200	TRB	1	3.6	720.0	0.0	72.0	648.0	0	0	0	0	0	0	466	4,048	112	533	65	65	4,193	36,431	1,004	4,795	765	765	212,224	6.88	0.00	214,276
Tracking / Torpedo Exercise-Submarine (TORPEX-Sub)	48																														
		48	TRB	1	3.6	172.8	0.0	17.3	155.5	0	0	0	0	0	0	112	971	27	128	20	20	1,006	8,743	241	1,151	184	184	50,934	1.65	0.00	51,426
Tracking / Torpedo Exercise-Surface (TRACKEX-Surface)	224																														
		70.7	TRB	0.32	3.6	254.7	0.0	25.5	229.2	0	0	0	0	0	0	165	1,432	39	188	30	30	1,483	12,885	355	1,696	270	270	75,060	2.43	0.00	75,786
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	50																														
		70.7	TRB	0.32	3.6	254.7	0.0	25.5	229.2	0	0	0	0	0	0	165	1,432	39	188	30	30	1,483	12,885	355	1,696	270	270	75,060	2.43	0.00	75,786
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	153																														
		47.7	TRB	0.3	3.6	171.7	0.0	17.2	154.5	0	0	0	0	0	0	111	965	27	127	20	20	1,000	8,689	240	1,144	182	182	50,616	1.64	0.00	51,105
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	6																														
		47.7	TRB	0.3	3.6	171.7	0.0	17.2	154.5	0	0	0	0	0	0	111	965	27	127	20	20	1,000	8,689	240	1,144	182	182	50,616	1.64	0.00	51,105
Service Weapons Test (SWT)	2																														
		2	TRB	1	3.6	7.2	0.0	0.7	6.5	0	0	0	0	0	0	5	40	1	5	1	1	42	364	10	48	8	8	2,122	0.07	0.00	2,143
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	26																														
		15.8	TRB	0.61	2.0	31.7	0.0	3.2	28.5	0	0	0	0	0	0	20	178	5	23	4	4	184	1,602	44	211	34	34	9,330	0.30	0.00	9,420
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	10																														
		15.8	TRB	0.61	2.0	31.7	0.0	3.2	28.5	0	0	0	0	0	0	20	178	5	23	4	4	184	1,602	44	211	34	34	9,330	0.30	0.00	9,420
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																														
		3.7	TRB	0.61	2.0	7.3	0.0	0.7	6.6	0	0	0	0	0	0	5	41	1	5	1	1	43	370	10	49	8	8	2,153	0.07	0.00	2,174
Expeditionary Warfare																															
Dive and Salvage Operations	3																														
		6	CRRC	2	8.0	48.0	48.0	0.0	0.0	0	7	619	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51,394	1.67	0.00	51,831
Small Boat Attack	0																														
		0	RHIB	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
MINE WARFARE																															
Civilian Port Defense - Homeland Security	1																														
		1	RHIB	1	24.0	24.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	RHIB	2	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Marine Mammal System	10																														
		10	RHIB	1	4.0	40.0	40.0	0.0	0.0	14	366	2	58	6	6	0	0	0	0	0	0	0	0	0	0	0	0	42,829	1.39	0.00	43,243
Mine Neutralization - EOD	20																														
		60	RHIB	3	12.0	720.0	720.0	0.0	0.0	245	6,581	43	1,037	108	108	0	0	0	0	0	0	0	0	0	0	0	0	770,914	25.01	0.00	778,367
Mine Neutralization - ROV	6																														
		6	RHIB	1	12.0	72.0	72.0	0.0	0.0	24	658	4	104	11	11	0	0	0	0	0	0	0	0	0	0	0	0	77,091	2.50	0.00	77,837
SLMM (Sub-mobile) Mine Exercise for Training and Certification	5																														
		5	Bayliner	1	8.0	40.0	40.0	0.0	0.0	1,494	2,967	241	937	104	104	0	0	0	0	0	0	0	0	0	0	0	0	307,017	9.96	0.00	309,985
Underwater Demo Qual	25																														
		50	CRRC	2	8.0	400.0	400.0	0.0	0.0	0	59	5,161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	428,286	13.89	0.00	432,426
SURFACE WARFARE																															
Gunnery Exercise, Surface to Surface, (Boat) Med Caliber	10																														
		10	BW	1	2.0	20.0	20.0	0.0	0.0	2,235	32	918	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1,974	0.06	0.00	1,993
		10	Bayliner	1	2.0	20.0	20.0	0.0	0.0	747	1,483	120	468	52	52	0	0	0	0	0	0	0	0	0	0	0	0	153,508	4.98	0.00	154,932
Gunnery Exercise, Surface to Surface, (Boat) Small Caliber	0																														
		0	BW	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	Bayliner	1	2.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
OTHER																															
Elevated Causeway	0																														
		0	WT	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	PW	2	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
		0	LCM	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Offshore Petroleum Discharge System	4																														
		8	OUB	2	4.0	32.0	32.0	0.0	0.0	1,159	1,438	17	100	50	50	0	0	0	0	0	0	0	0	0	0	0	0	67,068	2.18	0.00	67,716
Precision Anchoring	20																														
		20	RHIB	1	4.0	80.0	80.0	0.0	0.0	27	731	5	115	12	12	0	0	0	0	0	0	0	0	0	0	0	0	85,657	2.78	0.00	86,485
Underwater Demolition - Multiple Charge - Mat Weave and Obstacle Loading	0																														
		0	CRRC	2	8.0	0.0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
UUV Training, Certification, and Development Operations	25																														
		0	RHIB	1	4.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
Surf Zone Test Detachment/Equipment Test and Evaluation	0																														
		0	CRRC	2	8.0	0.0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0

EMISSIONS / YEAR (tons) BY JURISDICTION																															
		State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions									
		CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e						
		5	17	4	6	1	1	3	17	1	6	1	1	7	54	2	10	1	1	6,104	0	0	6162.99463						

Table C-51: Alternative 2 Amphibious Vessel Testing Emissions - SCAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
ANTI-SUBMARINE WARFARE																															
Tracking/Torpedo Exercise-Surface (TORPEX-Surface)	71	22.4	TRB	0.32	3.6	80.7	0.0	8.1	72.6	0.0	0.0	0.0	0.0	0.0	0.0	52.2	453.8	12.5	59.7	9.5	9.5	470.0	4084.1	112.6	537.6	85.7	85.7	23791.5	1	0	24,021
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	132	39.6	TRB	0.3	3.6	142.6	0.0	14.3	128.3	0.0	0.0	0.0	0.0	0.0	0.0	92.2	801.5	22.1	105.5	16.8	16.8	830.1	7213.3	198.9	949.4	151.4	151.4	42020.4	1	0	42,427
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	74	45.0	TRB	0.61	2.0	90.1	0.0	9.0	81.1	0.0	0.0	0.0	0.0	0.0	0.0	58.3	506.5	14.0	66.7	10.6	10.6	524.6	4558.2	125.7	600.0	95.7	95.7	26553.7	1	0	26,810
Countermeasure Testing	17	34	RHIB	2	12.0	408.0	0.0	253.0	155.0	0.0	0.0	0.0	0.0	0.0	0.0	86.0	2312.1	15.2	364.3	37.9	37.9	52.7	1417.1	9.3	223.3	23.3	23.3	436851.4	14	0	441,075
Torpedo (Explosive) Testing	11	66	RHIB	6	12.0	792.0	0.0	79.2	712.8	0.0	0.0	0.0	0.0	0.0	0.0	26.9	723.9	4.8	114.0	11.9	11.9	242.4	6515.0	42.8	1026.4	106.9	106.9	848005.6	28	0	856,203
Torpedo (Non-Explosive) Testing	18	36	RHIB	2	12.0	432.0	0.0	43.2	388.8	0.0	0.0	0.0	0.0	0.0	0.0	14.7	394.8	2.6	62.2	6.5	6.5	132.2	3553.6	23.3	559.9	58.3	58.3	462548.5	15	0	467,020
MINE WARFARE																															
Mine Countermeasure and Neutralization Testing	11	22	RHIB	2	8.0	176.0	0.0	0.0	176.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.8	1608.6	10.6	253.4	26.4	26.4	188445.7	6	0	190,267
Mine Detection and Classification Testing	16	64	RHIB	4	12.0	768.0	0.0	0.0	768.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	261.1	7019.5	46.1	1105.9	115.2	115.2	822308.5	27	0	830,258
OTHER																															
Personnel Insertion/Extraction - Non Submarine	0.5	0.5	Bayliner	1	8.0	4.0	4.0	0.0	0.0	149.4	296.7	24.1	93.7	10.4	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Non-Acoustic Component Testing	17	34	RHIB	2	6.0	204.0	0.0	0.0	204.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	69.4	1864.6	12.2	293.8	30.6	30.6	218425.7	7	0	220,537
		0.5	Bayliner	1	8.0	4.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	149.4	296.7	24.1	93.7	10.4	10.4	30701.7	1	0	30,998
Signature Analysis Operations	1	2	RHIB	2	8.0	16.0	16.0	0.0	0.0	5.4	146.2	1.0	23.0	2.4	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17131.4	1	0	17,297
UNMANNED SYSTEMS																															
Unmanned Surface Vehicle System Testing	4	4	RHIB	1	12.0	48.0	0.0	0.0	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	438.7	2.9	69.1	7.2	7.2	51394.3	2	0	51,891
Unmanned Underwater Vehicle Testing	231	231	RHIB	1	12.0	3432.0	0.0	0.0	3432.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1187.3	31916.9	209.5	5028.5	523.8	523.8	3738933.8	121	0	3,775,079
Air Defense Testing	9	9	RHIB	1	10.0	90.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.6	822.6	5.4	129.6	13.5	13.5	96364.3	3	0	97,296
Surface Warfare Testing	58	58	RHIB	1	12.0	696.0	0.0	0.0	696.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	236.6	6361.4	41.8	1002.2	104.4	104.4	745217.0	24	0	752,421
VESSEL EVALUATION																															
Undersea Warfare Training	16	32	RHIB	2	12.0	384.0	0.0	0.0	384.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	130.6	3509.8	23.0	553.0	57.6	57.6	411154.2	13	0	415,123
Submarine Sea Trials - Weapons System Testing	1	1	RHIB	1	24.0	24.0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	219.4	1.4	34.6	3.6	3.6	25697.1	1	0	25,946
SPAWAR																															
Vehicle Testing	166	166	RHIB	1	6.0	996.0	996.0	0.0	0.0	338.6	3103.4	53.8	1434.2	143.4	143.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1066431.3	35	0	1,076,741
Communications	10	10	RHIB	1	8.0	80.0	0.0	0.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2	731.2	4.8	115.2	12.0	12.0	85657.1	3	0	86,485

EMISSIONS / YEAR (tons) BY JURISDICTION

State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	5	0	1	0	0	0	3	0	0	0	0	2	41	0	6	1	1	4,669	0	0	4,714

Table C-52: Alternative 2 Amphibious Vessel Testing Emissions - SDAB

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
ANTI-SUBMARINE WARFARE																															
Tracking/Torpedo Exercise-Surface (TORPEX-Surface)	0	0.0	TRB	0.32	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	0	0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	0	0.0	TRB	0.61	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Countermeasure Testing	0	0	RHIB	2	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Torpedo (Explosive) Testing	11	66	RHIB	5	12.0	792.0	0.0	79.2	712.8	0.0	0.0	0.0	0.0	0.0	0.0	26.9	723.3	4.8	114.0	11.9	11.9	242.4	6515.0	42.8	1026.4	106.9	106.9	848005.6	28	0	856,203
Torpedo (Non-Explosive) Testing	18	36	RHIB	2	12.0	432.0	0.0	43.2	388.8	0.0	0.0	0.0	0.0	0.0	0.0	14.7	394.8	2.6	62.2	6.5	6.5	132.2	3553.6	23.3	559.9	58.3	58.3	462548.5	15	0	467,020
MINE WARFARE																															
Mine Countermeasure and Neutralization Testing	0	0	RHIB	2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Mine Detection and Classification Testing	0	0	RHIB	4	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
OTHER																															
Personnel Insertion/Extraction - Non Submarine	0	0	Bayliner	1	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Non-Acoustic Component Testing	0	0	RHIB	2	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
		0	Bayliner	1	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Signature Analysis Operations	0	0	RHIB	2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
UNMANNED SYSTEMS																															
Unmanned Surface Vehicle System Testing	0	0	RHIB	1	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Unmanned Underwater Vehicle Testing	0	0	RHIB	1	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Air Defense Testing	0	0	RHIB	1	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Surface Warfare Testing	0	0	RHIB	1	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
VESSEL EVALUATION																															
Undersea Warfare Training	0	0	RHIB	2	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Submarine Sea Trials - Weapons System Testing	0	0	RHIB	1	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
SPAWAR																															
Vehicle Testing	0	0	RHIB	1	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Communications	0	0	RHIB	1	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0

EMISSIONS / YEAR (tons) BY JURISDICTION

State (0-3 nm offshore)						Waters of U S (3-12 nm)						Int Waters (> 12 nm)						GHG Emissions			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
0	0	0	0	0	0	0	1	0	0	0	0	0	5	0	1	0	0	655	0	0	662

Table C-53: Alternative 2 Amphibious Vessel Testing Emissions - Hawaii

ACTIVITY		OPERATIONAL INFORMATION - VESSELS								ANNUAL EMISSIONS (lb/yr) BY JURISDICTION														GHG Emissions			
		Ship / Vessel / Boat			Range Time (hr)		Distribution (hr)			State (0-3 nm offshore)						Waters of U.S (3-12 nm)						Int Waters (> 12 nm)									
Type Training	Training Ops (#)	Number	Ship Type	Participation	Per Ship	Total	0-3 nm from shore	3-12 nm from shore	>12 nm from shore	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_2e
ANTI-SUBMARINE WARFARE																															
Tracking / Torpedo Exercise-Surface (TORPEX-Surface)	22	6.9	TRB	0.32	3.6	25.0	0.0	2.5	22.5	0.0	0.0	0.0	0.0	0.0	0.0	16.2	140.6	3.9	18.5	3.0	3.0	145.6	1265.5	34.9	166.6	26.6	26.6	7372.0	0	0	7,443
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	0	0	TRB	0.3	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	65	39.6	TRB	0.61	2.0	79.1	0.0	7.9	71.2	0.0	0.0	0.0	0.0	0.0	0.0	51.2	444.9	12.3	58.6	9.3	9.3	460.8	4003.8	110.4	527.0	84.0	84.0	23324.2	1	0	23,550
Countermeasure Testing	15	30	RHIB	2	12.0	360.0	0.0	223.2	136.8	0.0	0.0	0.0	0.0	0.0	0.0	75.9	2040.0	13.4	321.4	33.5	33.5	46.5	1250.4	8.2	197.0	20.5	20.5	385457.1	13	0	389,183
Torpedo (Explosive) Testing	12	72	RHIB	6	12.0	864.0	0.0	86.4	777.6	0.0	0.0	0.0	0.0	0.0	0.0	29.4	789.7	5.2	124.4	13.0	13.0	264.4	7107.3	46.7	1119.7	116.6	116.6	925097.0	30	0	934,040
Torpedo (Non-Explosive) Testing	18	36	RHIB	2	12.0	432.0	0.0	43.2	388.8	0.0	0.0	0.0	0.0	0.0	0.0	14.7	394.8	2.6	62.2	6.5	6.5	132.2	3553.6	23.3	559.9	58.3	58.3	462548.5	15	0	467,020
MINE WARFARE																															
Mine Countermeasure and Neutralization Testing	0	0	RHIB	2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Mine Detection and Classification Testing	7	28	RHIB	4	12.0	336.0	0.0	0.0	336.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.2	3071.0	20.2	483.8	50.4	50.4	359753.9	12	0	363,238
OTHER																															
Personnel Insertion/Extraction - Non Submarine	1	1	Bayliner	1	8.0	8.0	8.0	0.0	0.0	298.9	593.4	48.1	187.4	20.8	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Non-Acoustic Component Testing	8	16	RHIB	2	6.0	96.0	0.0	0.0	96.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.6	877.4	5.8	138.2	14.4	14.4	102788.6	3	0	103,782
		1	Bayliner	1	8.0	8.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	298.9	593.4	48.1	187.4	20.8	20.8	61403.3	2	0	61,937
Signature Analysis Operations	2	4	RHIB	2	8.0	32.0	32.0	0.0	0.0	10.9	292.5	1.9	46.1	4.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34262.9	1	0	34,584
UNMANNED SYSTEMS																															
Unmanned Surface Vehicle System Testing	3	3	RHIB	1	12.0	36.0	0.0	0.0	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	329.0	2.2	51.8	5.4	5.4	38545.7	1	0	38,918
Unmanned Underwater Vehicle Testing	3	3	RHIB	1	12.0	36.0	0.0	0.0	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	329.0	2.2	51.8	5.4	5.4	38545.7	1	0	38,918
Air Defense Testing	4	4	RHIB	1	10.0	40.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	365.6	2.4	57.6	6.0	6.0	42828.6	1	0	43,243
Surface Warfare Testing	45	45	RHIB	1	12.0	540.0	0.0	0.0	540.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	183.6	4935.6	32.4	777.6	81.0	81.0	578185.6	19	0	583,775
VESSEL EVALUATION																															
Undersea Warfare Training	15	30	RHIB	2	12.0	360.0	0.0	0.0	360.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	122.4	3230.4	21.6	518.4	54.0	54.0	385457.1	13	0	389,183
Submarine Sea Trials - Weapons System Testing	1	1	RHIB	1	24.0	24.0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	219.4	1.4	34.6	3.6	3.6	25697.1	1	0	25,946
SPAWAR																															
Vehicle Testing	4	4	RHIB	1	6.0	24.0	24.0	0.0	0.0	8.2	219.4	1.4	34.6	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25697.1	1	0	25,946
Communications	1	1	RHIB	1	8.0	8.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	73.1	0.5	11.5	1.2	1.2	8565.7	0	0	8,643

EMISSIONS / YEAR (tons) BY JURISDICTION

State (0-3 nm offshore)						Waters of U.S (3-12 nm)						Int Waters (> 12 nm)									
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4	CO_{2e}
0	1	0	0	0	0	0	2	0	0	0	0	1	16	0	2	0	0	1,753	0	0	1,770

Table C-54: Alternative 2 Aircraft Training Emissions - SCAB

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers	3000																											
		2.83	8490	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87769620	12907297	271750232	8816	7680	274,569,302
		0.17	510	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3254310	478575	10075918	327	285	10,180,443
Air Defense Exercise	275																											
		0.21	58	E-2	0	0	0	0	0	0	0	0	0	0	0	0	166	657	24	26	62	62	130861.5	19244	405170	13	11	409,373
		0.00	0.00	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	352	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	1310	26837	218	728	11936	11936	3638976	535144	11266912	366	318	11,383,792
Gunnery Exercise	2.5																											
		2.83	7	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	73141.35	10756	226459	7	6	228,808
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2711.925	399	8397	0	0	8,484
Gunnery Exercise, SA Large Caliber	82.5																											
		1	83	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2947	777	561	53	167	167	263340	38726	815347	26	23	823,805
Gunnery Exercise, SA Medium Caliber	97.5																											
		1	98	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	3483	918	663	62	198	198	311220	45768	963592	31	27	973,588
Missile Exercise, AAb	2																											
		4	8	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106176	15614	328740	11	9	332,150
		6	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	248112	36487	768199	25	22	776,168
		1	2	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18128	2666	56127	2	2	56,710
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	2	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36000	5294	111462	4	3	112,619
Missile Exercise, SA	12.5																											
		1	13	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	281	288	25	18	189	189	45000	6618	139328	5	4	140,773
		1	13	P-3	0	0	0	0	0	0	0	0	0	0	0	0	257	793	59	41	407	407	153750	22610	476037	15	13	480,975
		0.5	6	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	298	79	57	5	17	17	19950	2934	61769	2	2	62,409
		0.0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																											
Amphibious Assault	18																										
		8	144	AH-1	3932	1308	200	140	1473	1473	0	0	0	0	0	0	0	0	0	0	0	0	350784	51586	1086089	35	31	1,097,356
		0.00	0.00	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	72	UH-1	330	551	20	47	430	430	0	0	0	0	0	0	0	0	0	0	0	0	116640	17153	361138	12	10	364,864
USMC Battalion Landing	2																										
		8	16.0	FA-18A/C	4	11	1	1	10	10	10	27	2	2	25	25	6	16	1	1	15	15	53088	7807	164370	5	5	166,075
		8	16.0	FA-18E/F	2	37	0	1	16	16	4	31	1	2	41	41	3	55	0	1	24	24	82704	12162	256066	8	7	258,723
		6	12.0	AV-8B	66	74	5	3	33	33	4	4	0	0	2	2	4	4	0	0	2	2	38286	5630	118540	4	3	119,770
		4	8.0	AH-1	66	32	3	2	25	25	4	2	0	0	1	1	4	2	0	0	1	1	6436	355	20113	1	1	20,321
		2	4.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25200	3706	78024	3	2	78,833
		4	8.0	H-53	103	390	7	19	107	107	6	22	0	1	6	6	6	22	0	1	6	6	53568	7878	165856	5	5	167,577
		12	24.0	MV-22	64	4	1	50	136	136	4	97	0	3	11	11	4	97	0	3	11	11	43200	6353	133755	4	4	135,142
		3	6.0	UH-1	10	14	0	1	12	12	1	1	0	0	1	1	1	1	0	0	1	1	3240	476	10032	0	0	10,136
Amphibious Raid	0																								0			
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	8																										
		0.17	1	FA-18E/F	0	0	0	0	0	0	30	622	5	17	277	277	0	0	0	0	0	0	42173.04	6203	130534	4	4	131,348
		0.17	1	AH-1	0	0	0	0	0	0	37	18	2	1	14	14	0	0	0	0	0	0	3312.96	487	10258	0	0	10,364
		0.17	1	AV-8B	0	0	0	0	0	0	200	224	14	10	39	39	0	0	0	0	0	0	26034.48	3829	80607	3	2	81,444
Humanitarian Assistance	1																										
		30	30.0	AH-1	2458	1193	125	88	321	321	0	0	0	0	0	0	0	0	0	0	0	0	219240	32241	678806	22	19	685,847
		58	58.0	MV-22	346	0	7	266	1050	1050	0	0	0	0	0	0	0	0	0	0	0	0	208800	30706	646462	21	18	653,188
		32	32.0	CH-53	313	3463	64	171	347	347	0	0	0	0	0	0	0	0	0	0	0	0	428544	63021	1326848	43	37	1,340,612
		38	38.0	AV-8B	0	0	0	0	0	0	5601	6256	393	291	2764	2764	0	0	0	0	0	0	727434	106976	2252264	73	64	2,275,628
		48	48.0	UH-1	260	367	13	31	327	327	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240759	8	7	243,256
ANTI-SUBMARINE WARFARE																											
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)	524																										
		0.17	89	SH-60B	0	0	0	0	0	0	568	581	50	36	381	381	1838	1882	162	118	1235	1235	384825.6	56532	1191468	39	34	1,203,848
		0.83	435	SH-60F	0	0	0	0	0	0	2771	2838	244	177	1862	1862	8972	9187	789	574	6029	6029	1878854.4	276002	5817265	189	164	5,877,612
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)	104																						0	0		0.00	0.00	0
		0.17	18	SH-60B	0	0	0	0	0	0	113	115	10	7	76	76	365	373	32	23	245	245	76377.6	11232	236479	8	7	238,332
		0.83	86	SH-60F	0	0	0	0	0	0	550	563	48	35	370	370	1781	1823	157	114	1137	1137	372902.4	54833	1154572	37	33	1,166,543
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)	50																										
		1	50	P-3	116	357	27	18	183	183	232	713	54	37	366	366	1968	6061	455	314	3113	3113	1230000	180882	3808297	124	108	3,847,803
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)	25																						0	0	0	0.00	0.00	0
		1	25	P-3	58	178	13	9	32	32	116	357	27	18	183	183	984	3031	227	157	1556	1556	615000	90441	1904143	62	54	1,923,302
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																						0	0	0	0.00	0.00	0
		1	6	P-3	0	0	0	0	0	0	0	0	0	0	0	0	278	856	64	44	439	439	147600	21706	456936	15	13	461,736
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																											
Electronic Warfare	350																										
		0.08	28	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	441	452	39	28	236	236	70560	10376	218466	7	6	220,733
		0.05	18	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	276	282	24	18	185	185	44100	6485	136541	4	4	137,358
		0.004	1	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	22	23	2	1	15	15	3528	513	10923	0	0	11,037
		0.04	14	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114800	16882	355441	12	10	353,128
		0.29	102	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1347108	198104	4170884	135	118	4,214,152
		0.29	102	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2038614	308620	6437679	211	184	6,565,085
		0.02	7	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31724	4665	98223	3	3	99,242
		0.02	7	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89460	13156	276984	9	8	279,857
		0.2	70	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148360	21906	461206	15	13	465,391
		0.01	4	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7448	1035	23060	1	1	23,300
Counter Targeting Flare Exercise	130																										
		2	260	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7391670	1087010	22885915	742	647	23,123,328
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	260	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2331500	431103	3076441	294	257	3,170,536
		2	260	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1465750	215551	4538221	147	128	4,585,293
		2	260	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2331500	431103	3076441	294	257	3,170,536
		1	130	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276640	40682	856526	28	24	865,412
Counter Targeting Chaff Exercise - Aircraft	140																										
		2	280	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7360260	1170626	24646370	800	697	24,302,045
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	280	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3157000	464265	3774629	317	276	3,876,023
		2	280	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1578500	232132	4887315	159	138	4,338,014
		2	280	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3157000	464265	3774629	317	276	3,876,023
		1	140	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	237920	43812	322413	30	26	331,382
Expeditionary Warfare																											
Personnel Insertion/Extraction - Swimmer/Diver	165																										
		1	165	SH-60B	2539	2661	223	166	1746	1746	0	0	0	0	0	0	0	0	0	0	0	0	415800	61147	1287330	42	36	1,300,745
MINE WARFARE																											
Airborne Mine Countermeasures - Mine Detection	10																										
		1	10	SH-60B	158	161	14	10	106	106	0	0	0	0	0	0	0	0	0	0	0	0	25200	3706	78024	3	2	78,833
Airborne Mine Countermeasures - Towed Mine Neutralization	340																										
		1	340	SH-60B	5355	5484	471	343	3599	3599	0	0	0	0	0	0	0	0	0	0	0	0	856800	126000	2652804	86	75	2,680,324
Civilian Port Defense - Homeland Security																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - EOD	170																										
		1	170	SH-60B	2678	2742	236	171	1799	1799	0	0	0	0	0	0	0	0	0	0	0	0	428400	63000	1326402	43	37	1,340,162
Mine Countermeasure Exercise - Mine Neutralization Small-Medium Caliber	36																										
		1	36	SH-60B	567	581	50	36	381	381	0	0	0	0	0	0	0	0	0	0	0	0	90720	13341	280885	9	8	283,793
Mine Neutralization - ROV	60																										
		1	60	SH-60B	345	368	83	60	635	635	0	0	0	0	0	0	0	0	0	0	0	0	151200	22235	468142	15	13	472,398
Mine Laying	18																										
		0.29	5.22	P-3	16	50	4	3	25	25	13	40	3	2	20	20	3	10	1	1	5	5	13261.8	2833	53638	2	2	60,257
		0.65	11.7	FA-18A/C	3	9	1	1	8	8	3	7	0	0	7	7	1	2	0	0	2	2	38820.6	5703	120195	4	3	121,442
		0.59	10.62	FA-18E/F	1	27	0	1	12	12	1	22	0	1	10	10	0	5	0	0	2	2	54834.78	8073	163964	6	5	171,727

ANTI-SURFACE WARFARE																												
Bombex, Air to Surface	640																											
		0.53	339	FA-18A/C	0	0	0	0	0	0	275	753	50	45	716	716	275	753	50	45	716	716	2250331.2	331013	6963280	226	197	7,041,578
		0.53	339	FA-18E/F	0	0	0	0	0	0	126	2586	21	70	1150	1150	126	2586	21	70	1150	1150	3506643.6	515684	10857206	352	307	10,963,836
		0.28	179	P-3	0	0	0	0	0	0	32	284	21	15	146	146	32	284	21	15	146	146	734720	108047	2274823	74	64	2,298,421
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Medium Caliber	363																											
		1.62	588.1	SH-60B	0	0	0	0	0	0	2205	2258	194	141	1482	1482	2205	2258	194	141	1482	1482	705672	103775	2184885	71	62	2,207,551
		0.55	199.7	SH-60F	0	0	0	0	0	0	749	767	66	48	503	503	749	767	66	48	503	503	239580	35232	741782	24	21	749,477
		0.02	7.3	MH-60R/S	0	0	0	0	0	0	27	28	2	2	18	18	27	28	2	2	18	18	8712	1281	26974	1	1	27,254
Gunnery Exercise, Air to Surface, Small Caliber	2040																											
		1.62	3305	SH-60B	0	0	0	0	0	0	12393	12690	1091	793	8328	8328	12393	12690	1091	793	8328	8328	3965760	583200	12278693	398	347	12,406,069
		0.55	3305	SH-60F	0	0	0	0	0	0	12393	12690	1091	793	8328	8328	12393	12690	1091	793	8328	8328	3965760	583200	12278693	398	347	12,406,069
		0.02	3305	MH-60R/S	0	0	0	0	0	0	12393	12690	1091	793	8328	8328	12393	12690	1091	793	8328	8328	3965760	583200	12278693	398	347	12,406,069
Laser Targeting	310																											
		0.55	501	SH-60B	0	0	0	0	0	0	1877	1922	165	120	1261	1261	1877	1922	165	120	1261	1261	600600	88324	1859564	60	53	1,878,854
		0.28	255	SH-60F	0	0	0	0	0	0	356	378	84	61	642	642	356	378	84	61	642	642	305760	44365	346687	31	27	356,508
		0.3	273	FA-18A/C	0	0	0	0	0	0	221	611	40	36	576	576	221	611	40	36	576	576	1811628	266416	5609120	182	153	5,667,306
		0.3	273	FA-18E/F	0	0	0	0	0	0	102	2081	17	56	926	926	102	2081	17	56	926	926	2822274	415040	8738258	283	247	8,828,307
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maritime Security Ops	250																											
		0.74	185	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	5550	5683	488	355	3730	3730	888000	130588	2749405	89	78	2,777,326
		0.25	63	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	1875	1920	165	120	1260	1260	300000	44118	328853	30	26	338,469
Missile Exercise, Air to Surface	117																											
		0.55	64	SH-60B	0	0	0	0	0	0	724	741	64	46	486	486	724	741	64	46	486	486	231660	34068	717260	23	20	724,701
		0.28	33	SH-60F	0	0	0	0	0	0	369	377	32	24	248	248	369	377	32	24	248	248	117936	17344	365151	12	10	368,339
		0.3	35	FA-18A/C	0	0	0	0	0	0	57	157	10	9	148	148	57	157	10	9	148	148	465847.2	68507	1442345	47	41	1,457,308
		0.3	35	FA-18E/F	0	0	0	0	0	0	26	535	4	15	238	238	26	535	4	15	238	238	725727.6	106725	2246361	73	64	2,270,290
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface, Rocket	246																											
		0.55	135.3	SH-60B	0	0	0	0	0	0	1522	1553	134	97	1023	1023	1522	1553	134	97	1023	1023	487080	71629	1508086	49	43	1,523,730
		0.28	68.9	SH-60F	0	0	0	0	0	0	775	793	68	50	521	521	775	793	68	50	521	521	247968	36466	767753	25	22	775,717
		0.3	73.8	FA-18A/C	0	0	0	0	0	0	119	330	22	20	311	311	119	330	22	20	311	311	379473.6	144040	3032623	98	86	3,064,083
		0.3	73.8	FA-18E/F	0	0	0	0	0	0	55	1125	9	31	500	500	55	1125	9	31	500	500	1525888.8	224335	4724421	153	134	4,773,431
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinking Exercise	1																											
		2	2	E-2	0	0	0	0	0	0	0	0	0	0	0	0	18	73	3	3	7	7	72512	10664	224510	7	6	226,839
		8	8	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	95	1952	16	53	868	868	1323264	194598	4097059	133	116	4,139,561
		1	1	P-3	0	0	0	0	0	0	0	0	0	0	0	0	16	51	4	3	26	26	65500	9647	203103	7	6	205,216
		2	2	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	240	246	21	15	161	161	38400	5647	118693	4	3	120,127
OTHER																												
Kilo Dip-Helo	2400																											
		0.83	1992	SH-60F	0	0	0	0	0	0	881	903	78	56	532	532	2854	2922	251	183	1918	1918	537600	87882	1850275	60	52	1,863,463
		0.83	1992	MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	537600	87882	1850275	60	52	1,863,463

EMISSIONS (lb/yr)																											
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
21,107	21,257	1,574	1,633	14,192	14,192	58,603	63,465	5,206	3,364	42,368	42,368	83,733	123,341	8,785	6,328	71,205	71,205	174,016,870	25,530,716	536,786,940	17,478	15,226	544,376,182
11	11	1	1	7	7	29	35	3	2	21	21	42	62	4	3	36	36			263,333	9	8	272,188

Table C-55: Alternative 2 Aircraft Training Emissions - SDAB

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers																												
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Defense Exercise																												
		0.21	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise																												
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, SA Large Caliber																												
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, AAb																												
		4	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, SA																												
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.5	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																												
Amphibious Assault		8	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USMC Battalion Landing																												
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid																												
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise																												
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	1																											
		30	30.0	AH-1	2458	1193	125	88	321	321	0	0	0	0	0	0	0	0	0	0	0	0	219240	32241	678806	22	19	685,847
		58	58.0	MV-22	346	0	7	266	1050	1050	0	0	0	0	0	0	0	0	0	0	0	0	208800	30706	646482	21	18	653,188
		32	32.0	CH-53	913	3463	64	171	347	347	0	0	0	0	0	0	0	0	0	0	0	0	428544	63021	1326848	43	37	1,340,612
		38	38.0	AV-8B	0	0	0	0	0	0	5601	6256	393	231	2764	2764	0	0	0	0	0	0	727434	106976	2252264	73	64	2,275,628
		48	48.0	UH-1	260	367	13	31	327	327	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240753	8	7	243,256
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise-Helo (TRACKEX-Helo)		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-Helo (TORPEX-Helo)																							0	0		0.00	0.00	0
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TRACKEX-MPA)																												
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise-MPA (TORPEX-MPA)																							0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys																							0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																											
Electronic Warfare		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counter Targeting Flare Exercise	130																										
		2	260	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7331670	1087010	22885315	742	647	23,123,328
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	260	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931500	431103	3076441	294	257	3,170,536
		2	260	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1465750	215551	4538221	147	128	4,585,293
		2	260	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931500	431103	3076441	294	257	3,170,536
		1	130	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276640	40682	856526	28	24	865,412
Counter Targeting Chaff Exercise - Aircraft																											
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Warfare																											
Personnel Insertion/Extraction - Swimmer/Diver		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINE WARFARE																											
Airborne Mine Countermeasures - Mine Detection	0																										
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0	0	0
Airborne Mine Countermeasures - Towed Mine Neutralization	0																										
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0	0	0
Civilian Port Defense - Homeland Security	3																										
		1	3	SH-60B	270	276	24	17	161	161	0	0	0	0	0		0	0	0	0	0		43200	6353	133755	4	4	135,142
Mine Neutralization - EOD	0																										
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0	0	0
Mine Countermeasure Exercise - Mine Neutralization Small-Medium Caliber	0																										
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0	0	0
Mine Neutralization - ROV	312																										
		1	312	SH-60B	4314	5032	432	314	3302	3302	0	0	0	0	0		0	0	0	0	0		786240	115624	2434338	79	69	2,453,531
Mine Laying	18																										
		0.29	5.22	P-3	16	50	4	3	25	25	13	40	3	2	20		3	10	1	1	5		13261.8	2833	53638	2	2	60,257
		0.65	11.7	FA-18A/C	3	9	1	1	8	8	3	7	0	0	7		1	2	0	0	2		38820.6	5703	120195	4	3	121,442
		0.53	10.62	FA-18E/F	1	27	0	1	12	12	1	22	0	1	10		0	5	0	0	2		54834.78	8073	163364	6	5	171,727

ANTI-SURFACE WARFARE																													
Bombex, Air to Surface	0																												
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Medium Caliber	0																												
		1.62	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0.0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Small Caliber	0																												
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maritime Security Ops	0																												
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface	0																												
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface, Rocket	0																												
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinking Exercise	0																											0	
		2	0	E-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS (lb/yr)																											
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
9,180	10,416	670	892	6,774	6,774	5,618	6,324	396	294	2,801	2,764	4	17	1	1	3	0	17,601,255	2,588,420	54,436,592	1,768	1,540	55,061,926
5	5	0	0	3	3	3	3	0	0	1	1	0	0	0	0	0	0			27,248	1	1	27,531

Table C-56: Alternative 2 Aircraft Training Emissions - Hawaii

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers	814																											
		2.83	2304	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23814823.56	3502180	73734896	2392	2084	74,499,804
		0.17	138	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	883002.78	129853	2733932	89	77	2,762,294
Air Defense Exercise	185																											
		0.21	39	E-2	0	0	0	0	0	0	0	0	0	0	0	0	112	442	16	18	41	41	88034.1	12946	272569	9	8	275,397
		0.00	0.00	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.28	237	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	881	18054	147	490	8030	8030	2448038.4	360006	7579559	246	214	7,658,187
Gunnery Exercise, A-A	0																											
		2.83	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, SA Large Caliber	51																											
		1	51	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	1822	480	347	33	103	103	162792	23940	504033	16	14	509,261
Gunnery Exercise, SA Medium Caliber	72																											
		1	72	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	2572	678	490	46	146	146	229824	33798	711576	23	20	718,957
Missile Exercise, AAb	64																											
		4	256	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3397632	499652	10519668	341	297	10,628,797
		6	384	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7939584	1167586	24582353	797	695	24,837,364
		1	64	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	580096	85308	1796080	58	51	1,814,712
			0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	64	DC-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1152000	169412	3566795	116	101	3,603,796
Missile Exercise, SA	30																											
		1	30	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	675	691	59	43	454	454	108000	15882	334387	11	9	337,856
		1	30	P-3	0	0	0	0	0	0	0	0	0	0	0	0	618	1903	143	98	977	977	369000	54265	1142489	37	32	1,154,341
		0.5	15	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	715	188	136	13	41	41	47880	7041	148245	5	4	149,783
		0.0	0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AMPHIBIOUS WARFARE																												
Amphibious Assault	12																											
		8	96	AH-1	2622	1272	133	94	382	382	0	0	0	0	0	0	0	0	0	0	0	0	233856	34391	724059	23	20	731,571
		0.00	0.00	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.00	0.00	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	48	UH-1	260	367	13	31	327	327	0	0	0	0	0	0	0	0	0	0	0	0	77760	11435	240759	8	7	243,256
USMC Battalion Landing	0																											
		8	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		8	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	0.0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0.0	C-130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4	0.0	H-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		12	0.0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	0.0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphibious Raid	0																											
		0.053	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.035	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.020	0	CH-53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.023	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.030	0	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expeditionary Fires Exercise	0																											
		0.17	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AH-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.17	0	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Humanitarian Assistance	2																											
		90	180.0	AH-1	4915	2385	250	175	1842	1842	0	0	0	0	0	0	0	0	0	0	0	0	438480	64482	1357611	44	38	1,371,695
		58	116.0	MV-22	631	0	13	532	2100	2100	0	0	0	0	0	0	0	0	0	0	0	0	417600	61412	1292363	42	37	1,306,376
		32	64.0	CH-53	1826	6925	129	343	1834	1834	0	0	0	0	0	0	0	0	0	0	0	0	857088	126042	2653636	86	75	2,681,224
		38	76.0	AV-8B	0	0	0	0	0	0	11202	12512	786	582	5528	5528	0	0	0	0	0	0	1454868	213951	4504528	146	127	4,551,257
		48	36.0	UH-1	519	734	26	62	653	653	0	0	0	0	0	0	0	0	0	0	0	0	155520	22871	481517	16	14	486,513
ANTI-SUBMARINE WARFARE																												
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	159																											
		0.17	27	SH-60B	0	0	0	0	0	0	172	176	15	11	116	116	558	571	43	36	375	375	116763.6	17172	361539	12	10	365,230
		0.83	132	SH-60F	0	0	0	0	0	0	841	861	74	54	565	565	2722	2788	240	174	1829	1829	570110.4	83840	1765162	57	50	1,783,474
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking/Torpedo Exercise-Helo (TORPEX-Helo)	6																						0	0				
		0.17	1	SH-60B	0	0	0	0	0	0	6	7	1	0	4	4	21	22	2	1	14	14	4406.4	648	13643	0	0	13,785
		0.83	5	SH-60F	0	0	0	0	0	0	32	32	3	2	21	21	103	105	3	7	63	63	21513.6	3164	66610	2	2	67,301
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	26																											
		1	26	P-3	60	185	14	10	95	95	120	371	28	19	190	190	1023	3152	236	163	1619	1619	639600	34053	1380314	64	56	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking/Torpedo Exercise-MPA (TORPEX-MPA)	10																						0	0	0	0.00	0.00	0
		1	10	P-3	23	71	5	4	37	37	46	143	11	7	73	73	394	1212	91	63	623	623	246000	36176	761659	25	22	763,561
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking/Torpedo Exercise - MPA-Multi-Static Active Coherent Sonobuoys	6																						0	0	0	0.00	0.00	0
		1	6	P-3	0	0	0	0	0	0	0	0	0	0	0	0	278	856	64	44	439	439	147600	21706	456936	15	13	461,736
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																												
Electronic Warfare	33																											
		0.08	3	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	42	43	4	3	28	28	6652.8	378	20598	1	1	20,812
		0.05	2	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	26	27	2	2	17	17	4158	611	12874	0	0	13,007
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	1	332.64	43	1030	0	0	1,041
		0.04	1	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10824	1592	33513	1	1	33,861
		0.29	10	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127013.04	18678	393255	13	11	397,334
		0.29	10	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	197869.32	29098	612638	20	17	618,394
		0.02	1	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2931.12	440	9261	0	0	9,357
		0.02	1	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8434.8	1240	26116	1	1	26,387
		0.2	7	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14044.6	2065	43485	1	1	43,336
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	702.24	103	2174	0	0	2,197
Counter Targeting Flare Exercise	193																											
		2	398	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11314941	1663962	35033054	1136	390	35,396,478
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	398	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4487450	659319	13833937	451	393	14,038,069
		2	398	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2243725	329360	6946368	225	196	7,019,035
		2	398	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4487450	659319	13833937	451	393	14,038,069
		1	199	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	423472	62275	1311144	43	37	1,324,746
Counter Targeting Chaff Exercise - Aircraft	59																											
		2	118	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3354681	493335	10386684	337	294	10,494,433
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	118	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1330450	195654	4119308	134	116	4,162,041
		2	118	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	665225	97827	2059654	67	58	2,081,020
		2	118	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1330450	195654	4119308	134	116	4,162,041
		1	59	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125552	18464	388731	13	11	392,764
Expeditionary Warfare																												
Personnel Insertion/Extraction - Swimmer/Diver	435																											
		1	435	SH-60B	7736	7363	686	433	5233	5233	0	0	0	0	0	0	0	0	0	0	0	0	1247400	183441	3862171	125	103	3,302,236
MINE WARFARE																												
Airborne Mine Countermeasures - Mine Detection	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Countermeasures - Towed Mine Neutralization	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Civilian Port Defense - Homeland Security	1																											
		1	1	SH-60B	30	32	8	6	60	60	0	0	0	0	0	0	0	0	0	0	0	0	14400	2118	44585	1	1	45,047
Mine Neutralization - EOD	20																											
		1	20	SH-60B	315	323	28	20	212	212	0	0	0	0	0	0	0	0	0	0	0	0	50400	7412	156047	5	4	157,666
Mine Countermeasure Exercise - Mine Neutralization Small-Medium Caliber	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Neutralization - ROV	6																											
		1	6	SH-60B	35	37	8	6	64	64	0	0	0	0	0	0	0	0	0	0	0	0	15120	2224	46614	2	1	47,300
Mine Laying	6																											
		0.29	1.74	P-3	5	17	1	1	8	8	4	13	1	1	7	7	1	3	0	0	2	2	6420.6	944	19879	1	1	20,086
		0.65	3.9	FA-	1	3	0	0	3	3	1	2	0	0	2	2	0	1	0	0	1	1	12340.2	1303	40065	1	1	40,481
		0.59	3.54	FA-18E/F	0	3	0	0	4	4	0	7	0	0	3	3	0	2	0	0	1	1	18238.26	2631	56655	2	2	57,242

ANTI-SURFACE WARFARE																												
Bombex, Air to Surface	187																											
		0.53	99	FA-18A/C	0	0	0	0	0	0	80	222	14	13	209	209	80	222	14	13	209	209	657693.96	36720	2036337	66	58	2,057,461
		0.53	99	FA-18E/F	0	0	0	0	0	0	37	756	6	20	336	336	37	756	6	20	336	336	1024593.18	150676	3172340	103	90	0
		0.28	52	P-3	0	0	0	0	0	0	27	83	6	4	43	43	27	83	6	4	43	43	214676	31570	664675	22	13	671,570
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Exercise, Air to Surface, Medium Caliber	217																											
		1.62	351.5	SH-60B	0	0	0	0	0	0	1316	1350	116	84	886	886	1316	1350	116	84	886	886	421848	62036	1306116	42	37	1,319,665
		0.55	119.4	SH-60F	0	0	0	0	0	0	448	458	39	29	301	301	448	458	39	29	301	301	143220	21062	443434	14	13	448,034
		0.02	4.3	MH-60R/S	0	0	0	0	0	0	16	17	1	1	11	11	16	17	1	1	11	11	5208	766	16125	1	0	16,292
Gunnery Exercise, Air to Surface, Small Caliber	585																											
		1.62	948	SH-60B	0	0	0	0	0	0	3554	3639	313	227	2388	2388	3554	3639	313	227	2388	2388	1137240	167241	3521036	114	100	3,557,623
		0.55	948	SH-60F	0	0	0	0	0	0	3554	3639	313	227	2388	2388	3554	3639	313	227	2388	2388	1137240	167241	3521036	114	100	3,557,623
		0.02	948	MH-60R/S	0	0	0	0	0	0	3554	3639	313	227	2388	2388	3554	3639	313	227	2388	2388	1137240	167241	3521036	114	100	3,557,623
Laser Targeting	50																											
		0.55	28	SH-60B	0	0	0	0	0	0	103	106	9	7	69	69	103	106	9	7	69	69	33000	4853	102174	3	3	103,234
		0.28	14	SH-60F	0	0	0	0	0	0	53	54	5	3	35	35	53	54	5	3	35	35	16800	2471	52016	2	1	52,555
		0.3	15	FA-	0	0	0	0	0	0	12	34	2	2	32	32	12	34	2	2	32	32	93540	14638	308193	10	3	311,391
		0.3	15	FA-18E/F	0	0	0	0	0	0	6	114	1	3	51	51	6	114	1	3	51	51	155070	22804	480124	16	14	485,105
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maritime Security Ops	70																											
		0.74	52	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1554	1591	137	99	1044	1044	248640	36565	769833	25	22	777,819
		0.25	18	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	525	538	46	34	353	353	84000	12353	260079	8	7	262,777
Missile Exercise, Air to Surface	10																											
		0.55	6	SH-60B	0	0	0	0	0	0	62	63	5	4	42	42	62	63	5	4	42	42	19800	2912	61304	2	2	61,340
		0.28	3	SH-60F	0	0	0	0	0	0	32	32	3	2	21	21	32	32	3	2	21	21	10080	1482	31209	1	1	31,533
		0.3	3	FA-	0	0	0	0	0	0	5	13	1	1	13	13	5	13	1	1	13	13	33816	5855	123277	4	3	124,556
		0.3	3	FA-18E/F	0	0	0	0	0	0	2	46	0	1	20	20	2	46	0	1	20	20	62028	3122	132050	6	5	134,042
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile Exercise, Air to Surface, Rocket	227																											
		0.55	124.9	SH-60B	0	0	0	0	0	0	1405	1438	124	90	944	944	1405	1438	124	90	944	944	443460	66097	1331607	45	39	1,406,044
		0.28	63.6	SH-60F	0	0	0	0	0	0	715	732	63	46	481	481	715	732	63	46	481	481	226816	33643	708455	23	20	715,804
		0.3	68.1	FA-	0	0	0	0	0	0	110	305	20	18	287	287	110	305	20	18	287	287	303823.2	132915	2798396	91	79	2,827,426
		0.3	68.1	FA-18E/F	0	0	0	0	0	0	51	1038	8	28	462	462	51	1038	8	28	462	462	1408035.6	207064	4359527	141	123	4,404,751
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinking Exercise	3																											
		2	6	E-2	0	0	0	0	0	0	0	0	0	0	0	0	55	218	8	9	20	20	217536	31991	673530	22	19	680,517
		8	24	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	286	5855	48	153	2604	2604	3363792	583793	12291177	393	347	12,418,682
		1	3	P-3	0	0	0	0	0	0	0	0	0	0	0	0	43	152	11	8	78	78	196800	28941	609328	20	17	615,643
		2	6	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	720	737	63	46	484	484	115200	16941	356680	12	10	360,380
OTHER																												
Kilo Dip-Helo	60																											
		0.83	50	SH-60F	0	0	0	0	0	0	22	23	2	1	15	15	71	73	6	5	48	48	14940	2197	46257	2	1	46,750
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EMISSIONS (lb/yr)																											
State (0-3 nm)							U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
19,219	20,464	1,316	1,782	13,520	13,520	27,590	31,325	2,283	1,716	17,332	17,332	30,967	58,162	3,717	2,631	30,848	30,848	92,255,419	13,566,373	285,639,056	3,266	8,072	283,396,112
10	10	1	1	7	7	14	16	1	1	9	9	15	29	2	1	15	15			142,820	5	4	141,638

Table C-57: Alternative 2 Aircraft Testing Emissions - SCAB

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvers	110																											
		2.83	311	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3218213.4	473268	3364175	323	282	10,067,541
		0.17	19	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119324.7	17548	369450	12	10	373,283
Air Platform Weapons Integration Test	10																											
		0.3	3	P8-MMA	0	2	0	0	0	0	1	5	0	0	0	0	6	45	1	2	3	3	39151.2	5758	121219	4	3	122,477
		0.4	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	15	305	2	8	136	136	82704	12162	256066	8	7	258,723
		0.3	3	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	3	34	1	1	3	3	13536	1393	42096	1	1	42,532
Air Platform - Vehicle Test	35																											
		0.3143	11	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	20	28	1	2	25	25	23760	3494	73565	2	2	74,328
		0.3429	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	89	1830	15	50	814	814	496224	72974	1536397	50	43	1,552,335
		0.3143	11	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	63	250	3	10	23	23	99704	14662	308701	10	9	311,904
Intelligence, Surveillance, and Reconnaissance Test	254																											
		1	254	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	3699	27626	835	1193	1671	1671	3944404.8	1462412	30783632	993	870	31,103,036
ANTI-SUBMARINE WARFARE																												
Tracking/Torpedo Exercise-Helo (TRACKEX-Helo)	132																											
		0.17	22	SH-60B	0	0	0	0	0	0	143	146	13	3	36	36	463	474	41	30	311	311	36340.8	14256	300146	10	8	303,259
		0.83	110	SH-60F	0	0	0	0	0	0	698	715	61	45	469	469	2260	2314	199	145	1519	1519	473293.2	69603	1465418	48	41	1,480,620
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking/Torpedo Exercise-MPA (TRACKEX-MPA)	74																						0	0	0	0.00	0.00	0
		1	74	P-3	171	528	40	27	271	271	343	1055	79	55	542	542	2313	8371	673	464	4607	4607	1820400	267706	5636280	183	153	5,634,749
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	6																						0	0	0	0.00	0.00	0
		0.83	5	SH-60B	0	0	0	0	0	0	2	2	0	0	1	1	7	7	1	0	5	5	1434	220	4626	0	0	4,674
Sonobuoy Lot Acceptance Test	160																											
		1	160	P8-MMA	2476	18430	559	799	1118	1118	291	2175	66	94	132	132	146	1088	33	47	66	66	6264192	321205	13335044	629	548	13,536,243
Anti-Submarine Warfare Mission Package Testing	27																											
		0.83	22	SH-60B	0	0	0	0	0	0	143	146	13	3	36	36	462	473	41	30	311	311	36811.2	14237	293745	10	8	302,854
At-Sea Sonar Testing	22																											
		1	22	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1650	1690	145	106	1103	1103	264000	38824	817391	27	23	825,870
		1	22	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	830	6647	201	287	402	402	1435544	211109	4444638	144	126	4,430,806
Torpedo (Explosive) Testing	11																											
		1	11	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	660	676	58	42	444	444	105600	15529	326956	11	9	330,348
		1	11	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	356	2653	80	115	161	161	574217.6	84444	1777879	58	50	1,736,322
Torpedo (Non-Explosive) Testing	18																											
		1	18	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1080	1106	95	69	726	726	172800	25412	535019	17	15	540,569
		1	18	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	583	4350	132	188	263	263	939628.8	138181	2909257	94	82	2,939,436

ELECTRONIC WARFARE																												
Counter Targeting Flare Exercise	15																											
		2	30	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	852885	125424	2640682	86	75	2,668,076
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	30	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	338250	43743	1047282	34	30	1,058,146
		2	30	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	527175	77526	1632227	53	46	1,643,153
		2	30	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	338250	43743	1047282	34	30	1,058,146
		1	15	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31920	4634	38830	3	3	39,855
Counter Targeting Chaff Exercise - Aircraft	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	4																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	3	3	806.4	119	2437	0	0	2,523
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	2	2	504	74	1560	0	0	1,577
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40.32	6	125	0	0	126
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1312	193	4062	0	0	4,104
		0.29	1	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15395.52	2264	47667	2	1	48,162
		0.29	1	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23984.16	3527	74259	2	2	75,030
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	362.56	53	1123	0	0	1,134
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1022.4	150	3166	0	0	3,198
		0.2	1	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1702.4	250	5271	0	0	5,326
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85.12	13	264	0	0	266
Radar and Other System Testing	52																											
		3	156	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	44577	11752	8485	797	2530	2530	1391808	292313	6166389	200	174	6,230,964
		1	52	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6450312	348664	13973162	648	564	20,180,359
		1	52	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	4680	4732	412	300	3145	3145	748800	110118	2318417	75	66	2,342,468
MINE WARFARE																												
Mine Countermeasure Mission Package Testing	58																											
		1	58	SH-60B	1088	1114	96	70	731	731	653	668	57	42	438	438	435	445	38	28	232	232	348000	51176	1077463	35	30	1,088,647
Mine Countermeasure and Neutralization Testing	11																											
		2	22	SH-60B	660	676	58	42	444	444	396	406	35	25	266	266	264	270	23	17	177	177	211200	31059	653312	21	18	660,636
Mine Detection and Classification Testing	16																											
		2	32	SH-60B	960	983	84	61	645	645	576	590	51	37	387	387	384	393	34	25	258	258	307200	45176	951145	31	27	961,012
Airborne Dipping Sonar Minehunting Test	12																											
		1	12	SH-60B	113	115	10	7	76	76	68	69	6	4	45	45	45	46	4	3	30	30	36000	5294	111462	4	3	112,619
Airborne Laser-Based Mine Detection System Test	20																											
		1	20	SH-60B	150	154	13	10	101	101	90	92	8	6	60	60	60	61	5	4	40	40	48000	7059	148616	5	4	150,158
Airborne Mine Neutralization System Test	37																											
		1	37	SH-60B	278	284	24	18	186	186	167	170	15	11	112	112	111	114	10	7	75	75	88800	13059	274340	9	8	277,793
Airborne Sonobuoy Minehunting Test	9																											
		1	9	SH-60B	68	69	6	4	45	45	41	41	4	3	27	27	27	28	2	2	18	18	21600	3176	66877	2	2	67,571
Mine Laying Test	2																											
		1	2	P8-MMA	4	30	1	1	2	2	2	18	1	1	1	1	2	12	0	1	1	1	13050.4	1319	40406	1	1	40,826

					EMISSIONS (lb/yr)																							
					State (0-3 nm)						U.S. (3-12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
					CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	CO	NOx	HC	SOx	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-SURFACE WARFARE																												
Bombing Test, Air to Surface	14	0.53	7	FA-18A/C	0	0	0	0	0	0	6	17	1	1	16	16	6	17	1	1	16	16	49239.12	7241	152453	5	4	154,035
		0.53	7	FA-18E/F	0	0	0	0	0	0	3	57	0	2	25	25	3	57	0	2	25	25	76707.96	11281	237501	8	7	239,965
		0.28	4	P-3	0	0	0	0	0	0	2	6	0	0	3	3	2	6	0	0	3	3	16072	2364	49762	2	1	50,278
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Test, Air to Surface	60																											
		1.62	37	SH-60B	0	0	0	0	0	0	365	373	32	23	245	245	365	373	32	23	245	245	116640	17153	361138	12	10	364,884
		0.55	37	SH-60F	0	0	0	0	0	0	365	373	32	23	245	245	365	373	32	23	245	245	116640	17153	361138	12	10	364,884
		0.02	37	MH-60R/S	0	0	0	0	0	0	365	373	32	23	245	245	365	373	32	23	245	245	116640	17153	361138	12	10	364,884
Gun Testing - Large Caliber	43																											
		0.74	32	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	355	378	84	61	641	641	152736	22461	472698	15	13	477,803
		0.25	11	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	323	330	28	21	217	217	51600	7588	159763	5	5	161,420
High Energy Laser Weapons Test	54																											
		1	54	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	810	829	71	52	544	544	129600	19059	401264	13	11	405,427
Laser Targeting Test	5																											
		0.55	3	SH-60B	0	0	0	0	0	0	10	11	1	1	7	7	10	11	1	1	7	7	3300	485	10217	0	0	10,323
		0.28	1	SH-60F	0	0	0	0	0	0	5	5	0	0	4	4	5	5	0	0	4	4	1680	247	5202	0	0	5,256
		0.3	2	FA-18A/C	0	0	0	0	0	0	1	3	0	0	3	3	1	3	0	0	3	3	3354	1464	30813	1	1	31,133
		0.3	2	FA-18E/F	0	0	0	0	0	0	1	11	0	0	5	5	1	11	0	0	5	5	15507	2280	48012	2	1	48,510
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile and Rocket Testing	32																								0	0.00	0.00	0
		0.55	17.6	SH-60B	0	0	0	0	0	0	198	203	17	13	133	133	198	203	17	13	133	133	63360	9318	196174	6	6	198,209
		0.28	3.0	SH-60F	0	0	0	0	0	0	101	103	9	6	68	68	101	103	9	6	68	68	32256	4744	99870	3	3	100,906
		0.3	9.6	FA-18A/C	0	0	0	0	0	0	16	43	3	3	41	41	16	43	3	3	41	41	127411.2	18737	394488	13	11	398,580
		0.3	9.6	FA-18E/F	0	0	0	0	0	0	7	146	1	4	65	65	7	146	1	4	65	65	138483.6	23190	614553	20	17	620,334
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocket Test	22									0						0						0			0			
		0.55	12.1	SH-60B	0	0	0	0	0	0	136	139	12	9	31	31	136	139	12	9	31	31	43560	6406	134863	4	4	136,263
		0.28	6.2	SH-60F	0	0	0	0	0	0	69	71	6	4	47	47	69	71	6	4	47	47	22176	3261	68661	2	2	69,373
		0.3	6.6	FA-18A/C	0	0	0	0	0	0	11	30	2	2	28	28	11	30	2	2	28	28	87595.2	12882	271210	9	8	274,024
		0.3	6.6	FA-18E/F	0	0	0	0	0	0	5	101	1	3	45	45	5	101	1	3	45	45	136461.6	20068	422503	14	12	426,832
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Shipboard Integration Test	110	1	110	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	437	11641	8	336	1328	1328	840400	123588	2602027	84	74	2,623,019
		1	110	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	445	3323	100	144	201	201	717772	105555	2222349	72	63	2,245,403
Shipboard Electronic Systems Evaluation	0	1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical and Biological Simulant Testing	220	1	220	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2706000	397941	8378254	272	237	8,465,167
Non-Acoustic Component Testing	17																											
		1	17	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	418200	61500	1294821	42	37	1,308,253
		1	17	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1020	1044	90	65	685	685	163200	24000	505296	16	14	510,538
UNMANNED SYSTEMS																												
Air Defense Testing	9	1	9	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	675	631	53	43	454	454	108000	15882	334387	11	3	337,856
Propulsion Testing	17	1	17	Lesrjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	217056	31920	672044	22	13	673,015
VESSEL EVALUATION																												
Undersea Warfare Training	16	1	16	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1200	1229	106	77	806	806	192000	28235	594466	19	17	600,633
Vessel Signature Evaluation	42	1	17	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1672800	246000	5173284	168	146	5,233,013
		2	34	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	6120	6267	533	392	4113	4113	979200	144000	3031776	98	86	3,063,227
SPAWAR																												
Intelligence, Surveillance, and Reconnaissance Sensor Systems	55	1	55	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	1335	3370	301	431	603	603	2153316	316664	6667046	216	188	6,736,209

Table C-58: Alternative 2 Aircraft Testing Emissions- SDAB

GENERAL INFO					EMISSIONS (lb/yr)																					
			Aircraft		State (0–3 nm)						U.S. (3–12 nm)						International (> 12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvera	110																											
		2.83	311	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3218219.4	473268	3964175	323	282	10,067,541
		0.17	19	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119324.7	17548	369450	12	10	373,283
Air Platform Weapons Integration Test	10																											
		0.3	3	P8-MMA	0	2	0	0	0	0	1	5	0	0	0	0	6	45	1	2	3	3	39151.2	5758	121219	4	3	122,477
		0.4	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	15	305	2	8	136	136	82704	12162	256066	8	7	258,723
		0.3	3	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	9	34	1	1	3	3	13596	1999	42096	1	1	42,532
Air Platform – Vehicle Test	35																											
		0.314	11	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	20	28	1	2	25	25	23760	3494	73565	2	2	74,328
		0.343	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	89	1830	15	50	814	814	496224	72974	1536397	50	43	1,552,335
		0.314	11	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	63	250	9	10	23	23	99704	14662	308701	10	9	311,904
Intelligence, Surveillance, and Reconnaissance Test	254																											
		1	254	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	3699	27626	835	1193	1671	1671	9944404.8	1462412	30789632	999	870	31,109,036
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise–Helo (TRACKEX-Helo)	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise–MPA (TRACKEX-MPA)	0																						0	0	0	0.00	0.00	0
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	0																						0	0	0	0.00	0.00	0
		0.83	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anti-Submarine Warfare Mission Package Testing	0																											
		0.83	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
At-Sea Sonar Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo (Explosive) Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Torpedo (Non-Explosive) Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ELECTRONIC WARFARE																												
Counter Targeting Flare Exercise	0																											
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counter Targeting Chaff Exercise – Aircraft	0																								0.00	0.00	0	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radar and Other System Testing	1																											
		3	3	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	857	226	163	15	49	49	38304	5633	118596	4	3	119,826
		1	1	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124056	18244	384099	12	11	388,084
		1	1	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	90	92	8	6	60	60	14400	2118	44585	1	1	45,047
MINE WARFARE																												
Mine Countermeasure Mission Package Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Countermeasure and Neutralization Testing	0																											
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection and Classification Testing	0																											
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Dipping Sonar Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Laser-Based Mine Detection System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbonre Sonobuoy Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying Test	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

					EMISSIONS (lb/yr)																							
					State (0–3 nm)						U.S. (3–12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
					CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
ANTI-SURFACE WARFARE																												
Bombing Test, Air to Surface	0																											
		0.53	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.53	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Test, Air to Surface	0																											
		1.62	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.55	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	MH-60R/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gun Testing – Large Caliber	0																											
		0.74	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.25	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
High Energy Laser Weapons Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laser Targeting Test	0																											
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile and Rocket Testing	0																											
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocket Test	0																											
		0.55	0.0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0.0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0.0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Shipboard Integration Test	0																											
		1	0	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shipboard Electronic Systems Evaluation	26																											
		1	26	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	195	200	17	12	131	131	31200	4588	96601	3	3	97,603
Chemical and Biological Simulant Testing	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-Acoustic Component Testing	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNMANNED SYSTEMS																												
Air Defense Testing	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Propulsion Testing	0																											
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VESSEL EVALUATION																												0
Undersea Warfare Training	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vessel Signature Evaluation	0																											
		1	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPAWAR																												
Intelligence, Surveillance, and Reconnaissance Sensor Systems	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C-59: Alternative 2 Aircraft Testing Emissions - Hawaii

GENERAL INFO					EMISSIONS (lb/yr)																							
			Aircraft		State (0–3 nm)						U.S. (3–12 nm)						International (>12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
Type Training	Training Ops (#)	Distribution	A/C Sorties (#)	Type	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	CO	NO_x	HC	SO_x	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
AIR WARFARE																												
Air Combat Maneuvera	110																											
		2.83	311	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3218219.4	473268	9964175	323	282	10,067,541
		0.17	19	AV-8B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119324.7	17548	369450	12	10	373,283
Air Platform Weapons Integration Test	10																											
		0.3	3	P8-MMA	0	2	0	0	0	0	1	5	0	0	0	0	6	45	1	2	3	3	39151.2	5758	121219	4	3	122,477
		0.4	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	15	305	2	8	136	136	82704	12162	256066	8	7	258,723
		0.3	3	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	9	34	1	1	3	3	13596	1999	42096	1	1	42,532
Air Platform – Vehicle Test	35																											
		0.314	11	UH-1	0	0	0	0	0	0	0	0	0	0	0	0	20	28	1	2	25	25	23760	3494	73565	2	2	74,328
		0.343	12	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	89	1830	15	50	814	814	496224	72974	1536397	50	43	1,552,335
		0.314	11	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	63	250	9	10	23	23	99704	14662	308701	10	9	311,904
Intelligence, Surveillance, and Reconnaissance Test	254																											
		1	254	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	3699	27626	835	1193	1671	1671	9344404.8	1462412	30789632	993	870	31,109,036
ANTI-SUBMARINE WARFARE																												
Tracking / Torpedo Exercise Helo (TRACKEX-Helo)	0																											
		0.17	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.83	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				MH-60R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tracking / Torpedo Exercise MPA (TRACKEX-MPA)	65																											
		1	65	P-3	151	464	35	24	238	238	301	927	70	48	476	476	2559	7880	591	408	4047	4047	1539000	235147	4950786	161	140	5,002,144
		0	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilo Dip-Helo	0																											
		0.83	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonobuoy Lot Acceptance Test	0																											
		1	0	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anti-Submarine Warfare Mission Package Testing	27																											
		0.83	22	SH-60B	0	0	0	0	0	0	143	146	13	9	96	96	462	473	41	30	311	311	96811.2	14237	293745	10	8	302,854
At-Sea Sonar Testing	17																											
		1	17	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1275	1306	112	82	857	857	204000	30000	631620	20	18	638,172
		1	17	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	688	5136	155	222	311	311	1109284	163130	3434539	111	97	3,470,168
Torpedo (Explosive) Testing	12																											
		1	12	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	720	737	63	46	484	484	115200	16941	356680	12	10	360,380
		1	12	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	388	2900	88	125	175	175	626419.2	92120	1939504	63	55	1,959,624
Torpedo (Non-Explosive) Testing	18																											
		1	18	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1080	1106	95	69	726	726	172800	25412	535019	17	15	540,569
		1	18	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	583	4350	132	188	263	263	939628.8	138181	2909257	94	82	2,939,436

ELECTRONIC WARFARE																												
Counter Targeting Flare Exercise	5																											
		2	10	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	284295	41808	880227	29	25	889,359
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	10	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112750	16581	349094	11	10	352,715
		2	10	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	175725	25842	544076	18	15	549,720
		2	10	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112750	16581	349094	11	10	352,715
		1	5	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10640	1565	32943	1	1	33,285
Counter Targeting Chaff Exercise – Aircraft	0																						0	0	0	0.00	0.00	0
		2	0	FA-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	EA-18G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EP-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronic Systems Evaluation	0																											
		0.08	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.05	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.004	0	HH-60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.04	0	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.29	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	E-2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.02	0	EA-6B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.2	0	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.01	0	Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radar and Other System Testing	4																											
		3	12	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	3429	904	653	61	195	195	153216	22532	474384	15	13	479,305
		1	4	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	496224	72974	1536397	50	43	1,552,335
		1	4	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	360	369	32	23	242	242	57600	8471	178340	6	5	180,190
MINE WARFARE																												
Mine Countermeasure Mission Package Testing	24																											
		1	24	SH-60B	450	461	40	29	302	302	270	276	24	17	181	181	180	184	16	12	121	121	144000	21176	445849	14	13	450,475
Mine Countermeasure and Neutralization Testing	0																											
		2	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Detection and Classification Testing	7																											
		2	14	SH-60B	420	430	37	27	282	282	252	258	22	16	169	169	168	172	15	11	113	113	134400	19765	416126	13	12	420,443
Airborne Dipping Sonar Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Laser-Based Mine Detection System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airborne Mine Neutralization System Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airbonre Sonobuoy Minehunting Test	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Laying Test	1																											
		1	1	P8-MMA	2	15	0	1	1	1	1	9	0	0	1	1	1	6	0	0	0	0	6525.2	960	20203	1	1	20,413

ANTI-SURFACE WARFARE																												
Bombing Test, Air to Surface	8																											
		0.53	4	FA-18A/C	0	0	0	0	0	0	3	9	1	1	9	9	3	9	1	1	9	9	28136.64	4138	87116	3	2	88,020
		0.53	4	FA-18E/F	0	0	0	0	0	0	2	32	0	1	14	14	2	32	0	1	14	14	43833.12	6446	135715	4	4	137,123
		0.28	2	P-3	0	0	0	0	0	0	1	4	0	0	2	2	1	4	0	0	2	2	9184	1351	28435	1	1	28,730
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Test, Air to Surface	5																											
		1.62	8	SH-60B	0	0	0	0	0	0	30	31	3	2	20	20	30	31	3	2	20	20	9720	1429	30095	1	1	30,407
		0.55	8	SH-60F	0	0	0	0	0	0	30	31	3	2	20	20	30	31	3	2	20	20	9720	1429	30095	1	1	30,407
		0.02	8	MH-60R/S	0	0	0	0	0	0	30	31	3	2	20	20	30	31	3	2	20	20	9720	1429	30095	1	1	30,407
Gun Testing – Large Caliber	43																								0			
		0.74	32	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	955	978	84	61	641	641	152736	22461	472898	15	13	477,803
		0.25	11	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	323	330	28	21	217	217	51600	7588	159763	5	5	161,420
High Energy Laser Weapons Test	54																											
		1	54	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	810	829	71	52	544	544	129600	19059	401264	13	11	405,427
Laser Targeting Test	0																											
		0.55	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.28	0	SH-60F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18A/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0.3	0	FA-18E/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Missile and Rocket Testing	25																								0	0	0.00	0.00	0
		0.55	13.8	SH-60B	0	0	0	0	0	0	155	158	14	10	104	104	155	158	14	10	104	104	49500	7279	153261	5	4	154,851
		0.28	7.0	SH-60F	0	0	0	0	0	0	79	81	7	5	53	53	79	81	7	5	53	53	25200	3706	78024	3	2	78,833
		0.3	7.5	FA-18A/C	0	0	0	0	0	0	12	34	2	2	32	32	12	34	2	2	32	32	99540	14638	308193	10	9	311,391
		0.3	7.5	FA-18E/F	0	0	0	0	0	0	6	114	1	3	51	51	6	114	1	3	51	51	155070	22804	480124	16	14	485,105
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocket Test	2									0						0						0			0			
		0.55	1.1	SH-60B	0	0	0	0	0	0	12	13	1	1	8	8	12	13	1	1	8	8	3960	582	12261	0	0	12,388
		0.28	0.6	SH-60F	0	0	0	0	0	0	6	6	1	0	4	4	6	6	1	0	4	4	2016	296	6242	0	0	6,307
		0.3	0.6	FA-18A/C	0	0	0	0	0	0	1	3	0	0	3	3	1	3	0	0	3	3	7963.2	1171	24655	1	1	24,911
		0.3	0.6	FA-18E/F	0	0	0	0	0	0	0	9	0	0	4	4	0	9	0	0	4	4	12405.6	1824	38410	1	1	38,808
		0	0.0	S-3B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER																												
Air Platform Shipboard Integration Test	7																											
		1	7	MV-22	0	0	0	0	0	0	0	0	0	0	0	0	28	754	1	21	84	84	53480	7865	165584	5	5	167,301
		1	7	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	28	211	6	9	13	13	45676.4	6717	141422	5	4	142,889
Shipboard Electronic Systems Evaluation	0																											
		1	0	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical and Biological Simulant Testing	220																											
		1	220	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2706000	397941	8378254	272	237	8,465,167
Non-Acoustic Component Testing	8																											
		1	8	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	196800	28941	609328	20	17	615,649
		1	8	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	480	492	42	31	323	323	76800	11294	237786	8	7	240,253
UNMANNED SYSTEMS																												
Air Defense Testing	4																											
		1	4	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	300	307	26	19	202	202	48000	7059	148616	5	4	150,158
Propulsion Testing	8																											
		1	8	Learjet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102144	15021	316256	10	9	319,537
VESSEL EVALUATION																												
Undersea Warfare Training	15																											
		1	15	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	1125	1152	99	72	756	756	180000	26471	557312	18	16	563,093
Vessel Signature Evaluation	22																											
		1	8	P-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	787200	115765	2437310	79	69	2,462,594
		2	16	SH-60B	0	0	0	0	0	0	0	0	0	0	0	0	2880	2949	253	184	1935	1935	460800	67765	1426718	46	40	1,441,519
SPAWAR																												
Intelligence, Surveillance, and Reconnaissance Sensor Systems	15																											
		1	15	P8-MMA	0	0	0	0	0	0	0	0	0	0	0	0	364	2719	82	117	164	164	587268	86363	1818285	59	51	1,837,148

EMISSIONS (lb/yr)																											
State (0–3 nm)							U.S. (3–12 nm)						International (> 12 nm)						Annual Fuel Use (total)		GHG Emissions (lb)			
CO	NO_X	HC	SO_X	PM_{10}	$PM_{2.5}$	CO	NO_X	HC	SO_X	PM_{10}	$PM_{2.5}$	CO	NO_X	HC	SO_X	PM_{10}	$PM_{2.5}$	Pounds	Gallons	CO_2	N_2O	CH_4	CO_2e
1,023	1,372	112	80	824	824	1,336	2,178	163	120	1,269	1,269	19,086	60,099	3,151	2,786	12,887	12,887	24,617,161	3,620,171	76,219,076	2,473	2,154	77,009,754
1	1	0	0	0	0	1	1	0	0	1	1	10	30	2	1	6	6			38,110	1	1	38,505

Table C-60: Alternative 2 Ordnance Training Emissions

MEM Category	Location – Range Complex	Training MEM # / yr	Emissions (lb/year) Training CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Bombs									
Bombs (1000 lb MK83)	HRC	12	0	740	0		0	0	0
	SOCAL	12	0	740	0		0	0	0
	Total	24	0						
Bombs (2000 lb MK84)	HRC	261	0	38,551	0		0	0	0
	SOCAL	320	0	44,816	0		0	0	0
	Total	581	0						
Bombs (2000 lb LGB)	HRC	36	0	5,042	0		0	0	0
	SOCAL	0	0	0	0		0	0	0
	Total	36	0						
Projectiles									
20 MM Projectile	HRC	4,000	64	132	2	0	0	3	2
	SOCAL	4,000	64	132	2	0	0	3	2
	Transit			0	0	0	0	0	0
	Total	8,000							
25 MM Projectile	HRC	256	4	5	0	0	0	1	0
	SOCAL	256	4	5	0	0	0	1	0
	Total	512							
30 MM Projectile MK-238	HRC	1100	18	8	2	0	0	37	23
	SOCAL	1640	26	12	3	0	0	55	34
	Transit	200	3	1	0	0	0	7	4
	Total	2,940							
M1060 40 MM Projectile MK-3A	HRC	400	6	2	1	0	0	4	2
	SOCAL	1140	18	5	1	0	0	11	6
	Transit	200	3	1	0	0	0	1	1
	Total	1,740							
Rockets 2.75 in	HRC	327	5	304	2	0	0	131	95
	SOCAL	1874	30	1,743	10	0	0	750	543
	Total	2201							
(5) Caliber HE CDF	HRC	0	0	0	0	0	0	0	0
	SOCAL	4,950	79	42,719	411	0	13	17,028	644
	Total	4,950							
5 in 54 HE Surf	HRC	1,908	31	305	0	0	0	18	14
	SOCAL	4,224	68	676	0	0	0	41	31
	Transit	32	1	5	0	0	0	0	0
	Total	6,164							
A-A Missiles (H-E)	HRC	62	1	0	0	0	0	0	0
	SOCAL	4	0	0	0	0	0	0	0
	Total	66							
Missiles hellfire (propelled by solid propellant)	HRC	10	0	0	0	0	0	0	0
	SOCAL	25	0	0	0	0	0	0	0
	Total	35							
Missiles Griffin (note, fired by 5" caliber)	HRC	22	0	4	0	0	0	0	0
	SOCAL	29	0	5	0	0	0	0	0
	Total	51							
Missiles (H-E)	HRC	30	0	0	0	0	0	0	0
	SOCAL	25	0	0	0	0	0	0	0
	Total	55							
Missiles Maverick (Thiokol SR 109-TC-1 solid-propellant)	HRC	20	0	0	0	0	0	0	0
	SOCAL	96	1	0	0	0	0	0	0
	Total	116							
Missiles Harpoon (turbojet solid propellant)	HRC	27	0	0	0	0	0	0	0
	SOCAL	6	0	0	0	0	0	0	0
	Total	33							

		CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Total for HRC		131	43,094	6	0	0	194	136
		0.1	21.5	0.0	0.0	0.0	0.1	0.1
Total for SOCAL		292	90,851	447	0	13	17,888	1,261
		0.1	45.4	0.2	0.0	0.0	8.9	0.6
Total for Transit Area		7	7	1	0	0	9	5
		0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL for Activity	pounds	430	132,472	454	0	13	18,091	1,403
	tons	0.2	66.2	0.2	0.0	0.0	9.0	0.7
Total for Study Area	pounds							
	tons	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Within 3 nm		CO	NOx	VOC	SOx	PM10	PM2.5
Total for HRC		0	0	0	0	0	0
		0.0	0.0	0.0	0.0	0.0	0.0
Total for SOCAL		42,719	411	0	13	17,028	644
		21.4	0.2	0.0	0.0	8.5	0.3
Total for Transit Area		0	0	0	0	0	0
TOTAL for Activity	pounds	42,719	411	0	13	17,028	644
	tons	21.4	0.2	0.0	0.0	8.5	0.3
Total for Study Area	tons	0.0	0.0	0.0	0.0	0.0	0.0

Table C-61: Alternative 2 Ordnance Testing Emissions

MEM Category	Location – Range Complex	Testing MEM #/yr	Emissions (lb/year) Testing						
			CO2	CO	NOx	VOC	SOx	PM10	PM2.5
Bombs									
Bombs (1000 lb MK83)	HRC		0	0	0		0	0	0
	SOCAL		0	0	0		0	0	0
	Total	0	0						
Bombs (2000 lb MK84)	HRC		0	0	0		0	0	0
	SOCAL		0	0	0		0	0	0
	Total	0	0						
Bombs (500 lb LGB)	HRC	1	0	61	0		0	0	0
	SOCAL	1	0	61	0		0	0	0
	Total	2	0						
Bombs (2000 lb LGB)	HRC		0	0	0		0	0	0
	SOCAL		0	0	0		0	0	0
	Total	0	0						
Projectiles									
20 MM Projectile	HRC		0	0	0	0	0	0	0
	SOCAL	200	1	7	0	0	0	0	0
	Total	200							
25 MM Projectile	HRC		0	0	0	0	0	0	0
	SOCAL		0	0	0	0	0	0	0
	Total	0							
30 MM Projectile MK-238	HRC	1925	31	14	3	0	0	65	40
	SOCAL	7225	116	53	12	0	0	244	150
	Total	9,150							
30 MM Projectile NAVSEA	HRC	13440	215	98	22	0	0	454	280
	SOCAL	13916	223	101	23	0	0	470	289
	Total	27,356							
M1060 40 MM Projectile MK-3A	HRC		0	0	0	0	0	0	0
	SOCAL		0	0	0	0	0	0	0
	Total	0							
57 MM HE	HRC	636	10	38	3	0	0	39	19
	SOCAL	636	10	38	3	0	0	39	19
	Total	1,272							
Rockets 2.75 in	HRC	3	0	3	0	0	0	1	1
	SOCAL	103	2	96	1	0	0	41	30
	Total	106							
LG Caliber HE CPF	HRC	2,680	43	22,936	231	0	7	9,150	348
	SOCAL	2,720	44	23,474	237	0	7	9,457	354
	Total	5,380							
5 in 54 HE Surf	HRC	700	11	112	0	0	0	7	5
	SOCAL	700	11	112	0	0	0	7	5
	Total	1,400							
A-A Missiles (H-E)	HRC		0						
	SOCAL		0						
	Total	0							
Missiles Hellfire	HRC	8	0	0	0	0	0	0	0
	SOCAL	18	0	0	0	0	0	0	0
	Total	26							
Missiles Griffin	HRC		0						
	SOCAL		0						
	Total	0							
Missiles (H-E)	HRC	377	6	0	0	0	0	0	0
	SOCAL	404	6	0	0	0	0	0	0
	Total	781							
Missiles Maverick	HRC		0						
	SOCAL		0						
	Total	0							
Missiles Harpoon	HRC	10	0	0	0	0	0	0	0
	SOCAL	20	0	0	0	0	0	0	0
	Total	30							
JSOW	HRC	1	0	0	0	0	0	0	0
	SOCAL	1	0	0	0	0	0	0	0
	Total	2							
			CO2	**CO**	**NOx**	**VOC**	**SOx**	**PM10**	**PM2.5**
Total for HRC			116	23,282	260	0	7	9,717	691
			0.2	11.6	0.1	0.0	0.0	4.9	0.3
Total for SOCAL			415	23,941	275	0	7	10,159	848
			0.2	12.0	0.1	0.0	0.0	5.1	0.4
TOTAL for Activity	pounds		731	47,223	535	0	15	19,876	1,538
	tons		0.4	23.6	0.3	0.0	0.0	9.9	0.8
Total for Study Area	pounds		731	47,223	535	0	15	19,876	1,538
	tons		0.4	23.6	0.3	0.0	0.0	9.9	0.8

C.5 RECORD OF NON-APPLICABILITY

This appendix provides a Record of Non-Applicability (RONA) for each California Air Basin potentially impacted by the Proposed Action (South Coast Air Basin and San Diego Air Basin) in accordance with 40 CFR 93.153(b).

C.5.1 SOUTH COAST AIR BASIN

NAVY RECORD OF NON-APPLICABILITY FOR CLEAN AIR ACT CONFORMITY

The Proposed Action falls under the Record of Non-Applicability (RONA) category, and is documented with this RONA.

Action Proponents: United States Pacific Fleet, Naval Sea Systems Command, Naval Air Systems Command, Office of Naval Research, and Space and Naval Warfare Systems Command

Proposed Action: Hawaii-Southern California Training and Testing (HSTT) Activities

Proposed Action Location: Southern California Range Complex, CA

Proposed Action and Emissions Summary:

The action involves operation of military aircraft, vessels, and small boats in order to achieve requisite training and testing requirements. Some of these activities would occur in the vicinity of San Clemente Island, within the South Coast Air Basin.

Attainment Area Status and Emissions Evaluation Conclusion:

The South Coast Air Basin is classified as an extreme non-attainment area for ozone, a serious non-attainment area for particulate matter with a diameter less than or equal to 2.5 microns, and a maintenance area for carbon monoxide, nitrogen dioxide, and particulate matter with a diameter less than or equal to 10 microns. As a result, Proposed Action emissions were evaluated to assess compliance with the General Conformity Rule *de minimis* thresholds. The estimated annual emissions for Alternative 1 and Alternative 2 compared to the baseline are presented in Table 1.

Table 1: Estimated Air Pollutant Emissions Under the Proposed Action

Parameter	Emissions by Air Pollutant (TPY)					
	CO	NO_X	VOC	PM_{10}	$PM_{2.5}$	SO_X
Baseline	99	158	23	22	22	34
Alternative 1	73	104	28	20	20	22
Alternative 2	73	104	28	20	20	22
Net Change from Alternative 1	(26)	(54)	5	(2)	(2)	(12)
Net Change from Alternative 2	(26)	(54)	5	(2)	(2)	(12)
De Minimis Threshold	100	10	10	100	70	70
Alternative 1 Exceeds Threshold?	No	No	No	No	No	No
Alternative 2 Exceeds Threshold?	No	No	No	No	No	No

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding. CO = carbon monoxide; NO_X = nitrogen oxides; PM_{10} = particulates under 10 microns; $PM_{2.5}$ = particulates under 2.5 microns; TPY = tons per year; VOC = volatile organic compounds

The U.S. Navy concludes that *de minimis* thresholds for all emissions would not be exceeded as a result of implementation of the Proposed Action. The emissions data supporting that conclusion is shown in Table 1. The calculations, methodology, data, and references are contained in Section 3.1 and Appendix C of the HSTT Environmental Impact Statement/Overseas Environmental Impact Statement. Therefore, the Navy concludes that formal Conformity Determination procedures are not required, resulting in this RONA.

Affected Air Basin: South Coast Air Basin

Date RONA prepared: 26 September 2018

RONA prepared by: Naval Facilities Engineering Command, Southwest

RONA Approval:

Larry M. Foster

Date: 3 Oct 2018

Larry M. Foster
Director Environmental Readiness, U.S. Pacific Fleet

C.5.2 SAN DIEGO AIR BASIN

NAVY RECORD OF NON-APPLICABILITY FOR CLEAN AIR ACT CONFORMITY

The Proposed Action falls under the Record of Non-Applicability (RONA) category, and is documented with this RONA.

Action Proponents: United States Pacific Fleet, Naval Sea Systems Command, Naval Air Systems Command, Office of Naval Research, and Space and Naval Warfare Systems Command

Proposed Action: Hawaii-Southern California Training and Testing (HSTT) Activities

Proposed Action Location: Southern California Range Complex, CA

Proposed Action and Emissions Summary:

The action involves operation of military aircraft, vessels, and small boats in order to achieve requisite training and testing requirements. Some of these activities would occur in the vicinity of Camp Pendleton and San Diego Bay, within the San Diego Air Basin.

Attainment Area Status and Emissions Evaluation Conclusion:

The San Diego Air Basin is classified as non-attainment area for ozone and as a maintenance area for carbon monoxide. Effective June 3, 2016, the San Diego Air Basin was reclassified to a Moderate nonattainment area by USEPA. The estimated annual emissions for Alternative 1 and Alternative 2 compared to the baseline are presented in Table 1.

Table 1: Estimated Air Pollutant Emissions Under the Proposed Action

Parameter	Emissions by Air Pollutant (TPY)		
	CO	NO_X	VOC
Baseline	146	855	456
Alternative 1	138	835	445
Alternative 2	139	849	445
Net Change from Alternative 1	(8)	(20)	(11)
Net Change from Alternative 2	(7)	(6)	(11)
***De Minimis* Threshold**	100	100	100
Alternative 1 Exceeds Threshold?	No	No	No
Alternative 2 Exceeds Threshold?	No	No	No

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding. CO = carbon monoxide; NO_X = nitrogen oxides; PM_{10} = particulates under 10 microns; $PM_{2.5}$ = particulates under 2.5 microns; TPY = tons per year; VOC = volatile organic compounds

The U.S. Navy concludes that de minimis thresholds for all emissions would not be exceeded as a result of implementation of the Proposed Action. The emissions data supporting that conclusion is shown in Table 1. The calculations, methodology, data, and references are contained in Section 3.1 and Appendix C of the HSTT Environmental Impact Statement/Overseas Environmental Impact Statement. Therefore, the Navy concludes that formal Conformity Determination procedures are not required, resulting in this RONA.

Affected Air Basin: San Diego Air Basin

Date RONA prepared: 26 September 2018

RONA prepared by: Naval Facilities Engineering Command, Southwest

RONA Approval:

Larry M. Foster

Date: 3 Oct 2018

Larry M. Foster
Director Environmental Readiness, U.S. Pacific Fleet

Appendix D: Acoustic and Explosive Concepts

Final
Environmental Impact Statement/Overseas Environmental Impact Statement
Hawaii-Southern California Training and Testing

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APPENDIX D ACOUSTIC AND EXPLOSIVE CONCEPTS

This section introduces basic principles and terminology for acoustics and explosives to help the reader understand the analyses presented in this Environmental Impact Statement. This section briefly explains the transmission of sound and explosive energy; introduces some of the basic mathematical formulas used to describe propagation; and defines acoustical terms, abbreviations, and units of measurement. The difference between transmission of sound in water and in air is also discussed. Finally, it discusses methods used to analyze what animals may hear.

A number of other sources provide a more extensive background on acoustics and explosives than presented in this overview and are recommended for further inquiry. These include, but are not limited to:

- *Marine Mammals and Noise* (Richardson et al., 1995) for a general overview
- *Principles of Underwater Sound* (Urick, 1983), *Fundamentals of Acoustical Oceanography* (Medwin & Clay, 1998), and *Principles of Marine Bioacoustics* (Au & Hastings, 2008) for comprehensive explanations of underwater acoustics

D.1 Terminology

The following terms are used in this document when discussing sound and the attributes of a sound source.

D.1.1 Sound

Sound is produced when an elastic medium (such as air or water) is set into motion, typically by a vibrating object within the medium. As the object vibrates, its motion is transmitted to adjacent "particles" of the medium. The motion of these particles is transmitted to adjacent particles, and so on. The result is a mechanical disturbance (the "sound wave") that moves away from the source and propagates at a medium-dependent speed (the "sound speed"). As the sound wave travels through the medium, the individual particles of the medium oscillate about their original positions but do not actually move with the sound wave. As the particles of the medium move back and forth they create small changes about the original values of the medium density, pressure, and temperature.

Sound may be described by both physical and subjective attributes. Physical attributes, such as sound amplitude and frequency, may be directly measured. Subjective (or sensory) attributes like loudness depend on an animal's perception of sound. Physical attributes of a sound at a particular point are usually obtained by measuring pressure changes as sound waves pass.

D.1.2 Signal versus Noise

When sound is purposely created to convey information, communicate, or obtain information about the environment, it is often referred to as a signal. Examples of sounds that could be considered signals are sonar pings, marine mammal vocalizations and echolocation clicks, tones used in hearing experiments, and small sonobuoy explosions used for submarine detection.

Noise is undesired sound (American National Standards Institute, 1994). Sounds produced by naval aircraft and vessel propulsion are considered noise because they represent possible inefficiencies and increased detectability. Whether a sound is perceived as noise often depends on the receiver (i.e., the animal or system that detects the sound). For example, small explosives and sonar used to generate

sounds that can locate an enemy submarine produce signals that are useful to sailors engaged in anti-submarine warfare, but are assumed to be noise when detected by marine mammals.

The combination of all sounds at a particular location, whether these sources are located near or far, is ambient noise (American National Standards Institute, 1994). Ambient noise includes natural sources, such as sound from crashing waves, rain, and animals (e.g., snapping shrimp), and anthropogenic sources, such as seismic surveys and vessel noise.

D.1.3 Frequency and Wavelength

Frequency is the physical attribute most closely associated with the subjective attribute "pitch"; the higher the frequency, the higher the pitch. Frequency is defined by the number of oscillations in the sound pressure or particle motion per second. One hertz (Hz) is equal to one oscillation per second, and one kilohertz (kHz) is equal to 1,000 oscillations per second. Human hearing generally spans the frequency range from 20 Hz to 20 kHz. The frequency range of a sound is called its bandwidth.

Pure tones have energy at a constant, single frequency. Complex tones contain energy at multiple, discrete frequencies, rather than a single frequency. A harmonic of a sound at a particular frequency is a multiple of that frequency (e.g., harmonic frequencies of a 2 kHz tone are 4 kHz, 6 kHz, 8 kHz, etc.). A source operating at a nominal frequency may emit several harmonic frequencies, but at lower amplitudes. Some sources may also emit subharmonics; however, these are typically many orders of magnitude less powerful than at the center frequency. Sounds with large bandwidth ("broadband" sounds) have energy spread across many frequencies.

In this document, sounds are generally described as either low- (less than 1 kHz), mid- (1 kHz–10 kHz), high- (10 kHz–100 kHz), or very high- (greater than 100 kHz) frequency. Hearing ranges of marine animals (e.g., fish, birds, sea turtles, and marine mammals) are quite varied and are species-dependent. For example, some fish can hear sounds below 100 Hz and some species of marine mammals have hearing capabilities that extend above 100 kHz. Acoustic impact analyses must therefore focus not only on the sound amplitude (i.e., pressure or particle motion, see Section D.1.4), but on the sound frequency and the hearing capabilities of the species being considered.

The wavelength of a sound is the distance between wave peaks. Wavelength decreases as frequency increases. The frequency multiplied by the wavelength equals the speed of sound in a medium, as shown in this equation:

$$\text{Frequency } (s^{-1}) \times \text{wavelength (m)} = \text{sound speed (m/s)}$$

The approximate speed of sound in sea water is 1500 m/s and in air is 340 m/s, although speed varies depending on environmental conditions (e.g., pressure, temperature, and, in the case of sea water, salinity; see Section D.3.1, Speed of Sound).

D.1.4 Sound Amplitude

Sound amplitude is the physical attribute most closely associated with the subjective attribute loudness. Amplitude is related to the amount that the medium particles oscillate about their original positions and can be thought of as the "strength" of a sound (as the amplitude increases, the loudness also increases). As the sound wave travels, the particles of the medium oscillate but do not actually travel with the wave. The result is a mechanical disturbance (i.e., the sound wave) that propagates away from the sound source.

Sound amplitude is typically characterized by measuring the acoustic pressure or particle motion (see Section D.2, Sound Metrics).

D.1.5 Impulsive versus Non-Impulsive Sounds

Although no standard definitions exist, sounds may be broadly categorized as impulsive or non-impulsive. Impulsive sounds have short durations, rapid rise-times, broad frequency content, and high peak sound pressures. Impulsive sounds are often produced by processes involving a rapid release of energy or mechanical impacts (Hamernik & Hsueh, 1991). Explosions, air guns, weapon firing, and impact pile driving are examples of impulsive sound sources analyzed in this document. In contrast, sonars, vessel operation, vibratory pile driving, and underwater transducers lack the characteristics of impulsive sources and are thus examples of non-impulsive sound sources. Non-impulsive sounds can be essentially continuous, such as machinery noise, or intermittent, such as sonar pings.

D.1.6 Acoustic Impedance

Acoustic impedance is a property of the propagation medium (air, water, or tissue) that can be simply described as the opposition to flow of a pressure wave. Acoustic impedance is a function of the density and speed of sound in a medium. Sound transmits more readily through materials of similar acoustic impedance, such as water and animal tissue. When sound waves encounter a medium with different acoustic impedance (for example, an air-water interface), they reflect and refract (see Sections D.3.3.3, Refraction; and D.3.3.4, Reflection and Multipath Propagation), creating more complex propagation conditions. For example, sound traveling in air (low impedance) encountering the water surface (high impedance) will be largely reflected, preventing most sound energy in the air from being transmitted into the water. The impedance difference at the tissue-air interface in animals with gas-containing organs also makes these areas susceptible to damage when exposed to the shock wave near an explosion, since the transmission from high-impedance to low-impedance can result in large motion at the boundary.

D.1.7 Duty Cycle

Duty cycle describes the portion of time that a sound source actually generates sound. It is defined as the percentage of time during which a sound is generated over a total operational time period. For example, if a sonar source produces a one-second ping once every 10 seconds, the duty cycle is 10 percent. Duty cycles vary among different acoustic sources; in general, a low duty cycle could be considered 20 percent or less and a high duty cycle 80 percent or higher.

D.1.8 Resonance

Resonance occurs when an object is vibrated at a frequency near its “natural frequency” or resonant frequency. The resonant frequency can be considered the preferred frequency at which an object will oscillate at a greater magnitude than when exposed to other frequencies. In this document, resonance is considered in relation to the size of an air bubble or air cavity in an animal that is exposed to high pressure waves and the potential for injury. The natural frequencies of dolphin and beluga lungs near the surface are about 36 Hz and 30 Hz, respectively (Finneran, 2003), the natural frequency of lungs of a large whale would be lower, while the natural frequency of small air bubbles would be much higher. Resonant frequencies would tend to increase as an animal dives, since the increased water pressure would compress an air-filled structure and reduce its size.

D.2 Sound Metrics

The sound metrics described here are used in this document to quantify exposure to a sound or explosion.

D.2.1 Pressure

Sound pressure is the incremental variation in a medium's static pressure as a sound wave travels through it. Sound pressure is typically expressed in units of pascals (Pa) (1 Pa = 1 N/m^2 = 10 µbar = 1.45×10^{-4} psi), although explosive overpressure may also be described in pounds per square inch (psi).

Various sound pressure metrics are illustrated in Figure D-1 for (a) a non-impulsive sound (a pure tone in this illustration) and (b) an impulsive sound. As shown in Figure D-1, the non-impulsive sound has a relatively gradual rise in pressure from static pressure (the ambient pressure without the added sound), while the impulsive sound has a near-instantaneous rise to a high peak pressure. The peak pressure shown on both illustrations is the maximum absolute value of the instantaneous sound pressure during a specified time interval ("zero-to-peak" or "peak"), which accounts for the values of peak pressures below the static (ambient) pressure (American National Standards Institute, 2013). "Peak-to-peak" pressure is the difference between the maximum and minimum sound pressures. The root-mean-square (rms) value is often used to describe the average sound pressure level of sounds, and sound pressure levels provided in this EIS/OEIS are root-mean-square values unless otherwise specified. As the name suggests, this method takes the square root of the average squared sound pressure values over a time interval. The duration of this time interval can have a strong effect on the measured rms sound pressure for a given sound, especially where pressure levels vary significantly, as during an impulsive sound exposure. If the analysis duration includes a significant portion of the waveform after the sound pressure has returned to zero, the rms pressure would be relatively low. If the analysis duration includes only the highest pressures of the impulsive exposure, the rms value would be comparatively high. For this reason, it is important to specify the duration used to calculate the rms pressure for impulsive sounds.

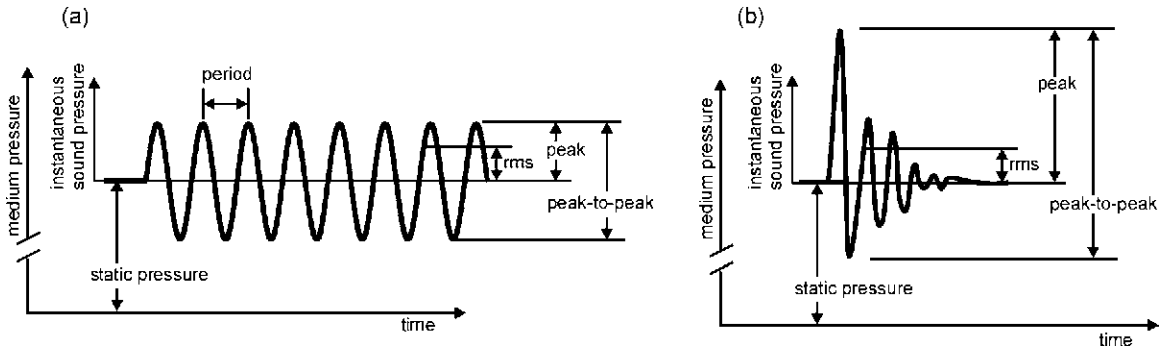


Figure D-1: Various Sound Pressure Metrics for a Hypothetical (a) Pure Tone (Non-Impulsive) and (b) Impulsive Sound

D.2.2 Sound Pressure Level

The most common sound level metric is sound pressure level (SPL). Because many animals can detect very large pressure ranges and judge the relative loudness of sounds by the ratio of the sound pressures (a logarithmic behavior), SPL is described by taking the logarithm of the ratio of the sound pressure to a reference pressure. Use of a logarithmic scale compresses the wide range of measured pressure values into a more useful scale.

Sound pressure levels are normally expressed in decibels. A decibel is 1/10 of a bel, a unit of level when the logarithm is to the base ten and the quantities concerned are proportional to power (American National Standards Institute, 2013). Sound pressure level in decibels is calculated as follows:

$$SPL = 20\log_{10}\left(\frac{P}{P_{ref}}\right)$$

where P is the sound pressure and P_{ref} is the reference pressure. Unless stated otherwise, the pressure P is the rms value of the pressure (American National Standards Institute, 2013). In some situations, SPL is calculated for the peak pressure rather than the rms pressure. On the occasions when rms pressure is not used, the pressure metric will be stated (e.g., peak SPL means an SPL calculated using the peak pressure rather than the rms pressure).

When a value is presented in decibels, it is important to also specify the value and units of the reference quantity. Normally the numeric value is given, followed by the text "re," meaning "with reference to," and the numeric value and unit of the reference quantity. For example, a pressure of 1 Pa, expressed in decibels with a reference of 1 micropascal (µPa), is written 120 dB re 1 µPa. The standard reference pressures are 1 µPa for water and 20 µPa for air. The reference pressure for air, 20 µPa, is the approximate lowest threshold of human hearing. It is important to note that because of the differences in reference units, the same sound pressures would result in different SPL values for each medium (the same sound pressure measured in water and in air would result in a higher SPL in water than in air, since the in-air reference is larger). Therefore, sound pressure levels in air and in water should never be directly compared.

D.2.3 Sound Exposure Level

Sound exposure level (SEL) can be thought of as a composite metric that represents both the SPL of a sound and its duration. Individual time-varying noise events (e.g., a series of sonar pings or an impulsive sound) have two main characteristics: (1) a sound pressure that changes throughout the event and (2) a period of time during which the source is exposed to the sound. SEL can be provided for a single exposure (i.e., a single sonar ping or single explosive detonation) or for an entire acoustic event (i.e., multiple sonar pings or multiple explosive detonations). Cumulative SEL provides a measure of the net exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. SEL is determined by calculating the decibel level of the cumulative sum-of-squared pressures over the duration of a sound, with units of dB re 1 micropascal squared seconds (re 1 μPa^2-s) for sounds in water and dB re (20 micropascal) squared seconds [dB re (20 $\mu Pa)^2$-s] for sounds in air.

Some rules of thumb for SEL are as follows:

- The numeric value of SEL is equal to the SPL of a 1-second sound that has the same total energy as the exposure event. If the sound duration is 1 second, SPL and SEL have the same numeric value (but not the same reference quantities). For example, a 1 second sound with an SPL of 100 dB re 1 µPa has a SEL of 100 dB re 1 μPa^2-s.
- If the sound duration is constant but the SPL changes, SEL will change by the same number of decibels as the SPL.
- If the SPL is held constant and the duration (T) changes, SEL will change as a function of $10\log_{10}(T)$:
    - $10\log_{10}(10) = 10$, so increasing duration by a factor of 10 raises SEL by 10 dB.
    - $10\log_{10}(0.1) = -10$, so decreasing duration by a factor of 10 lowers SEL by 10 dB.

- Since $10 \log_{10}(2) \approx 3$, so doubling the duration increases SEL by 3 dB.
- $10 \log_{10}(1/2) \approx -3$, so halving the duration lowers SEL by 3 dB.

Figure D-2 illustrates the summation of energy for a succession of sonar pings. In this hypothetical case, each ping has the same duration and SPL. The SEL at a particular location from each individual ping is 100 dB re 1 μPa^2-s (red circles). The upper, blue curve shows the running total or cumulative SEL.

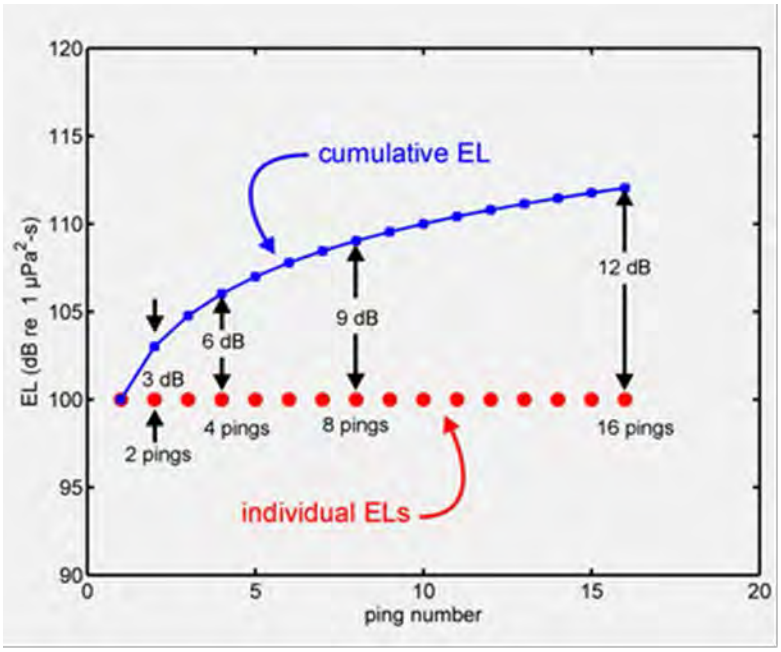


Figure D-2: Summation of Acoustic Energy from a Hypothetical, Intermittently Pinging, Stationary Sound Source

Notes: EL = Exposure Level (i.e., Sound Exposure Level)

After the first ping, the cumulative SEL is 100 dB re 1 μPa^2-s. Since each ping has the same duration and SPL, receiving two pings is the same as receiving a single ping with twice the duration. The cumulative SEL from two pings is therefore 103 dB re 1 μPa^2-s. The cumulative SEL from four pings is 3 dB higher than the cumulative SEL from two pings, or 106 dB re 1 μPa^2-s. Each doubling of the number of pings increases the cumulative SEL by 3 dB.

Figure D-3 shows a more realistic example where the individual pings do not have the same SPL or SEL. These data were recorded from a stationary hydrophone as a sound source approached, passed, and moved away from the hydrophone. As the source approached the hydrophone, the received SPL from each ping increased, causing the SEL of each ping to increase. After the source passed the hydrophone, the received SPL and SEL from each ping decreased as the source moved farther away (downward trend of red line), although the cumulative SEL increased with each additional ping received (slight upward trend of blue line). The main contributions are from those pings with the highest individual SELs. Individual pings with SELs 10 dB or more below the ping with the highest level contribute little (less than 0.5 dB) to the total cumulative SEL. This is shown in Figure D-3, where only a small error is introduced by summing the energy from the eight individual pings with SEL greater than 185 dB re 1 μPa^2-s (black line), as opposed to including all pings (blue line).

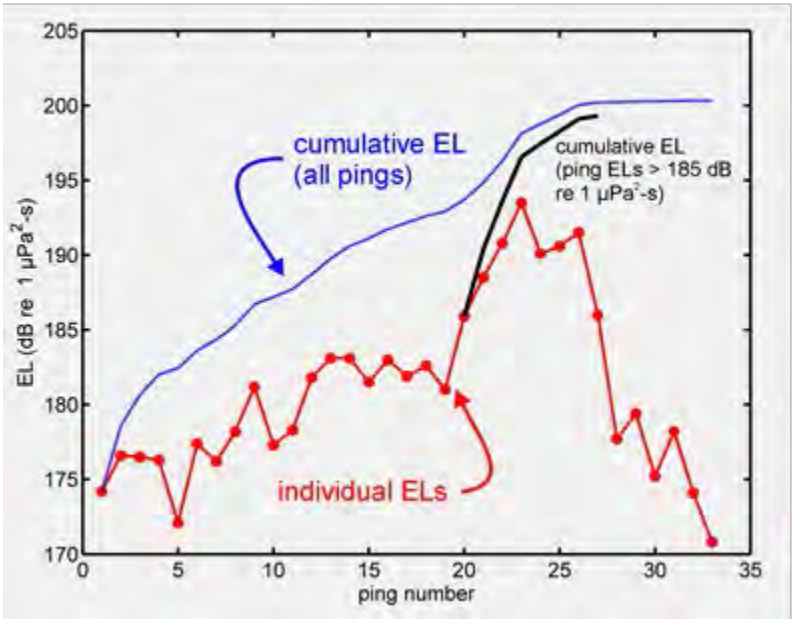


Figure D-3: Cumulative Sound Exposure Level under Realistic Conditions with a Moving, Intermittently Pinging Sound Source

Notes: EL = Exposure Level (i.e., Sound Exposure Level)

D.2.4 Particle motion

The particles of a medium (e.g., water or air) oscillate around their original position as a sound wave passes. This motion is quantified using average displacement (m or dB re 1pm), velocity (m/s or dB re 1 nm/s^2), and acceleration (m/s^2 or dB re 1 µm/s^2) of the particles (Nedelec et al., 2016). Note that particle velocity is not the same as sound speed, which is how fast a sound wave moves through a medium. Particle motion is directional, whereas pressure measurement is not (Nedelec et al., 2016).

Far from a sound source and without any boundaries that could cause wave interference, particle velocity is directly proportional to sound pressure. Closer to a sound source, particle velocity begins to increase relative to sound pressure. Because this phenomena is related to wavelength, it may be relevant only when very close to sound sources with extremely low frequencies.

D.2.5 Impulse

Impulse is a metric used to describe the pressure and time component of a pressure wave. Impulse is typically only considered for high energy exposures to impulsive sources, such as exposures close to explosives. Specifically, positive impulse is the time integral of the initial peak positive pressure with units of Pascal-seconds (Pa-s). Impulse is a measured quantity that is distinct from the term "impulsive," which is not a measurement term, but rather describes a type of sound (see Section D.1.5, Impulsive versus Non-Impulsive Sounds).

D.3 Predicting How Sound Travels

While the concept of a sound wave traveling from its source to a receptor is relatively simple, sound propagation is quite complex because of the simultaneous presence of numerous sound waves of different frequencies and source levels, and other phenomena such as reflections of sound waves and subsequent constructive (additive) or destructive (cancelling) interferences between reflected and

incident waves. Other factors such as refraction, diffraction, bottom types, and surface conditions also affect sound propagation. While simple examples are provided here for illustration, the Navy Acoustic Effects Model used to quantify acoustic exposures to marine mammals and sea turtles takes into account the influence of multiple factors to predict acoustic propagation [see technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017a)].

D.3.1 Speed of Sound

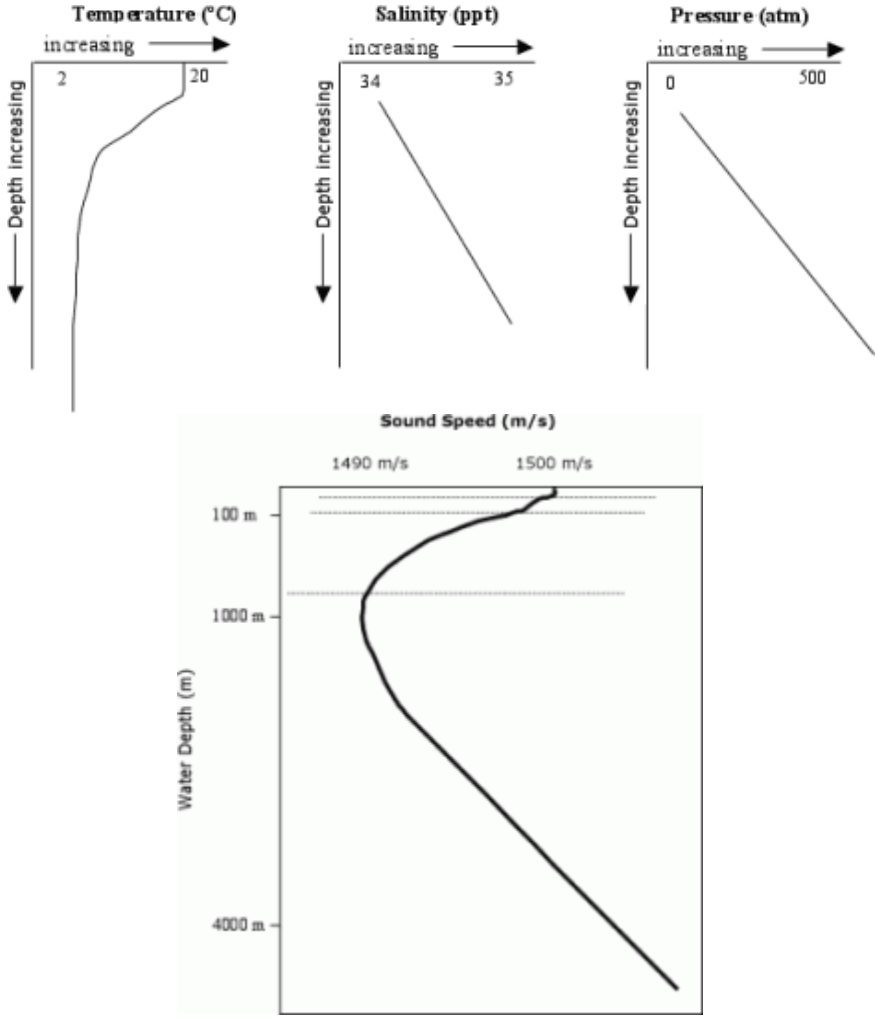
The speed of sound is not affected by the SPL or frequency of the sound, but rather depends wholly on characteristics of the medium through which it is passing (e.g., the density and the compressibility). Sound travels faster through a medium that is harder to compress. For example, water is more difficult to compress than air, and sound travels approximately 340 m/s in air and 1,500 m/s in seawater.

The speed of sound in air is primarily influenced by temperature, relative humidity, and pressure, because these factors affect the density and compressibility of air. Generally, the speed of sound in air increases as air temperature increases.

The speed of sound in seawater also increases with increasing temperature and, to a lesser degree, with increasing hydrostatic pressure and salinity. Figure D-4 shows an example of how these attributes can change with depth. In seawater, temperature has the most important effect on sound speed for depths less than about 300 m. Below 1,500 m, the increasing hydrostatic pressure is the dominant factor because the water temperature is relatively constant. The variation of sound speed with depth in the ocean is called a sound velocity profile.

D.3.2 Source Directivity

Most sonar and other active acoustic sources do not radiate sound in all directions. Rather, they emit sounds over a limited range of angles, in order to focus sound energy on a specific area or object of interest. The specific angles are sometimes given as horizontal or vertical beam width. Some sources can be described qualitatively as “forward-looking,” when sound energy is radiated in a limited direction in front of the source, or “downward-looking,” when sound energy is directed toward the bottom.



Source: http://blogs.oregonstate.edu/bioacoustics/2014/10/21/talk-weather/

Figure D-4: Sound Velocity Profile (Sound Speed) Is Related to Temperature, Salinity, and Hydrostatic Pressure of Seawater

D.3.3 Transmission Loss

As a sound wave passes through a medium, the sound level decreases with distance from the sound source. This phenomenon is known as transmission loss (TL). The transmission loss is used to relate the source SPL (SL), defined as the SPL produced by a sound source at a distance of one meter, and the received SPL (RL) at a particular location, as follows:

$$RL = SL - TL$$

The main contributors to transmission loss are as follows (Urick, 1983):

- Geometric spreading of the sound wave as it propagates away from the source
- Sound absorption (conversion of sound energy into heat)
- Scattering, diffraction, multipath interference, and boundary effects

D.3.3.1 Geometrical Spreading Loss

Spreading loss is a geometric effect representing regular weakening of a sound wave as it spreads out from a source. Spreading describes the reduction in sound pressure caused by the increase in surface area as the distance from a sound source increases. Spherical and cylindrical spreading are common types of spreading loss.

In the simple case of sound propagating from a point source without obstruction or reflection, the sound waves take on the shape of an expanding sphere. An example of spherical spreading loss is shown in Figure D-5. As spherical propagation continues, the sound energy is distributed over an ever-larger area following the inverse square law: the pressure of a sound wave decreases inversely with the square of the distance between the source and the receptor. For example, doubling the distance between the receptor and a sound source results in a reduction in the pressure of the sound to one-fourth of its initial value; tripling the distance results in one-ninth of the original pressure, and so on. Since the surface area of a sphere is $4\pi r^2$, where r is the sphere radius, the change in SPL with distance r from the source is proportional to the radius squared. This relationship is known as the spherical spreading law. The transmission loss for spherical spreading between two locations is:

$$TL = 20 \log_{10} (r_2/r_1)$$

where r_1 and r_2 are distances from the source. Spherical spreading results in a 6 dB reduction in SPL for each doubling of distance from the sound source. For example, calculated transmission loss for spherical spreading is 40 dB at 100 m and 46 dB at 200 m.

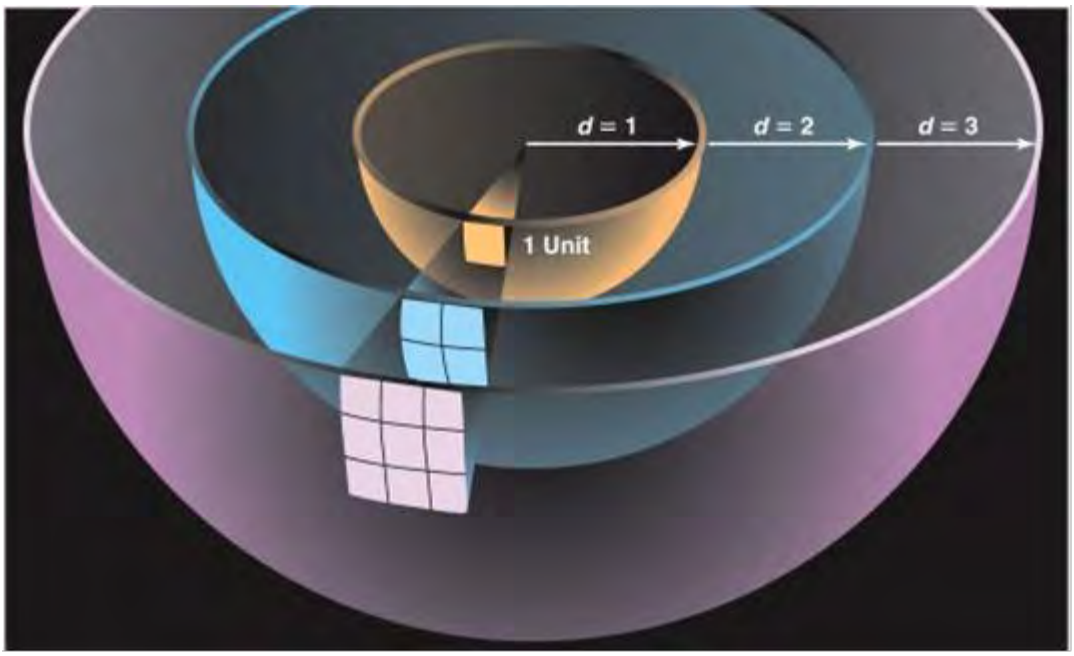


Figure D-5: Graphical Representation of the Inverse Square Relationship in Spherical Spreading

In cylindrical spreading, spherical waves expanding from the source are constrained by the water surface and the seafloor and take on a cylindrical shape. In this case the sound wave expands in the shape of a cylinder rather than a sphere, and the transmission loss is:

$$TL = 10\log_{10}(r_2/r_1)$$

Cylindrical spreading is an approximation of sound propagation in a water-filled channel with horizontal dimensions much larger than the depth. Cylindrical spreading predicts a 3 dB reduction in SPL for each doubling of distance from the source. For example, calculated transmission loss for cylindrical spreading is 30 dB at 1,000 m and 33 dB at 2,000 m.

The cylindrical and spherical spreading equations above represent two simple hypothetical cases. In reality, geometric spreading loss is more spherical near a source and more cylindrical with distance, and is better predicted using more complex models that account for environmental variables, such as the Navy Acoustic Effects Model [see technical report *Modeling and Quantitative Analysis of Acoustic and Explosive Impacts to Marine Species due to Navy Training and Testing Activities* (DON 2017)].

However, when conducting simple spreading loss calculations in near shore environments, "practical spreading loss" can be applied, where:

$$TL = 15\log_{10}(r_2/r_1)$$

Practical spreading loss accounts for other realistic losses in the environment, such as absorption and scattering, which are not accounted for in geometrical spreading.

D.3.3.2 Absorption

Absorption is the conversion of acoustic energy to kinetic energy in the particles of the propagation medium (Urick, 1983). Absorption is directly related to sound frequency, with higher frequencies having higher rates of absorption. Absorption rates range from 0.07 dB/km for a 1 kHz sound to about 30 dB/km for a 100 kHz sound. Therefore, absorption is the cause of a significant amount of attenuation for high and very high frequency sound sources, reducing the distance over which these sources may be perceived compared to mid- and low-frequency sound sources with the same source level.

D.3.3.3 Refraction

When a sound wave propagating in a medium encounters a second medium with a different density (e.g., the air-water boundary), part of the incident sound will be reflected back into the first medium and part will be transmitted into the second medium (Kinsler et al., 1982). The propagation direction will change as the sound wave enters the second medium; this phenomenon is called refraction. Refraction may also occur within a single medium if the properties of the medium change enough to cause a variation in the sound speed. Refraction of sound resulting from spatial variations in the sound speed is one of the most important phenomena that affect sound propagation in water (Urick, 1983).

As discussed in Section D.3.1 (Speed of Sound), the sound speed in the ocean primarily depends on hydrostatic pressure (i.e., depth) and temperature. Although the actual variations in sound speed are small, the existence of sound speed gradients in the ocean has an enormous effect on the propagation of sound in the ocean. If one pictures sound as rays emanating from an underwater source, the propagation of these rays changes as a function of the sound speed profile in the water column. Specifically, the directions of the rays bend toward regions of slower sound speed. This phenomenon creates ducts in which sound becomes "trapped," allowing it to propagate with high efficiency for large distances within certain depth boundaries. During winter months, the reduced sound speed at the surface due to cooling can create a surface duct that efficiently propagates sound such as commercial shipping noise (Figure D-6). Sources located within this surface duct can have their sounds trapped, but sources located below this layer would have their sounds refracted downward. The deep sound channel, or sound frequency and ranging (SOFAR) channel, is another duct that exists where sound speeds are slowest deeper in the water column (600–1,200 m depth at the mid-latitudes).

Similarly, the path of sound will bend toward regions of lower sound speed in air. Air temperature typically decreases with altitude, meaning sounds produced in air tend to bend skyward. When an atmospheric temperature inversion is present, air is cooler near the earth's surface. In inversion conditions, sound waves near the earth's surface will tend to refract downward.

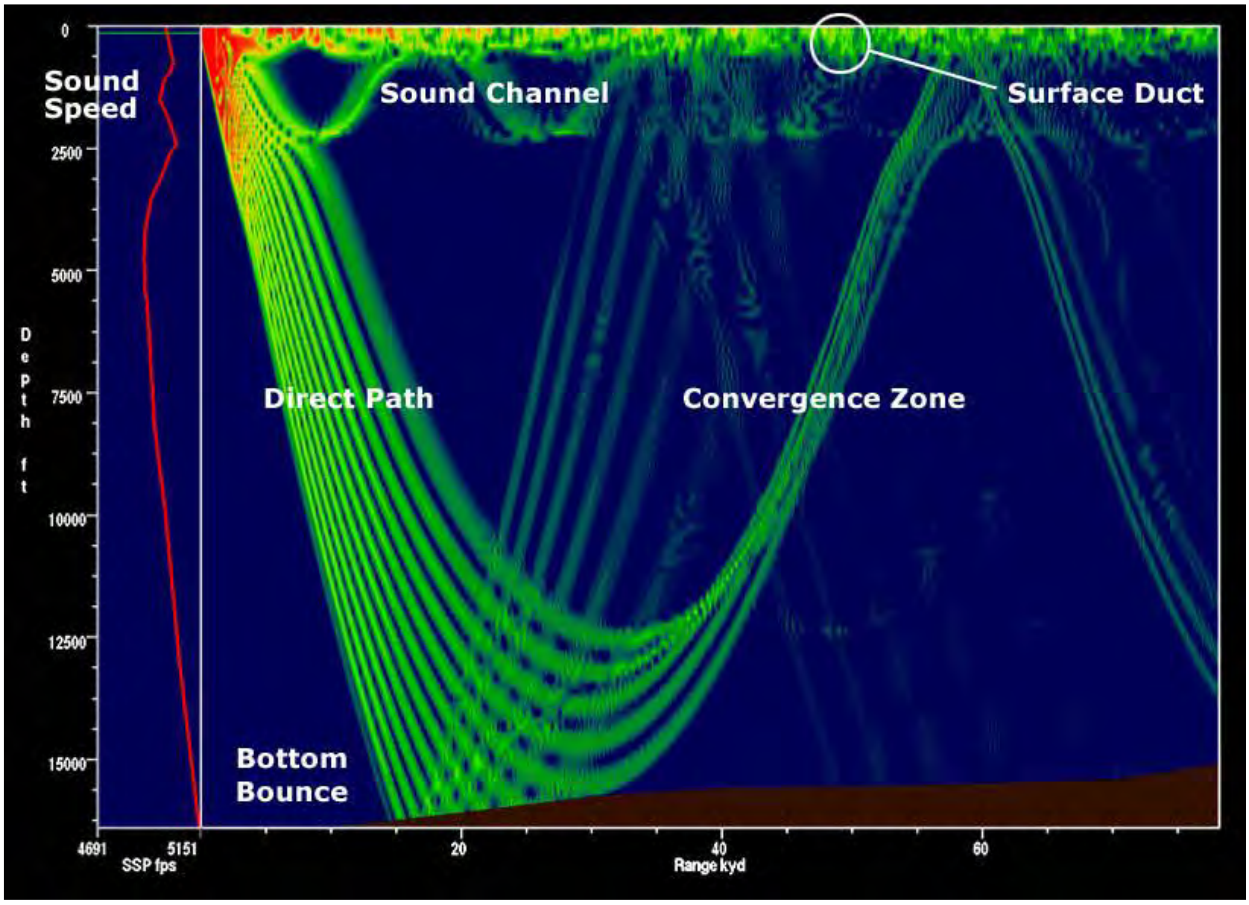


Figure D-6: Sound Propagation Showing Multipath Propagation and Conditions for Surface Duct

Note: 1 kiloyard (kyd) = 0.9 km

D.3.3.4 Reflection and Multipath Propagation

In multipath propagation, sound may not only travel a direct path (with no reflection) from a source to a receiver, but also be reflected from the surface or bottom multiple times before reaching the receiver (Urick, 1983). Reflection is shown in Figure D-6 at the seafloor (bottom bounce) and at the water surface. At some distances, the reflected wave will be in phase with the direct wave (their waveforms add together) and at other distances the two waves will be out of phase (their waveforms cancel). The existence of multiple sound paths, or rays, arriving at a single point can result in multipath interference, a condition that permits the addition and cancellation between sound waves, resulting in the fluctuation of sound levels over short distances.

Reflection plays an important role in the pressures observed at different locations in the water column. Near the bottom, the direct path pressure wave may sum with the bottom-reflected pressure wave, increasing the exposure. Near the surface, however, the surface-reflected pressure wave may

destructively interfere with the direct path pressure wave, "cutting off" the wave and reducing exposure (called the Lloyd mirror effect). This can cause the sound level to decrease dramatically within the top few meters of the water column.

D.3.3.5 Diffraction, Scattering, and Reverberation

Diffraction, scattering, and reverberation are examples of what happens when sound waves interact with obstacles in the propagation path.

Diffraction may be thought of as the change of direction of a sound wave as it passes around an obstacle. Diffraction depends on the size of the obstacle and the sound frequency. The wavelength of the sound must be larger than the obstacle for notable diffraction to occur. If the obstacle is larger than the wavelength of sound, an acoustic shadow zone will exist behind the obstacle where the sound is unlikely to be detected. Common examples of diffraction include sound heard from a source around the corner of a building and sound propagating through a small gap in an otherwise closed door or window.

An obstacle or inhomogeneity (e.g., smoke, suspended particles, gas bubbles due to waves, and marine life) in the path of a sound wave causes scattering as these inhomogeneities reradiate incident sound in a variety of directions (Urick, 1983). Reverberation refers to the prolongation of a sound, after the source has stopped emitting, caused by multiple reflections at water boundaries (surface and bottom) and scattering.

D.3.3.6 Surface and Bottom Effects

Because the sea surface reflects and scatters sound, it has a major effect on the propagation of underwater sound in applications where either the source or receiver is at a shallow depth (Urick 1983). If the sea surface is smooth, the reflected sound pressure is nearly equal to the incident sound pressure; however, if the sea surface is rough, the amplitude of the reflected sound wave will be reduced. Sound waves reflected from the sea surface experience a phase reversal. When the surface-reflected waves interact with the direct path waves near the surface, a destructive interference pattern is created in which the received pressure approaches zero.

The sea bottom is also a reflecting and scattering surface, similar to the sea surface. Sound interaction with the sea bottom is more complex, however, primarily because the acoustic properties of the sea bottom are more variable and the bottom is often layered into regions of differing density. As sound travels into the seafloor it reflects off of these different density layers in complex ways. For sources in contact with the bottom, such as during pile driving or bottom-placed explosives, a ground wave is produced that travels through the bottom sediment and may refract back into the water column.

For a hard bottom such as rock, the reflected wave will be approximately in phase with the incident wave. Thus, near the ocean bottom, the incident and reflected sound pressures may add together (constructive interference), resulting in an increased sound pressure near the sea bottom. Soft bottoms such as mud or sediment absorb sound waves and reduce the level in the water column overall.

D.3.3.7 Air-Water Interface

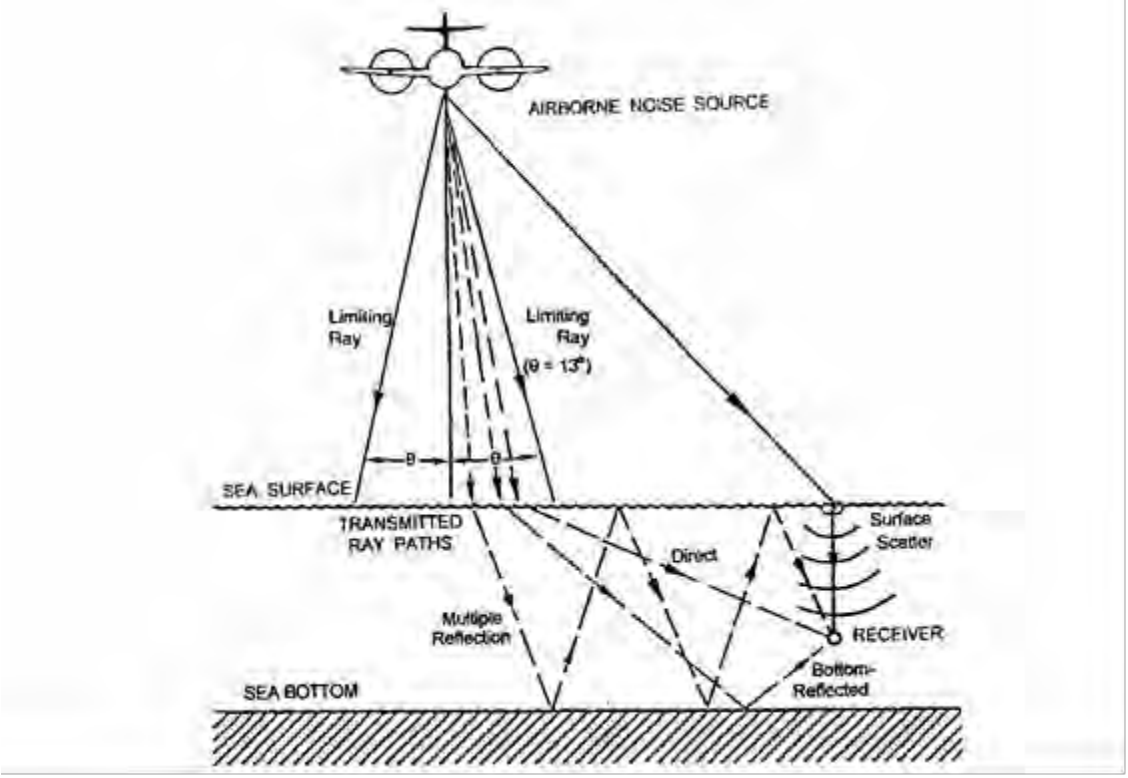
Sound from aerial sources such as aircraft and weapons firing may be transmitted into the water under certain conditions. The most studied of these sources are fixed-wing aircraft and helicopters, which create noise with most energy below 500 Hz. Noise levels in water are highest at the surface and are highly dependent on the altitude of the aircraft and the angle at which the aerial sound encounters the

ocean surface. Transmission of the sound once it is in the water is identical to any other sound as described in the sections above.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Young (1973), Urick (1983), Richardson et al. (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means: (1) a direct path, refracted upon passing through the air-water interface; (2) direct-refracted paths reflected from the bottom in shallow water; (3) evanescent transmission in which sound travels laterally close to the water surface; and (4) scattering from interface roughness due to wave motion.

When sound waves in air meet the water surface, the sound can either be transmitted across the air-water boundary or reflected off the water surface. When sound waves meet the water at a perpendicular angle (e.g., straight down from an in-air source to a flat water surface), the sound waves are both transmitted directly across the water surface in the same direction of travel and reflected 180° back toward the original direction of travel. This can create a localized condition at the water surface where the incident and reflected waves sum, doubling the in-air overpressure (+ 6 dB). As the incident angle of the in-air sound wave changes from perpendicular, this phenomena is reduced, ultimately reaching the angle where sound waves are parallel to the water surface and there is no surface reflection.

The sound that enters the water is refracted due to the difference in sound velocity between air and water, as shown in Figure D-7. As the angle of the in-air incident wave moves away from perpendicular, the direction of travel of the underwater refracted waves becomes closer to parallel to the water surface. When the incident angle is reached where the underwater refracted sound wave is parallel to the water surface, all of the sound is reflected back into the air and no sound enters the water. This occurs at an angle of about 13-14°. As a result, most of the acoustic energy transmitted into the water through a relatively narrow cone extending vertically downward from the in-air source. The width of the footprint would be a function of the source altitude. Lesser amounts of sound may enter the water outside of this cone due to surface scattering (e.g., from water surface waves that can vary the angle of incidence over an area) and as evanescent waves that are only present very near the surface.



Source: Richardson et al. 1995

Figure D-7: Characteristics of Sound Transmission through the Air-Water Interface

If a sound wave is ideally transmitted into water (that is, with no surface transmission loss, such as due to foamy, wave conditions that could decrease sound entering the water), the sound pressure level underwater is calculated by changing the pressure reference unit from 20 µPa in air to 1 µPa in water. For a sound with the same pressure in air and water, this calculation results in a +26 dB sound pressure level in water compared to air. For this reason, sound pressure levels in water and sound pressure levels in air should never be directly compared.

D.4 Auditory Perception

Animals with an eardrum or similar structure, including mammals, birds, and reptiles, directly detect the pressure component of sound. Some marine fish also have specializations to detect pressure changes, although most invertebrates and many marine fish do not have anatomical structures that enable them to detect the pressure component of sound and are only sensitive to the particle motion component of sound. This difference in acoustic energy sensing mechanisms limits the range at which these animals can detect most sound sources analyzed in this document. This is because far from a sound source (i.e., in the far field), particle velocity and sound pressure are directly proportional. But close to a source (i.e., in the near field), particle velocity increases relative to sound pressure and may become more detectable to certain animals. As sound frequency increases, the wavelength becomes shorter, resulting in a smaller near field.

Because mammalian ears can detect large pressure ranges and humans judge the relative loudness of sounds by the ratio of the sound pressures (a logarithmic behavior), sound amplitude is described by the SPL, calculated by taking the logarithm of the ratio of the sound pressure to a reference pressure (see

Section D.2.2, Sound Pressure Level). Use of a logarithmic scale compresses the wide range of pressure values into a more usable numerical scale. On the decibel scale, the smallest audible sound in air (near total silence) to a human is 0 dB re 20 µPa. If the sound intensity increases by a factor of 10, the SPL would increase to 10 dB re 20 µPa. If the sound intensity increases by a factor of 100, the SPL would increase to 20 dB re 20 µPa, and if the sound intensity increases by a factor of 1000, the SPL would be 30 dB re 20 µPa. A quiet conversation has an SPL of about 50 dB re 20 µPa, while the threshold of pain is around 120–140 dB re 20 µPa.

As described in Section D.2.2 (Sound Pressure Level), SPLs under water differ from those in air because they rely on different reference pressures in their calculation; therefore, the two should never be directly compared.

While sound pressure and frequency are physical measure of the sound, loudness is a subjective attribute that varies with not only sound pressure but also other attributes of the sound, such as frequency. For example, a human listener would perceive a 60 dB re 20 µPa sound at 2 kHz to be louder than a 60 dB re 20 µPa sound at 50 Hz, even though the SPLs are identical. This effect is most noticeable at lower sound pressure levels; however, at very high sound pressure levels, the difference in perceived loudness at different frequencies becomes smaller.

To account for differences in hearing sensitivity at various frequencies, acoustic risk analyses commonly use auditory weighting functions—mathematical functions that adjust (or "weight") received sound levels across sound frequency based on how the listener's sensitivity or susceptibility to sound changes at different frequencies. For humans, the most common weighting function is called "A-weighting" (see Figure D-8). A-weighted sound levels are specified in units of "dBA" (A-weighted decibels). For example, if the unweighted received level of a 500 Hz tone at a human receiver was 90 dB re 20 µPa, the A-weighted sound level would be 90 dB – 3 dB = 87 dBA because the A-weighting function amplitude at 500 Hz is -3 dB. Many measurements of sound in air appear as A-weighted decibels in the literature because the intent of the authors is to assess noise impacts on humans.

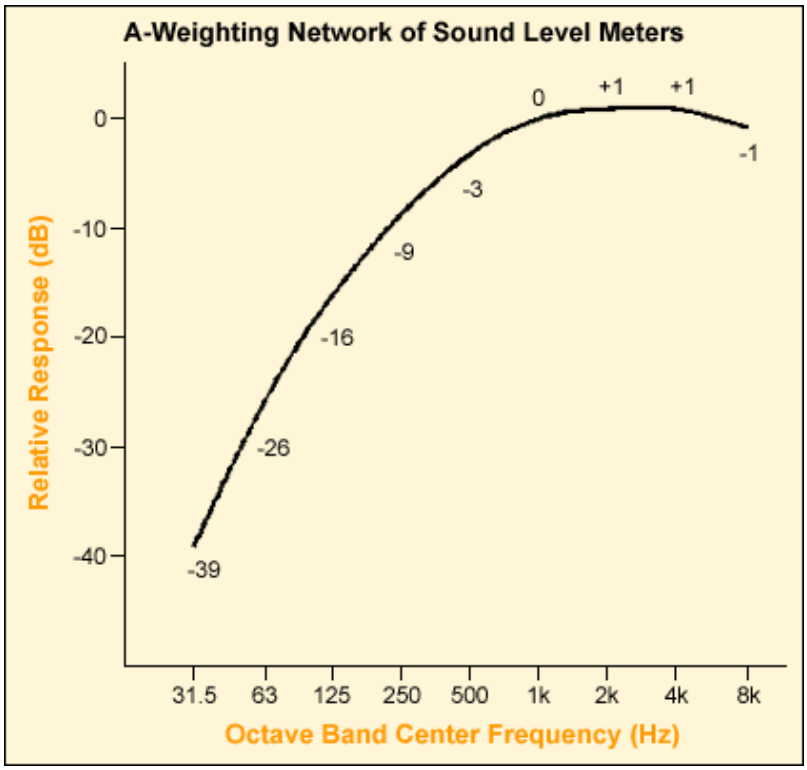


Figure D-8: A-weighting for Human Hearing of Sounds in Air (OSHA). The Numbers along the Curve Indicate How a Received Sound Level Would Be Adjusted at that Frequency.

The auditory weighting concept can be applied to other species. When used in analyzing the impacts of sound on an animal, auditory weighting functions adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges of less or no sensitivity. Auditory weighting functions were developed for marine mammals and sea turtles and are used to assess acoustic impacts. For more information on weighting functions and their derivation for this analysis see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis* (U.S. Department of the Navy, 2017b).

D.5 Explosives

Explosive materials used in Navy testing and training activities are either (1) "high explosives," sometimes referred to as HE, which means that the explosive material has a very fast rate of detonation (exceeding the speed of sound), or (2) low explosives, which exhibit a relatively slow burn, or deflagration, such as black powder. Because low explosives are typically used in small quantities and have less destructive power, the below discussion focuses on high explosives.

This rate of detonation of a high explosive is highly supersonic, producing a high pressure, steep instantaneous shock wave front travelling through the explosive material. This shock front is produced by the supersonic expansion of the explosive products, but as the shock front travels away from the immediate area of the detonation, it begins to behave as an acoustic wave front travelling at the speed of sound.

The near-instantaneous rise from ambient to an extremely high peak pressure is what makes the explosive shock wave potentially damaging. The area under this positive pressure duration is calculated as the positive impulse.

The positive pressure produced by an explosion is also referred to as the overpressure. As the shock front passes a location, the positive pressure exponentially decays, as shown in Figure D-9. As the shock front travels away from the detonation, the waveform is stretched – the peak pressure decreases while the positive duration increases. The reduction in peak pressure reduces the rate at which the positive impulse is received. Both the reduction in peak pressure and stretching of the positive impulse reduce the potential for injury. In addition, absorption losses of higher frequencies over distance results in a softening of the shock front, such that the rise to peak pressure is no longer near-instantaneous.

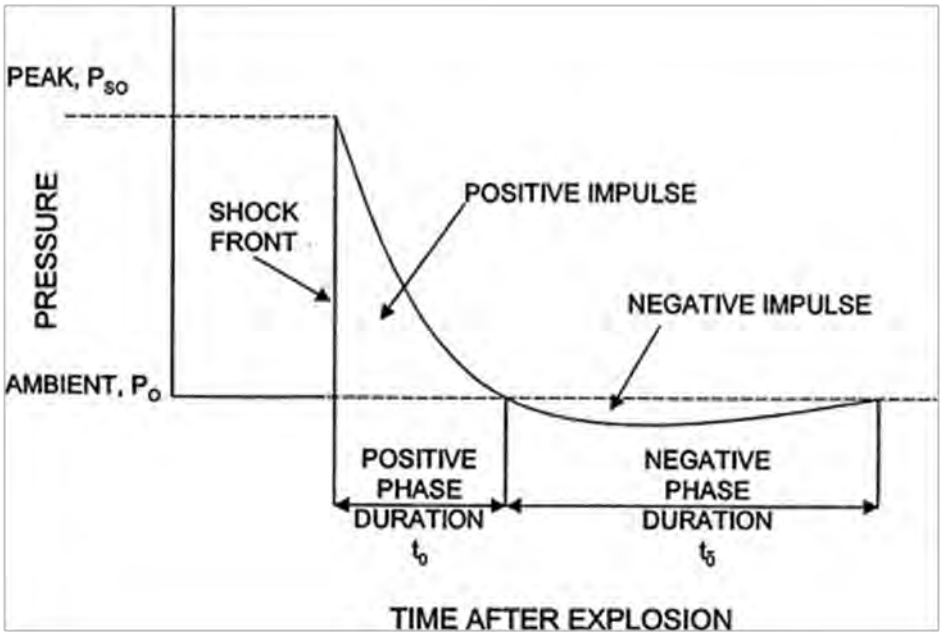


Figure D-9: Impulse Shown as a Function of Pressure over Duration at a Specific Location

The peak pressure experienced by a receptor (i.e., an animal) is a function of the explosive material, the net explosive weight, and the distance from the charge. Net explosive weight (NEW) is a way to classify and compare quantities of different explosive compounds. The net explosive weight for a charge is the energetic equivalent weight of trinitrotoluene (TNT). In general, shock wave effects near an explosive charge increase in proportion to the cube root of the explosive weight (Young, 1991). For example, shock wave impacts will double when the explosive charge weight is increased by a factor of eight (i.e., cube root of eight equals two). This relationship is known as the similarity principle, and the corresponding similitude equations allow for prediction of various explosive metrics for a given charge weight and material.

The similitude equations allow for a simple prediction of peak pressure in a uniform free field environment, and sources are provided below for using these equations for estimating explosive effects in air and in water. However, at longer distances or in more complex environments with boundaries and variations in the propagation medium, explosive propagation modeling is preferred.

D.5.1 Explosions in Air

Explosions in air produce an initial blast front that propagates away from the detonation. When pressure waves from an explosion in air meet the water surface, the pressure wave can be transmitted across the air-water boundary and reflected off the water surface. When pressure waves in air meet the water at a perpendicular angle (e.g., straight down from an in-air source to a flat water surface), the

sound waves are both transmitted directly across the water surface in the same direction of travel and reflected 180° back toward the original direction of travel. For acoustic waves, this can create a localized condition at the water surface where the incident and reflected waves sum, doubling the in-air overpressure (+ 6 dB). For shock waves with high incident pressures travelling at supersonic speeds, the reflection from the water surface depends on the angle of incidence and the speed of the shock wave, and the reflected shock wave pressure can be greater than the incident shock wave pressure(Kinney & Graham, 1985; Swisdak, 1975).

In certain explosive geometries, depending on the size of the explosive and its height of detonation, a combined shock wave, called a Mach stem, can be created by the summing of the direct and reflected shock waves at larger angles of incidence (Kinney & Graham, 1985). In instances where this specific geometry does not occur, only the direct path wave is experienced because there is no surface reflection (waves are parallel to or angled away from the water surface, such as would occur when an explosive is detonated at the water surface), or separate direct and reflected pressure waves may be experienced.

D.5.1.1 Fragmentation

Missiles, rockets, projectiles, and other cased weapons will produce casing fragments upon detonation. These fragments may be of variable size and are ejected at supersonic speed from the detonation. The casing fragments will be ejected at velocities much greater than debris from any target due to the proximity of the casing to the explosive material. Unlike detonations on land targets, detonations during Navy training and testing would not result in other propelled materials such as crater debris.

Fragment density can be simply assumed to follow an inverse-square law with distance, in which the possibility of fragment strike is reduced by the square of the distance from the original detonation point. The forces of gravity and drag will further reduce the likelihood of strike with increasing distance than is accounted for in the inverse-square relationship (Zaker, 1975). The possible area of strike risk at any given distance from the detonation point is limited to the surface area of produced fragments, with drag and gravity reducing the number of produced fragments that travel to greater distances.

D.5.2 Explosions in Water

At the instant of explosion underwater, gas byproducts are generated at high pressure and temperature, creating a bubble. The heat causes a certain amount of water to vaporize, adding to the volume of the bubble. This action immediately begins to force the water in contact with the blast front in an outward direction, creating an intense, supersonic pressure shock wave. As the high-pressure wave travels away from the source, it slows to the speed of sound and acts like an acoustic wave similar to other impulsive sources that lack a strong shock wave (e.g., air guns). Explosions have the greatest amount of energy in lower frequencies below 500 Hz, although energy is present in frequencies exceeding 10 kHz (Urick, 1983). The higher frequency components exhibit more attenuation with distance due to absorption (see Section D.3.3.2, Absorption).

The shock wave caused by an explosion in deeper water may be followed by several bubble pulses in which the explosive byproduct gases expand and contract, with correlated high and low pressure oscillations. These bubble pulses lack the steep pressure front of the initial explosive pulse, but the first bubble pulse may still contribute to the total energy released at frequencies below 100 Hz (Urick, 1983). Subsequent bubble pulses contribute little to the total energy released during the explosion (Urick, 1983). If the detonation occurs at or just below the surface, a portion of the explosive power is released into the air and a pulsating gas bubble is not formed.

The pressure waves from an explosive can constructively add or destructively cancel each other in ocean environments with multi-path propagation, as described for acoustic waves in Section D.3.3.3 (Refraction) and Section D.3.3.4 (Reflection and Multipath Propagation). The received impulse is affected by the depth of the charge and the depth of the receiving animal. Pressure waves from the detonation may travel directly to the receiver or be reflected off the water surface before arriving at the receiver. If a charge is detonated closer to the surface or if an animal is closer to the surface, the time between the initial direct path arrival and the following surface-reflected tension wave arrival is reduced, resulting in a steep negative pressure cut-off of the initial direct path positive impulse exposure. Two animals at similar distances from a charge, therefore, may experience the same peak pressure but different levels of impulse at different depths.

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Appendix E: Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors Under Navy Training and Testing Activities

Final
Environmental Impact Statement/Overseas Environmental Impact Statement
Hawaii-Southern California Training and Testing

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APPENDIX E ESTIMATED MARINE MAMMAL AND SEA TURTLE IMPACTS FROM EXPOSURE TO ACOUSTIC AND EXPLOSIVE STRESSORS UNDER NAVY TRAINING AND TESTING ACTIVITIES

Navy training and testing activities would result in the incidental takes of marine mammals and sea turtles within the Study Area. The following appendix provides the estimated number of marine mammal and sea turtle impacts. Specifically, estimated impacts are derived from the quantitative analysis for activities under Alternatives 1 and 2 that involve the use of acoustic or explosive stressors. The quantitative analysis takes into account Navy activities, marine species density layers, acoustic modeling, and other environmental parameters. A detailed explanation of the quantitative analysis is provided in the technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017c). It is important to note that *impacts*, as discussed in this appendix, represent the estimated instances of take of marine mammals or sea turtles, not necessarily the number of individuals impacted (i.e., some marine mammals or sea turtles could be impacted several times, while others would not experience any impact). In addition, across training and testing activities, the five-year total impacts in each table may be less than five times the maximum impact in any year, because the level of certain activities may vary annually as described in Chapter 2 (Description of Proposed Action and Alternatives).

E.1 Estimated Marine Mammal Impacts from Sonar and Other Transducers Under Navy Training Activities

Table E-1 provides a summary of the estimated number of marine mammal impacts from exposure to sonar and other transducers used during Navy training activities under Alternatives 1 and 2 over the course of a year.

Table E-1: Estimated Marine Mammals Impacts per Year from Sonar Training Activities

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Mysticeti (baleen whales)										
Family Balaenopteridae (rorquals)										
Blue whale*	Central North Pacific	9	23	0	9	25	0	11	33	0
	Eastern North Pacific	344	571	0	408	739	0	519	898	0
Bryde's whale	Eastern Tropical Pacific	7	14	0	8	18	0	9	25	0
	Hawaiian	24	72	0	25	80	0	31	101	0
Fin whale*	California, Oregon, & Washington	381	617	0	457	781	0	572	975	0
	Hawaiian	13	17	0	14	19	0	16	19	0
Humpback whale†	California, Oregon, & Washington†	198	851	0	221	1,019	0	280	1,403	1
	Central North Pacific	1,583	3,575	0	1,643	3,939	0	1,850	4,760	1
Minke whale	California, Oregon, & Washington	127	421	0	141	504	0	184	702	0
	Hawaiian	699	2,402	0	750	2,703	1	871	3,229	1
Sei whale*	Eastern North Pacific	14	30	0	15	37	0	20	48	0
	Hawaiian	26	79	0	28	90	0	34	103	0
Family Eschrichtiidae										
Gray whale†	Eastern North Pacific	441	1,595	1	573	2,122	2	616	2,372	2
	Western North Pacific†	1	2	0	1	3	0	1	3	0
Suborder Odontoceti (toothed whales)										
Family Physeteridae (sperm whale)										
Sperm whale*	California, Oregon, & Washington	1,144	33	0	1,351	43	0	1,600	53	0
	Hawaiian	1,526	21	0	1,691	23	0	1,966	27	0
Family Kogiidae (sperm whales)										
Dwarf sperm whale	Hawaiian	2,981	9,587	12	3,124	10,700	14	3,477	13,121	16
Pygmy sperm whale	Hawaiian	1,155	3,845	5	1,214	4,296	6	1,364	5,219	6

Species	Stock	Alternative 1 – Minimum			Alternative 1 – Maximum			Alternative 2		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Kogia whales	California, Oregon, & Washington	1,253	3,901	9	1,346	4,588	12	1,658	6,357	15
Family Ziphiidae (beaked whales)										
Baird's beaked whale	California, Oregon, & Washington	1,155	8	0	1,307	10	0	1,831	12	0
Blainville's beaked whale	Hawaiian	3,428	11	0	3,675	12	0	4,495	14	0
Cuvier's beaked whale	California, Oregon, & Washington	6,144	50	0	6,899	64	0	9,468	80	0
	Hawaiian	1,149	2	0	1,232	3	0	1,470	3	0
Longman's beaked whale	Hawaiian	12,057	52	0	12,953	57	0	15,939	70	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	3,308	27	0	3,715	34	0	5,098	43	0
Family Delphinidae (dolphins)										
Bottlenose dolphin	California Coastal	182	5	0	189	5	0	189	5	0
	California, Oregon, & Washington Offshore	24,320	2,320	0	28,953	3,007	0	35,590	3,651	0
	Hawaiian Pelagic	1,856	82	0	1,993	92	0	2,361	104	0
	Kauai & Niihau	70	0	0	74	0	0	75	0	0
	Oahu	8,134	35	0	8,137	35	0	8,188	35	0
	4-Island	148	2	0	150	2	0	151	2	0
	Hawaii	39	3	0	39	3	0	42	5	0
False killer whale†	Hawaii Pelagic	622	26	0	672	29	0	819	32	0
	Main Hawaiian Islands Insular†	381	9	0	394	10	0	485	13	0
	Northwestern Hawaiian Islands	226	10	0	245	11	0	299	12	0
Fraser's dolphin	Hawaiian	25,225	772	0	27,491	910	0	31,075	1,008	0
Killer whale	Eastern North Pacific Offshore	53	8	0	63	10	0	83	15	0

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
	Eastern North Pacific Transient/West Coast Transient	99	15	0	117	18	0	155	27	0
	Hawaiian	74	3	0	80	4	0	92	5	0
Long-beaked common dolphin	California	89,185	7,093	0	119,518	9,324	0	130,970	11,093	0
Melon-headed whale	Hawaiian Islands	1,949	148	0	2,141	192	0	2,669	192	0
	Kohala Resident	180	2	0	180	2	0	211	4	0
Northern right whale dolphin	California, Oregon, & Washington	41,973	5,103	0	50,090	6,692	0	61,039	8,025	0
Pacific white-sided dolphin	California, Oregon, & Washington	32,075	3,999	0	38,735	5,156	0	47,145	6,355	0
Pantropical spotted dolphin	Hawaii Island	2,437	114	0	2,463	122	0	2,821	182	0
	Hawaii Pelagic	6,002	299	0	6,467	341	0	8,077	398	0
	Oahu	4,092	29	0	4,097	29	0	4,114	29	0
	4-Island	259	1	0	259	1	0	271	1	0
Pygmy killer whale	Hawaiian	5,018	268	0	5,510	305	0	6,386	354	0
	Tropical	370	30	0	433	38	0	568	47	0
Risso's dolphin	California, Oregon, & Washington	56,098	6,402	0	67,867	8,356	0	81,280	10,099	0
	Hawaiian	5,761	304	0	6,253	336	0	7,676	391	0
Rough-toothed dolphin	Hawaiian	3,717	251	0	4,012	280	0	4,806	328	0
	NSD[1]	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	705,511	75,760	1	832,626	99,397	1	1,055,419	121,779	2
Short-finned pilot whale	California, Oregon, & Washington	808	51	0	922	68	0	1,119	81	0
	Hawaiian	7,671	284	0	8,271	320	0	9,788	370	0
Spinner dolphin	Hawaii Island	86	1	0	88	1	0	90	1	0
	Hawaii Pelagic	2,753	152	0	2,972	166	0	3,815	177	0
	Kauai & Niihau	264	1	0	309	1	0	370	1	0
	Oahu & 4-Island	1,469	16	0	1,473	16	0	1,504	17	0

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Striped dolphin	California, Oregon, & Washington	99,418	7,404	0	109,630	9,566	0	148,534	12,136	0
	Hawaiian	4,615	274	0	5,076	312	0	5,952	351	0
Family Phocoenidae (porpoises)										
Dall's porpoise	California, Oregon, & Washington	5,064	17,166	50	5,715	21,082	64	6,473	27,223	79
Suborder Pinnipedia										
Family Otariidae (eared seals)										
California sea lion	U.S.	59,495	3,591	0	65,455	3,709	0	75,497	3,890	0
Guadalupe fur seal*	Mexico	428	10	0	506	12	0	558	17	0
Northern fur seal	California	8,250	79	0	9,684	100	0	12,163	129	0
Family Phocidae (true seals)										
Harbor seal	California	950	1,466	1	1,138	1,937	1	1,196	2,157	1
Hawaiian monk seal*	Hawaiian	91	40	0	92	44	0	100	63	0
Northern elephant seal	California	21,498	10,452	0	24,582	13,351	1	30,109	16,784	1

*ESA-listed species (all stocks) within the HSTT Study Area. †Only designated stocks are ESA-listed. [1]NSD: No stock designation. PTS: permanent threshold shift; TTS: temporary threshold shift.

E.2 Estimated Impacts Marine Mammal Impacts per 5-Year Period from Sonar and Other Transducers Under Navy Training Activities

Table E-2 provides a summary of the estimated number of marine mammal impacts from exposure to sonar and other transducers used during Navy training activities under Alternatives 1 and 2 over the course of five years.

Table E-2: Estimated Marine Mammals Impacts per 5-Year Period from Sonar Training Activities

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Mysticeti (baleen whales)							
Family Balaenopteridae (rorquals)							
Blue whale*	Central North Pacific	42	97	0	53	151	0
	Eastern North Pacific	1,827	3,171	0	2,562	4,474	0
Bryde's whale	Eastern Tropical Pacific	37	78	0	46	123	0
	Hawaiian	115	314	0	149	457	0
Fin whale*	California, Oregon, & Washington	2,049	3,400	0	2,834	4,862	0
	Hawaiian	62	71	0	73	86	0
Humpback whale†	California, Oregon, & Washington†	1,030	4,549	0	1,384	6,985	3
	Central North Pacific	7,842	15,706	0	9,101	21,776	3
Minke whale	California, Oregon, & Washington	655	2,249	0	913	3,493	0
	Hawaiian	3,462	10,161	2	4,245	14,339	2
Sei whale*	Eastern North Pacific	70	162	0	100	238	0
	Hawaiian	127	326	0	161	449	0
Family Eschrichtiidae							
Gray whale†	Eastern North Pacific	2,509	9,088	7	3,033	11,850	11
	Western North Pacific†	3	11	0	4	14	0
Suborder Odontoceti (toothed whales)							
Family Physeteridae (sperm whale)							
Sperm whale*	California, Oregon, & Washington	6,053	186	0	7,921	267	0
	Hawaiian	6,997	81	0	9,081	119	0

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Family Kogiidae (sperm whales)							
Dwarf sperm whale	Hawaiian	14,946	41,963	49	17,193	59,432	68
Pygmy sperm whale	Hawaiian	5,790	16,824	20	6,739	23,609	28
Kogia whales	California, Oregon, & Washington	6,417	20,572	50	8,227	31,538	74
Family Ziphiidae (beaked whales)							
Baird's beaked whale	California, Oregon, & Washington	6,001	43	0	9,091	59	0
Blainville's beaked whale	Hawaiian	16,321	43	0	21,457	59	0
Cuvier's beaked whale	California, Oregon, & Washington	31,900	276	0	46,994	401	0
	Hawaiian	5,488	9	0	7,028	12	0
Longman's beaked whale	Hawaiian	56,966	206	0	75,671	304	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	17,177	149	0	25,305	216	0
Family Delphinidae (dolphins)							
Bottlenose dolphin	California Coastal	752	24	0	758	24	0
	California, Oregon, & Washington Offshore	129,894	12,944	0	176,229	18,221	0
	Hawaiian Pelagic	8,711	340	0	11,168	464	0
	Kauai & Niihau	356	0	0	377	0	0
	Oahu	40,671	177	0	40,941	177	0
	4-Island	739	11	0	754	11	0
	Hawaii	194	13	0	211	27	0
False killer whale†	Hawaii Pelagic	2,906	99	0	3,858	137	0
	Main Hawaiian Islands Insular†	1,873	39	0	2,381	59	0
	Northwestern Hawaiian Islands	1,057	37	0	1,409	51	0
Fraser's dolphin	Hawaiian	119,407	3,339	0	146,716	4,564	0
Killer whale	Eastern North Pacific Offshore	282	44	0	413	73	0

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
	Eastern North Pacific Transient/West Coast Transient	524	82	0	766	136	0
	Hawaiian	338	14	0	424	21	0
Long-beaked common dolphin	California	518,773	40,017	0	647,923	55,313	0
Melon-headed whale	Hawaiian Islands	9,015	686	0	12,446	859	0
	Kohala Resident	901	12	0	1,055	21	0
Northern right whale dolphin	California, Oregon, & Washington	224,296	28,590	0	302,249	40,037	0
Pacific white-sided dolphin	California, Oregon, & Washington	172,522	22,249	0	233,540	31,717	0
Pantropical spotted dolphin	Hawaii Island	12,036	567	0	14,014	909	0
	Hawaii Pelagic	27,948	1,255	0	38,060	1,786	0
	Oahu	20,463	142	0	20,571	146	0
	4-Island	1,289	6	0	1,357	6	0
Pygmy killer whale	Hawaiian	23,304	1,121	0	29,758	1,573	0
	Tropical	1,941	164	0	2,804	234	0
Risso's dolphin	California, Oregon, & Washington	302,456	35,847	0	402,777	50,398	0
	Hawaiian	26,931	1,210	0	36,139	1,704	0
Rough-toothed dolphin	Hawaiian	17,473	1,033	0	22,716	1,454	0
	NSD[1]	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	3,734,713	424,461	6	5,223,474	607,478	8
Short-finned pilot whale	California, Oregon, & Washington	4,204	288	0	5,542	401	0
	Hawaiian	35,880	1,181	0	46,118	1,652	0
Spinner dolphin	Hawaii Island	428	5	0	448	6	0
	Hawaii Pelagic	12,322	504	0	17,530	657	0
	Kauai & Niihau	1,385	2	0	1,834	4	0
	Oahu & 4-Island	7,346	79	0	7,516	83	0
Striped dolphin	California, Oregon, & Washington	509,735	41,090	0	736,477	60,512	0
	Hawaiian	21,438	1,088	0	27,710	1,497	0

Species	Stock	Alternative 1 – 5-Year			Alternative 2 – 5-Year		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Family Phocoenidae (porpoises)							
Dall's porpoise	California, Oregon, & Washington	26,564	92,325	278	32,012	134,842	393
Suborder Pinnipedia							
Family Otariidae (eared seals)							
California sea lion	U.S.	307,054	18,188	0	375,420	19,446	0
Guadalupe fur seal*	Mexico	2,334	52	0	2,791	83	0
Northern fur seal	California	43,571	436	0	60,342	647	0
Family Phocidae (true seals)							
Harbor seal	California	5,121	8,309	4	5,898	10,778	6
Hawaiian monk seal*	Hawaiian	455	192	0	496	305	0
Northern elephant seal	California	112,002	57,762	3	149,089	83,680	4

*ESA-listed species (all stocks) within the HSTT Study Area.

†Only designated stocks are ESA-listed.

[1]NSD: No stock designation.

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift.

E.3 Estimated Marine Mammal Impacts from Sonar and Other Transducers Under Navy Testing Activities

Table E-3 provides a summary of the estimated number of marine mammal impacts from exposure to sonar and other transducers used during Navy testing activities under Alternatives 1 and 2 over the course of a year.

Table E-3: Estimated Marine Mammals Impacts per Year from Sonar Testing Activities

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Mysticeti (baleen whales)										
Family Balaenopteridae (rorquals)										
Blue whale*	Central North Pacific	6	8	0	6	8	0	6	8	0
	Eastern North Pacific	367	436	0	383	444	0	383	444	0
Bryde's whale	Eastern Tropical Pacific	6	8	0	6	8	0	6	8	0
	Hawaiian	15	26	0	15	26	0	15	26	0
Fin whale*	California, Oregon, & Washington	356	583	0	378	595	0	380	596	0
	Hawaiian	7	8	0	7	8	0	7	8	0
Humpback whale†	California, Oregon, & Washington†	245	462	0	259	472	0	260	468	0
	Central North Pacific	1,145	2,284	0	1,194	2,291	0	1,193	2,289	0
Minke whale	California, Oregon, & Washington	111	154	0	118	156	0	118	156	0
	Hawaiian	467	962	0	483	966	0	485	966	0
Sei whale*	Eastern North Pacific	11	14	0	12	14	0	11	15	0
	Hawaiian	18	30	0	18	31	0	19	30	0
Family Eschrichtiidae										
Gray whale†	Eastern North Pacific	719	1,127	1	742	1,147	1	743	1,148	1
	Western North Pacific†	1	1	0	1	1	0	1	1	0
Suborder Odontoceti (toothed whales)										
Family Physeteridae (sperm whale)										
Sperm whale*	California, Oregon, & Washington	1,045	10	0	1,084	10	0	1,093	10	0
	Hawaiian	750	7	0	775	7	0	775	7	0
Family Kogiidae (sperm whales)										

Species	Stock	Alternative 1 – Minimum			Alternative 1 – Maximum			Alternative 2		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Dwarf sperm whale	Hawaiian	2,525	3,629	9	2,633	3,638	9	2,639	3,631	9
Pygmy sperm whale	Hawaiian	1,023	1,447	4	1,067	1,454	4	1,069	1,448	4
Kogia whales	California, Oregon, & Washington	1,250	1,644	5	1,365	1,678	5	1,373	1,672	5
Family Ziphiidae (beaked whales)										
Baird's beaked whale	California, Oregon, & Washington	678	4	0	723	4	0	738	4	0
Blainville's beaked whale	Hawaiian	1,638	4	0	1,694	4	0	1,688	4	0
Cuvier's beaked whale	California, Oregon, & Washington	4,156	13	0	4,446	13	0	4,476	13	0
	Hawaiian	541	1	0	560	1	0	560	1	0
Longman's beaked whale	Hawaiian	5,999	23	0	6,199	23	0	6,174	23	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	2,238	7	0	2,394	7	0	2,410	7	0
Family Delphinidae (dolphins)										
Bottlenose dolphin	California Coastal	1,560	33	0	1,561	33	0	1,561	33	0
	California, Oregon, & Washington Offshore	21,798	667	0	22,747	669	0	22,868	667	0
	Hawaiian Pelagic	1,174	39	0	1,203	39	0	1,195	39	0
	Kauai & Niihau	409	31	0	460	31	0	410	31	0
	Oahu	444	15	0	460	15	0	462	15	0
	4-Island	135	7	0	197	7	0	197	7	0
	Hawaii	35	3	0	35	3	0	35	3	0
False killer whale†	Hawaii Pelagic	313	13	0	327	13	0	320	13	0
	Main Hawaiian Islands Insular†	173	6	0	178	6	0	177	6	0
	Northwestern Hawaiian Islands	115	5	0	120	5	0	117	5	0

Species	Stock	Alternative 1 – Minimum			Alternative 1 – Maximum			Alternative 2		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Fraser's dolphin	Hawaiian	11,857	368	0	12,287	369	0	12,133	368	0
Killer whale	Eastern North Pacific Offshore	33	1	0	33	1	0	34	1	0
	Eastern North Pacific Transient/West Coast Transient	61	2	0	62	2	0	64	2	0
	Hawaiian	38	2	0	38	2	0	39	2	0
Long-beaked common dolphin	California	108,573	4,399	0	113,786	4,397	0	113,672	4,399	0
Melon-headed whale	Hawaiian Islands	1,064	39	0	1,119	38	0	1,111	39	0
	Kohala Resident	149	7	0	161	7	0	151	7	0
Northern right whale dolphin	California, Oregon, & Washington	38,513	1,337	0	39,922	1,328	0	40,240	1,337	0
Pacific white-sided dolphin	California, Oregon, & Washington	29,325	919	0	30,487	916	0	30,677	920	0
Pantropical spotted dolphin	Hawaii Island	1,266	105	0	1,304	105	0	1,295	105	0
	Hawaii Pelagic	3,432	132	0	3,505	133	0	3,508	132	0
	Oahu	176	15	0	187	15	0	189	15	0
	4-Island	304	15	0	441	15	0	439	15	0
Pygmy killer whale	Hawaiian	2,548	95	0	2,612	95	0	2,617	95	0
	Tropical	258	12	0	277	12	0	274	12	0
Risso's dolphin	California, Oregon, & Washington	46,491	1,724	0	48,211	1,720	0	48,456	1,725	0
	Hawaiian	2,627	110	0	2,696	110	0	2,695	110	0
Rough-toothed dolphin	Hawaiian	2,042	92	0	2,099	92	0	2,102	92	0
	NSD[1]	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	515,030	18,786	0	540,773	18,796	0	542,718	18,794	0

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Short-finned pilot whale	California, Oregon, & Washington	831	56	0	867	56	0	867	56	0
	Hawaiian	4,081	110	0	4,225	110	0	4,197	110	0
Spinner dolphin	Hawaii Island	187	11	0	191	11	0	190	11	0
	Hawaii Pelagic	1,336	36	0	1,359	36	0	1,367	36	0
	Kauai & Niihau	1,249	62	0	1,374	62	0	1,253	62	0
	Oahu & 4-Island	249	13	0	314	13	0	315	13	0
Striped dolphin	California, Oregon, & Washington	50,550	2,031	0	53,992	2,022	0	54,545	2,032	0
	Hawaiian	2,247	92	0	2,302	92	0	2,316	92	0
Family Phocoenidae (porpoises)										
Dall's porpoise	California, Oregon, & Washington	7,816	8,213	17	8,312	8,182	17	8,351	8,290	17
Suborder Pinnipedia										
Family Otariidae (eared seals)										
California sea lion	U.S.	46,695	921	1	47,719	920	1	47,774	921	1
Guadalupe fur seal*	Mexico	871	3	0	936	3	0	942	3	0
Northern fur seal	California	5,219	23	0	5,479	23	0	5,501	23	0
Family Phocidae (true seals)										
Harbor seal	California	1,235	1,023	0	1,280	1,025	0	1,281	1,025	0
Hawaiian monk seal*	Hawaiian	34	12	0	48	12	0	48	12	0
Northern elephant seal	California	17,060	4,276	0	18,208	4,302	0	18,277	4,303	0

*ESA-listed species (all stocks) within the HSTT Study Area. †Only designated stocks are ESA-listed.
[1]NSD = No stock designation.
PTS = permanent threshold shift; TTS = temporary threshold shift.

E.4 Estimated Marine Mammal Impacts per 5-Year Period from Sonar and Other Transducers Under Navy Testing Activities

Table E-4 provides a summary of the estimated number of marine mammal impacts from exposure to sonar and other transducers used during Navy testing activities under Alternatives 1 and 2 over the course of five years.

Table E-4: Estimated Marine Mammals Impacts per 5-Year Period from Sonar Testing Activities

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Mysticeti (baleen whales)							
Family Balaenopteridae (rorquals)							
Blue whale*	Central North Pacific	28	37	0	29	38	0
	Eastern North Pacific	1,842	2,135	0	1,904	2,171	0
Bryde's whale	Eastern Tropical Pacific	31	38	0	32	38	0
	Hawaiian	74	120	0	76	121	0
Fin whale*	California, Oregon, & Washington	1,791	2,870	0	1,885	2,926	0
	Hawaiian	35	39	0	36	39	0
Humpback whale†	California, Oregon, & Washington†	1,238	2,231	0	1,293	2,261	0
	Central North Pacific	5,768	10,838	0	5,960	10,916	0
Minke whale	California, Oregon, & Washington	562	737	0	589	746	0
	Hawaiian	2,347	4,486	0	2,418	4,536	0
Sei whale*	Eastern North Pacific	54	70	0	57	70	0
	Hawaiian	90	139	0	93	141	0
Family Eschrichtiidae							
Gray whale†	Eastern North Pacific	3,608	5,517	3	3,708	5,605	3
	Western North Pacific†	4	7	0	4	7	0
Suborder Odontoceti (toothed whales)							
Family Physeteridae (sperm whale)							
Sperm whale*	California, Oregon, & Washington	5,208	44	0	5,407	44	0
	Hawaiian	3,700	31	0	3,806	31	0

Species	Stock	Alternative 1 – 5-Year			Alternative 2 – 5-Year		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Family Kogiidae (sperm whales)							
Dwarf sperm whale	Hawaiian	12,772	16,929	42	13,208	17,059	42
Pygmy sperm whale	Hawaiian	5,174	6,737	18	5,348	6,792	18
Kogia whales	California, Oregon, & Washington	6,379	7,920	24	6,854	8,075	24
Family Ziphiidae (beaked whales)							
Baird's beaked whale	California, Oregon, & Washington	3,400	18	0	3,646	18	0
Blainville's beaked whale	Hawaiian	8,098	19	0	8,313	19	0
Cuvier's beaked whale	California, Oregon, & Washington	20,852	60	0	22,137	61	0
	Hawaiian	2,670	5	0	2,751	5	0
Longman's beaked whale	Hawaiian	29,640	103	0	30,396	104	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	11,228	32	0	11,920	33	0
Family Delphinidae (dolphins)							
Bottlenose dolphin	California Coastal	7,802	164	0	7,806	164	0
	California, Oregon, & Washington Offshore	109,203	3,106	0	113,511	3,123	0
	Hawaiian Pelagic	5,834	179	0	5,923	180	0
	Kauai & Niihau	2,069	92	0	2,072	92	0
	Oahu	2,218	76	0	2,293	76	0
	4-Island	736	33	0	982	33	0
	Hawaii	172	14	0	173	14	0
False killer whale†	Hawaii Pelagic	1,560	62	0	1,591	62	0
	Main Hawaiian Islands Insular†	866	26	0	881	26	0
	Northwestern Hawaiian Islands	571	23	0	582	23	0
Fraser's dolphin	Hawaiian	58,632	1,673	0	59,837	1,683	0
Killer whale	Eastern North Pacific Offshore	163	3	0	169	3	0

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
	Eastern North Pacific Transient/West Coast Transient	303	6	0	313	6	0
	Hawaiian	189	9	0	193	10	0
Long-beaked common dolphin	California	546,154	21,403	0	566,667	21,426	0
Melon-headed whale	Hawaiian Islands	5,271	152	0	5,466	154	0
	Kohala Resident	759	36	0	767	36	0
Northern right whale dolphin	California, Oregon, & Washington	192,644	6,132	0	199,615	6,168	0
Pacific white-sided dolphin	California, Oregon, & Washington	146,709	4,191	0	152,185	4,218	0
Pantropical spotted dolphin	Hawaii Island	6,301	490	0	6,426	491	0
	Hawaii Pelagic	17,017	591	0	17,340	604	0
	Oahu	883	74	0	937	74	0
	4-Island	1,652	74	0	2,188	74	0
Pygmy killer whale	Hawaiian	12,586	419	0	12,887	427	0
	Tropical	1,295	56	0	1,361	56	0
Risso's dolphin	California, Oregon, & Washington	232,439	7,945	0	240,360	7,982	0
	Hawaiian	12,995	492	0	13,289	499	0
Rough-toothed dolphin	Hawaiian	10,125	399	0	10,382	404	0
	NSD[1]	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	2,582,358	88,389	0	2,694,739	89,093	0
Short-finned pilot whale	California, Oregon, & Washington	4,168	272	0	4,315	272	0
	Hawaiian	20,261	484	0	20,762	490	0
Spinner dolphin	Hawaii Island	936	57	0	949	57	0
	Hawaii Pelagic	6,606	161	0	6,743	164	0
	Kauai & Niihau	6,340	190	0	6,356	190	0
	Oahu & 4-Island	1,306	65	0	1,572	65	0
Striped dolphin	California, Oregon, & Washington	253,588	9,287	0	269,681	9,428	0
	Hawaiian	11,120	417	0	11,418	423	0

Species	Stock	Alternative 1 – 5-Year			Alternative 2 – 5-Year		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Family Phocoenidae (porpoises)							
Dall's porpoise	California, Oregon, & Washington	39,593	39,225	78	41,691	39,682	78
Suborder Pinnipedia							
Family Otariidae (eared seals)							
California sea lion	U.S.	233,207	4,542	4	237,668	4,544	4
Guadalupe fur seal*	Mexico	4,344	13	0	4,641	13	0
Northern fur seal	California	26,049	105	0	27,200	106	0
Family Phocidae (true seals)							
Harbor seal	California	6,211	4,945	0	6,394	4,957	0
Hawaiian monk seal*	Hawaiian	184	45	0	240	45	0
Northern elephant seal	California	86,031	20,431	0	90,843	20,675	0

*ESA-listed species (all stocks) within the HSTT Study Area.

†Only designated stocks are ESA-listed.

[1]NSD: No stock designation. PTS = permanent threshold shift; TTS = temporary threshold shift.

E.5 Estimated Marine Mammal Impacts from Air Guns Under Navy Training Activities

There are no air gun activities under training; therefore, there would be no takes.

E.6 Estimated Marine Mammal Impacts from Air Guns Under Navy Testing Activities

Table E-5 provides a summary of the estimated number of marine mammal impacts from exposure to air guns used during Navy testing activities under Alternatives 1 and 2 over the course of a year. Most species and stocks in the Study Area either do not occur in areas where air gun activities take place, or did not result in any estimated impact based on the quantitative analysis.

Table E-5: Estimated Marine Mammals Impacts per Year from Air Gun Activities

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Mysticeti (baleen whales)										
Family Balaenopteridae (rorquals)										
Blue whale*	Eastern North Pacific	1	0	0	1	0	0	1	0	0
Family Eschrichtiidae										
Gray whale	Eastern North Pacific	1	0	0	1	0	0	1	0	0
Suborder Odontoceti (toothed whales)										
Family Kogiidae (sperm whales)										
Dwarf sperm whale	Hawaiian	0	6	1	0	6	1	0	6	1
Pygmy sperm whale	Hawaiian	0	3	1	0	3	1	0	3	1
Kogia whales	California, Oregon, & Washington	0	1	1	0	1	1	0	1	1
Family Delphinidae (dolphins)										
Bottlenose dolphin	California, Oregon, & Washington Offshore	6	0	0	6	0	0	6	0	0
Long-beaked common dolphin	California	51	0	0	51	0	0	51	0	0
Northern right whale dolphin	California, Oregon, & Washington	9	0	0	9	0	0	9	0	0
Pacific white-sided dolphin	California, Oregon, & Washington	6	0	0	6	0	0	6	0	0
Risso's dolphin	California, Oregon, & Washington	23	0	0	23	0	0	23	0	0
Short-beaked common dolphin	California, Oregon, & Washington	198	2	1	198	2	1	198	2	1
Family Phocoenidae (porpoises)										
Dall's porpoise	California, Oregon, & Washington	3	5	2	3	5	2	3	5	2

Species	Stock	Alternative 1 – Minimum			Alternative 1 – Maximum			Alternative 2		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Suborder Pinnipedia										
Family Otariidae (eared seals)										
California sea lion	U.S.	6	0	0	6	0	0	6	0	0
Northern fur seal	California	1	0	0	1	0	0	1	0	0
Family Phocidae (true seals)										
Harbor seal	California	3	0	0	3	0	0	3	0	0
Northern elephant seal	California	9	2	0	9	2	0	9	2	0

* ESA-listed species (all stocks) within the HSTT Study Area.
Notes: PTS = permanent threshold shift; TTS = temporary threshold shift.

E.7 Estimated Marine Mammal Impacts per 5-year Period from Air Guns Under Navy Testing Activities

Table E-6 provides a summary of the estimated number of marine mammal impacts from exposure to air guns used during Navy testing activities under Alternatives 1 and 2 over the course of five years. Most species or stock in the Study Area either do not occur in areas where air gun activities take place, or did not result in any estimated impact based on the quantitative analysis.

Table E-6: Estimated Marine Mammals Impacts per 5-Year Period from Air Gun Activities

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Mysticeti (baleen whales)							
Family Balaenopteridae (rorquals)							
Blue whale*	Eastern North Pacific	3	0	0	3	0	0
Family Eschrichtiidae							
Gray whale	Eastern North Pacific	6	0	0	6	0	0
Suborder Odontoceti (toothed whales)							
Family Kogiidae (sperm whales)							
Dwarf sperm whale	Hawaiian	0	29	6	0	29	6
Pygmy sperm whale	Hawaiian	0	13	3	0	13	3
Kogia whales	California, Oregon, & Washington	0	4	3	0	4	3
Family Delphinidae (dolphins)							
Bottlenose dolphin	California, Oregon, & Washington Offshore	31	0	0	31	0	0
Long-beaked common dolphin	California	254	0	0	254	0	0
Northern right whale dolphin	California, Oregon, & Washington	44	0	0	44	0	0
Pacific white-sided dolphin	California, Oregon, & Washington	31	0	0	31	0	0
Risso's dolphin	California, Oregon, & Washington	113	0	0	113	0	0
Short-beaked common dolphin	California, Oregon, & Washington	992	10	7	992	10	7

Species	Stock	Alternative 1 – 5-Year			Alternative 2 – 5-Year		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Family Phocoenidae (porpoises)							
Dall's porpoise	California, Oregon, & Washington	14	26	10	14	26	10
Suborder Pinnipedia							
Family Otariidae (eared seals)							
California sea lion	U.S.	30	0	0	30	0	0
Northern fur seal	California	6	0	0	6	0	0
Family Phocidae (true seals)							
Harbor seal	California	16	0	0	16	0	0
Northern elephant seal	California	45	10	0	45	10	0

* ESA-listed species (all stocks) within the HSTT Study Area.
Notes: PTS = permanent threshold shift; TTS = temporary threshold shift.

E.8 Estimated Marine Mammal Impacts from Pile Driving Under Navy Training Activities

Table E-7 provides a summary of the estimated number of marine mammal impacts from exposure to pile driving used during Navy training activities under Alternatives 1 and 2 over the course of a year. Pile driving only occurs in the Southern California region of the Study Area, therefore species or stocks that occur near or around Hawaii would not be impacted. Most species or stocks in the Study Area either do not occur in areas where pile driving activities take place, or did not result in any estimated impact based on the quantitative analysis.

Table E-7: Estimated Marine Mammals Impacts per Year from Pile Driving Activities

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Odontoceti (toothed whales)										
Family Delphinidae (dolphins)										
Bottlenose dolphin	California Coastal	20	0	0	20	0	0	20	0	0
	California, Oregon, & Washington Offshore	8	0	0	8	0	0	8	0	0
Long-beaked common dolphin	California	82	0	0	82	0	0	82	0	0
Northern right whale dolphin	California, Oregon, & Washington	12	0	0	12	0	0	12	0	0
Pacific white-sided dolphin	California, Oregon, & Washington	6	0	0	6	0	0	6	0	0
Risso's dolphin	California, Oregon, & Washington	18	0	0	18	0	0	18	0	0
Short-beaked common dolphin	California, Oregon, & Washington	238	0	0	238	0	0	238	0	0
Striped dolphin	California, Oregon, & Washington	2	0	0	2	0	0	2	0	0
Family Phocoenidae (porpoises)										
Dall's porpoise	California, Oregon, & Washington	2	2	0	2	2	0	2	2	0
Suborder Pinnipedia										
Family Otariidae (eared seals)										
California sea lion	U.S.	150	0	0	150	0	0	150	0	0
Northern fur seal	California	2	0	0	2	0	0	2	0	0

Species	*Stock*	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Family Phocidae (true seals)										
Harbor seal	California	2	0	0	2	0	0	2	0	0
Northern elephant seal	California	12	0	0	12	0	0	12	0	0

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift

E.9 Estimated Marine Mammal Impacts per 5-year Period from Pile Driving Under Navy Training Activities

Table E-8 provides a summary of the estimated number of marine mammal impacts from exposure to pile driving used during Navy training activities under Alternatives 1 and 2 over the course of five years. Pile driving only occurs in the Southern California region of the Study Area, therefore species or stocks that occur near or around Hawaii would not be impacted. Most species or stocks in the Study Area either do not occur in areas where pile driving activities take place, or did not result in any estimated impact based on the quantitative analysis.

Table E-8: Estimated Marine Mammals Impacts per 5-Year Period from Pile Driving Activities

Species	*Stock*	*Alternative 1 – 5-Year*			*Alternative 2 – 5-Year*		
		Behavioral Response	*TTS*	*PTS*	*Behavioral Response*	*TTS*	*PTS*
Suborder Odontoceti (toothed whales)							
Family Delphinidae (dolphins)							
Bottlenose dolphin	California Coastal	100	0	0	100	0	0
	California, Oregon, & Washington Offshore	40	0	0	40	0	0
Long-beaked common dolphin	California	410	0	0	410	0	0
Northern right whale dolphin	California, Oregon, & Washington	60	0	0	60	0	0
Pacific white-sided dolphin	California, Oregon, & Washington	30	0	0	30	0	0
Risso's dolphin	California, Oregon, & Washington	90	0	0	90	0	0
Short-beaked common dolphin	California, Oregon, & Washington	1190	0	0	1190	0	0
Striped dolphin	California, Oregon, & Washington	10	0	0	10	0	0
Family Phocoenidae (porpoises)							
Dall's porpoise	California, Oregon, & Washington	10	10	0	10	10	0
Suborder Pinnipedia							
Family Otariidae (eared seals)							
California sea lion	U.S.	750	0	0	750	0	0
Northern fur seal	California	10	0	0	10	0	0

Species	Stock	Alternative 1 – 5-Year			Alternative 2 – 5-Year		
		Behavioral Response	TTS	PTS	Behavioral Response	TTS	PTS
Family Phocidae (true seals)							
Harbor seal	California	10	0	0	10	0	0
Northern elephant seal	California	60	0	0	60	0	0

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift

E.10 Estimated Marine Mammal Impacts from Pile Driving Under Navy Testing Activities

There are no pile driving activities under testing; therefore, there would be no takes.

E.11 Estimated Marine Mammal Impacts from Explosives Under Navy Training Activities

Table E-9 provides a summary of the estimated number of marine mammal impacts from exposure to explosives used during Navy training activities under Alternatives 1 and 2 over the course of a year. In addition to impacts listed in Table E-9, over the course of a year, the quantitative analysis estimates mortality of one short-beaked common dolphin and one California sea lion (a total of two marine mammals) as a result of exposure to explosive training activities.

Table E-9: Estimated Marine Mammals Impacts per Year from Explosive Training Activities

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Suborder Mysticeti (baleen whales)													
Family Balaenopteridae (rorquals)													
Blue whale*	Central North Pacific	0	0	0	0	0	0	0	0	0	0	0	0
	Eastern North Pacific	0	8	1	0	0	8	1	0	0	8	1	0
Bryde's whale	Eastern Tropical Pacific	0	1	0	0	0	1	0	0	0	1	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale*	California, Oregon, & Washington	0	7	0	0	0	7	0	0	0	7	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale†	California, Oregon, & Washington†	0	14	1	0	0	14	1	0	0	14	1	0
	Central North Pacific	0	21	1	0	0	22	1	0	0	22	1	0
Minke whale	California, Oregon, & Washington	0	3	1	0	0	4	1	0	0	4	1	0
	Hawaiian	0	8	0	0	0	10	0	0	0	10	0	0
Sei whale*	Eastern North Pacific	0	1	0	0	0	1	0	0	0	1	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Family Eschrichtiidae													
Gray whale†	Eastern North Pacific	0	56	3	0	0	56	3	0	0	56	3	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
	Western North Pacific†	0	0	0	0	0	0	0	0	0	0	0	0
Suborder Odontoceti (toothed whales)													
Family Physeteridae (sperm whale)													
Sperm whale*	California, Oregon, & Washington	2	1	0	0	2	1	0	0	2	1	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Family Kogiidae (sperm whales)													
Dwarf sperm whale	Hawaiian	29	102	20	0	31	106	21	0	31	106	21	0
Pygmy sperm whale	Hawaiian	13	31	9	0	14	32	10	0	14	32	10	0
Kogia whales	California, Oregon, & Washington	32	44	11	0	33	45	11	0	33	45	11	0
Family Ziphiidae (beaked whales)													
Baird's beaked whale	California, Oregon, & Washington	0	0	0	0	0	0	0	0	0	0	0	0
Blainville's beaked whale	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Cuvier's beaked whale	California, Oregon, & Washington	23	29	0	0	23	30	0	0	23	30	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Longman's beaked whale	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	13	16	0	0	13	16	0	0	13	16	0	0
Family Delphinidae (dolphins)													
Bottlenose dolphin	California Coastal	0	0	0	0	0	0	0	0	0	0	0	0
	California, Oregon, & Washington Offshore	6	12	2	0	6	12	2	0	6	12	2	0
	Hawaiian Pelagic	0	1	0	0	0	1	0	0	0	1	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0	0	0	0	0
	Oahu	3	11	1	0	3	11	1	0	3	11	1	0
	4-Island	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaii	0	0	0	0	0	0	0	0	0	0	0	0
False killer whale†	Hawaii Pelagic	0	0	0	0	0	0	0	0	0	0	0	0
	Main Hawaiian Islands Insular†	0	1	0	0	0	1	0	0	0	1	0	0
	Northwestern Hawaiian Islands	0	0	0	0	0	0	0	0	0	0	0	0
Fraser's dolphin	Hawaiian	3	5	1	0	3	5	1	0	3	5	1	0
Killer whale	Eastern North Pacific Offshore	0	0	0	0	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
	Eastern North Pacific Transient/West Coast Transient	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Long-beaked common dolphin	California	27	43	13	1	27	43	13	1	27	43	13	1
Melon-headed whale	Hawaiian Islands	0	0	0	0	1	1	0	0	1	1	0	0
	Kohala Resident	0	0	0	0	0	0	0	0	0	0	0	0
Northern right whale dolphin	California, Oregon, & Washington	8	18	7	1	8	18	7	1	8	18	7	1
Pacific white-sided dolphin	California, Oregon, & Washington	4	13	3	0	4	13	3	0	4	13	3	0
Pantropical spotted dolphin	Hawaii Island	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaii Pelagic	0	1	0	0	0	1	0	0	0	1	0	0
	Oahu	0	1	0	0	0	1	0	0	0	1	0	0
	4-Island	0	0	0	0	0	0	0	0	0	0	0	0
Pygmy killer whale	Hawaiian	0	1	0	0	0	1	0	0	0	1	0	0
	Tropical	0	0	0	0	0	0	0	0	0	0	0	0
Risso's dolphin	California, Oregon, & Washington	8	27	6	0	8	27	6	0	8	27	6	0
	Hawaiian	0	0	0	0	0	1	0	0	0	1	0	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Rough-toothed dolphin	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
	NSD[1]	0	0	0	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	47	139	38	6	50	142	38	6	50	142	38	6
Short-finned pilot whale	California, Oregon, & Washington	0	0	1	0	0	0	1	0	0	0	1	0
	Hawaiian	1	2	0	0	1	2	0	0	1	2	0	0
Spinner dolphin	Hawaii Island	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaii Pelagic	0	0	0	0	0	0	0	0	0	0	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0	0	0	0	0
	Oahu & 4-Island	1	3	1	0	1	3	1	0	1	3	1	0
Striped dolphin	California, Oregon, & Washington	6	14	1	0	7	14	1	0	7	14	1	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Family Phocoenidae (porpoises)													
Dall's porpoise	California, Oregon, & Washington	150	329	73	0	150	331	73	0	150	331	73	0
Suborder Pinnipedia													
Family Otariidae (eared seals)													
California sea lion	U.S.	78	151	82	8	78	151	82	8	78	151	82	8

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Guadalupe fur seal*	Mexico	0	0	0	0	0	0	0	0	0	0	0	0
Northern fur seal	California	0	0	0	0	0	0	0	0	0	0	0	0
Family Phocidae (true seals)													
Harbor seal	California	18	24	6	0	18	24	6	0	18	24	6	0
Hawaiian monk seal*	Hawaiian	0	3	1	0	0	3	1	0	0	3	1	0
Northern elephant seal	California	46	176	68	2	47	177	69	2	47	177	69	2

* ESA-listed species (all stocks) within the HSTT Study Area.

†Only designated stocks are ESA-listed.

[1]NSD = No stock designation

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift.

E.12 Estimated Marine Mammal Impacts per 5-year Period from Explosives Under Navy Training Activities

Table E-10 provides a summary of the estimated number of marine mammal impacts from exposure to explosives used during Navy training activities under Alternatives 1 and 2 over the course of five years. In addition to impacts listed in Table E-10, over the course of a 5-year period, the quantitative analysis estimates mortality of three short-beaked common dolphins and four California sea lions (a total of seven marine mammals) as a result of exposure to explosive training activities.

Table E-10: Estimated Marine Mammals Impacts per 5-Year Period from Explosive Training Activities

Species	*Stock*	*Alternative 1 – 5-Year*				*Alternative 2 – 5-Year*			
		Behavioral Response	*TTS*	*PTS*	*Injury*	*Behavioral Response*	*TTS*	*PTS*	*Injury*
Suborder Mysticeti (baleen whales)									
Family Balaenopteridae (rorquals)									
Blue whale*	Central North Pacific	0	0	0	0	0	0	0	0
	Eastern North Pacific	0	38	3	0	0	40	3	0
Bryde's whale	Eastern Tropical Pacific	0	3	0	0	0	3	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Fin whale*	California, Oregon, & Washington	0	33	0	0	0	34	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Humpback whale†	California, Oregon, & Washington†	0	66	3	0	0	67	3	0
	Central North Pacific	0	106	6	0	0	112	7	0
Minke whale	California, Oregon, & Washington	0	16	4	0	0	17	4	0
	Hawaiian	0	41	0	0	0	51	0	0
Sei whale*	Eastern North Pacific	0	4	0	0	0	4	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Family Eschrichtiidae									
Gray whale†	Eastern North Pacific	0	263	12	0	0	263	12	0
	Western North Pacific†	0	0	0	0	0	0	0	0
Suborder Odontoceti (toothed whales)									
Family Physeteridae (sperm whale)									
Sperm whale*	California, Oregon, & Washington	12	6	0	0	12	6	0	0
	Hawaiian	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – 5-Year				Alternative 2 – 5-Year			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Family Kogiidae (sperm whales)									
Dwarf sperm whale	Hawaiian	148	514	99	0	157	528	105	0
Pygmy sperm whale	Hawaiian	64	155	44	0	68	162	48	0
Kogia whales	California, Oregon, & Washington	160	217	55	0	162	221	56	0
Family Ziphiidae (beaked whales)									
Baird's beaked whale	California, Oregon, & Washington	0	0	0	0	0	0	0	0
Blainville's beaked whale	Hawaiian	0	0	0	0	0	0	0	0
Cuvier's beaked whale	California, Oregon, & Washington	581	737	0	0	581	737	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Longman's beaked whale	Hawaiian	0	0	0	0	0	0	0	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	313	397	0	0	313	397	0	0
Family Delphinidae (dolphins)									
Bottlenose dolphin	California Coastal	0	0	0	0	0	0	0	0
	California, Oregon, & Washington Offshore	29	59	9	0	30	59	9	0
	Hawaiian Pelagic	0	4	0	0	0	4	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0
	Oahu	13	57	7	0	13	57	7	0
	4-Island	0	0	0	0	0	0	0	0
	Hawaii	0	0	0	0	0	0	0	0
False killer whale†	Hawaii Pelagic	0	0	0	0	0	0	0	0
	Main Hawaiian Islands Insular†	0	3	0	0	0	3	0	0

Species	Stock	Alternative 1 – 5-Year				Alternative 2 – 5-Year			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
	Northwestern Hawaiian Islands	0	0	0	0	0	0	0	0
Fraser's dolphin	Hawaiian	13	25	3	0	13	25	3	0
Killer whale	Eastern North Pacific Offshore	0	0	0	0	0	0	0	0
	Eastern North Pacific Transient/West Coast Transient	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Long-beaked common dolphin	California	132	208	64	5	132	208	64	5
Melon-headed whale	Hawaiian Islands	2	2	0	0	4	4	0	0
	Kohala Resident	0	0	0	0	0	0	0	0
Northern right whale dolphin	California, Oregon, & Washington	35	87	34	6	36	87	34	6
Pacific white-sided dolphin	California, Oregon, & Washington	20	61	12	0	20	61	13	0
Pantropical spotted dolphin	Hawaii Island	0	0	0	0	0	0	0	0
	Hawaii Pelagic	0	4	0	0	0	4	0	0
	Oahu	0	5	0	0	0	5	0	0
	4-Island	0	0	0	0	0	0	0	0
Pygmy killer whale	Hawaiian	0	3	0	0	0	4	0	0
	Tropical	0	0	0	0	0	0	0	0
Risso's dolphin	California, Oregon, & Washington	37	130	30	0	37	130	30	0
	Hawaiian	0	2	0	0	0	3	0	0
Rough-toothed dolphin	Hawaiian	0	0	0	0	0	0	0	0
	NSD[1]	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – 5-Year				Alternative 2 – 5-Year			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Short-beaked common dolphin	California, Oregon, & Washington	232	687	183	27	245	697	186	28
Short-finned pilot whale	California, Oregon, & Washington	0	0	5	0	0	0	5	0
	Hawaiian	6	10	0	0	6	10	0	0
Spinner dolphin	Hawaii Island	0	0	0	0	0	0	0	0
	Hawaii Pelagic	0	0	0	0	0	0	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0
	Oahu & 4-Island	4	16	5	0	4	16	5	0
Striped dolphin	California, Oregon, & Washington	32	69	3	0	34	71	3	0
	Hawaiian	0	0	0	0	0	0	0	0
Family Phocoenidae (porpoises)									
Dall's porpoise	California, Oregon, & Washington	730	1,617	356	0	732	1,622	357	0
Suborder Pinnipedia									
Family Otariidae (eared seals)									
California sea lion	U.S.	390	754	409	38	391	754	410	38
Guadalupe fur seal*	Mexico	0	0	0	0	0	0	0	0
Northern fur seal	California	0	0	0	0	0	0	0	0
Family Phocidae (true seals)									
Harbor seal	California	80	116	30	0	80	116	30	0
Hawaiian monk seal*	Hawaiian	0	15	3	0	0	15	3	0
Northern elephant seal	California	225	877	338	8	228	882	343	8

*ESA-listed species (all stocks) within the HSTT Study Area.

†Only designated stocks are ESA-listed.

[1]NSD: No stock designation.

Notes: PTS: permanent threshold shift; TTS: temporary threshold shift.

E.13 Estimated Marine Mammal Impacts from Explosives Under Navy Testing Activities

Table E-11 provides a summary of the estimated number of marine mammal impacts from exposure to explosives used during Navy testing activities under Alternatives 1 and 2 over the course of a year. In addition to impacts listed in Table E-11 over the course of a year, the quantitative analysis estimates mortality of one short-beaked common dolphin as a result of exposure to explosive testing activities.

Table E-11: Estimated Marine Mammals Impacts per Year for Explosive Testing Activities

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Suborder Mysticeti (baleen whales)													
Family Balaenopteridae (rorquals)													
Blue whale*	Central North Pacific	0	0	0	0	0	0	0	0	0	0	0	0
	Eastern North Pacific	0	5	0	0	0	5	0	0	0	5	0	0
Bryde's whale	Eastern Tropical Pacific	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale*	California, Oregon, & Washington	0	7	1	0	0	7	1	0	0	7	1	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale†	California, Oregon, & Washington†	0	7	0	0	0	9	0	0	0	9	0	0
	Central North Pacific	0	37	2	0	0	37	2	0	0	37	2	0
Minke whale	California, Oregon, & Washington	0	2	0	0	0	2	0	0	0	2	0	0
	Hawaiian	0	18	1	0	0	18	1	0	0	18	1	0
Sei whale*	Eastern North Pacific	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Family Eschrichtiidae													
Gray whale†	Eastern North Pacific	0	29	1	0	0	30	1	0	0	30	1	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
	Western North Pacific†	0	0	0	0	0	0	0	0	0	0	0	0
Suborder Odontoceti (toothed whales)													
Family Physeteridae (sperm whale)													
Sperm whale*	California, Oregon, & Washington	0	1	0	0	0	2	0	0	0	2	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Family Kogiidae (sperm whales)													
Dwarf sperm whale	Hawaiian	82	100	19	0	82	100	19	0	82	100	19	0
Pygmy sperm whale	Hawaiian	34	37	8	0	34	37	8	0	34	37	8	0
Kogia whales	California, Oregon, & Washington	31	34	7	0	35	41	9	0	35	41	9	0
Family Ziphiidae (beaked whales)													
Baird's beaked whale	California, Oregon, & Washington	0	0	0	0	0	0	0	0	0	0	0	0
Blainville's beaked whale	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Cuvier's beaked whale	California, Oregon, & Washington	5	7	0	0	5	20	1	0	5	20	1	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Longman's beaked whale	Hawaiian	0	1	0	0	0	1	0	0	0	1	0	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	3	4	0	0	3	11	1	0	3	11	1	0
Family Delphinidae (dolphins)													
Bottlenose dolphin	California Coastal	1	0	0	0	1	0	0	0	1	0	0	0
	California, Oregon, & Washington Offshore	7	6	1	0	7	7	1	0	7	7	1	0
	Hawaiian Pelagic	0	0	0	0	0	0	0	0	0	0	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0	0	0	0	0
	Oahu	0	0	0	0	0	0	0	0	0	0	0	0
	4-Island	2	1	0	0	2	1	0	0	2	1	0	0
	Hawaii	0	0	0	0	0	0	0	0	0	0	0	0
False killer whale†	Hawaii Pelagic	0	0	0	0	0	0	0	0	0	0	0	0
	Main Hawaiian Islands Insular†	0	0	0	0	0	0	0	0	0	0	0	0
	Northwestern Hawaiian Islands	0	0	0	0	0	0	0	0	0	0	0	0
Fraser's dolphin	Hawaiian	3	5	1	0	3	5	1	0	3	5	1	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Killer whale	Eastern North Pacific Offshore	0	0	0	0	0	0	0	0	0	0	0	0
	Eastern North Pacific Transient/West Coast Transient	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0	0	0	0	0
Long-beaked common dolphin	California	20	22	4	1	21	23	5	1	21	23	5	1
Melon-headed whale	Hawaiian Islands	0	0	0	0	0	0	0	0	0	0	0	0
	Kohala Resident	0	0	0	0	0	0	0	0	0	0	0	0
Northern right whale dolphin	California, Oregon, & Washington	11	9	3	0	11	9	3	0	11	9	3	0
Pacific white-sided dolphin	California, Oregon, & Washington	6	7	2	0	7	8	2	0	7	8	2	0
Pantropical spotted dolphin	Hawaii Island	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaii Pelagic	1	1	0	0	1	1	0	0	1	1	0	0
	Oahu	0	0	0	0	0	0	0	0	0	0	0	0
	4-Island	1	1	0	0	1	1	0	0	1	1	0	0
Pygmy killer whale	Hawaiian	0	1	0	0	0	1	0	0	0	1	0	0
	Tropical	0	0	0	0	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Risso's dolphin	California, Oregon, & Washington	16	13	3	0	16	15	3	0	16	15	3	0
	Hawaiian	1	1	0	0	1	1	0	0	1	1	0	0
Rough-toothed dolphin	Hawaiian	1	1	0	0	1	1	0	0	1	1	0	0
	NSD[1]	0	0	0	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	156	174	37	4	163	188	39	4	163	187	39	4
Short-finned pilot whale	California, Oregon, & Washington	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaiian	2	1	0	0	2	1	0	0	2	1	0	0
Spinner dolphin	Hawaii Island	0	0	0	0	0	0	0	0	0	0	0	0
	Hawaii Pelagic	1	0	0	0	1	0	0	0	1	0	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0	0	0	0	0
	Oahu & 4-Island	2	2	0	0	2	2	0	0	2	2	0	0
Striped dolphin	California, Oregon, & Washington	8	11	2	0	9	12	2	0	9	12	2	0
	Hawaiian	1	1	0	0	1	1	0	0	1	1	0	0
Family Phocoenidae (porpoises)													
Dall's porpoise	California, Oregon, & Washington	280	254	48	0	300	289	53	0	300	289	53	0

Species	Stock	Alternative 1 – Minimum				Alternative 1 – Maximum				Alternative 2			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Suborder Pinnipedia													
Family Otariidae (eared seals)													
California sea lion	U.S.	11	7	3	0	11	9	4	1	11	9	4	1
Guadalupe fur seal*	Mexico	0	0	0	0	0	0	0	0	0	0	0	0
Northern fur seal	California	1	1	1	0	1	1	1	0	1	1	1	0
Family Phocidae (true seals)													
Harbor seal	California	9	8	1	0	9	8	1	0	9	8	1	0
Hawaiian monk seal*	Hawaiian	3	3	0	0	3	3	0	0	3	3	0	0
Northern elephant seal	California	54	98	25	0	58	123	27	0	58	122	27	0

* ESA-listed species (all stocks) within the HSTT Study Area.

†Only designated stocks are ESA-listed.

[1]NSD = No stock designation

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift.

E.14 Estimated Marine Mammal Impacts per 5-Year Period from Explosives Under Navy Testing Activities

Table E-12 provides a summary of the estimated number of marine mammal impacts from exposure to explosives used during Navy testing activities under Alternatives 1 and 2 over the course of five years. In addition to impacts listed in Table E-12, over the course of a 5-year period, the quantitative analysis estimates mortality of three short-beaked common dolphins as a result of exposure to explosive testing activities.

Table E-12: Estimated Marine Mammals Impacts per 5-Year Period from Explosive Testing Activities

Species	*Stock*	*Alternative 1 – 5-Year*				*Alternative 2 – 5-Year*			
		Behavioral Response	*TTS*	*PTS*	*Injury*	*Behavioral Response*	*TTS*	*PTS*	*Injury*
Suborder Mysticeti (baleen whales)									
Family Balaenopteridae (rorquals)									
Blue whale*	Central North Pacific	0	0	0	0	0	0	0	0
	Eastern North Pacific	0	25	0	0	0	27	0	0
Bryde's whale	Eastern Tropical Pacific	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Fin whale*	California, Oregon, & Washington	0	34	3	0	0	34	3	0
	Hawaiian	0	0	0	0	0	0	0	0
Humpback whale†	California, Oregon, & Washington†	0	39	0	0	0	42	0	0
	Central North Pacific	0	171	11	0	0	171	11	0
Minke whale	California, Oregon, & Washington	0	10	0	0	0	11	0	0
	Hawaiian	0	85	4	0	0	85	4	0
Sei whale*	Eastern North Pacific	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Family Eschrichtiidae									
Gray whale†	Eastern North Pacific	0	146	4	0	0	152	4	0
	Western North Pacific†	0	0	0	0	0	0	0	0
Suborder Odontoceti (toothed whales)									
Family Physeteridae (sperm whale)									
Sperm whale*	California, Oregon, & Washington	0	7	0	0	0	8	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Family Kogiidae (sperm whales)									

Species	Stock	Alternative 1 – 5-Year				Alternative 2 – 5-Year			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Dwarf sperm whale	Hawaiian	392	485	92	0	392	485	92	0
Pygmy sperm whale	Hawaiian	166	180	39	0	166	180	39	0
Kogia whales	California, Oregon, & Washington	157	183	40	0	173	205	45	0
Family Ziphiidae (beaked whales)									
Baird's beaked whale	California, Oregon, & Washington	0	0	0	0	0	0	0	0
Blainville's beaked whale	Hawaiian	0	0	0	0	0	0	0	0
Cuvier's beaked whale	California, Oregon, & Washington	130	337	20	0	130	496	33	0
	Hawaiian	0	0	0	0	0	0	0	0
Longman's beaked whale	Hawaiian	0	3	0	0	0	3	0	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	70	182	11	0	70	267	18	0
Family Delphinidae (dolphins)									
Bottlenose dolphin	California Coastal	2	0	0	0	2	0	0	0
	California, Oregon, & Washington Offshore	37	33	4	0	37	35	4	0
	Hawaiian Pelagic	0	0	0	0	0	0	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0
	Oahu	0	0	0	0	0	0	0	0
	4-Island	6	3	0	0	6	3	0	0
	Hawaii	0	0	0	0	0	0	0	0
False killer whale†	Hawaii Pelagic	0	0	0	0	0	0	0	0
	Main Hawaiian Islands Insular†	0	0	0	0	0	0	0	0
	Northwestern Hawaiian Islands	0	0	0	0	0	0	0	0

Species	Stock	Alternative 1 – 5-Year				Alternative 2 – 5-Year			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Fraser's dolphin	Hawaiian	15	25	6	0	15	25	6	0
Killer whale	Eastern North Pacific Offshore	0	0	0	0	0	0	0	0
	Eastern North Pacific Transient/West Coast Transient	0	0	0	0	0	0	0	0
	Hawaiian	0	0	0	0	0	0	0	0
Long-beaked common dolphin	California	99	110	21	3	103	117	23	3
Melon-headed whale	Hawaiian Islands	0	0	0	0	0	0	0	0
	Kohala Resident	0	0	0	0	0	0	0	0
Northern right whale dolphin	California, Oregon, & Washington	53	44	15	0	53	46	16	0
Pacific white-sided dolphin	California, Oregon, & Washington	31	38	8	0	33	41	10	0
Pantropical spotted dolphin	Hawaii Island	0	0	0	0	0	0	0	0
	Hawaii Pelagic	3	4	0	0	3	4	0	0
	Oahu	0	0	0	0	0	0	0	0
	4-Island	5	3	0	0	5	3	0	0
Pygmy killer whale	Hawaiian	0	3	0	0	0	3	0	0
	Tropical	0	0	0	0	0	0	0	0
Risso's dolphin	California, Oregon, & Washington	78	71	16	0	80	77	17	0
	Hawaiian	4	4	0	0	4	4	0	0
Rough-toothed dolphin	Hawaiian	4	4	0	0	4	4	0	0
	NSD[1]	0	0	0	0	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	786	896	188	21	813	936	194	21

Species	Stock	Alternative 1 – 5-Year				Alternative 2 – 5-Year			
		Behavioral Response	TTS	PTS	Injury	Behavioral Response	TTS	PTS	Injury
Short-finned pilot whale	California, Oregon, & Washington	0	0	0	0	0	0	0	0
	Hawaiian	8	4	0	0	8	4	0	0
Spinner dolphin	Hawaii Island	0	0	0	0	0	0	0	0
	Hawaii Pelagic	3	0	0	0	3	0	0	0
	Kauai & Niihau	0	0	0	0	0	0	0	0
	Oahu & 4-Island	10	8	0	0	10	8	0	0
Striped dolphin	California, Oregon, & Washington	42	56	11	0	45	62	11	0
	Hawaiian	4	5	0	0	4	5	0	0
Family Phocoenidae (porpoises)									
Dall's porpoise	California, Oregon, & Washington	1,421	1,332	250	0	1,499	1,443	264	0
Suborder Pinnipedia									
Family Otariidae (eared seals)									
California sea lion	U.S.	53	38	17	2	53	47	20	3
Guadalupe fur seal*	Mexico	0	0	0	0	0	0	0	0
Northern fur seal	California	4	4	4	0	5	5	4	0
Family Phocidae (true seals)									
Harbor seal	California	47	39	7	0	47	42	7	0
Hawaiian monk seal*	Hawaiian	11	14	0	0	11	14	0	0
Northern elephant seal	California	275	551	131	0	291	610	135	0

* ESA-listed species (all stocks) within the HSTT Study Area.

†Only designated stocks are ESA-listed.

[1]NSD: No stock designation.

Notes: PTS = permanent threshold shift; TTS = temporary threshold shift.

E.15 Estimated Sea Turtle Impacts from Sonar and Other Transducers Under Navy Training and Testing Activities

Based on the quantitative analysis, no sea turtle impacts are anticipated from exposure to sonar and other transducers used during Navy training and testing activities under Alternatives 1 and 2 over the course of a year or five years.

E.16 Estimated Sea Turtle Impacts from Air Guns Under Navy Training and Testing Activities

There are no air gun activities under training; therefore, there would be no takes. No sea turtle impacts are anticipated from exposure to air guns used during Navy testing activities under Alternatives 1 and 2 over the course of a year and over the course of five years.

E.17 Estimated Sea Turtle Impacts from Pile Driving Under Navy Training and Testing Activities

There are no pile driving activities under testing; therefore, there would be no takes. No sea turtle impacts are anticipated from exposure to pile driving used during Navy training activities under Alternatives 1 and 2 over the course of a year and over the course of five years.

E.18 Estimated Sea Turtle Impacts from Explosives Under Navy Training and Testing Activities

Table E-13 provides a summary of the estimated number of sea turtle impacts from exposure to explosives used during Navy training and testing activities under Alternatives 1 and 2 over the course of a year.

Table E-13: Estimated Sea Turtle Impacts per Year from Explosive Training and Testing Activities

Species	*Alternative 1 – Minimum*			*Alternative 1 – Maximum*			*Alternative 2*		
	TTS	*PTS*	*Injury*	*TTS*	*PTS*	*Injury*	*TTS*	*PTS*	*Injury*
Explosive Training Activities									
Family Cheloniidae (hardshell turtles)									
Green turtle*	20	7	1	20	7	1	20	7	1
Hawksbill turtle*	0	0	0	0	0	0	0	0	0
Loggerhead turtle*	0	0	0	0	0	0	0	0	0
Olive ridley turtle*	0	0	0	0	0	0	0	0	0
Family Dermochelyidae (scuteless turtles)									
Leatherback turtle*	0	0	0	0	0	0	0	0	0
Explosive Testing Activities									
Family Cheloniidae (hardshell turtles)									
Green turtle*	0	0	0	0	0	0	0	0	0
Hawksbill turtle*	0	0	0	0	0	0	0	0	0
Loggerhead turtle*	0	0	0	0	0	0	0	0	0

Species	Alternative 1 – Minimum			Alternative 1 – Maximum			Alternative 2		
	TTS	PTS	Injury	TTS	PTS	Injury	TTS	PTS	Injury
Olive ridley turtle*	0	0	0	0	0	0	0	0	0
Family Dermochelyidae (scuteless turtles)									
Leatherback turtle*	0	0	0	0	0	0	0	0	0

*ESA-listed species within the HSTT Study Area. PTS: permanent threshold shift; TTS: temporary threshold shift.

E.19 Estimated Sea Turtle Impacts per 5-year Period from Explosives Under Navy Training and Testing Activities

Table E-14 provides a summary of the estimated number of sea turtle impacts from exposure to explosives used during Navy training and testing activities under Alternatives 1 and 2 per 5-year period.

Table E-14: Estimated Sea Turtle Impacts per 5-Year Period from Explosive Training and Testing Activities

Species	Alternative 1 – 5-Year			Alternative 2 – 5-Year		
	TTS	PTS	Injury	TTS	PTS	Injury
Explosive Training Activities						
Family Cheloniidae (hardshell turtles)						
Green turtle*	98	35	3	98	35	3
Hawksbill turtle*	0	0	0	0	0	0
Loggerhead turtle*	0	0	0	0	0	0
Olive ridley turtle*	0	0	0	0	0	0
Family Dermochelyidae (scuteless turtles)						
Leatherback turtle*	0	0	0	0	0	0
Explosive Testing Activities						
Family Cheloniidae (hardshell turtles)						
Green turtle*	0	0	0	0	0	0
Hawksbill turtle*	0	0	0	0	0	0
Loggerhead turtle*	0	0	0	0	0	0
Olive ridley turtle*	0	0	0	0	0	0
Family Dermochelyidae (scuteless turtles)						
Leatherback turtle*	0	0	0	0	0	0

*ESA-listed species within the HSTT Study Area. PTS = permanent threshold shift; TTS = temporary threshold shift.

Appendix F: Military Expended Material and Direct Strike Impact Analyses

Final
Environmental Impact Statement/Overseas Environmental Impact Statement
Hawaii-Southern California Training and Testing

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APPENDIX F MILITARY EXPENDED MATERIAL AND DIRECT STRIKE IMPACT ANALYSES

F.1 ESTIMATING THE IMPACT OF MILITARY EXPENDED MATERIALS AND UNDERWATER EXPLOSIONS ON ABIOTIC SUBSTRATES AS A HABITAT FOR BIOLOGICAL RESOURCES

This section discusses the methods and results for quantifying two scenarios under Alternative 1 and Alternative 2 of the Proposed Action: (1) the highly improbable worst-case scenario of all military expended materials or underwater explosions occurring on one particular substrate type; and (2) the unlikely, but slightly more realistic, scenario of uniform or proportional impact distribution within a particular area. Training and testing typically occurs in areas that are not called out or linked to specific activities for various reasons (e.g., flexibility and national security). Because training and testing activities would not be conducted under the No Action Alternative, it will not be discussed in this appendix.

This section describes the calculation of the disturbance footprint (i.e., military expended material footprint or explosive crater footprint) of an instantaneous impact of military expended materials or explosions on the substrate. The actual instantaneous impact on the bottom will depend on the number and location of military expended materials expended and not recovered, which is likely much lower and more concentrated than either scenario being analyzed. Longer-term impacts on the bottom are far more difficult to quantify—refer to the Habitats section (3.5) of Chapter 3 (Affected Environment and Environmental Consequences) for qualitative discussion.

The analysis requires two data elements: (1) a tabular summary of the military expended material or crater (underwater explosions) footprints expected in training and testing areas; and (2) a tabular summary of analysis dimensions, which includes abiotic substrate areas. The data for (1) comes from the Hawaii and Southern California Training and Testing (HSTT) action proponents and represents the most locational flexibility with regard to expenditure of military expended materials and underwater explosions. The data for both expended and recovered material is reported in Table F-1 through Table F-16 below. Appendix A (Navy Activity Descriptions) of the HSTT Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) provides basic descriptions of military expended materials, and Chapter 3.0 (3.0.3.3.2, Explosive Stressors) provides basic descriptions of explosive categories. The data for number of military expended materials and underwater explosions are then multiplied by an estimate of the footprint size documented in Table F-1. The data for (2) comes from a compilation of abiotic substrate mapping presented in the Habitats section of Chapter 3 (Section 3.5).

To determine the potential level of disturbance of military expended materials on marine substrates, it was assumed that the impact footprint of the expended material on the seafloor is twice the size of its footprint (unless specified otherwise in Appendix F notes). By doubling the footprint, the results should more accurately reflect the potential disturbance to soft bottom habitats (i.e., to account for sediment plumes), but should overestimate disturbance to hard bottom habitats (i.e., because sediment plumes are not expected) based on mitigation requirements. Items with casings (e.g., small-, medium-, and large-caliber munitions; flares; sonobuoys) have their impact footprints further doubled to account for both the item and its casing. To be conservative, items and their casings were assumed to be the same size, although in reality the items are a smaller size in order to fit in their casing.

Additionally, highly explosive munitions that explode either at the surface or in the water column were treated in the same manner as non-explosive practice munitions, although in reality, the explosions would result in smaller fragments reaching the substrate than expected by the fully intact non-explosive practice munitions.

The data for analysis dimensions (data element 2) comes from the Aquatic Habitat Database technical report and supporting databases (Building and Maintaining a Comprehensive Database and Prioritization Scheme for Overlapping Habitat Data, (U.S. Department of the Navy, 2016)), in addition to spatial data depicting training and testing areas.

The combined analysis dimensions data was used to create a table of substrate category acreage by training and testing areas, and large marine ecosystems. Within the HSTT Study Area there are acreages of substrate that are included under Protective Measures Assessment Protocol categories from the Phase II HSTT EIS/OEIS. These Protective Measures Assessment Protocol categories indicate the amount of mapped substrate that may be protected by Navy mitigation measures. However, the Protective Measures Assessment Protocol areas were not excluded from the quantitative impacts analysis due to how Protective Measures Assessment Protocol is implemented. For more information on the substrates protected under the Protective Measures Assessment Protocol see Chapter 5 (Mitigation).

The percentage of impacted substrate (Scenario 1) was calculated by totaling the impact footprint of individual activities divided by the total area of a given substrate in the training or testing area for which the impacts could occur. The results are provided in Table F-17 through Table F-26.

Assumptions used in the Scenario 1 analysis included:

- Areas of unknown substrate type were not included in the analysis.
- The analysis focused on substrates that are likely to have habitat for sedentary benthic organisms; therefore, areas that are not likely to have substrate inhabited by these organisms (i.e., the Pacific Basin and Abyssal Zone open ocean areas) were excluded from the analysis.
- Artificial substrate was removed from the analysis because it was inconsistently mapped or mapped with a degree of uncertainty considered too high for quantitative analysis.

The above assumptions also applied to Scenario 2 (Proportional Impacts), which used the proportion of a substrate type in an analysis dimension (i.e., training or testing area) multiplied by the total military expended material or crater footprints. The resulting acres indicated the impact area expected if the military expended materials or bottom explosions were distributed uniformly across the training or testing area. In other words, a majority proportion of the military expended material footprint would impact soft substrate if the majority of the analysis dimension was soft substrate. The results are provided in Table F-27 through Table F-30. This scenario is considered more realistic than Scenario 1, yet still unlikely as it does not account for areas of concentrated training, nor does it account for the clumping of military expended materials and explosives in a particular area and over a particular substrate type where a training or testing activity occurs.

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Bomb	Bombs (Explosive)	NA	NA	8.1203	112.9048	The MEM footprint was calculated using the bomb with the largest footprint in terms of material fragments, which in this case is the Rockeye which disperses 247 bomblets.
	Bombs (Non-explosive)	NA	NA	8.1203	112.9048	
Countermeasure	Acoustic Countermeasures	NA	NA	0.31107	1.2432	Includes all type of non-recoverable Acoustic Countermeasures
	Chaff- Air Cartridge	NA	NA	0.0012	0.0022	Chaff is a radar reflector material made of thin, narrow, metallic strips cut in various lengths to elicit frequency responses, which deceive enemy radars. Chaff-Air is fired from an aircraft using a small cartridge.
	Chaff-Ship Cartridge	NA	NA	2.000	4.000	Chaff-ship serves the same purpose of chaff-air. It is fired from a ship in cartridges.
	Anti-torpedo Torpedo	NA	NA	4.5424	9.0847	The Countermeasure Anti-torpedo consists of an anti-torpedo torpedo enclosed within All Up Round Equipment canister. The anti-torpedo torpedo is a 6.75-inch diameter high-maneuverability hard-kill torpedo designed to rapidly intercept and engage an incoming threat torpedo. The All Up Round Equipment consists of a nose sabot, ram plate, launch tube, muzzle cover, and breech mechanism to encapsulate, protect, and ultimately launch the anti-torpedo torpedo. Anti-torpedo torpedo s are frequently recovered; assume all are non-recoverable for worst-case.
Explosive Charge	Flares	NA	NA	1.2196	4.8782	Assumed to not have parachutes
	0.5 lb. explosive charges	50%	12	NA	NA	None
	10 lb. explosive charges	50%	85	NA	NA	None

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Explosive Charge (continued)	20 lb. explosive charges	50%	135	NA	NA	None
	5 lb. explosive charges	50%	54	NA	NA	None
	60 lb. explosive charges	50%	281	NA	NA	None
Missiles	Missiles (Explosive)	NA	NA	37.3669	74.7338	MEM size based on SM-6
	Missile (Non-explosive)	NA	NA	31.0011	62.0023	MEM size based on Tomahawk
	Rockets (Explosive)	NA	NA	0.7987	1.5974	MEM sized based on Hydra 70
	Rockets (Non-explosive)	NA	NA	0.7987	1.5974	MEM size based on Hydra 70. Also include flechette rockets.
	Rockets (Non-explosive): Flechette	NA	NA	0.7987	1.5974	MEM size based on Hydra 70. Included flechette darts in warhead.
Other	Air-launched lightweight (Explosive) torpedo	NA	NA	19.1199	38.2399	MEM size based on MK50/MK54
	Air-launched lightweight (Non-explosive) torpedo	NA	NA	19.1199	38.2399	MEM size based on MK50/MK54. Typically recovered
	AMNS/EMNS Neutralizer (Explosive)	50%	430.5564	1.6286	3.2572	AMNS is air deployed whereas EMNS is ship deployed

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Other (continued)	AMNS Neutralizer (Non-explosive)	NA	NA	0.1513	0.3026	The neutralizer itself is recovered, but the associated fiber optic cable and the can that holds the fiber optic cable is not.
	Anchor (Expendable)	NA	NA	6.2495	12.5001	Associated primarily with mine shapes.
	Anchor (Recoverable)	NA	NA	6.2495	12.5001	Associated primarily with mine shapes.
	Biodegradable Polymer	NA	NA	NA	NA	A substance composed of molecules that degrade as a result of microorganisms and/or enzymes. Footprint is not applicable because the material breaks up within a couple of hours, depending on the type of material out of which the polymer is made. Reference: Karlsson and Albertsson. 1998. Biodegradable polymers and environmental interaction. Polymer Engineering and Science 38(8): 1251-1253.
	Bottom Placed Instruments	NA	NA	2.0000	4.000	Likely moored tracking beacons, so the footprint on the bottom would be approximately 2 square feet. It would weight approximately 50 pounds.
	Buoy (Explosive)	NA	NA	0.9752	3.8987	Explosive buoys including mini-sound source and SUS. MEM-size based on Marine Marker.
	Buoy (Non-explosive)	NA	NA	0.9752	3.8987	These buoys are separate from sonobuoys, and are included for DWADS (expendable) or IMPASS (recovered). MEM size based on Marine Marker. Can be expended or recovered.
	Concrete slugs	NA	NA	0.0011	0.0022	Assume similar in dimensions to a chaff cartridge

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Other (continued)	Endcaps & Pistons – Non Chaff & Flare	NA	NA	0.0043	0.0086	Applies only to where it cannot be associated to another object (e.g., endcaps and pistons associated with chaff would be covered by 'chaff'). Used for testing.
	Endcaps – Chaff & Flare	NA	NA	0.00215	0.0043	Applies only to Chaff-Air and Flares. 1 Endcap is expended per chaff-air or flare.
	Flare O-Ring	NA	NA	0.0043	0.0086	Assumed similar 2-dimensional footprint as endcaps and pistons. Associated with flares. Assumed 1 Flare O-Ring per flare.
	Fiber Optic Can	NA	NA	0.0011	0.0022	Assumed similar 2-dimensional footprint as chaff-air cartridge. Associated with AMNS Neutralizer fiber optic cable. Can that holds fiber optic cable is expended.
	Bathythermograph – Expended	NA	NA	0.0258	0.0516	An instrument that is deployed from a ship to record temperature and depth measurements. Small wires transmit the temperature data from the probe to the ship. This item is fairly standard in terms of footprint; these are off the shelf Commercial products. Reference: NOAA 2015. http://www.aoml.noaa.gov/goos/uot/xbt-what-is.php. Accessed November 3, 2015.
	Fiber optic cables	NA	NA	NA	NA	Associated with some rockets and AMNS neutralizers
	Guidance wires	NA	NA	0	0	Fragments created for relatively small portion associated with explosive devices (associated with heavyweight torpedoes).
	Bathythermograph – Expended Wire	NA	NA	NA	NA	Single vertical wire
	Heavyweight (Explosive) torpedo	NA	NA	39.6155	79.2299	MEM size based on MK-48

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Other (continued)	Heavyweight torpedo accessories	NA	NA	0.1615	3.2367	MEM includes ballast weights, flex tubing
	Heavyweight (Non-explosive) torpedo	NA	NA	NA	NA	Typically recovered
	Illumination flares	NA	NA	1.2196	4.8782	Flares that have a large parachute; MEM size based on half the surface area of an 18 ft. diameter parachute used with an LUU-2 illumination flare.
	Lightweight Torpedo Accessories	NA	NA	1.0107	2.0215	MEM includes ballast weights, flex tubing (parachute size not included)
	Marine marker			0.9752	3.8987	MEM footprint based on two Navy marine markers (MK25 and MK58
	Mine (Explosive)	50%	14,800.3763	25.7903	51.5806	Another name for a 650 lb. explosive charge including material based on the footprint of a mine shape.
	Parachute (Large)	NA	NA	283.9961	567.9932	MEM size based on diameter of LUU-2 illumination flare parachute (18 ft. diameter).
	Parachute (Medium)	NA	NA	9.0417	18.0834	Associated with air-launched torpedoes
	Small Decelerator/ Parachute	NA	NA	2.8438	5.6876	Associated with launched sonobuoys
	Sabot	NA	NA	1.2195	4.8782	An accessory used during projectile firing. Footprint similar in size to the projectile.

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Other (continued)	Sonobuoys (Non-explosive)	NA	NA	1.2206	2.4413	Sonobuoys have an extra item footprint (half the dimensions of the sonobuoy) added in addition to the actual sonobuoy and casing to account for the items that are discarded from the sonobuoy following its release. MEM size does not include the associated Small Decelerator/Parachute (noted in table above)
	Sonobuoys (Explosive)	0	NA	1.2206	2.4413	
	Sonobuoy wires	NA	NA	NA	NA	One wire is associated with each sonobuoy
	Surface-Launched Lightweight (Explosive) Torpedo	0	NA	10.0782	20.1576	MEM size based on MK50/MK54
	Surface-Launched Lightweight (Non-Explosive) Torpedo	NA	NA	10.0782	20.1576	Typically recovered
Projectile	Grenades (Explosive)	0	NA	0.1044	0.2088	None
	Large Caliber (Explosive)	NA	NA	1.0097	4.0386	Item assumed to have a projectile and casing
	Large Caliber (Non-explosive)	NA	NA	1.0097	4.0386	Item assumed to have a projectile and casing
	Large caliber (Casing only)	NA	NA	0.5048	1.0097	Used when the target is on land; no MEM from projectile
	Medium Caliber (Explosive)	NA	NA	0.0560	0.2239	Item assumed to have a projectile and casing
	Medium Caliber (Non-explosive)	NA	NA	0.0560	0.2239	Item assumed to have a projectile and casing
	Small Caliber (Non-explosive)	NA	NA	0.0301	0.1216	Item assumed to have a projectile and casing

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Projectile	Small Caliber (Casing only)	NA	NA	0.0151	0.0301	Used only for small caliber 'blanks'. All other small caliber rounds are included under NEPM
	Kinetic Energy Round	NA	NA	0.5048	1.0097	Item assumed to only have a projectile (no casing) - size of Large Caliber round.
Target	Aerial Drones – Expendable	NA	NA	294.6082	589.2164	MEM when specifically known it is an aerial drone; MEM size based on Firebee
	Aerial Drones – Recovered	NA	NA	294.6082	589.2164	MEM when specifically known it is an aerial drone; MEM size based on Firebee. Typically recovered.
	Air Target – Expended (Non-Drone)	NA	NA	42.1622	84.3244	MEM when specifically known it is an air launched decoy. MEM size based on dimensions of Tactical Air Launched Decoy or Miniature Air-Launched Decoy.
	Metal Plates	NA	NA	2.7782	5.5563	Charges are secured to a 20" X 20" X 1/2" ferrous metal plate The target unit (concrete blocks, metal plate, and any debris) is brought to the surface and analyzed.
	Surface Target - Expended	NA	NA	5.7522	11.5034	Includes remote controlled or towed targets
	Surface Target - Recovered	NA	NA	NA	NA	Reported as recovered.
	Surface Target (Mobile) - Expended	NA*	NA	5.7522	11.5034	Includes remote controlled or towed targets
	Surface Target (Stationary) - Expended	NA	NA	96.8752	193.7504	MEM when specifically known it is a stationary surface target. MEM size based on Killer Tomato.
	Subsurface Target (Mobile) - Expended	NA	NA	1.2206	2.4412	MEM when specifically known it is a sub-surface Motorized Autonomous Target

Table F-1: Categories and Footprints for Various Materials and Underwater Explosions (continued)

Material Group	*Material Category*	*Bottom Frequency[1]*	*Crater Footprint ($ft.^2$)*	*MEM Size ($ft.^2$)*	*MEM Footprint ($ft.^2$)*	*Material Specific Notes*
Target	Surface Target (Stationary) - Expended	NA	NA	96.8752	193.7504	MEM when specifically known it is a stationary surface target. MEM size based on Killer Tomato.
	Subsurface Target (Mobile) - Expended	NA	NA	1.2206	2.4412	MEM when specifically known it is a sub-surface Motorized Autonomous Target
	Mine Shape - Expended	NA	NA	25.7903	51.5807	Mine shapes that were specifically identified as non-recoverable; footprint based on size of explosive mine; size not including anchor
	Mine Shape - Expended	NA	NA	25.7903	51.5807	Mine shape and associated anchor block that are recovered. The vast majority of practice mines have built-in anchors for placing on the bottom; relatively few are moored/floating, and none are drifting.
	Ship Hulk	NA	NA	316,136.0367	632,272.0734	None.

[1]Bottom frequencies (%) are only listed for underwater explosions; crater footprints are only listed for material that may be detonated on the bottom.
Notes: MEM = Military Expended Materials; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

F.1.1 MILITARY EXPENDED AND RECOVERED MATERIAL – TRAINING ACTIVITIES

Tables F-2 through F-8 show military expended and recovered materials and impact footprints within the HSTT Study Area for both a Single Year and Five Year totals.

Table F-2: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in a Single Year under Alternatives 1 and 2

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Bombs								
Bombs (Explosive)	8.1203	112.9048	328	0.8502	0	0.0000	341	0.8839
Bombs (Non-Explosive)	8.1203	112.9048	2,862	7.4181	90	0.2333	12	0.0311
Projectiles								
Grenade (explosive)	0.1044	0.2088	400	0.0019	200	0.0010	1,140	0.0055
Large-Caliber Land Based (Casing)	0.5048	1.0097	0	0.0000	0	0.0000	4,950	0.1147
Large-Caliber (Explosive)	1.0097	4.0386	2,500	0.2318	32	0.0030	5,684	0.5270
Large-Caliber (Non-Explosive)	1.0097	4.0386	666	0.0617	384	0.0356	7,146	0.6625
Medium-Caliber (Explosive)	0.056	0.2239	5,356	0.0275	200	0.0010	5,896	0.0303
Medium Caliber (Non-Explosive)	0.056	0.2239	163,225	0.8390	43,600	0.2241	489,255	2.5148
Missiles (Explosive)	37.6691	74.7338	146	0.2505	0	0.0000	267	0.4581
Rockets (Explosive)	0.7987	1.5974	627	0.0230	0	0.0000	570	0.0209
Rockets (Non-Explosive)	0.7987	1.5974	36	0.0013	0	0.0000	2,491	0.0913
Rockets (Non-Explosive): Flechette	0.7987	1.5974	0	0.0000	0	0.0000	129	0.0047
Small-Caliber (Non-Explosive)	0.0301	0.1216	415,850	1.1609	100,000	0.2792	3,741,000	10.4432
Small-Caliber (Casing Only)	0.0151	0.0301	415,850	0.2874	100,000	0.0691	3,741,000	2.5850
Countermeasures								
Acoustic Countermeasures	0.3111	1.2432	972	0.0277	14	0.0004	346	0.0099
Chaff (Air cartridge)	0.0011	0.0022	513	0.0000	0	0.0000	3,780	0.0002
Chaff (ship cartridge)	2	4	74	0.0068	0	0.0000	250	0.0230
Flares	1.2196	4.8782	1,482	0.1660	0	0.0000	8,184	0.9165

Table F-2: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in a Single Year under Alternatives 1 and 2 (continued)

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Targets								
Air Target - Expended (Decoy)	14.0216	28.0432	2,078	1.3378	30	0.0193	14	0.0090
Air Target – Expended (Drone)	95.6400	191.2800	1	0.0044	0	0.000	1	0.0044
Mine Shapes – (Non-Explosive)	25.7903	51.5807	21	0.0249	0	0.0000	104	0.1231
Sub-Surface Targets (Stationary) - Expended	5.7522	11.5034	40	0.0106	0	0.0000	72	0.0190
Surface Targets (Mobile) - Expended	5.7522	11.5034	1,398	0.3692	134	0.0354	3,460	0.9137
Other								
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	6	0.0004	0	0.0000	32	0.0024
Anchor (Expendable)	6.2495	12.5001	3	0.0009	0	0.0000	1	0.0003
Bathythermograph - Expended	0.2777	0.5544	713	0.0091	7	0.0001	3,480	0.0444
Canister	2.0000	4.0000	104	0.0096	0	0.0000	2,459	0.2258
Compression Pad/Piston	0.0043	0.0086	1,482	0.0003	0	0.0000	8,184	0.0016
Endcaps	0.0021	0.0043	2,057	0.0002	0	0.0000	11,968	0.0012
Fiber Optic Can	0.0011	0.0022	6	0.0000	0	0.0000	32	0.0000
Flare O-Ring	0.0043	0.0086	1,544	0.0003	0	0.0000	8,188	0.0016
Heavyweight Torpedo (Explosive)	39.6155	79.2299	14	0.0255	0	0.0000	3	0.0055
Heavyweight Torpedo Accessories	0.1615	3.2367	392	0.0291	0	0.0000	212	0.0158
Illumination Flare	1.2196	4.8782	62	0.0069	0	0.0000	4	0.0004
JATO Bottle	3.6061	7.2134	39	0.0065	0	0.0000	36	0.0060
Lightweight Torpedo Accessories	1.1011	2.0215	48	0.0022	0	0.0000	189	0.0088
Marine Marker	0.9752	3.8987	692	0.0619	11	0.0010	678	0.0607

Table F-2: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in a Single Year under Alternatives 1 and 2 (continued)

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Other (continued)								
Parachutes – Extra Large	5,026.50	10,053.09	3	0.6924	0	0.0000	0	0.0000
Parachutes - Large	1,963.50	3,926.90	36	3.2454	0	0.0000	36	3.2454
Parachutes - Medium	254.5	508.9	62	0.7243	0	0.0000	4	0.0467
Ship Hulk	316,136	632,272	6	87.0898	0	0.0000	1	14.5150
Total			**1,021,367**	**104.1552**	**244,702**	**0.9024**	**8,051,258**	**37.6894**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Notes: HSTT = Hawaii and Southern California Training and Testing; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-3: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in a Single Year with Differences between Alternatives 1 and 2

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Alternative 1								
Targets								
Subsurface Targets (Mobile) - Expended	1.2206	2.4413	131	0.0073	45	0.0025	100	0.0056
Surface Targets (Stationary)- Expended	96.8752	193.7504	2,902	12.9078	495	2.2017	1,126	5.0083
Total			**3,033**	**12.9151**	**540**	**2.2042**	**1,226**	**5.0139**
Other								
Buoy (Non-Explosive)	0.9752	3.8987	13	0.0012	0	0.0000	65	0.0058
Small Decelerator/Parachute	9.0417	18.0834	11,020	4.5748	120	0.0498	23,574	9.7865
Sonobuoys (Non-Explosive)	1.2207	2.4413	11,004	0.6167	120	0.0067	23,445	1.3140
Total			**22,037**	**5.1927**	**240**	**0.0565**	**47,084**	**11.1062**
Alternative 2								
Targets								
Subsurface Targets (Mobile) - Expended	1.2206	2.4413	332	0.0186	182	0.0102	322	0.0180
Surface Targets (Stationary)- Expended	96.8752	193.7504	3,024	13.4504	507	2.2551	1,139	5.0662
Total			**3,356**	**13.4690**	**689**	**2.2653**	**1,461**	**5.0842**
Other								
Buoy (Non-Explosive)	0.9752	3.8987	13	0.0012	0	0.0000	73	0.0065
Small Decelerator/Parachute	9.0417	18.0834	11,020	4.5748	120	0.0498	24,386	10.1235
Sonobuoys (Non-Explosive)	1.2207	2.4413	11,004	0.6167	120	0.0067	24,257	1.3595
Total			**22,037**	**5.1927**	**240**	**0.0565**	**48,716**	**11.4896**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-4: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in Five Years under Alternatives 1 and 2

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	Impact (Acre)
Bombs								
Bombs (Non-Explosive)	8.1203	112.9048	14,310	37.0906	450	1.1664	60	0.1555
Projectiles								
Grenade (explosive)	0.1044	0.2088	2,000	0.0096	1,000	0.0048	5,700	0.0273
Large-Caliber Land Based (Casing)	0.5048	1.0097	0	0.0000	0	0.0000	24,570	0.5737
Medium-Caliber (Explosive)	0.056	0.2239	26,780	0.1377	1,000	0.0051	29,480	0.1515
Medium Caliber (Non-Explosive)	0.056	0.2239	816,125	4.1949	218,000	1.1205	2,446,275	12.5739
Rockets (Explosive)	0.7987	1.5974	3,135	0.1150	0	0.0000	2,850	0.1045
Rockets (Non-Explosive)	0.7987	1.5974	36	0.0013	0	0.0000	36	0.0013
Rockets (Non-Explosive): Flechette	0.7987	1.5974	0	0.0000	0	0.0000	645	0.0235
Countermeasures								
Chaff (Air cartridge)	0.0011	0.0022	2,565	0.0001	0	0.0000	18,900	0.0010
Chaff (Ship cartridge)	2	4	370	0.0340	0	0.0000	1,250	0.1148
Flares	1.2196	4.8782	7,410	0.8298	0	0.0000	40,920	4.5826
Targets								
Air Target - Expended (Decoy)	14.0216	28.0432	601	0.3869	65	0.0418	115	0.0740
Air Target – Expended (Drone)	95.6400	191.2800	2,001	8.7868	0	0.0000	9	0.0410
Mine Shapes – (Non-Explosive) Expended	25.7903	51.5807	106	0.1255	0	0.0000	520	0.6157
Sub-Surface Targets (Mobile) - Expended	1.2206	2.4413	1,498	0.0840	862	0.0483	1,371	0.0768
Sub-Surface Targets (Stationary) - Expended	5.7522	11.5034	200	0.0528	0	0.0000	361	0.0953

Table F-4: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in Five Years under Alternatives 1 and 2 (continued)

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	Impact (Acre)
Targets (continued)								
Surface Targets (Mobile) - Expended	5.7522	11.5034	6,986	1.8449	668	0.1764	17,293	4.5668
Surface Targets (Stationary) - Expended	96.8752	193.7504	10,906	48.5088	12,607	56.0732	8,236	36.6329
Other								
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	30	0.0022	0	0.0000	160	0.0120
Anchor (Expendable)	6.2495	12.5001	15	0.0043	0	0.0000	5	0.0014
Canister	2.0000	4.0000	520	0.0478	0	0.0000	12,295	1.1290
Compression Pad/Piston	0.0043	0.0086	7,410	0.0015	0	0.0000	40,920	0.0081
Endcaps	0.0021	0.0043	10,285	0.0010	0	0.0000	59,840	0.0059
Fiber Optic Can	0.0011	0.0022	30	0.0000	0	0.0000	160	0.0000
Flare O-Ring	0.0043	0.0086	7,720	0.0015	0	0.0000	40,940	0.0081
Illumination Flare	1.2196	4.8782	310	0.0347	0	0.0000	20	0.0022
JATO Bottle	3.6061	7.2134	195	0.0323	0	0.0000	180	0.0298
Lightweight Torpedo Accessories	1.1011	2.0215	240	0.0111	0	0.0000	897	0.0416
Marine Marker	0.9752	3.8987	3,460	0.3097	55	0.0049	3,390	0.3034
Rockets (Non-Explosive)	0.7987	1.5974	180	0.0066	0	0.0000	180	0.0066
Parachutes – Extra Large	5,026.50	10053.09	15	3.4618	0	0.0000	0	0.0000
Parachutes - Large	1,963.50	3,926.90	180	16.2269	0	0.0000	180	16.2269
Parachutes - Medium	254.5	508.9	310	3.6216	0	0.0000	20	0.2337
Total			**925,929**	**125.9656**	**234,707**	**58.6415**	**2,757,313**	**78.3974**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Notes: AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-5: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in Five Years with Differences between Alternatives 1 and 2

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Alternative 1								
Countermeasures								
Acoustic Countermeasures	0.3311	1.2432	4,757	0.1358	70	0.0020	1,580	0.0451
Other								
Bathythermograph - Expended	0.2771	0.5554	3,565	0.0455	35	0.0004	17,040	0.2173
Bomb (Explosive)	8.1203	112.9048	1,496	3.8775	0	0.0000	1,661	4.3052
Buoy (Non-Explosive)	0.9752	3.8987	51	0.0046	0	0.0000	271	0.0243
Heavyweight Torpedo (Explosive)	39.6155	79.2299	38	0.0691	0	0.0000	7	0.0127
Heavyweight Torpedo Accessories	0.1615	3.2367	1,928	0.1433	0	0.0000	524	0.0389
Large-Caliber (Explosive)	1.0097	4.0386	12,180	1.1293	160	0.0148	28,340	2.6275
Large-Caliber (Non-Explosive)	1.0097	4.0386	3,010	0.2791	1,920	0.1780	35,650	3.3052
Missiles (Explosive)	37.6691	74.7338	698	1.1975	0	0.0000	1,327	2.2767
Ship Hulk	316,136	632,272	14	203.2096	0	0.0000	1	14.5150
Small Caliber casing	0.0151	0.0301	1,919,250	1.3262	500,000	0.3455	18,665,000	12.8975
Small Decelerator/Parachute	2.8438	5.6876	45,678	18.9627	600	0.2491	110,958	46.0629
Small-Caliber (Non-Explosive)	0.0301	0.1216	1,919,250	5.3577	500,000	1.3958	18,665,000	52.1043
Sonobuoys (Non-Explosive)	1.2207	2.4413	45,598	2.5555	600	0.0336	110,313	6.1824
Total			**3,957,512**	**238.2932**	**1,003,385**	**2.2193**	**37,637,672**	**145**

Table F-5: Number and Impacts[1] of Military Expended Materials Proposed for Use During Training Activities in Five Years with Differences between Alternatives 1 and 2 (continued)

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Alternative 2								
Countermeasures								
Acoustic Countermeasures	0.3311	1.2432	4,815	0.1374	70	0.0020	1,634	0.0466
Other								
Bathythermograph - Expended	0.2771	0.5554	3,565	0.0455	35	0.0004	17,400	0.2219
Bomb (Explosive)	8.1203	112.9048	1,640	4.2508	0	0.0000	1,697	4.3985
Buoy (Non-Explosive)	0.9752	3.8987	65	0.0058	0	0.0000	365	0.0327
Heavyweight Torpedo (Explosive)	39.6155	79.2299	70	0.1273	0	0.0000	15	0.0273
Heavyweight Torpedo Accessories	0.1615	3.2367	1,960	0.1456	0	0.0000	532	0.0395
Large-Caliber (Explosive)	1.0097	4.0386	12,500	1.1589	160	0.0148	28,420	2.6349
Large-Caliber (Non-Explosive)	1.0097	4.0386	3,330	0.3087	1,920	0.1780	35,730	3.3127
Missiles (Explosive)	37.6691	74.7338	730	1.2524	0	0.0000	1,335	1.1474
Ship Hulk	316,136	632,272	30	435.4491	0	0.0000	5	72.5748
Small Caliber casing	0.0151	0.0301	2,079,250	1.4368	500,000	0.3455	18,705,000	12.9252
Small Decelerator/Parachute	2.8438	5.6876	48,890	20.2961	600	0.2491	119,050	49.4221
Small-Caliber (Non-Explosive)	0.0301	0.1216	2,079,250	5.8043	500,000	1.3958	18,705,000	52.2160
Sonobuoys (Non-Explosive)	1.2207	2.4413	48,810	2.7355	600	0.0336	118,405	6.6360
Total			**4,284,904**	**473.1543**	**1,003,385**	**2.2193**	**37,734,588**	**205.6355**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-6: Number and Impacts[1] of Recovered Bottom-Placed Materials Proposed for Use During Training Activities in a Single Year under Alternatives 1 and 2

Recovered Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Anchors - Recovered	6.2495	12.5001	10	0	0	0	7	0
Mine Shape (Recovered)	25.7903	51.5807	573	1	0	0	7,915	9
Bottom Placed Instruments	2.0000	4.0000	4	0	0	0	6	0
Total			**587**	**0.6817**	**0**	**0.0000**	**7,928**	**9.3749**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-7: Numbers of Recovered Materials Proposed for Use During Training Activities in Five Years under Alternatives 1 and 2

Recovered Materials		*Hawaii Range Complex*	*HSTT Transit Lane*	*Southern California Range Complex*
		Number	*Number*	*Number*
Other				
Air-Launched Lightweight Non-Explosive Torpedo		80	0	645
Heavyweight Non-Explosive Torpedo		1,890	0	517
Surface-Launched Lightweight Torpedo (Non-Explosive)		160	0	252
Targets				
Aerial Drones		39	0	36
Air Target – Recovered Decoy	Alternative 1	649	0	178
	Alternative 2			189
Subsurface Target (Stationary) Recovered		750	0	1,046
Subsurface Target (Mobile) Recovered		995	0	959
Surface Target (Stationary) Recovered		26,172	0	23,294
Surface Target (Mobile) Recovered		865	3	5,629
Total		**31,567**	**3**	**32,793**

Note: AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-8: Number and Impacts[1] of Recovered Bottom-Placed materials Proposed for Use During Training Activities in Five Years under Alternatives 1 and 2

Recovered Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*HSTT Transit Lane*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*	*Number*	*Impact (Acre)*
Anchors - Recovered	6.2495	12.5001	50	0.0143	0	0.0000	35	0.0100
Mine Shape (Recovered)	25.7903	51.5807	929	1.1001	0	0.0000	7,375	8.7330
Bottom Placed Instruments	2.0000	4.0000	20	0.0018	0	0.0000	30	0.0028
Total			**999**	**1.1162**	**0**	**0.0000**	**7,440**	**8.7457**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

F.1.2 MILITARY EXPENDED AND RECOVERED MATERIALS – TESTING ACTIVITIES

Tables F-9 through F-16 show military expended and recovered materials and impact footprints within the HSTT Study Area for both a Single Year and Five Year totals.

Table F-9: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing Activities in a Single Year under Alternatives 1 and 2

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Bombs						
Bombs (Explosive)	8.1203	112.9048	2	0.0052	2	0.0052
Bombs (Non-Explosive)	8.1203	112.9048	56	0.1451	114	0.2955
Projectiles						
Kinetic Energy Round	0.5048	1.0097	7,400	0.1715	7,736	0.1793
Large-Caliber (Explosive)	1.0097	4.0386	4,684	0.4342	4,744	0.4398
Large-Caliber (Non-Explosive)	1.0097	4.0386	21,704	2.0123	21,854	2.0262
Medium-Caliber (Explosive)	0.056	0.2239	15,365	0.0790	27,341	0.1405
Medium Caliber (Non-Explosive)	0.056	0.2239	222,515	5.7187	302,461	7.5883
Missiles (Non-Explosive)	31.0011	62.0023	278	0.3957	796	1.1330
Missiles (Explosive)	37.6691	74.7228	395	0.6767	454	0.7779
Rocket (Non-Explosive): Flechette	0.7987	1.5974	3	0.0001	33	0.0012
Rockets (Explosive)	0.7987	1.5974	3	0.0001	203	0.0074
Rockets (Non-Explosive)	0.7987	1.5974	7	0.0003	97	0.0036
Sabot	0.5048	1.0097	7,400	0.1715	7,736	0.1793
Small-Caliber (Non-Explosive)	0.0301	0.1216	44,100	0.1231	90,800	0.2535
Small-Caliber Casing	0.0151	0.0301	44,100	0.0305	90,800	0.0628
Countermeasures						
Acoustic Countermeasures	0.3311	1.2432	1,607	0.0459	1,612	0.0460
Chaff - Air Cartridges	0.0011	0.0022	2,490	0.0001	4,660	0.0002
Chaff - Ship Cartridges	2	4	902	0.0828	1,250	0.1148
Flares	1.2196	4.8782	2,490	0.2789	4,260	0.4771

Table F-9: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing Activities in a Single Year under Alternatives 1 and 2 (continued)

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Targets						
Air Target – Expended Decoy	14.0216	28.0432	10	0.0064	40	0.0258
Surface Targets	5.7522	11.5034	575	0.1518	1,134	0.2995
Surface Target - Stationary	96.8752	193.7504	56	0.2491	5	0.0222
Sub-Surface Targets - Mobile	1.2206	2.4413	295	0.0165	310	0.0174
Mine Shapes (Non-Explosive)	25.7903	51.5807	1,384	1.6388	10,450	12.3742
Other						
Air-Launched Lightweight Torpedo (Explosive)	19.1199	38.2399	4	0.0035	4	0.0035
Anchor - Expendable	6.2495	12.5001	852	0.1222	1,822	0.2614
Anti-Torpedo Torpedo	4.524	9.0847	148	0.0309	148	0.0309
Anti-Torpedo Torpedo Accessories	1.1011	2.0215	148	0.0069	148	0.0069
Bathythermograph - Expended	0.2771	0.5554	1,156	0.0147	1,388	0.0177
Buoy (Explosive)	0.9752	3.8987	567	0.0507	617	0.0552
Compression Pads/Pistons	0.0043	0.0086	2,490	0.0005	4,260	0.0008
Endcaps	0.0021	0.0043	4,980	0.0005	8,920	0.0009
Flare O-Ring	0.0043	0.0086	2,490	0.0005	4,260	0.0008
Heavyweight Torpedo (Explosive)	39.6155	79.2299	6	0.0109	6	0.0109
Heavyweight Torpedo Accessories	0.1615	3.2367	231	0.0172	231	0.0172
Lightweight Torpedo Accessories	1.1011	2.0215	283	0.0131	449	0.0208
Sonobuoy (Explosive)	1.2207	2.4413	0	0.0000	72	0.0040
Surface-Launched Lightweight Torpedo (Explosive)	10.0782	20.1576	24	0.0111	24	0.0111
Total			**388,889**	**10.6609**	**589,341**	**14.1995**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Table F-10: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing Activities in a Single Year with Differences Between Alternatives 1 and 2

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Alternative 1						
Targets						
Subsurface Targets (Mobile) - Expended	1.2206	2.4413	688	0.0386	719	0.0403
Subsurface Targets (Stationary) - Expended	5.7522	11.5034	1,243	0.3283	306	0.0808
Surface Targets (Mobile) - Expended	5.7522	11.5034	799	0.2110	1,054	0.2783
Surface Targets (Stationary) - Expended	96.8752	193.7504	1,151	5.1195	1,339	5.9557
Other						
Anchor - Mine (Expendable)	6.2495	12.5001	0	0.0000	0	0.0000
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	144	0.0108	434	0.0324
Buoy (Non-Explosive)	0.97521	3.8987	403	0.0361	823	0.0737
Fiber Optic Can	0.0011	0.0022	144	0.0000	434	0.0000
Mine (Explosive)	25.7903	51.5807	0	0.0000	0	0.0000
Mine Shape (Non-Explosive)	25.7903	51.5807	3	0.0036	42	0.0497
Small Decelerator/Parachute	2.8438	5.6876	9,337	3.8761	15,929	6.6127
Sonobuoys (Non-Explosive)	1.2207	2.4413	9,193	0.5152	15,696	0.8797
Total			**766,472**	**28.6663**	**1,180,110**	**39.4148**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Note: AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System; Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-10: Number and Impacts1 of Military Expended Materials Proposed for Use During Testing Activities in a Single Year with Differences Between Alternatives 1 and 2 (continued)

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Alternative 2						
Targets						
Subsurface Targets (Mobile) - Expended	1.2206	2.4413	725	0.0406	1,278	0.0716
Subsurface Targets (Stationary) - Expended	5.7522	11.5034	1,243	0.3283	277	0.0732
Surface Targets (Mobile) - Expended	5.7522	11.5034	817	0.2158	1,073	0.2834
Surface Targets (Stationary) - Expended	96.8752	193.7504	1,151	5.1195	3,240	14.4112
Other						
Anchor - Mine (Expendable)	6.2495	12.5001	0	0.0000	6	0.0017
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	144	0.0108	440	0.0329
Buoy (Non-Explosive)	0.97521	3.8987	424	0.0379	853	0.0763
Fiber Optic Can	0.0011	0.0022	144	0.0000	440	0.0000
Mine (Explosive)	25.7903	51.5807	0	0.0000	6	0.0071
Mine Shape (Non-Explosive)	25.7903	51.5807	3	0.0036	43	0.0509
Small Decelerator/Parachute	2.8438	5.6876	9,647	4.0048	16,379	6.7995
Sonobuoys (Non-Explosive)	1.2207	2.4413	9,503	0.5326	16,146	0.9049
Total			**23,801**	**10.2939**	**40,181**	**22.7128**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Note: AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System; Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-11: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing in Five Years under Alternatives 1 and 2

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Bombs						
Bomb (Explosive)	8.1203	112.9048	10	0.0259	10	0.0259
Bombs (Non-Explosive)	8.1203	112.9048	280	0.7257	570	1.4774
Projectiles						
Kinetic Energy Round	0.5048	1.0097	37,000	0.8576	38,680	0.8966
Large-Caliber (Explosive)	1.0097	4.0386	23,418	2.1711	23,718	2.1989
Large-Caliber (Non-Explosive)	1.0097	4.0386	108,520	10.0613	109,270	10.1308
Sabot	1.2196	2.4413	37,000	0.8576	38,680	0.8965
Small-Caliber (Non-Explosive)	0.0301	0.1216	220,500	0.6155	454,000	1.2674
Small-Caliber Casing	0.0151	0.0301	220,500	0.1526	454,000	0.3141
Countermeasures						
Chaff (Air cartridge)	0.0011	0.0022	12,450	0.0006	23,300	0.0012
Chaff (Ship cartridge)	2	4	4,510	0.4141	6,250	0.5739
Flares	1.2196	4.8782	12,450	1.3943	21,300	2.3853
Targets						
Air Target - Expended Decoy	39.0407	78.0894	50	0.0322	200	0.1288
Sub-Surface Targets (Mobile) - Expended	1.2206	2.4413	3,327	0.1865	6,295	0.3528
Surface Target (Stationary): Expended	96.8752	193.7504	6,216	1.6415	1,386	0.3660

Table F-11: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing in Five Years under Alternatives 1 and 2 (continued)

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Other						
Acoustic Countermeasures	0.3311	1.2423	7,510	0.2143	8,270	0.2360
Air-Launched Lightweight Torpedo (Explosive)	19.1199	39.2399	20	0.0176	20	0.0176
Anti-Torpedo Torpedo	4.524	9.0847	715	0.1491	760	0.1585
Anti-Torpedo Torpedo Accessories	1.1011	2.0215	715	0.0332	760	0.0353
Buoy (Explosive)	0.9752	3.8987	2,835	0.2537	3,085	0.2761
Compression Pad/Piston	0.0043	0.0086	12,450	0.0025	21,300	0.0042
Endcaps	0.0021	0.0043	24,900	0.0025	44,600	0.0044
Flare O-Ring	0.0043	0.0086	12,450	0.0025	21,300	0.0042
Heavyweight Torpedo (Explosive)	39.6155	79.2299	30	0.0546	30	0.0546
Heavyweight Torpedo Accessories	0.1615	3.2367	1,079	0.0802	1,154	0.0857
Parachute – Extra Large	5026.50	10053.09	0	0.0000	0	0.0000
Parachute - Large	1963.50	3926.90	0	0.0000	0	0.0000
Sonobuoy (Explosive)	1.2207	2.4413	0	0.0000	360	0.0202
Surface-Launched Lightweight Torpedo (Explosive)	10.0782	20.1576	120	0.0555	120	0.0555
Total			**749,054**	**20.0021**	**1,279,417**	**21.9679**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Table F-12: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing Activities in Five Years with Differences between Alternatives 1 and 2

Military Expended Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Alternative 1						
Projectiles						
Medium-Caliber (Explosive)	0.056	0.2239	76,825	0.3949	122,705	0.6307
Medium Caliber (Non-Explosive)	0.056	0.2239	1,112,575	5.7187	1,476,305	7.5883
Missile (Non-Explosive)	31.0011	62.0023	1,390	1.9785	3,940	5.6081
Missiles (Explosive)	37.6691	74.7228	1,973	3.3836	2,244	3.8485
Rockets (Explosive)	0.7987	1.5974	15	0.0006	815	0.0299
Rockets (Non-Explosive): Flechette	0.7987	1.5974	12	0.0004	134	0.0049
Rockets (Non-Explosive)	0.7987	1.5974	34	0.0012	400	0.0147
Targets						
Aerial Drones	95.64	191.28	1,099	4.8237	5,575	24.4809
Surface Targets (Mobile) - Expended	5.7522	11.5034	4,087	1.0793	5,221	1.3788
Surface Targets (Stationary) - Expended	96.8752	193.7504	2,925	13.0083	15,812	70.3311
Other						
Anchor - Mine (Expendable)	6.2495	12.5001	0	0.0000	0	0.0000
Anchor - Other (Expendable)	3.1248	6.2495	3,835	0.5502	8,586	1.2318
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	576	0.0431	2,009	0.1502
Bathythermograph - Expended	0.2771	0.5554	5,765	0.0735	6,880	0.0877
Buoy (Non-Explosive)	0.9752	3.8987	1,855	0.1660	3,980	0.3562
Fiber Optic Can	0.0011	0.0022	576	0.0000	2,009	0.0001
Lightweight Torpedo Accessories	1.1011	2.0215	1,316	0.0611	2,049	0.0951
Mine (Explosive)	25.7903	51.5807	0	0.0000	0	0.0000
Mine Shape (Non-Explosive)	25.7903	51.5807	17	0.0204	209	0.2475

Table F-12: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing Activities in Five Years with Differences between Alternatives 1 and 2 (continued)

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Other (continued)						
Parachute - Medium	254.50	508.90	705	8.2363	1,041	12.1617
Small Decelerator/Parachute	9.0417	18.0834	44,231	18.3620	73,419	30.4790
Sonobuoys (Non-Explosive)	1.2207	2.4413	43,526	2.4394	72,378	4.0564
Total			**1,303,335**	**60.3412**	**1,805,710**	**162.7815**
Alternative 2						
Projectiles						
Medium-Caliber (Explosive)	0.056	0.2239	76,825	0.3949	134,705	0.6924
Medium Caliber (Non-Explosive)	0.056	0.2239	1,112,575	5.7184	1,512,305	7.7729
Missile (Non-Explosive)	31.0011	62.0023	1,390	0.9048	3,964	2.5803
Missiles (Explosive)	37.6691	74.7228	1,973	2.8076	2,268	3.2275
Rockets (Explosive)	0.7987	1.5974	15	0.0006	1,015	0.0372
Rockets (Non-Explosive): Flechette	0.7987	1.5974	12	0.0004	162	0.0059
Rockets (Non-Explosive)	0.7987	1.5974	34	0.0012	484	0.0177
Targets						
Aerial Drones	95.64	191.28	972	4.2693	6,074	26.6721
Surface Targets (Mobile) - Expended	5.7522	11.5034	4,087	1.0793	5,225	1.3798
Surface Targets (Stationary) - Expended	96.8752	193.7504	2,980	13.2538	15,861	70.5491

Table F-12: Number and Impacts[1] of Military Expended Materials Proposed for Use During Testing Activities in Five Years with Differences between Alternatives 1 and 2 (continued)

Military Expended Materials	*Size (ft.²)*	*Impact Footprint (ft.²)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Other						
Anchor - Mine (Expendable)	6.2495	12.5001	0	0.0000	30	0.0086
Anchor - Other (Expendable)	3.1248	6.2495	4,257	0.6107	9,110	1.3070
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	576	0.0431	2,199	0.1644
Bathythermograph - Expended	0.2771	0.5554	5,780	0.0737	6,940	0.0885
Buoy (Non-Explosive)	0.9752	3.8987	2,060	0.1844	4,280	0.3831
Fiber Optic Can	0.0011	0.0022	576	0.0000	2,199	0.0001
Lightweight Torpedo Accessories	1.1011	2.0215	1,331	0.0618	2,157	0.1001
Mine (Explosive)	25.7903	51.5807	0	0.0000	30	0.0355
Mine Shape (Non-Explosive)	25.7903	51.5807	17	0.0204	214	0.2534
Parachute - Medium	254.50	508.90	720	8.4116	1,149	13.4235
Small Decelerator/Parachute	9.0417	18.0834	47,951	19.9063	81,595	33.8732
Sonobuoys (Non-Explosive)	1.2207	2.4413	47,231	2.6470	80,446	4.5086
Total			**1,311,361**	**60.3893**	**1,872,411**	**167.0808**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System
Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-13: Number of Recovered Materials Proposed for Use During Testing Activities in a Single Year as Part of Alternatives 1 and 2

Recovered Materials		*Hawaii Range Complex*	*Southern California Range Complex*
		Number	*Number*
Other			
Air-Launched Lightweight Torpedo (Non-Explosive)		128	217
Heavyweight Torpedo (Non-explosive)		225	225
Surface-Launched Lightweight Torpedo (Non-Explosive)		136	218
Targets			
Air Target – Recovered Decoy		0	1
Sub-Surface Targets (Stationary)	Alternative 1	1,285	395
	Alternative 2		367
Sub-Surface Targets (Mobile)	Alternative 1	485	2,518
	Alternative 2	538	3,080
Surface Targets (Stationary)	Alternative 1	212	4,102
	Alternative 2	200	4,154
Surface Targets (Mobile)	Alternative 1	709	1,158
	Alternative 2	691	1,139
	Total	**4,609**	**17,574**

Table F-14: Number and Impacts[1] of Recovered Bottom Placed Materials Proposed for Use During Testing Activities in a Single Year as Part of Alternatives 1 and 2

Recovered Materials	*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
			Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Mine Shape (Recovered)	25.7903	51.5807	20	0.0237	301	0.3564
				0.0000	1,317	1.5595
Anchor (Recovered)	6.2495	12.5001	85	0.0244	425	0.1220
Total			**105**	**0.0481**	**2,043**	**2.0379**

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

Table F-15: Number of Recovered Materials Proposed for Use During Testing Activities in Five Years as Part of Alternatives 1 and 2

Recovered Materials		*Hawaii Range Complex*	*Southern California Range Complex*
		Number	*Number*
Other			
Air-Launched Lightweight Torpedo (Non-Explosive)	Alternative 1	625	961
	Alternative 2	640	1,069
Heavyweight Torpedo (Non-explosive)		1,049	1,124
Surface-Launched Lightweight Torpedo (Non-Explosive)		596	1,018
Targets			
Aerial Drone (Recovered)	Alternative 1	2,207	3,420
	Alternative 2	1,828	3,426
Air Target – Recovered Decoy		0	5
Sub-Surface Targets (Stationary)		6,424	1,834
Sub-Surface Targets (Mobile)		2,658	15,305
Surface Targets (Mobile)	Alternative 1	709	1,158
	Alternative 2	691	1,139
Surface Targets (Stationary)	Alternative 1	251	20,274
	Alternative 2	428	20,461
	Total	**18,106**	**71,194**

Table F-16: Number and Impacts[1] of Recovered Bottom Placed materials Proposed for Use During Testing Activities in Five Years as part of Alternatives 1 and 2

Recovered Materials		*Size ($ft.^2$)*	*Impact Footprint ($ft.^2$)*	*Hawaii Range Complex*		*Southern California Range Complex*	
				Number	*Impact (Acre)*	*Number*	*Impact (Acre)*
Mine Shape (Recovered)	Alternative 1	25.7903	51.5807	98	0.1157	6,557	7.7637
	Alternative 2	25.7903	51.5807			6,586	7.7990
Anchor (Recovered)		6.2495	12.5001	7,000	2.0087	13,902	3.9893

[1]Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560

F.1.3 IMPACTS TO ABIOTIC SUBSTRATE – TRAINING AND TESTING

Tables F-17 through F-30 show impact to abiotic substrate within the HSTT Study Area for both a Single Year and Five Year totals.

Table F-17: Impact from Explosives On or Near the Bottom for Training Activities in Alternative 1 and 2 in a Single Year

Training Areas	*Net Explosive Weight (lb.)*	*Number of Charges*	*Total Impact Footprint (Acre)*	*Hard Substrate*		*Intermediate Substrate*		*Soft substrate*	
				Acre	*% Impact*	*Acre*	*% Impact*	*Acre*	*% Impact*
Hawaii Range Complex	0.5	2	0.0030	2,053	0.000144394	0	0.0000000	1,607	0.0001845
	20	618	10.3080		0.501994488		0.0000000		0.6415172
	29	6	0.2624		0.01277875		0.0000000		0.0163304
	60	1	0.0034		0.000165578		0.0000000		0.0002116
	AMNS/EMNS Neutralizer	6	0.0297		0.001444069		0.0000000		0.0018454
Total	***NA***	***NA***	***10.6064***		***0.51652728***		***0.0000000***		***0.6600892***
Southern California Range Complex	0.5	4	0.0059	11,249	0.000053	16,413	0.0000361	2,770	0.0002141
	5	16	0.1067		0.000949		0.0006501		0.0038518
	10	24	0.2520		0.002240		0.0015354		0.0090971
	20	637	10.6249		0.094452		0.0647342		0.3835558
	29	151	6.6045		0.058712		0.0402391		0.2384205
	60	36	1.2499		0.011111		0.0076152		0.0451210
	650	78	13.2510		0.117797		0.0807342		0.4783573
	AMNS/EMNS Neutralizer	32	0.1581		0.001406		0.0009635		0.0057091
Total	***NA***	***NA***	***32.253078***		***0.286720***		***0.1965079***		***1.1643268***

Table F-18: Impact from Explosives On or Near the Bottom for Testing Activities in Alternative 1 in a Single Year

Training Areas	*Net Explosive Weight (lb.)*	*Number of Charges*	*Total Impact Footprint (Acre)*	*Hard Substrate*		*Intermediate Substrate*		*Soft substrate*	
				Acre	*% Impact*	*Acre*	*% Impact*	*Acre*	*% Impact*
Hawaii Range Complex	AMNS Neutralizer	144	0.7117	2,053	0.034665	0	0.0000000	1,607	0.044285
Total	***NA***	***NA***	***0.7117***		***0.034665***		***0.0000000***		***0.044285***
Southern California Range Complex	0.5	24	0.0035	11,249	0.000032	16,413	0.0000216	2,770	0.0001281
	650	90	15.2897		0.135921		0.0931553		0.5519538
	AMNS/EMNS Neutralizer	434	2.1437		0.019057		0.0130609		0.0773870
Total	***NA***	***NA***	***17.4369***		***0.155009***		***0.1062379***		***0.6294688***

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-19: Impact from Explosives On or Near the Bottom for Testing Activities in Alternative 2 in a Single Year

Training Areas	*Net Explosive Weight (lb.)*	*Number of Charges*	*Total Impact Footprint (Acre)*	*Hard Substrate*		*Intermediate Substrate*		*Soft substrate*	
				Acre	*% Impact*	*Acre*	*% Impact*	*Acre*	*% Impact*
Hawaii Range Complex	AMNS Neutralizer	144	0.7117	2,053	0.034665	0	0.0000000	1,607	0.044285
Total	***NA***	***NA***	***0.7117***		***0.034665***		***0.0000000***		***0.044285***
Southern California Range Complex	5	24	0.1597	11,249	0.001420	16,413	0.0009731	2,770	0.0057660
	650	96	16.3090		0.144982		0.0993653		0.5887486
	AMNS/EMNS Neutralizer	440	2.0328		0.018071		0.0123854		0.0733870
Total	***NA***	***NA***	***18.5015***		***0.164473***		***0.1127238***		***0.6679016***

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-20: Impact from Explosives On or Near the Bottom for Training Activities under Alternatives 1 and 2 Over Five Years

Training Areas	*Net Explosive Weight (lb.)*	*Number of Charges*	*Total Impact Footprint (Acre)*	*Hard Substrate*		*Intermediate Substrate*		*Soft substrate*	
				Acre	*% Impact*	*Acre*	*% Impact*	*Acre*	*% Impact*
Hawaii Range Complex	0.5	10	0.0148	2,053	0.000720753	0	0.0000000	1,607	0.0009211
	20	3090	51.5400		2.509972441		0.0000000		3.2075861
	29	30	1.3100		0.06379635		0.0000000		0.0815277
	60	5	0.1736		0.008454234		0.0000000		0.0108040
	AMNS/EMNS Neutralizer	30	0.1483		0.007222136		0.0000000		0.0092294
Total	***NA***	***NA***	***53.1867***		***2.59016591***		***0.0000000***		***3.3100683***
Southern California Range Complex	0.5	20	0.0297	11,249	0.000264	16,413	0.0001810	2,770	0.0010722
	5	80	0.5337		0.004744		0.0032517		0.0192664
	10	120	1.2602		0.011203		0.0076780		0.0454929
	20	3185	53.1246		0.472262		0.3236715		1.9177828
	29	755	33.0224		0.293559		0.2011951		1.1920991
	60	150	5.2078		0.046296		0.0317295		0.1880001
	650	390	66.2551		0.588988		0.4036715		2.3917900
	AMNS/EMNS Neutralizer	160	0.7907		0.007029		0.0048175		0.0285440
Total	***NA***	***NA***	***160.224200***		***1.424345***		***0.9761958***		***5.7840475***

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-21: Impact from Explosives On or Near the Bottom for Testing Activities under Alternative 1 Over Five Years

Training Areas	*Net Explosive Weight (lb.)*	*Number of Charges*	*Total Impact Footprint (Acre)*	*Hard Substrate*		*Intermediate Substrate*		*Soft substrate*	
				Acre	*% Impact*	*Acre*	*% Impact*	*Acre*	*% Impact*
Hawaii Range Complex	AMNS Neutralizer	576	2.8466	2,053	0.138658	0	0.0000000	1,607	0.177140
Total	***NA***	***NA***	***2.8466***		***0.138658***		***0.0000000***		***0.177140***
Southern California Range Complex	0.5	120	0.1775	11,249	0.001578	16,413	0.0010815	2,770	0.0064077
	650	290	49.2666		0.437965		0.3001659		1.7785101
	AMNS/EMNS Neutralizer	2,009	9.9277		0.088254		0.0604864		0.3583871
Total	***NA***	***NA***	***59.3718***		***0.527797***		***0.3617338***		***2.1433049***

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-22: Impact from Explosives On or Near the Bottom for Testing Activities under Alternative 2 Over Five Years

Training Areas	*Net Explosive Weight (lb.)*	*Number of Charges*	*Total Impact Footprint (Acre)*	*Hard Substrate*		*Intermediate Substrate*		*Soft substrate*	
				Acre	*% Impact*	*Acre*	*% Impact*	*Acre*	*% Impact*
Hawaii Range Complex	AMNS Neutralizer	576	2.8466	2,053	0.138658	0	0.0000000	1,607	0.177140
Total	***NA***	***NA***	***2.8466***		***0.138658***		***0.0000000***		***0.177140***
Southern California Range Complex	0.5	120	1.7750	11,249	0.015779	16,413	0.0108145	2,770	0.0640770
	650	480	81.5448		0.724909		0.4968269		2.9437438
	AMNS/EMNS Neutralizer	2,199	10.8676		0.096610		0.0662136		0.3923336
Total	***NA***	***NA***	***94.1874***		***0.837298***		***0.5738550***		***3.4001544***

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-23: Potential Impact of Military Expended Materials from Training Activities on Each Substrate Type Within the Range Complexes in a Single Year

Training Areas	*Percent Impact to Hard Bottom*		*Percent Impact to Intermediate Bottom*		*Percent Impact to Soft Bottom*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*	*Alternative 1*	*Alternative 2*
Hawaii Range Complex	3.0419		0		3.8874000	
Southern California Range Complex	0.5539	0.5565	0.3796	0.3814	2.2493000	2.2599

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2; AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table F-24: Potential Impact of Military Expended Materials from Testing Activities on Each Substrate Type Within the Range Complexes in a Single Year

Testing Areas	*Percent Impact to Hard Bottom*		*Percent Impact to Intermediate Bottom*		*Percent Impact to Soft Bottom*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*	*Alternative 1*	*Alternative 2*
Hawaii Range Complex	0.619	0.6219	0		0.7911000	0.7948000
Southern California Range Complex	0.244	0.2448	0.1672	0.1678	0.9908000	0.9943000

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-25: Potential Impact of Military Expended materials from Training Activities on Each Substrate Type within the Range Complexes over Five Years

Training Areas	*Percent Impact to Hard Bottom*		*Percent Impact to Intermediate Bottom*		*Percent Impact to Soft Bottom*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*	*Alternative 1*	*Alternative 2*
Hawaii Range Complex	9.4038	15.172	0		12.0175	19.3888
Southern California Range Complex	2.2308	2.7773	1.529	1.9034	9.0591	11.2781

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-26: Potential Impact of Military Expended materials from Testing Activities on Each Substrate Type within the Range Complexes over Five Years

Testing Areas	*Percent Impact to Hard Bottom*		*Percent Impact to Intermediate Bottom*		*Percent Impact to Soft Bottom*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*	*Alternative 1*	*Alternative 2*
Hawaii Range Complex	3.0705	3.1096	0		3.9240	3.9739
Southern California Range Complex	1.2035	1.2242	0.8249	0.839	4.8874	4.9714

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-27: Proportional Impact to Bottom Habitat from Training Activities under Alternatives 1 and 2 in a Single Year

Training Areas		*Impact to Hard Bottom*		*Impact to Intermediate Bottom*		*Impact to Soft Bottom*		*Impact to Unknown Bottom*	
		MEM Footprint (Acres)	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*
Hawaii Range Complex	Alternative 1	0.0159	0.002708	0	0	0.012449	0.002119	62.4379	10.6329
	Alternative 2								
HSTT Transit Lane	Alternative 1	0	0	0	0	0	0	0.5918	0
	Alternative 2								
Southern California Range Complex	Alternative 1	2.3502	1.2165	3.4291	1.775	0.5787	0.2996	55.951	28.962
	Alternative 2	2.3613		3.4453		0.5815		56.215	

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-28: Proportional Impact to Bottom Habitat from Testing Activities under Alternatives 1 and 2 in a Single Year

Testing Areas		*Impact to Hard Bottom*		*Impact to Intermediate Bottom*		*Impact to Soft Bottom*		*Impact to Unknown Bottom*	
		MEM Footprint (Acres)	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*
Hawaii Range Complex	Alternative 1	0.003237	0.0002416	0	0	0.002533	0.000189043	12.7082	0.9485
	Alternative 2	0.003252				0.002545		12.7678	
Southern California Range Complex	Alternative 1	1.0352	0.6589	1.5105	0.9614	0.2549	0.1623	24.6461	15.6863
	Alternative 2	1.0389	0.7029	1.5158	1.0256	0.2558	0.1731	24.7323	16.7336

Note: Calculations for "Impact (Acre) Column = [(Impact Footprint) x (Number)]/43560
Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-29: Proportional Impact to Bottom Habitat from Training Activities under Alternatives 1 and 2 Over Five Years

Training Areas		*Impact to Hard Bottom*		*Impact to Intermediate Bottom*		*Impact to Soft Bottom*		*Impact to Unknown Bottom*	
		MEM Footprint (Acres)	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*
Hawaii Range Complex	Alternative 1	0.0492	0.0135	0.0000	0.0000	0.0385	0.0106	193.0242	53.1647
	Alternative 2	0.0793				0.0621		311.4137	
HSTT Transit Lane	Alternative 1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.9589	0.0000
	Alternative 2								
Southern California Range Complex	Alternative 1	9.4656	6.0434	13.8110	8.8178	2.3309	1.4882	225.3454	143.8746
	Alternative 2	11.7840		17.1937		2.9019		280.5402	

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

Table F-30: Proportional Impact to Bottom Habitat from Testing Activities under Alternatives 1 and 2 Over Five Years

Training Areas		*Impact to Hard Bottom*		*Impact to Intermediate Bottom*		*Impact to Soft Bottoms*		*Impact to Unknown Bottom*	
		MEM Footprint (Acres)	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*	*MEM Footprint (Acres)*	*Explosive Footprint (Acres)*
Hawaii Range Complex	Alternative 1	0.0161	0.0012	0.0000	0.0000	0.0126	0.0009	63.0364	4.7423
	Alternative 2	0.0163				0.0127		63.8390	
Southern California Range Complex	Alternative 1	5.1065	2.2394	7.4508	3.2675	1.2575	0.5515	121.5703	53.3134
	Alternative 2	5.1943	3.5144	7.5789	5.1278	1.2791	0.8654	123.6614	83.6682

Note: Blue shading indicates numbers and impacts of MEM that differ between Alternatives 1 and 2

F.2 Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures from Military Expended Materials

This section discusses the methods and results for calculating the probability of a direct strike of an animal from any military items from the proposed training and testing activities falling toward (or directed at) the sea surface. For the purposes of this section, military items include non-explosive practice munitions, sonobuoys, acoustic countermeasures, targets, and high-energy lasers. Only marine mammals and sea turtles will be analyzed using these methods because animal densities are necessary to complete the calculations, and density estimates are currently only available for marine mammals and sea turtles within the Study Area. The analysis conducted here does not account for explosive munitions because impacts from explosives are analyzed within the Navy Acoustic Effects Model as described in the Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing (U.S. Department of the Navy, 2017).

F.2.1 Direct Impact Analysis

A probability was calculated to estimate the impact probability (P) and number of exposures (T) associated with direct impact of military items on marine animals on the sea surface within the specified training or testing area (R) in which the activities are occurring. The statistical probability analysis is based on probability theory and modified Venn diagrams with rectangular "footprint" areas for the individual animal (A) and total impact (I) inscribed inside the training or testing area (R). The analysis is over-predictive and conservative, in that it assumes: (1) that all animals would be at or near the surface 100 percent of the time, when in fact, marine mammals spend the majority of their time underwater, and (2) that the animals are stationary, which does not account for any movement or any potential avoidance of the training or testing activity.

1. A = length*width, where the individual animal's width (breadth) is assumed to be 20 percent of its length for marine mammals and 112 percent of its length for sea turtles. This product for A is multiplied by the number of animals N_a in the specified training or testing area (i.e., product of the highest average month animal density [D] and training or testing area [R]: $N_a = D*R$) to obtain the total animal footprint area ($A*N_a = A*D*R$) in the training or testing area. As a conservative scenario, the total animal footprint area is calculated for the species with the highest average month density in the training or testing area with the highest use of military items within the entire Study Area.
2. $I = N_{mun}$*length*diameter, where N_{mun} = total annual number of military items for each type, and "length" and "diameter" refer to the individual military equipment dimensions. For each type, the individual impact footprint area is multiplied by the total annual number of military items to obtain the type-specific impact footprint area ($I = N_{mun}$*length*diameter). Each training or testing activity uses one or more different types of military items, each with a specific number and dimensions, and several training and testing activities occur in a given year. When integrating over the number of military items types for the given activity (and then over the number of activities in a year), these calculations are repeated (accounting for differences in dimensions and numbers) for all military items types used, to obtain the type-specific impact footprint area (I). These impact footprint areas are summed over all military items types for the given activity, and then summed (integrated) over all activities to obtain the total impact footprint area resulting from all activities occurring in the training or testing area in a given year.

As a conservative scenario, the total impact footprint area is calculated for the training or testing area with the highest use of military items within the entire Study Area.

Though marine mammals and sea turtles are not randomly distributed in the environment, a random point calculation was chosen due to the intensive data needs that would be required for a calculation that incorporated more detailed information on an animal's or military item's spatial occurrence.

The analysis is expected to provide an overestimation of the probability of a strike for the following reasons: (1) it calculates the probability of a single military item (of all the items expended over the course of the year) hitting a single animal at its species' highest seasonal density, (2) it does not take into account the possibility that an animal may avoid military activities, (3) it does not take into account the possibility that an animal may not be at the water surface, (4) it does not take into account that most projectiles fired during training and testing activities are fired at targets, and so only a very small portion of those projectiles that miss the target would hit the water with their maximum velocity and force, and (5) it does not quantitatively take into account the Navy avoiding animals that are sighted through the implementation of mitigation measures (for consideration of mitigation during analysis see Sections 3.7.3.4, Marine Mammals; and 3.8.3.4, Reptiles).

The likelihood of an impact is calculated as the probability (P) that the animal footprint (A) and the impact footprint (I) will intersect within the training or testing area (R). This is calculated as the area ratio A/R or I/R, respectively. Note that A (referring to an **individual** animal footprint) and I (referring to the impact footprint resulting from the **total** number of military items N_{mun}) are the relevant quantities used in the following calculations of single-animal impact probability [P], which is then multiplied by the number of animals to obtain the number of exposures (T). The probability that the random point in the training or testing area is within both types of footprints (i.e., A and I) depends on the degree of overlap of A and I. The probability that I overlaps A is calculated by adding a buffer distance around A based on one-half of the impact area (i.e., 0.5*I), such that an impact (center) occurring anywhere within the combined (overlapping) area would impact the animal. Thus, if L_i and W_i are the length and width of the impact footprint such that $L_i*W_i = 0.5*I$ and $W_i/L_i = L_a/W_a$ (i.e., similar geometry between the animal footprint and impact footprint), and if L_a and W_a are the length and width (breadth) of the individual animal such that $L_a*W_a = A$ (= individual animal footprint area), then, assuming a purely static, rectangular scenario (Scenario 1), the total area $A_{tot} = (L_a + 2*L_i)*(W_a + 2*W_i)$, and the buffer area $A_{buffer} = A_{tot} - L_a*W_a$.

Four scenarios were examined with respect to defining and setting up the overlapping combined areas of A and I:

1. **Scenario 1**: Purely static, rectangular scenario. Impact is assumed to be static (i.e., direct impact effects only; non-dynamic; no explosions or scattering of military items after the initial impact). Hence the impact footprint area (I) is assumed to be rectangular and given by the product of military items length and width (multiplied by the number of military items).
   $A_{tot} = (L_a + 2*L_i)*(W_a + 2*W_i)$ and $A_{buffer} = A_{tot} - L_a*W_a$.
2. **Scenario 2**: Dynamic scenario with end-on collision, in which the length of the impact footprint (Li) is enhanced by Rn = 5 military items lengths to reflect forward momentum.
   $A_{tot} = (L_a + (1 + R_n)*L_i)*(W_a + 2*W_i)$ and $A_{buffer} = A_{tot} - L_a*W_a$.
3. **Scenario 3**: Dynamic scenario with broadside collision, in which the width of the impact footprint (W_i) is enhanced by R_n = 5 military items lengths to reflect forward momentum.
   $A_{tot} = (L_a + 2*W_i)*(W_a + (1 + R_n)*L_i)$ and $A_{buffer} = A_{tot} - L_a*W_a$.

4. **Scenario 4**: Purely static, radial scenario, in which the rectangular animal and impact footprints are replaced with circular footprints while conserving area. Define the radius (R_a) of the circular individual animal footprint such that $\pi*R_a^2 = L_a*W_a$, and define the radius (R_i) of the circular impact footprint such that $\pi *R_i^2 = 0.5*L_i*W_i = 0.5*I$. Then $A_{tot} = \pi *(R_a + R_i)^2$ and $A_{buffer} = A_{tot} - \pi *R_a^2$ (where $\pi = 3.1415927$).

Static impacts (Scenarios 1 and 4) assume no additional aerial coverage effects of scattered military items beyond the initial impact. For dynamic impacts (Scenarios 2 and 3), the distance of any scattered military items must be considered by increasing the length (Scenario 2) or width (Scenario 3), depending on orientation (broadside versus end-on collision), of the impact footprint to account for the forward horizontal momentum of the falling object. Forward momentum typically accounts for five object lengths, resulting in a corresponding increase in impact area. Significantly different values may result from the static and dynamic orientation. Both of these types of collision conditions can be calculated each with 50 percent likelihood (i.e., equal weighting between Scenarios 2 and 3, to average these potentially different values).

Impact probability P is the probability of impacting one animal with the given number, type, and dimensions of all military items used in training or testing activities occurring in the area per year, and is given by the ratio of total area (A_{tot}) to training or testing area (R): $P = A_{tot}/R$. Number of exposures is $T = N*P = N*A_{tot}/R$, where N = number of animals in the training or testing area per year (given as the product of the animal density [D] and range size [R]). Thus, $N = D*R$ and hence $T = N*P = N*A_{tot}/R = D*A_{tot}$. Using this procedure, P and T were calculated for each of the four scenarios, for Endangered Species Act (ESA)-listed marine mammals and the marine mammal and sea turtle species with the highest average month density (used as the annual density value) and for each military item type. The scenario-specific P and T values were averaged over the four scenarios (using equal weighting) to obtain a single scenario -averaged annual estimate of P and T. The potential number of exposures (t) are reported in Table F-31 through Table F-34.

F.2.2 PARAMETERS FOR ANALYSIS

Impact probabilities (P) and number of exposures (T) were estimated by the analysis for the following parameters:

1. **Two action alternatives**: Alternative 1 and Alternative 2. Animal densities, animal dimensions, and military item dimensions are the same for the two action alternatives.
2. **Two training or testing areas**: Hawaii Range Complex and Southern California Range Complex.
3. The following types of non-explosive munitions or other items:
    - **Small-caliber projectiles:** up to and including .50 caliber rounds
    - **Medium-caliber projectiles:** larger than .50 caliber rounds but smaller than 57 millimeters (mm) projectiles
    - **Large-caliber projectiles:** includes projectiles greater than or equal to a 57 mm projectile
    - **Missiles:** includes rockets and jet-propelled munitions
    - **Bombs:** Non-explosive practice bombs and mine shapes, ranging from 10 to 2,000 pounds
    - **Torpedoes:** includes all lightweight torpedoes
    - **Sonobuoys:** includes all sonobuoys
    - **Targets:** includes expended, airborne and surface, targets, as well as mine shapes

- **Lightweight torpedo accessories:** includes all accessories that are dropped along with the torpedo (nose cap, air stabilizer, etc.)
- **Anchors:** includes blocks used to anchor mine shapes to the seafloor
- **Acoustic countermeasures:** includes aircraft deployed acoustic countermeasures
- **High-Energy Lasers:** includes high-energy laser weapons that are directed at a surface target
- **Expended Bathythermographs:** small sensor deployed from ships

4. **Animal species of interest:** The eight species of ESA-listed marine mammals and the non-ESA listed marine mammal species with the highest average month density in the training and testing areas of interest. The sea turtle species with the highest average month density in the training and testing areas of interest.

F.2.3 INPUT DATA

Input data for the direct strike analysis include animal species likely to be in the area and military items proposed for use under each of the two action alternatives. Animal species data include: (1) species identification and status (i.e., threatened, endangered, or neither), (2) highest average month density estimate for the species of interest, and (3) adult animal dimensions (length and width) for the species with the highest density. The animal's dimensions are used to calculate individual animal footprint areas (A = length*width), and animal densities are used to calculate the number of exposures (T) from the impact probability (P): T = N*P. Military items data include: (1) military items category (e.g., projectile, bomb, rocket, target), (2) military items dimensions (length and width), and (3) total number of military items used annually.

Military items input data, specifically the quantity (e.g., numbers of bombs and rockets), are different in magnitude between the two action alternatives. All animal species input data, the military items' identification and category, and the military items' dimensions are the same for the two alternatives; only the quantities (i.e., total number of military items) are different.

F.2.4 OUTPUT DATA

Estimates of impact probability (P) and number of exposures (T) for a given species of interest were made for the specified training or testing area with the highest annual number of military items used for each of the two action alternatives. The calculations derived P and T from the highest annual number of military items used in the Study Area for the given alternative. Differences in P and T between the alternatives arise from different numbers of events (and therefore military items) for the two alternatives.

Results for marine mammals and sea turtles are presented in Tables F-31 through F-34.

Table F-31: Estimated Representative Marine Mammal Exposures from Direct Strike of a High-Energy Laser by Area and Alternative in a Single Year

Hawaii Range Complex				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
False Killer Whale (MHI Insular DPS)	0.000000	0.000000	0.000000	0.000000
Sei Whale	0.000000	0.000000	0.000000	0.000000
Fin Whale	0.000000	0.000000	0.000000	0.000000
Blue Whale	0.000000	0.000000	0.000000	0.000000
Sperm Whale	0.000000	0.000000	0.000001	0.000001
Hawaiian Monk Seal	0.000000	0.000000	0.000000	0.000000
Bottlenose Dolphin (Oahu)	0.000000	0.000000	0.000068	0.000068
SOCAL Range Complex				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Gray Whale (Western North Pacific DPS)	0.000000	0.000000	0.000004	0.000015
Humpback Whale (Central American DPS)	0.000000	0.000000	0.000003	0.000011
Sei Whale	0.000000	0.000000	0.000000	0.000000
Fin Whale	0.000000	0.000000	0.000003	0.000012
Blue Whale	0.000000	0.000000	0.000004	0.000016
Sperm Whale	0.000000	0.000000	0.000002	0.000008
Guadalupe Fur Seal	0.000000	0.000000	0.000032	0.000146
Short Beaked Common Dolphin	0.000000	0.000000	0.000693	0.003321

Table F-32: Estimated Representative Sea Turtle Guild Exposures from Direct Strike of a High-Energy Laser by Area and Alternative in a Single Year

Hawaii Range Complex				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Pacific Sea Turtle Guild	0.000000	0.000000	0.000064	0.000064

Table F-33: Estimated Representative Marine Mammal Exposures from Direct Strike of Military Expended Materials by Area and Alternative in a Single Year

Hawaii Range Complex				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
False Killer Whale (MHI Insular DPS)	0.000035	0.000035	0.000042	0.000043
Sei Whale	0.000007	0.000007	0.000009	0.000009
Fin Whale	0.000003	0.000003	0.000003	0.000003
Blue Whale	0.000002	0.000002	0.000003	0.000003
Sperm Whale	0.000068	0.000068	0.000082	0.000083
Hawaiian Monk Seal	0.000048	0.000030	0.000037	0.000037
Bottlenose Dolphin (Oahu)	0.008154	0.008154	0.009900	0.009924
SOCAL Range Complex				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Gray Whale (Western North Pacific DPS)	0.000576	0.003197	0.000383	0.000386
Humpback whale (Central American DPS)	0.000443	0.002457	0.000295	0.000297
Sei whale	0.000012	0.000064	0.000008	0.000008
Fin whale	0.000424	0.002331	0.000283	0.000285
Blue whale	0.000565	0.003097	0.000378	0.000380
Sperm whale	0.000296	0.001641	0.000197	0.000199
Guadalupe Fur Seal	0.006305	0.035318	0.004181	0.004209
Short Beaked Common Dolphin	0.149682	0.841811	0.099091	0.099772

Table F-34: Estimated Representative Sea Turtle Exposures from Direct Strike of Military Expended Materials by Area and Alternative in a Single Year

Hawaii Range Complex				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Pacific Sea Turtle Guild	0.007559	0.007559	0.009177	0.009198

F.3 POISSON PROBABILITY OF DIRECT VESSEL STRIKE WITH MARINE MAMMALS

It is Navy policy to report all marine mammal strikes by Navy vessel. The information is collected by the Office of the Chief of Naval Operations Environmental Readiness and provided to the National Marine Fisheries Service (NMFS) on an annual basis. Only the Navy and the U.S. Coast Guard report in this manner. Therefore, it should be noted that Navy vessel strikes reported in the scientific literature and NMFS databases are the result of the Navy's commitment to reporting all vessel strikes to NMFS rather than a greater frequency of collisions relative to other ship types. Historically and as a cautionary practice today, some Navy strikes are reported to NMFS even though the strike to a marine mammal could not be confirmed, or if large cetacean was struck then exact species may not be known. Most vessel strikes of marine mammals reported involve commercial vessels and occur over or near the continental shelf (Laist et al., 2001). Reporting to NMFS of whale strikes by commercial vessels is not required and reporting rates are therefore unknown but likely to be much lower than actual occurrences.

Between 2007 and 2009, the Navy developed and distributed additional training, mitigation, and reporting tools to Navy operators to improve marine mammal protection and to ensure compliance with upcoming permit requirements. In 2007, the Navy implemented the Marine Species Awareness Training, which is designed to improve the effectiveness of visual observations for marine resources, including marine mammals and sea turtles. In subsequent years, the Navy issued refined policy guidance regarding marine mammal incidents (e.g., ship strikes) in order to collect the most accurate and detailed data possible in response to a possible incident. For over a decade, the Navy has implemented the Protective Measures Assessment Protocol software tool, which provides operators with notification of the required mitigation and a visual display of the planned training or testing activity location overlaid with relevant environmental data. Similar mitigation, reporting, and monitoring requirements have been in place since 2009 and are expected to continue into the future. Therefore, the conditions affecting the potential for ship strikes are the most consistent across this time frame. As a result, data from the past nine years (i.e., 2009 to 2016) are used to calculate the probability of a Navy vessel striking a whale during proposed training activities in the Study Area. The level of vessel use and the manner in which the Navy trains and tests in the future (2019–2023) is expected to be consistent with this time period.

Data over a period from 2009 to 2016 are used to calculate the most current probability of a Navy vessel striking a whale in the Study Area. From January 2009 through December 2016, a total of two (2) reported whale strikes have occurred from Navy training and testing activities in the HSTT Study Area, two in the Southern California Range Complex (both fin whales in 2009).

Large unmanned surface vessels are an emerging technology area. Within the timeframe covered by this analysis, the Navy anticipates that testing of large unmanned surface vehicles in the HSTT Study Area would could occur up to approximately 300 at-sea days per year. During some testing of large unmanned surface vessels, the platforms would be manned by testing personnel who would serve as Lookouts and would have the ability to over-ride autonomous navigation; however, other testing would occur while the platform is unmanned. As described in Chapter 5 (Mitigation), autonomous marine mammal detection technologies are being investigated, but it is assumed that these technologies may not be available for large unmanned surface vehicle testing in the timeframe covered by this analysis.

Unlike for manned naval vessels, there are no historical at-sea hours or strike data upon which a large unmanned surface vessel strike analysis can be based. The method presented above for naval vessels, therefore, is followed to assess the risk of strike due to the addition of large unmanned vessel at-sea

days. Following the method presented above, an additional 300 at-sea days annually are added to the strike risk to account for large unmanned surface vessels. This is a small increase in risk compared to the risk based on historical data for manned vessels; however, actual additional risk is assumed to be greater because of the lack of both lookouts and implementation of procedural mitigation. Still, this increased risk would be limited because large unmanned surface vessel at-sea days are a small portion (less than 7 percent) of overall vessel predicted at-sea days for 2019-2023; large unmanned surface vessels would be substantially smaller than most naval vessels; and a portion of large unmanned surface vessel tests would include lookouts who could implement avoidance mitigation.

Since the probability of a Navy vessel strike to whales is influenced by the amount of time at sea for Navy vessels within the HSTT Study Area, the Navy used historic at-sea days in HSTT from 2009–2016 and estimated potential at-sea days for the period from 2019 to 2023. The at-sea days then are used to calculate a strike rate based on the 2009–2016 reporting period. Total ship at-sea days for this period were 33,860 days. Dividing the two reported strikes by ship at-sea day (2/33,860) results in a strike rate of 0.00006 strike per day. Estimated ship at-sea days within HSTT for the period from 2019 to 2023 is 22,663 days. The historic strike rate (0.00006 strike per day) can be multiplied by the estimated at-sea days from 2019 to 2023 to estimate the number of whale strikes that could be anticipated (0.00006 strike per day x 22,663 days). This calculation predicts up to 1.34 strikes over the period from 2019 to 2023.

The probabilities of a specific number of strikes (n=0, 1, 2, etc.) over the period from 2019 to 2023 can be derived from a Poisson distribution. A Poisson distribution is often used to describe random occurrences when the probability of an occurrence is small, e.g., count data such as cetacean sighting data, or in this case strike data, often described as a Poisson or over-dispersed Poisson distribution. The formula for a Poisson distribution is:

$$P\left\langle n \middle| \mu \right\rangle = \frac{e^{-\mu} \bullet \mu^{n}}{n!}$$

P(n/μ) is the probability of observing n events in some time interval, when the expected number of events in that time interval is μ. For this analysis, $\underline{\mu}$ is the estimated 2019–2023 strike rate of 1.2.

From the strike rate (1.2), the Poisson distribution can estimate the probability of *n* where n=0 (no strikes), 1 strike, 2 strikes, and 3 strikes:

P(0)= 0.262 or a 26% chance of zero strikes over the period from 2019 to 2023

P(1)= 0.351 or a 35% chance of one strike over the period from 2019 to 2023

P(2)= 0.235 or a 23% chance of two strikes over the period from 2019 to 2023

P(3)= 0.105 or a 10% chance of three strikes over the period from 2019 to 2023

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REFERENCES

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Appendix G: Federal Register Notices

APPENDIX G
FEDERAL REGISTER NOTICES

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Final
Environmental Impact Statement/Overseas Environmental Impact Statement
Hawaii-Southern California Training and Testing

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APPENDIX G FEDERAL REGISTER NOTICES

Appendix G contains the following Federal Register Notices:

1. Notice of Intent to Prepare an Environmental Impact Statement/Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing and Notice of Public Scoping Meetings
2. Corrected Notice of Intent to Prepare an Environmental Impact Statement/Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing and Notice of Public Scoping Meetings
3. Notice of Public Meetings of the Draft Environmental Impact Statement/Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing
4. Notice of Availability of the Draft Environmental Impact Statement/Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing
5. Notice of Receipt of Application for Letter of Authorization for Taking Marine Mammals Incidental to U.S. Navy Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area
6. Proposed Rule for Takes of Marine Mammals Incidental to U.S. Navy Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area

Proposed Action is to conduct military readiness activities in the AFTT Study Area. These training and testing activities are generally consistent with those analyzed in the AFTT EIS/OEIS completed in August 2013 and are representative of training and testing that the Navy has been conducting in the AFTT Study Area for decades.

The following range complexes fall within the AFTT Study Area: Northeast Range Complexes, Virginia Capes Range Complex, Navy Cherry Point Range Complex, Jacksonville Range Complex, Key West Range Complex, and Gulf of Mexico Range Complex. The testing ranges in the AFTT Study Area include: Naval Undersea Warfare Center Division Newport, Newport, Rhode Island; Naval Surface Warfare Center (NSWC) Panama City Division, Panama City, Florida; and NSWC Carderock Division South Florida Ocean Measurement Facility, Dania, Florida. While most Navy military readiness activities take place in operating and warning areas in the AFTT Study Area, some activities, such as sonar maintenance and gunnery exercises, are conducted concurrent with normal transits and occur outside of these areas, but still within the Study Area. The pierside testing locations and associated port transit channels are located at the following Navy ports and naval shipyards: Portsmouth Naval Shipyard, Kittery, Maine; Naval Submarine Base New London, Groton, Connecticut; Naval Station Norfolk, Norfolk, Virginia; Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach, Virginia; Naval Submarine Base Kings Bay, Kings Bay, Georgia; Naval Station Mayport, Jacksonville, Florida; Norfolk Naval Shipyard, Portsmouth, Virginia; and Port Canaveral, Cape Canaveral, Florida. Additional AFTT Study Area pierside testing locations and associated port transit channels are located in Bath, Maine; Groton, Connecticut; Newport News, Virginia; and Pascagoula, Mississippi.

Pursuant to 40 CFR 1501.6, the Navy will invite the National Marine Fisheries Service to be a cooperating agency in preparation of the EIS/OEIS.

The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure that the Navy can meet its mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, as consistent with Congressional direction Section 5062, of Title 10 U.S. Code.

The AFTT Phase III EIS/OEIS will consider a No Action Alternative and action alternatives that account for types and tempo of training and testing activities beginning in 2018 as necessary to meet future readiness requirements.

Resource areas that will be addressed include, but are not limited to: Biological resources (including marine mammals and threatened and endangered species), sediments and water quality, air quality, noise, cultural resources, socioeconomic resources, and public health and safety.

The scoping process will be used to identify community concerns and local issues to be addressed in the EIS/OEIS. Federal agencies, state agencies, local agencies, Native American Indian Tribes and Nations, the public, and interested persons are encouraged to identify specific issues or topics of environmental concern that the Navy should consider. Written comments must be postmarked no later than January 12, 2016 to ensure they are considered in the development of the EIS/OEIS and mailed to: Naval Facilities Engineering Command Atlantic, Code EV2.2LDN (AFTT EIS/OEIS Project Manager), 6506 Hampton Boulevard, Norfolk, Virginia, 23508–1278. Comments also can be submitted electronically by January 12, 2016 via the project Web site at *http://www.AFTTEIS.com*.

Dated: November 5, 2015.

N.A. Hagerty-Ford,

Commander, Judge Advocate General's Corps, U.S. Navy, Administrative Law Division, Federal Register Liaison Officer.

[FR Doc. 2015–28760 Filed 11–10–15; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement/Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing and Notice of Public Scoping Meetings

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, as implemented by the Council on Environmental Quality Regulations (40 Code of Federal Regulations [CFR] parts 1500–1508), and Executive Order (EO) 12114, the Department of the Navy (Navy) announces its intent to prepare an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to evaluate the potential environmental effects associated with continuing to conduct military readiness activities, which consist of training activities and research, development, testing, and evaluation (hereinafter referred to as "testing") activities in the Hawaii-Southern California Training and Testing (HSTT) Study Area. The Study Area consists of the in-water areas of the Southern California (SOCAL) Range Complex (including San Diego Bay); in-water areas of Silver Strand Training Complex (SSTC); the Hawaii Range Complex (HRC); areas on the high seas where training and sonar testing and maintenance may occur during vessel transit between the Hawaii and Southern California Range Complexes; the Temporary Operating Area north and west of the Hawaii Range Complex; and specific Navy pierside, port, and harbor locations.

In order to achieve and maintain military readiness, the Navy proposes to:

- Conduct training and testing activities at levels required to support Navy military readiness requirements beginning in December 2018 into the reasonably foreseeable future; and
- Accommodate evolving mission requirements associated with force structure changes, including those resulting from the development, testing, and ultimate introduction of new platforms (vessels, aircraft, and weapon systems) into the fleet; thereby ensuring critical Navy requirements are met.

As part of this process the Navy will seek to obtain authorization and permitting, as required under the Marine Mammal Protection Act and Endangered Species Act, respectively.

The Navy invites comments on the scope and content of the EIS/OEIS from all interested parties. Comments may be provided by mail and through the EIS/OEIS Web site at: *http://www.hstteis.com*. Mailed comments must be postmarked no later than January 16, 2016 and mailed to the address below to ensure they are considered.

In addition, the Navy will conduct public scoping meetings to obtain comments on the scope of the EIS/OEIS and to identify specific environmental concerns or topics for consideration in the document.

DATES: *Dates and Addresses:* Three public scoping meetings will be held on:

1. Tuesday, December 1, 2015, 5:00–8:00 p.m., Marina Village Conference Center Starboard Room, 1930 Quivira Way, San Diego, CA 92109
2. Thursday, December 3, 2015, 5:00–8:00 p.m., Island School Main Hall, 3–1901 Kaumualiʻi Highway Lihue, Kauai, HI 96766
3. Saturday, December 5, 2015, 11:00–2:00 p.m., Keʻehi Lagoon Memorial,

2685 N. Nimitz Highway, Honolulu, HI 96819

The scoping meetings will consist of an informal, open-house session with informational stations staffed by Navy representatives. Meeting details will be announced in local newspapers. Additional information on the public scoping meetings will be available on the EIS/OEIS Web page located at: *http://www.hstteis.com*.

FOR FURTHER INFORMATION CONTACT: Nora Macaraig-See, Naval Facilities Engineering Command, Pacific, Attention: HSTT EIS/OEIS, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134, 808–472–1402.

SUPPLEMENTARY INFORMATION: The Navy's lead action proponent is Commander, United States Pacific Fleet. Additional action proponents include Naval Sea Systems Command (NAVSEA), Naval Air Systems Command (NAVAIR), Space and Naval Warfare Systems Command (SPAWAR), and the Office of Naval Research (ONR). The Proposed Action is to conduct military readiness activities in the HSTT Study Area. These training and testing activities are generally consistent with those analyzed in the HSTT EIS/OEIS completed in August 2013 and are representative of training and testing that the Navy has been conducting in the HSTT Study Area for decades.

The HSTT EIS/OEIS Study Area includes the HRC, the SOCAL Range Complex, in-water areas of SSTC, and San Diego Bay. It also includes the transit corridor between the HRC and the SOCAL Range Complex, as well as the Temporary Operating Area north and west of the HRC. Analysis will include in-water areas and activities, including pierside locations and harbors.

Pursuant to 40 CFR 1501.6, the Navy will invite the National Marine Fisheries Service to be a cooperating agency in preparation of the EIS/OEIS.

The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure that the Navy can meet its mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, consistent with Congressional direction in section 5062 of Title 10 of the U.S. Code.

The HSTT Phase III EIS/OEIS will consider a No Action Alternative and action alternatives that account for levels of training and testing activities beginning in December 2018 as necessary to meet future readiness requirements. Refurbishment of existing undersea instrumented ranges is also being considered.

Resource areas that will be addressed include, but are not limited to, biological resources (including marine mammals and threatened and endangered species), sediments and water quality, air quality, noise, cultural resources, socioeconomic resources, and public health and safety.

The scoping process will be used to identify community concerns and local issues to be addressed in the EIS/OEIS. Federal agencies, state agencies, local agencies, Native American Indian Tribes and Nations, Native Hawaiian Organizations, the public, and interested persons are encouraged to provide comments to the Navy to identify specific issues or topics of environmental concern that the commenter believes the Navy should consider. All comments provided orally or in writing at the scoping meetings will receive the same consideration during EIS/OEIS preparation.

Written comments must be postmarked no later than January 13, 2016 to ensure they are considered in the development of the EIS/OEIS and be mailed to: Naval Facilities Engineering Command, Pacific, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134, Attention: HSTT EIS/OEIS Project Manager. Comments also can be submitted electronically by January 12, 2016 via the project Web site at *http://www.hstteis.com*.

Dated: November 5, 2015.

N.A. Hagerty-Ford,

Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. 2015–29749 Filed 11–10–15; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF EDUCATION

National Advisory Committee on Institutional Quality and Integrity Meeting; Update and Correction

AGENCY: National Advisory Committee on Institutional Quality and Integrity (NACIQI), U.S. Department of Education.

ACTION: Announcement of the time and location of the NACIQI meeting; and a correction to the agenda.

SUMMARY: This meeting notice is an update to the previous notice published in the Federal Register (176 FR 54774) on September 11, 2015, and sets forth the time and location for the December 16, 17, and 18, 2015 NACIQI meeting. This notice also provides a correction to the current and requested scopes of recognition for the Western Association of Schools and Colleges, Accrediting Commission for Community Colleges and Junior Colleges (WASC ACCJC), and clarifies the scope of review to be conducted at the meeting for the Northwest Commission on Colleges and Universities (MWCCU) and WASC ACCJC. Further, this notice adds an item to the agenda. The notice of this meeting is required under Section 10(a)(2) of the Federal Advisory Committee Act (FACA) and Section 114(d)(1)(B) of the Higher Education Act of 1965 (HEA), as amended.

DATES: The NACIQI meeting will be held on December 16, 17, and 18, 2015, from 8:00 a.m. to 5:30 p.m., at the Hilton Alexandria Old Town, 1767 King Street, Alexandria, VA 22314.

FOR FURTHER INFORMATION CONTACT: Jennifer Hong, Executive Director/Designated Federal Official, NACIQI, U.S. Department of Education, 1990 K Street NW., Room 8073, Washington, DC 20006–8129, telephone: (202) 502–7696, fax: (202) 502–7874, or email: *Jennifer.Hong@ed.gov*.

SUPPLEMENTARY INFORMATION:

Meeting Agenda Correction: A correction to current and requested scopes of recognition for the Western Association of Schools and Colleges, Accrediting Commission for Community and Junior Colleges (WASC ACCJC); clarification regarding the scope of review at the meeting for the Northwest Commission on Colleges and Universities (NWCCU) and WASC ACCJC; and addition of an agenda item.

Below is the requested and current scopes of recognition for WASC ACCJC, scheduled for review during the December 2015 meeting:

Compliance Report

Current Scope of Recognition: The accreditation and preaccreditation ("Candidate for Accreditation") of community and other colleges with a primarily pre-baccalaureate mission located in California, Hawaii, the United States territories of Guam and American Samoa, the Republic of Palau, the Federated States of Micronesia, the Commonwealth of the Northern Mariana Islands, and the Republic of the Marshall Islands, which offer certificates, associate degrees, and the first baccalaureate degree by means of a substantive change review offered by institutions that are already accredited by the agency, and such programs offered via distance education and correspondence education at these colleges. This recognition also extends to the Committee on Substantive Change of the Commission, for decisions on

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DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent to Grant Exclusive Patent License: Lockmasters Incorporated

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: The Department of the Navy herby gives notice of its intent to grant to Lockmasters Incorporated a revocable, nonassignable, exclusive license for three years and a nonexclusive license thereafter to practice in the field of use of security locking devices in the United States and its territories, the Government-owned invention described in U.S. Patent Application 14/826014 entitled "Spindle Locator Tool", filed on Aug 13, 2015.

DATES: Anyone wishing to object to the grant of this license must file written objections along with supporting evidence, if any, not later than [INSERT DATE 15 DAYS AFTER PUBLICATION FIRST APPEARS IN Federal Register].

ADDRESSES: Written objections should be directed to NAVFAC Engineering & Expeditionary Warfare Center, 1100 23rd Avenue, Port Hueneme, CA 93043–4370.

FOR FURTHER INFORMATION CONTACT: Victor Cai, Office of Research and Technology Applications, NAVFAC EXWC, 1100 23rd Avenue, Port Hueneme, CA 93043–4370, telephone 805–982–3009, email: *victor.cai@navy.mil.*

SUPPLEMENTARY INFORMATION: The Spindle Locator Tool enables identification of proper and improper placement of a spindle in a locking mechanism. Specifically, it will be used for the X–10 electromechanical lock which has experienced a spindle and cam interface issue that can result in lockouts requiring neutralization.

Authority: (35 U.S.C. 207, 37 CFR part 404)

Dated: November 24, 2015.

N.A. Hagerty-Ford,

Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. 2015–30491 Filed 11–30–15; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent to Prepare an Environmental Impact Statement/ Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing and Notice of Public Scoping Meetings; Correction

AGENCY: Department of the Navy, DoD.

ACTION: Notice; correction.

SUMMARY: The Department of the Navy published a document in the **Federal Register** (80 FR 218) on November 12, 2015, announcing a Notice of Intent to prepare an Environmental Impact Statement/Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing and a Notice of Public Scoping Meetings. The document contained an incorrect date.

FOR FURTHER INFORMATION CONTACT: Nora Macariola-See, Naval Facilities Engineering Command, Pacific. Attention: HSTT EIS/OEIS, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134. 808–472–1402.

CORRECTION: In the **Federal Register** (80 FR 218) of November 12, 2015, on page 69952, in the third column, correct the mailed comments postmarked date to read January 12, 2016.

Dated: November 24, 2015.

N.A. Hagerty-Ford,

Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. 2015–30492 Filed 11–30–15; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Performance Review Board Membership

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to 5 U.S.C. 4314(c)(4), the Department of Navy (DON) announces the appointment of members to the DON's numerous Senior Executive Service (SES) Performance Review Boards (PRBs). The purpose of the PRBs is to provide fair and impartial review of the annual SES performance appraisal prepared by the senior executive's immediate and second level supervisor; to make recommendations to appointing officials regarding acceptance or modification of the performance rating; and to make recommendations for performance bonuses and basic pay increases. Composition of the specific PRBs will be determined on an ad hoc basis from among the individuals listed below:

CAPT Mark Bruington
CAPT Robert Palisin
Dr. John Montgomery
Dr. Judith Lean
Dr. Thomas Killion
Dr. Walter Jones
LtGen Mark Brilakis
Mr. Anthony Cifone
Mr. William O'Donnell
Mr. Brian Persons
Mr. Bryan Wood
Mr. Dennis Biddick
Mr. Donald McCormack
Mr. Garry Newton
Mr. Gary Kessler
Mr. Gary Ressing
Mr. James McCarthy
Mr. James Meade
Mr. James Smerchansky
Mr. John Goodhart
Mr. John Pazik
Mr. John Thackrah
Mr. Joseph Ludovici
Mr. Mark Andress
Mr. Mark Honecker
Mr. Mark Ridley
Mr. Michael Kistler
Mr. Patrick Sullivan
Mr. Paul Jaeger
Mr. Phillip Chudoba
Mr. Robert Hogue
Mr. Ronald Davis
Mr. Samuel Worth
Mr. Scott Lutterloh
Mr. Scott O'Neil
Mr. Stephen Trautman
Mr. Steve Iselin
Mr. Thomas Hicks
Mr. Todd Balazs
Mr. Tom Dee
Mr. William Deligne
Ms. Allison Stiller
Ms. Anne Brennan
Ms. Carmela Keeney
Ms. Cindy Shaver
Ms. Diane Boyle
Ms. Gloria Valdez
Ms. Jennifer LaTorre
Ms. Joan Johnson
Ms. Leslie Taylor
Ms. Lynn Wright
Ms. Mary Tompa
Ms. Sharon Smoot
Ms. Wen Masters
RADM Elizabeth Train
RADM Jeffrey Harley
RADM Thomas Moore
RDML Jon Hill
RDML Lorin Selby
RDML William Galinis
VADM Terry Benedict

FOR FURTHER INFORMATION CONTACT: Jacqueline Wourman, Performance Management Program Manager, Executive Management Program Office, Office of Civilian Human Resources at 202 685–6665.

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Plaza, Room 2151, New York, NY 10279–0090; Phone: (917) 790–8722; email: *kimberly.a.rightler@usace.army.mil.*

FOR FURTHER INFORMATION CONTACT: Questions about the overall Peckman River Basin Flood Risk Management Feasibility Study should be directed to Robert Greco, Project Manager, U.S. Army Corps of Engineers, New York District, Programs and Project Management Division, Civil Works Programs Branch, 26 Federal Plaza, Room 2127, New York, NY 10279–0090; Phone: (917) 790–8394; email: *robert.m.greco@usace.army.mil.*

SUPPLEMENTARY INFORMATION:

1. Background

The U.S. Army Corps of Engineers (Corps), in partnership with the New Jersey Department of Environmental Protection (NJDEP) as the non-Federal sponsor is undertaking this study. Extensive development in the Peckman River Basin has resulted in flood damages with flooding occurring from intense thunderstorms and heavy rainfall. The District was authorized under U.S. House of Representatives Resolution Docket 2644, dated June 21, 2000 to identify recommendations in the interest of water resources development.

A Feasibility Cost Sharing Agreement (FCSA) was executed in 2002 with the NJDEP in 2002. A Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) was published in the May 14, 2004 issue of the **Federal Register** (69 FR 26811). A NEPA scoping meeting held on February 11, 2004 in Little Falls, New Jersey at the initiation of the study. The alternative analysis was completed in 2014, and non-structural improvements located within the 10 year floodplain within Little Falls, N.J. with a bypass culvert designed to mitigate the flood risk from the Peckman River and floodwalls along Great Notch Brook in Woodland Park was identified as the Tentatively Selected National Economic Development Plan. The NJDEP requested a Locally Preferred Plan that consists of a levee/floodwall system in Little Falls along with the bypass culvert for the Peckman River and floodwalls along Great Notch Brook in Woodland Park. The LPP plan will be designed to protect Little Falls and Woodland Park from the 1% annual chance exceedance (100-yr) event from the Peckman River.

2. Project Area

The project area encompasses the portion of the Peckman River, Great Notch Brook and a portion of the Passaic River located in the Township of Little Falls and the Borough of Woodland Park in Passaic County, New Jersey.

3. Public Participation

The Corps and the NJDEP are currently anticipating hosting a NEPA Scoping Meeting in late November/early December 2017. Public notices announcing the meeting date, time, location and agenda will be published in the appropriate local newspapers, Little Falls Township Web page, Borough of Woodland Park Web page and on the Corps' New York District Web page (see STUDY WEBPAGE AND ADDRESSES) and will be distributed to the local stakeholders and known interested parties.

A scoping comment period of 30 days will be established from the scheduled date of the meeting to allow agencies, organizations and individuals to submit comments, questions and/or concerns regarding the Feasibility Study. Comments, concerns and information submitted to the Corps will be evaluated and considered during the development of the Draft EIS.

5. Lead and Cooperating Agencies

The U.S. Army Corps of Engineers is the lead federal agency for the preparation of the environmental impact statement (EIS) and meeting the requirements of the National Environmental Policy Act and the NEPA Implementing Regulations of the President's Council on Environmental Quality (40 CFR 1500–1508). Federal agencies interested in participating as a Cooperating Agency are requested to submit a letter of intent to Colonel Thomas D. Asbery, District Engineer (see ADDRESSES). The preparation of the EIS will be coordinated with New Jersey State and local municipalities with discretionary authority relative to the proposed actions. The Draft integrated Feasibility Report/EIS is currently scheduled for distribution to the public March 2018.

Dated: October 3, 2017.

Peter M. Weppler,

Chief, Environmental Analysis Branch, Planning Division.

[FR Doc. 2017–21933 Filed 10–12–17; 8:45 am]

BILLING CODE 3720–58–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Public Meetings of the Draft Environmental Impact Statement/ Overseas Environmental Impact Statement for Hawaii-Southern California Training and Testing

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: The Department of the Navy (DoN) has prepared and filed with the U.S. Environmental Protection Agency a Draft Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS). It is the role of DoN to maintain, train and equip combat ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. To fulfil its role, the DoN will continue ongoing military readiness activities, which include training and research, development, testing, and evaluation activities (hereafter referred to as "training and testing") conducted within the Hawaii-Southern California Training and Testing (HSTT) EIS/OEIS Study Area (hereafter referred to as the "Study Area"). In the Draft EIS/OEIS, the DoN re-evaluates potential environmental impacts associated with training and testing in the study area. The National Marine Fisheries Service (NMFS) is a cooperating agency for this EIS/OEIS. This notice announces the dates and locations of the public meetings and provides supplementary information about the environmental planning effort.

DATES AND ADDRESSES: Public meetings will include an open-house information session, followed by a short presentation by the DoN and public oral comment session. DoN representatives will be available during the open-house information sessions to clarify information related to the Draft EIS/ OEIS. Federal, state, and local agencies and officials, and interested organizations and individuals are encouraged to provide substantive comments on the Draft EIS/OEIS in writing during the public review period or in person at one of the scheduled public meetings.

Public meetings will be held in Hawaii from 4:00 to 8:00 p.m. and in San Diego from 5:00 to 8:00 p.m. A DoN presentation and public oral comment session will occur twice during the meetings. Public meetings will be held on the following dates and at the following locations:

1. Monday, November 6, 2017, at Oahu Veterans Center, Fred Ballard Hall,

1298 Kukila St., Honolulu, HI 96818.
2. Tuesday, November 7, 2017, at Maui High School, Cafeteria, 660 S. Lono Ave., Kahului, HI 96732.
3. Wednesday, November 8, 2017, at Kauai Veterans Center, Main Ballroom, 3215 Kapule Highway, Lihue, HI 96766.
4. Thursday, November 9, 2017, at Waiakea High School, Cafeteria, 155 W. Kawili St., Hilo, HI 96720.
5. Monday, November 13, 2017, at Portuguese Hall, Main Hall, 2818 Avenida de Portugal, San Diego, CA 92106.

Attendees will be able to submit oral and written comments during the public meetings. Oral comments from the public will be recorded by a court reporter and each speaker's comments will be limited to three (3) minutes. Equal weight will be given to oral and written statements. Comments may also be mailed to Naval Facilities Engineering Command Pacific, Attention: HSTT EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134, or electronically via the project Web site (*www.HSTTEIS.com*). All comments, oral or written, submitted during the 60-day public comment period will become part of the public record and substantive comments will be addressed in the Final EIS/OEIS. Comments must be postmarked or received online by December 12, 2017, for consideration in the Final EIS/OEIS.

Concurrent with the NEPA public involvement process, the DoN is conducting National Historic Preservation Act section 106 consultations regarding potential effects of the Proposed Action on historic properties. Historic properties include districts, sites, buildings, structures, or objects listed or eligible for listing in the National Register of Historic Places. During each of the meetings, an information station will be available, where subject matter experts will explain the section 106 process and solicit public input.

FOR FURTHER INFORMATION CONTACT: Naval Facilities Engineering Command Pacific, Attention: HSTT EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134.

SUPPLEMENTARY INFORMATION: A Notice of Intent to prepare this Draft EIS/OEIS was published in the **Federal Register** on November 12, 2015 (80 FR 59952).

The Proposed Action is to conduct DoN training and testing activities within the Study Area. These activities include the use of active sonar and explosives while employing marine species protective mitigation measures. The purpose of the Proposed Action is to maintain a ready force, which is needed to ensure the DoN can accomplish its mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, consistent with Congressional direction in Section 5062 of Title 10 of the U.S. Code (U.S.C.).

To achieve and maintain military readiness, the DoN proposes to: (1) Conduct training and testing activities at levels required to support DoN military readiness requirements beginning in 2018; and (2) Accommodate evolving mission requirements, including those resulting from the development, testing, and introduction of vessels, aircraft, and weapons systems into the fleet.

Proposed training and testing activities are similar to those that have occurred in the Study Area for decades. The tempo and types of training and testing activities fluctuate because of the introduction of new technologies, the evolving nature of international events, advances in warfighting doctrine and procedures, and changes in force structure (organization of ships, weapons, and personnel). These factors can influence the frequency, duration, intensity, and location of training and testing activities. This EIS/OEIS reflects the most up-to-date compilation of training and testing activities deemed necessary to accomplish military readiness requirements. The types and numbers of activities included in the Proposed Action account for fluctuations in training and testing to meet evolving or emergent military readiness requirements.

In the Draft EIS/OEIS, the DoN evaluates the potential environmental impacts of three alternatives, including a No Action Alternative. Under the No Action Alternative, the DoN would not conduct the proposed training and testing activities in the Study Area, and no authorizations or permits would be issued from NMFS. Under Alternative 1 (the DoN's preferred alternative), the DoN proposes to conduct military readiness training and testing activities, as needed to meet current and future readiness requirements, including new activities and activities subject to previous analysis that are ongoing and have historically occurred in the Study Area. Alternative 1 reflects a representative annual level of training and testing to account for the natural fluctuation of training cycles and deployment schedules that generally limit the maximum level of training from occurring year after year in any five-year period. Using a representative annual level of activity rather than a maximum level of training activity in every year has reduced the amount of active sonar estimated to be necessary to meet training requirements. Under Alternative 1, the DoN assumes that some unit-level training would be conducted using synthetic means (*e.g.*, simulators). Alternative 2 includes new and ongoing training and testing activities to enable the DoN to meet the highest levels of required military readiness. Alternative 2 reflects the maximum number of training and testing activities that could occur within a given year, and assumes that the maximum level of activity would occur every year over any five-year period. Alternative 2 would allow for the greatest flexibility for the DoN to maintain readiness when considering potential changes in the national security environment, fluctuations in schedules, and anticipated demands.

Additional project information, including details on the key differences between the 2013 Final EIS/OEIS and the 2017 Draft EIS/OEIS, can be found on the project Web site at *www.HSTTEIS.com*.

Minimizing impacts on the marine environment from training and testing activities is an important goal for the DoN. The DoN will implement mitigation and monitoring measures to avoid or reduce environmental impacts from naval activities. Due to the exposure of marine mammals to underwater sound from sonar and explosives, NMFS has received an application from the DoN for a Marine Mammal Protection Act Letter of Authorization and governing regulations to authorize the unintentional takes of marine mammals incidental to the activities conducted in the Study Area. In accordance with section 7 of the Endangered Species Act, the DoN will consult with NMFS and the U.S. Fish and Wildlife Service, as appropriate, on the potential impacts of training and testing activities on federally listed species. In accordance with the Magnuson-Stevens Fishery Conservation and Management Act, the DoN will consult with NMFS on federally managed species and their managed essential fish habitat, as appropriate. As applicable, the DoN will comply with the Coastal Zone Management Act, National Historic Preservation Act, and the National Marine Sanctuaries Act.

The Draft EIS/OEIS was distributed to federal and local agencies in which the DoN consulted with. Copies of the Draft EIS/OEIS are available for public review at the following local public libraries:

1. Hawaii State Library, 478 S. King St., Honolulu, HI 96813.
2. Hilo Public Library, 300 Waianuenue Ave., Hilo, HI 96720.
3. Kahului Public Library, 90 School St., Kahului, HI 96732.
4. Kailua-Kona Public Library, 75–138 Hualalai Road, Kailua-Kona, HI 96740.
5. Lihue Public Library, 4344 Hardy St., Lihue, HI 96766.
6. City of San Diego Central Library, 330 Park Blvd., San Diego, CA 92101.
7. Coronado Public Library, 640 Orange Ave., Coronado, CA 92118.
8. Long Beach Main Library, 101 Pacific Ave., Long Beach, CA 90822.

The HSTT Draft EIS/OEIS is available for electronic viewing or download at *www.HSTTEIS.com*. A compact disc of the Draft EIS/OEIS will be made available upon written request by contacting: Naval Facilities Engineering Command Pacific, Attention: HSTT EIS/OEIS Project Manager, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860–3134.

Authority: 42 U.S.C. 4332, EO 12114, and 40 CFR 1500–1508.

Dated: October 10, 2017.

A.M. Nichols,

Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. 2017–22195 Filed 10–12–17; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. EL18–5–000]

Braintree Electric Light Department; Notice of Petition For Limited Waiver

Take notice that on October 5, 2017, pursuant to Rule 207(a)(5) of the Federal Energy Regulatory Commission's (Commission) Rules of Practice and Procedure, 18 CFR 385.207(a)(5) and section 554(e) of the Administrative Procedure Act (5 U.S.C. 554(e)), Braintree Electric Light Department filed a petition for the Commission to authorize a limited, one-time waiver of the October 1 deadline for delivery of notification to ISO New England, Inc. (ISO–NE) of its proposed participation in ISO–NE's 2017–2018 Winter Reliability Program, as more fully described in the filing.

Any person desiring to intervene or to protest in any of the above proceedings must file in accordance with Rules 211 and 214 of the Commission's Rules of Practice and Procedure (18 CFR 385.211 and 385.214) on or before 5:00 p.m. Eastern time on the specified comment date. It is not necessary to separately intervene again in a subdocket related to a compliance filing if you have previously intervened in the same docket. Protests will be considered by the Commission in determining the appropriate action to be taken, but will not serve to make protestants parties to the proceeding. Anyone filing a motion to intervene or protest must serve a copy of that document on the Applicant. In reference to filings initiating a new proceeding, interventions or protests submitted on or before the comment deadline need not be served on persons other than the Applicant.

The Commission encourages electronic submission of protests and interventions in lieu of paper, using the FERC Online links at *http://www.ferc.gov*. To facilitate electronic service, persons with Internet access who will eFile a document and/or be listed as a contact for an intervenor must create and validate an eRegistration account using the eRegistration link. Select the eFiling link to log on and submit the intervention or protests.

Persons unable to file electronically should submit an original and 14 copies of the intervention or protest to the Federal Energy Regulatory Commission, 888 First St. NE., Washington, DC 20426.

The filings in the above proceedings are accessible in the Commission's eLibrary system by clicking on the appropriate link in the above list. They are also available for review in the Commission's Public Reference Room in Washington, DC. There is an eSubscription link on the Web site that enables subscribers to receive email notification when a document is added to a subscribed docket(s). For assistance with any FERC Online service, please email *FERCOnlineSupport@ferc.gov*, or call (866) 208–3676 (toll free). For TTY, call (202) 502–8659.

Comment Date: 5:00 p.m. Eastern Time on October 26, 2017.

Dated: October 6, 2017.

Kimberly D. Bose,

Secretary.

[FR Doc. 2017–22214 Filed 10–12–17; 8:45 am]

BILLING CODE 6717–01–P

ENVIRONMENTAL PROTECTION AGENCY

[EPA–HQ–OPPT–2017–0141; FRL–9966–70]

Certain New Chemicals or Significant New Uses; Statements of Findings for July 2017

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: Section 5(g) of the Toxic Substances Control Act (TSCA) requires EPA to publish in the **Federal Register** a statement of its findings after its review of TSCA section 5(a) notices when EPA makes a finding that a new chemical substance or significant new use is not likely to present an unreasonable risk of injury to health or the environment. Such statements apply to premanufacture notices (PMNs), microbial commercial activity notices (MCANs), and significant new use notices (SNUNs) submitted to EPA under TSCA section 5. This document presents statements of findings made by EPA on TSCA section 5(a) notices during the period from July 1, 2017 to July 31, 2017.

FOR FURTHER INFORMATION CONTACT: *For technical information contact:* Greg Schweer, Chemical Control Division (7405M), Office of Pollution Prevention and Toxics, Environmental Protection Agency, 1200 Pennsylvania Ave. NW., Washington, DC 20460–0001; telephone number: 202–564–8469; email address: *schweer.greg@epa.gov*.

For general information contact: The TSCA-Hotline, ABVI-Goodwill, 422 South Clinton Ave., Rochester, NY 14620; telephone number: (202) 554–1404; email address: *TSCA-Hotline@epa.gov*.

SUPPLEMENTARY INFORMATION:

I. General Information

A. Does this action apply to me?

This action is directed to the public in general. As such, the Agency has not attempted to describe the specific entities that this action may apply to. Although others may be affected, this action applies directly to the submitters of the PMNs addressed in this action.

B. How can I get copies of this document and other related information?

The docket for this action, identified by docket identification (ID) number EPA–HQ–OPPT–2017–0141, is available at *http://www.regulations.gov* or at the Office of Pollution Prevention and Toxics Docket (OPPT Docket), Environmental Protection Agency Docket Center (EPA/DC), West William

these efficiency gains, the lower respondent count is appropriate.

As a result of the efficiency gains, and an overestimate of the respondents in our past request, we are submitting a more accurate number of respondents. The estimate below reflects the work associated with the current information collection requirements:

FERC–717, Open Access Same-Time Information System and Standards for Business Practices and Communication Protocols

Information collection requirements	Number of respondents (1)	Annual number of responses per respondent (2)	Total number of responses (1) * (2) = (3)	Average burden hours and cost per response [2] (4)	Total annual burden hours and total annual cost (3) * (4) = (5)
FERC–717	170	1	170	30 hrs.; $2,295	5,100 hrs.; $390,150.

Comments: Comments are invited on: (1) Whether the collection of information is necessary for the proper performance of the functions of the Commission, including whether the information will have practical utility; (2) the accuracy of the agency's estimate of the burden and cost of the collection of information, including the validity of the methodology and assumptions used; (3) ways to enhance the quality, utility and clarity of the information collection; and (4) ways to minimize the burden of the collection of information on those who are to respond, including the use of automated collection techniques or other forms of information technology.

Dated: October 11, 2017.

Kimberly D. Bose,

Secretary.

[FR Doc. 2017–22472 Filed 10–16–17; 8:45 am]

BILLING CODE 6717–01–P

ENVIRONMENTAL PROTECTION AGENCY

[ER–FRL–9035–6]

Environmental Impact Statements; Notice of Availability

Responsible Agency: Office of Federal Activities, General Information (202) 564–7146 or *http://www2.epa.gov/nepa/*.

Weekly receipt of Environmental Impact Statements (EIS)
Filed 10/02/2017 through 10/06/2017
Pursuant to 40 CFR 1506.9

Notice

Section 309(a) of the Clean Air Act requires that EPA make public its comments on EISs issued by other Federal agencies. EPA's comment letters on EISs are available at: *https://cdxnodengn.epa.gov/cdx-nepa-public/action/eis/search*.

EIS No. 20170198, Final, USAF, MD, Presidential Aircraft Recapitalization Program, Joint Base Andrews-Naval Air Facility, Review Period Ends: 11/15/2017, Contact: Ms Jean Renolds 210–925–4534.

EIS No. 20170200, Draft, FTA, PA, King of Prussia Rail Project, Comment Period Ends: 12/4/2017, Contact: Daniel Koenig 202–366–8224.

EIS No. 20170201, Draft, USN, CA, Hawaii-Southern Californian Training and Testing, Comment Period Ends: 12/12/2017, Contact: Nora Macariola-See 808–472–1402.

EIS No. 20170202, Draft, USFS, CO, CP District-wide Salvage, Comment Period Ends: 11/30/2017, Contact: Mike Tooley 719–274–6321.

Dated: October 9, 2017.

Kelly Knight,

Director, NEPA Compliance Division, Office of Federal Activities.

[FR Doc. 2017–22165 Filed 10–13–17; 12:00 pm]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[FRL–9969–52–OA]

Notice of Meeting of the EPA Children's Health Protection Advisory Committee (CHPAC)

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of meeting.

SUMMARY: Pursuant to the provisions of the Federal Advisory Committee Act, notice is hereby given that the next meeting of the Children's Health Protection Advisory Committee (CHPAC) will be held November 29 and 30 at The George Washington University Milken Institute School of Public Health 950 New Hampshire Ave. NW., Washington, DC 20052. The CHPAC advises the Environmental Protection Agency on science, regulations, and other issues relating to children's environmental health.

DATES: November 29 and 30 at The George Washington University Milken Institute School of Public Health in Washington, DC.

ADDRESSES: 950 New Hampshire Ave. NW., Washington, DC 20052.

FOR FURTHER INFORMATION CONTACT: Angela Hackel, Office of Children's Health Protection, USEPA, MC 1107T, 1200 Pennsylvania Avenue NW., Washington, DC 20460, (202) 566–2977 or *hackel.angela@epa.gov*.

SUPPLEMENTARY INFORMATION: The meetings of the CHPAC are open to the public. An agenda will be posted to *epa.gov/children*.

Access and Accommodations: For information on access or services for individuals with disabilities, please contact Angela Hackel at 202–5566–2977.

Dated: October 2, 2017.

Angela Hackel,

Designated Federal Official.

[FR Doc. 2017–22498 Filed 10–16–17; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[FRL–9969–71–OA]

Notification of a Public Teleconference of the Science Advisory Board Risk and Technology Review (RTR) Methods Review Panel

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: The EPA Science Advisory Board (SAB) Staff Office announces a public teleconference meeting of the Science Advisory Board (SAB) Risk and Technology Review (RTR) Methods

[2] The Commission staff thinks that the average respondent for this collection is similarly situated to the Commission, in terms of salary plus benefits. Based upon FERC's 2017 annual average of $158,754 (for salary plus benefits), the average hourly cost is $76.50/hour.

Federal Register / Vol. 82, No. 202 / Friday, October 20, 2017 / Notices 48801

is an occasional chest rather than a bedroom chest; August 17, 2016.

Interested parties are invited to comment on the completeness of this list of completed scope inquiries. Any comments should be submitted to the Deputy Assistant Secretary for AD/CVD Operations, Enforcement and Compliance, International Trade Administration, 1401 Constitution Avenue NW., APO/Dockets Unit, Room 18022, Washington, DC 20230.

This notice is published in accordance with 19 CFR 351.225(o).

Dated: October 16, 2017.

James Maeder,

Senior Director performing the duties of Deputy Assistant Secretary for Antidumping and Countervailing Duty Operations.

[FR Doc. 2017–22804 Filed 10–19–17; 8:45 am]

BILLING CODE 3510–DS–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XF701

Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to U.S. Navy Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; receipt of application for Letters of Authorization; request for comments and information.

SUMMARY: NMFS has received a request from the U.S. Navy (Navy) for authorization to take marine mammals incidental to training and testing activities conducted in the Hawaii-Southern California Training and Testing (HSTT) Study Area for a period of five years, from December 26, 2018 through December 25, 2023. Pursuant to regulations implementing the Marine Mammal Protection Act (MMPA), NMFS is announcing receipt of the Navy's request for the development and implementation of regulations governing the incidental taking of marine mammals. NMFS invites the public to provide information, suggestions, and comments on the Navy's application and request.

DATES: Comments and information must be received no later than November 20, 2017.

ADDRESSES: Comments on the application should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service. Physical comments should be sent to 1315 East-West Highway, Silver Spring, MD 20910 and electronic comments should be sent to *ITP.Egger@noaa.gov*.

Instructions: NMFS is not responsible for comments sent by any other method, to any other address or individual, or received after the end of the comment period. Comments received electronically, including all attachments, must not exceed a 25-megabyte file size. Attachments to electronic comments will be accepted in Microsoft Word or Excel or Adobe PDF file formats only. All comments received are a part of the public record and will generally be posted to the Internet at *www.nmfs.noaa.gov/pr/permits/incidental/military.htm* without change. All personal identifying information (*e.g.*, name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Stephanie Egger, Office of Protected Resources, NMFS, (301) 427–8401. An electronic copy of the Navy's application may be obtained online at: *www.nmfs.noaa.gov/pr/permits/incidental/military.htm*. In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

An authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

NMFS has defined "negligible impact" in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

The MMPA states that the term "take" means to harass, hunt, capture, kill or attempt to harass, hunt, capture, or kill any marine mammal.

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as: Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

The National Defense Authorization Act for Fiscal Year 2004 (Pub. L. 108–136) removed the "small numbers" and "specified geographical region" limitations indicated above and amended the definition of "harassment" as it applies to a "military readiness activity" to read as follows (Section 3(18)(B) of the MMPA): (i) Any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (ii) Any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered (Level B Harassment).

Summary of Request

On October 12, 2017, NMFS received an adequate and complete application from the Navy requesting authorization for take of marine mammals, by Level A and B harassment, incidental to training, testing, and routine military operations (all categorized as military readiness activities) from the use of sonar and other transducers, in-water detonations, airguns, and pile driving. In addition, the Navy is requesting authorization of three takes of large whales by serious injury or mortality resulting from vessel strikes. The requested regulations would be valid for five years, from 2018 through 2023.

This will be the third time NMFS has promulgated incidental take regulations pursuant to the MMPA relating to similar military readiness activities in

HSTT, following those effective from January 5, 2009, through January 5, 2014, (74 FR 1456; January 12, 2009) and from December 24, 2013, through December 24, 2018 (78 FR 78106; December 24, 2013).

Description of the Specified Activity

The HSTT Study Area includes areas in the north-central Pacific Ocean, from Southern California west to Hawaii and the International Date Line, and including the Hawaii and Southern California (SOCAL) Range Complexes, as well as the Silver Strand Training Complex and overlaps a portion of the Point Mugu Sea Range. The Hawaii Range Complex encompasses ocean areas around the Hawaiian Islands, extending from 16 degrees north latitude to 43 degrees north latitude and from 150 degrees west longitude to the International Date Line. The SOCAL Range Complex is located approximately between Dana Point and San Diego, California, and extends southwest into the Pacific Ocean and also includes a small portion of the Point Mugu Sea Range. The Silver Strand Training Complex is an integrated set of training areas located on and adjacent to the Silver Strand, a narrow, sandy isthmus separating the San Diego Bay from the Pacific Ocean. Please refer to Figure 1–1 of the application for a map of the HSTT Study Area, Figures 2–1 to 2–4 for the Hawaii Operating Area (where the majority of training and testing activities occur within the Hawaii Range Complex), Figures 2–5 to 2–7 for the SOCAL Range Complex, and Figure 2–8 for the Silver Strand Training Complex. The following types of training and testing, which are classified as military readiness activities pursuant to section 315(f) of Public Law 101–314 (16 U.S.C. 703), are included in the specified activity described in the Navy's application: amphibious warfare (in-water detonations), anti-submarine warfare (sonar and other transducers, in-water detonations), surface warfare (in-water detonations), mine warfare (sonar and other transducers, in-water detonations), and other (sonar and other transducers, pile driving, air guns).

The Navy's application includes proposed mitigation measures for marine mammals that would be implemented during training and testing activities in the HSTT Study Area. Proposed procedural mitigation measures generally include: (1) The use of one or more trained lookouts to diligently observe for specific biological resources within a mitigation zone, (2) requirements for lookouts to immediately communicate sightings of specific biological resources to the appropriate watch station for information dissemination, and (3) requirements for the watch station to implement mitigation (*e.g.*, halt an activity) until certain recommencement conditions have been met. Mitigation measures are also proposed for specific mitigation areas and consist of a variety of measures in those areas including, but not limited to: Conducting a limited number of major training exercises per year, not planning or avoiding planning major training exercises, minimizing or not conducting active sonar, conducting a limited amount of hull-mounted mid-frequency active sonar per year, and not expending explosive or non-explosive ordnance.

The Navy also proposes to undertake monitoring and reporting efforts to track compliance with incidental take authorizations and to help investigate the effectiveness of implemented mitigation measures in the HSTT Study Area. This can include Adaptive Management, the Integrated Comprehensive Monitoring Program, the Strategic Planning Process, and Annual Monitoring and Exercise and Testing Reports. As an example, under the Integrated Comprehensive Monitoring Program, the monitoring relating to the effects of Navy training and testing activities on protected marine species are designed to increase the understanding of the likely occurrence of marine mammals in the vicinity of the action (*i.e.*, presence, abundance, distribution, and density of species) and to increase the understanding of the nature, scope, or context of the likely exposure of marine mammals to any of the potential stressors associated with the action.

Information Solicited

Interested persons may submit information, suggestions, and comments concerning the Navy's request (see **ADDRESSES**). NMFS will consider all information, suggestions, and comments related to the request during the development of proposed regulations governing the incidental taking of marine mammals by the Navy, if appropriate.

Dated: October 16, 2017.

Cathryn E. Tortorici,

Acting Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 2017–22733 Filed 10–19–17; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XF690

Fisheries Off West Coast States; Fisheries of the Exclusive Economic Zone Off Alaska; Seabird Cable Strike Mitigation Workshop; Public Meeting

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of public meeting.

SUMMARY: Emerging seabird mitigation technologies will be discussed at the Seabird Cable Strike Mitigation Workshop.

DATES: The meeting will be held November 7, 2017, from 8:30 a.m. to 4:30 p.m., and November 8, 2017, from 8:30 a.m. to 12:30 p.m., Pacific Standard Time.

ADDRESSES: The meeting will be held at the NOAA Western Regional Center, Building 9 (Kelly C. Sandy III Auditorium), 7600 Sand Point Way NE., Seattle, WA 98115. For information on building access, see **SUPPLEMENTARY INFORMATION**.

FOR FURTHER INFORMATION CONTACT: Anne Marie Eich, 907–586–7172, or Vanessa Tuttle, 206–860–3479.

SUPPLEMENTARY INFORMATION: Seabirds congregate around trawlers to feed on offal putting them at risk of colliding with cables (trawl warps and data cables) that run aft of trawlers. Cable strikes are a known source of seabird mortality, particularly on at-sea factory trawlers (referred to as catcher/processors). Research projects observing seabird cable strikes have been conducted in the Alaska catcher/processor fleet targeting pollock in the Bering Sea and in the West Coast at-sea hake fishery. Data from both studies indicate that estimated mortalities for cable strikes are greater than observed mortalities collected as part of typical observer duties. To address this issue, NMFS will host a 1.5-day workshop on gear modification strategies for reducing seabird cable strike mortality in West Coast trawl (hake) fisheries. The goal is to develop mitigation strategies that reduce cable strikes and could be used by both West Coast hake and Alaska pollock trawlers. This collaborative workshop will bring together the at-sea processing industry, engineers, biologists and fisheries managers to develop innovative, practical gear-modifications for reducing seabird cable strike mortality.

29872 Federal Register / Vol. 83, No. 123 / Tuesday, June 26, 2018 / Proposed Rules

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 218

[Docket No. 170918908–8501–01]

RIN 0648–BH29

Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to the U.S. Navy Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Proposed rule; request for comments and information.

SUMMARY: NMFS has received a request from the U.S. Navy (Navy) for authorization to take marine mammals incidental to the training and testing activities conducted in the Hawaii-Southern California Training and Testing (HSTT) Study Area. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue regulations and subsequent Letters of Authorization (LOA) to the Navy to incidentally take marine mammals during the specified activities. NMFS will consider public comments prior to issuing any final rule and making final decisions on the issuance of the requested MMPA authorizations. Agency responses to public comments will be summarized in the final rule. The Navy's activities qualify as military readiness activities pursuant to the MMPA, as amended by the National Defense Authorization Act for Fiscal Year 2004 (2004 NDAA).

DATES: Comments and information must be received no later than August 9, 2018.

ADDRESSES: You may submit comments, identified by NOAA–NMFS–2018–0071, by any of the following methods:

- *Electronic submissions:* Submit all electronic public comments via the Federal eRulemaking Portal, Go to *www.regulations.gov/#!docketDetail;D=NOAA-NMFS-2018-0071*, click the "Comment Now!" icon, complete the required fields, and enter or attach your comments.
- *Mail:* Submit comments to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910–3225.
- *Fax:* (301) 713–0376; Attn: Jolie Harrison.

Instructions: Comments sent by any other method, to any other address or individual, or received after the end of the comment period, may not be considered by NMFS. All comments received are a part of the public record and will generally be posted for public viewing on *www.regulations.gov* without change. All personal identifying information (*e.g.*, name, address, etc.), confidential business information, or otherwise sensitive information submitted voluntarily by the sender may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information. NMFS will accept anonymous comments (enter "N/A" in the required fields if you wish to remain anonymous). Attachments to electronic comments will be accepted in Microsoft Word, Excel, or Adobe PDF file formats only.

FOR FURTHER INFORMATION CONTACT: Stephanie Egger, Office of Protected Resources, NMFS; phone: (301) 427–8401. Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities*. In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review and the opportunity to submit comments.

An authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

NMFS has defined "negligible impact" in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

NMFS has defined "unmitigable adverse impact" in 50 CFR 216.103 as an impact resulting from the specified activity:

(1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) directly displacing subsistence users; or (iii) placing physical barriers between the marine mammals and the subsistence hunters; and

(2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

The MMPA states that the term "take" means to harass, hunt, capture, kill or attempt to harass, hunt, capture, or kill any marine mammal.

The 2004 NDAA (Pub. L. 108–136) removed the "small numbers" and "specified geographical region" limitations indicated above and amended the definition of "harassment" as it applies to a "military readiness activity" to read as follows (Section 3(18)(B) of the MMPA): (i) Any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (ii) Any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered (Level B Harassment).

Summary of Request

On September 13, 2017, NMFS received an application from the Navy requesting incidental take regulations and two LOAs to take individuals of 39 marine mammal species by Level A and B harassment incidental to training and testing activities (categorized as military readiness activities) from the use of sonar and other transducers, in-water detonations, air guns, and impact pile driving/vibratory extraction in the HSTT Study Area over five years. In addition, the Navy is requesting incidental take authorization by serious injury or mortality of ten takes of two species due to explosives and for up to three takes of large whales from vessel

strikes over the five-year period. The Navy's training and testing activities would occur over five years beginning in December 2018. On October 13, 2017, the Navy sent an amendment to its application and Navy's rulemaking/LOA application was considered final and complete.

The Navy requests two five-year LOAs, one for training and one for testing activities to be conducted within the HSTT Study Area (which extends from the north-central Pacific Ocean, from the mean high tide line in Southern California west to Hawaii and the International Date Line), including the Hawaii and Southern California (SOCAL) Range Complexes, as well as the Silver Strand Training Complex and overlapping a small portion of the Point Mugu Sea Range. The Hawaii Range Complex encompasses ocean areas around the Hawaiian Islands, extending from 16 degrees north latitude to 43 degrees north latitude and from 150 degrees west longitude to the International Date Line. The SOCAL Range Complex is located approximately between Dana Point and San Diego, California, and extends southwest into the Pacific Ocean and also includes a small portion of the Point Mugu Sea Range. The Silver Strand Training Complex is an integrated set of training areas located on and adjacent to the Silver Strand, a narrow, sandy isthmus separating the San Diego Bay from the Pacific Ocean. Please refer to Figure 1–1 of the Navy's rulemaking/LOA application for a map of the HSTT Study Area, Figures 2–1 to 2–4 for the Hawaii Operating Area (where the majority of training and testing activities occur within the Hawaii Range Complex), Figures 2–5 to 2–7 for the SOCAL Range Complex, and Figure 2–8 for the Silver Strand Training Complex. The following types of training and testing, which are classified as military readiness activities pursuant to the MMPA, as amended by the 2004 NDAA, would be covered under the LOAs (if authorized): Amphibious warfare (in-water detonations), anti-submarine warfare (sonar and other transducers, in-water detonations), surface warfare (in-water detonations), mine warfare (sonar and other transducers, in-water detonations), and other warfare activities (sonar and other transducers, pile driving, air guns).

This will be NMFS's third rulemaking (Hawaii and Southern California were separate rules in Phase I) for HSTT activities under the MMPA. NMFS published the first two rules for Phase I effective from January 5, 2009, through January 5, 2014, (74 FR 1456; on January 12, 2009) and effective January 14, 2009, through January 14, 2014 (74 FR 3882 on January 21, 2009) for Hawaii and Southern California, respectively. The rulemaking for Phase II (combined both Hawaii and Southern California) is applicable from December 24, 2013, through December 24, 2018 (78 FR 78106; on December 24, 2013). For this third rulemaking, the Navy is proposing to conduct similar activities as they have conducted over the past nine years under the previous rulemakings.

Background of Request

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by Federal law (10 U.S.C. 5062), which ensures the readiness of the naval forces of the United States. The Navy executes this responsibility by training and testing at sea, often in designated operating areas (OPAREA) and testing and training ranges. The Navy must be able to access and utilize these areas and associated sea space and air space in order to develop and maintain skills for conducting naval activities.

The Navy proposes to conduct training and testing activities within the HSTT Study Area. The Navy has been conducting similar military readiness activities in the Study Area since the 1940s. The tempo and types of training and testing activities have fluctuated because of the introduction of new technologies, the evolving nature of international events, advances in warfighting doctrine and procedures, and changes in force structure (organization of ships, weapons, and personnel). Such developments influence the frequency, duration, intensity, and location of required training and testing activities, but the basic nature of sonar and explosive events conducted in the HSTT Study Area has remained the same.

The Navy's rulemaking/LOA application reflects the most up to date compilation of training and testing activities deemed necessary to accomplish military readiness requirements. The types and numbers of activities included in the proposed rule account for fluctuations in training and testing in order to meet evolving or emergent military readiness requirements.

Description of the Specified Activity

The Navy is requesting authorization to take marine mammals incidental to conducting training and testing activities. The Navy has determined that acoustic and explosives stressors are most likely to result in impacts on marine mammals that could rise to the level of harassment. Detailed descriptions of these activities are provided in the HSTT Draft Environmental Impact Statement (DEIS)/Overseas EIS (OEIS) (DEIS/OEIS) and in the Navy's rule making/LOA application (*www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-military-readiness-activities*) and are summarized here.

Overview of Training and Testing Activities

The Navy routinely trains and tests in the HSTT Study Area in preparation for national defense missions. Training and testing activities covered in the Navy's rulemaking/LOA application are briefly described below, and in more detail within Chapter 2 of the HSTT DEIS/OEIS.

Primary Mission Areas

The Navy categorizes its activities into functional warfare areas called primary mission areas. These activities generally fall into the following seven primary mission areas: Air warfare; amphibious warfare; anti-submarine warfare (ASW); electronic warfare; expeditionary warfare; mine warfare (MIW); and surface warfare (SUW). Most activities addressed in the HSTT DEIS/OEIS are categorized under one of the primary mission areas; the testing community has three additional categories of activities for vessel evaluation, unmanned systems, and acoustic and oceanographic science and technology. Activities that do not fall within one of these areas are listed as "other activities." Each warfare community (surface, subsurface, aviation, and special warfare) may train in some or all of these primary mission areas. The testing community also categorizes most, but not all, of its testing activities under these primary mission areas.

The Navy describes and analyzes the impacts of its training and testing activities within the HSTT DEIS/OEIS and the Navy's rulemaking/LOA application. In its assessment, the Navy concluded that sonar and other transducers, in-water detonations, air guns, and pile driving/removal were the stressors that would result in impacts on marine mammals that could rise to the level of harassment (and serious injury or mortality by explosives or by vessel strike) as defined under the MMPA. The Navy's rulemaking/LOA application provides the Navy's assessment of potential effects from these stressors in

terms of the various warfare mission areas in which they would be conducted. In terms of Navy's primary warfare areas, this includes:

- Amphibious warfare (in-water detonations);
- ASW (sonar and other transducers, in-water detonations);
- SUW (in-water detonations);
- MIW (sonar and other transducers, in-water detonations); and
- Other warfare activities (sonar and other transducers, impact pile driving/vibratory removal, air guns).

The Navy's training and testing activities in air warfare, electronic warfare, and expeditionary warfare do not involve sonar or other transducers, in-water detonations, pile driving/removal, air guns or any other stressors that could result in harassment, serious injury, or mortality of marine mammals. Therefore, activities in the air, electronic or expeditionary warfare areas are not discussed further in this proposed rule, but are analyzed fully in the Navy's HSTT DEIS/OEIS.

Amphibious Warfare

The mission of amphibious warfare is to project military power from the sea to the shore (*i.e.*, attack a threat on land by a military force embarked on ships) through the use of naval firepower and expeditionary landing forces. Amphibious warfare operations range from small unit reconnaissance or raid missions to large scale amphibious exercises involving multiple ships and aircraft combined into a strike group.

Amphibious warfare training ranges from individual, crew, and small unit events to large task force exercises. Individual and crew training include amphibious vehicles and naval gunfire support training. Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Large scale amphibious exercises involve ship-to-shore maneuver, naval fire support, such as shore bombardment, and air strike and attacks on targets that are in close proximity to friendly forces.

Testing of guns, munitions, aircraft, ships, and amphibious vessels and vehicles used in amphibious warfare is often integrated into training activities and, in most cases, the systems are used in the same manner in which they are used for fleet training activities. Amphibious warfare tests, when integrated with training activities or conducted separately as full operational evaluations on existing amphibious vessels and vehicles following maintenance, repair, or modernization, may be conducted independently or in conjunction with other amphibious ship and aircraft activities. Testing is performed to ensure effective ship-to-shore coordination and transport of personnel, equipment, and supplies. Tests may also be conducted periodically on other systems, vessels, and aircraft intended for amphibious operations to assess operability and to investigate efficacy of new technologies.

Anti-Submarine Warfare

The mission of ASW is to locate, neutralize, and defeat hostile submarine forces that threaten Navy forces. ASW is based on the principle that surveillance and attack aircraft, ships, and submarines all search for hostile submarines. These forces operate together or independently to gain early warning and detection, and to localize, track, target, and attack submarine threats. ASW training addresses basic skills such as detecting and classifying submarines, as well as evaluating sounds to distinguish between enemy submarines and friendly submarines, ships, and marine life. More advanced training integrates the full spectrum of ASW from detecting and tracking a submarine to attacking a target using either exercise torpedoes (*i.e.*, torpedoes that do not contain a warhead) or simulated weapons. These integrated ASW training exercises are conducted in coordinated, at-sea training events involving submarines, ships, and aircraft. Testing of ASW systems is conducted to develop new technologies and assess weapon performance and operability with new systems and platforms, such as unmanned systems. Testing uses ships, submarines, and aircraft to demonstrate capabilities of torpedoes, missiles, countermeasure systems, and underwater surveillance and communications systems. Tests may be conducted as part of a large-scale fleet training event involving submarines, ships, fixed-wing aircraft, and helicopters. These integrated training events offer opportunities to conduct research and acquisition activities and to train crews in the use of new or newly enhanced systems during a large-scale, complex exercise.

Mine Warfare

The mission of MIW is to detect, classify, and avoid or neutralize (disable) mines to protect Navy ships and submarines and to maintain free access to ports and shipping lanes. MIW also includes offensive mine laying to gain control of or deny the enemy access to sea space. Naval mines can be laid by ships, submarines, or aircraft. MIW neutralization training includes exercises in which ships, aircraft, submarines, underwater vehicles, unmanned vehicles, or marine mammal detection systems search for mine shapes. Personnel train to destroy or disable mines by attaching underwater explosives to or near the mine or using remotely operated vehicles to destroy the mine. Towed influence mine sweep systems mimic a particular ship's magnetic and acoustic signature, which would trigger a real mine causing it to explode.

Testing and development of MIW systems is conducted to improve sonar, laser, and magnetic detectors intended to hunt, locate, and record the positions of mines for avoidance or subsequent neutralization. MIW testing and development falls into two primary categories: Mine detection or classification, and mine countermeasure and neutralization. Mine detection or classification testing involves the use of air, surface, and subsurface vessels and uses sonar, including towed and sidescan sonar, and unmanned vehicles to locate and identify objects underwater. Mine detection and classification systems are sometimes used in conjunction with a mine neutralization system. Mine countermeasure and neutralization testing includes the use of air, surface, and subsurface units to evaluate the effectiveness of detection systems, countermeasure and neutralization systems. Most neutralization tests use mine shapes, or non-explosive practice mines, to evaluate a new or enhanced capability. For example, during a mine neutralization test, a previously located mine is destroyed or rendered nonfunctional using a helicopter or manned/unmanned surface vehicle based system that may involve the deployment of a towed neutralization system.

A small percentage of MIW tests require the use of high-explosive mines to evaluate and confirm the ability of the system or the crews conducting the training or testing to neutralize a high-explosive mine under operational conditions. The majority of MIW systems are deployed by ships, helicopters, and unmanned vehicles. Tests may also be conducted in support of scientific research to support these new technologies.

Surface Warfare (SUW)

The mission of SUW is to obtain control of sea space from which naval forces may operate, and conduct offensive action against other surface, subsurface, and air targets while also defending against enemy forces. In conducting SUW, aircraft use guns, air-launched cruise missiles, or other precision-guided munitions; ships employ torpedoes, naval guns, and

surface-to-surface missiles; and submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles. SUW includes surface-to-surface gunnery and missile exercises; air-to-surface gunnery, bombing, and missile exercises; submarine missile or torpedo launch events, and the use of other munitions against surface targets.

Testing of weapons used in SUW is conducted to develop new technologies and to assess weapon performance and operability with new systems and platforms, such as unmanned systems. Tests include various air-to-surface guns and missiles, surface-to-surface guns and missiles, and bombing tests. Testing events may be integrated into training activities to test aircraft or aircraft systems in the delivery of munitions on a surface target. In most cases the tested systems are used in the same manner in which they are used for fleet training activities.

Other Warfare Activities

Naval forces conduct additional training, testing and maintenance activities, which fall under other primary mission areas that are not listed above. The HSTT DEIS/OEIS combines these training and testing activities together in an "other activities" grouping for simplicity. These training and testing activities include, but are not limited to, sonar maintenance for ships and submarines, submarine navigation and under-ice certification, elevated causeway system (pile driving and removal), and acoustic and oceanographic research. These activities include the use of various sonar systems, impact pile driving/vibratory extraction, and air guns.

Overview of Major Training Exercises and Other Exercises Within the HSTT Study Area

A major training exercise (MTE) is comprised of several "unit level" range exercises conducted by several units operating together while commanded and controlled by a single commander. These exercises typically employ an exercise scenario developed to train and evaluate the strike group in naval tactical tasks. In an MTE, most of the activities being directed and coordinated by the strike group commander are identical in nature to the activities conducted during individual, crew, and smaller unit level training events. In an MTE, however, these disparate training tasks are conducted in concert, rather than in isolation. Some integrated or coordinated ASW exercises are similar in that they are comprised of several unit level exercises but are generally on a smaller scale than an MTE, are shorter in duration, use fewer assets, and use fewer hours of hull-mounted sonar per exercise. For the purpose of analysis, three key factors are used to identify and group major, integrated, and coordinated exercises including the scale of the exercise, duration of the exercise, and amount of hull-mounted sonar hours modeled/used for the exercise. NMFS considered the effects of all training exercises, not just these major, integrated, and coordinated training exercises in this proposed rule.

Overview of Testing Activities Within the HSTT Study Area

The Navy's research and acquisition community engages in a broad spectrum of testing activities in support of the fleet. These activities include, but are not limited to, basic and applied scientific research and technology development; testing, evaluation, and maintenance of systems (*e.g.*, missiles, radar, and sonar) and platforms (*e.g.*, surface ships, submarines, and aircraft); and acquisition of systems and platforms to support Navy missions and give a technological edge over adversaries. The individual commands within the research and acquisition community included in the Navy's rulemaking/LOA application are the Naval Air Systems Command, the Naval Sea Systems Command, the Office of Naval Research, and the Space and Naval Warfare Systems Command.

Testing activities occur in response to emerging science or fleet operational needs. For example, future Navy experiments to develop a better understanding of ocean currents may be designed based on advancements made by non-government researchers not yet published in the scientific literature. Similarly, future but yet unknown Navy operations within a specific geographic area may require development of modified Navy assets to address local conditions. However, any evolving testing activities that would be covered under this rule would be expected to fall within the range of platforms, activities, sound sources, and other equipment described in this rule and to have impacts that fall within the range (*i.e.*, nature and extent) of those covered within the rule. For example, the Navy identifies "bins" of sound sources to facilitate analyses—*i.e.*, they identify frequency and source level bounds to a bin and then analyze the worst case scenario for that bin to understand the impacts of all of the sources that fall within a bin. While the Navy might be aware that sound source *e.g.*, XYZ1 will definitely be used this year, sound source *e.g.*, XYZ2 might evolve for testing three years from now, but if it falls within the bounds of the same sound source bin, it has been analyzed and any resulting take authorized.

Some testing activities are similar to training activities conducted by the fleet. For example, both the fleet and the research and acquisition community fire torpedoes. While the firing of a torpedo might look identical to an observer, the difference is in the purpose of the firing. The fleet might fire the torpedo to practice the procedures for such a firing, whereas the research and acquisition community might be assessing a new torpedo guidance technology or testing it to ensure the torpedo meets performance specifications and operational requirements.

Naval Air Systems Command Testing Activities

Naval Air Systems Command testing activities generally fall in the primary mission areas used by the fleets. Naval Air Systems Command activities include, but are not limited to, the testing of new aircraft platforms (*e.g.*, the F–35 Joint Strike Fighter aircraft), weapons, and systems (*e.g.*, newly developed sonobuoys) that will ultimately be integrated into fleet training activities. In addition to the testing of new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of weapons and systems, such as sonobuoys.

Naval Sea Systems Command Testing Activities

Naval Sea Systems Command activities are generally aligned with the primary mission areas used by the fleets. Additional activities include, but are not limited to, vessel evaluation, unmanned systems, and other testing activities. In the Navy's rulemaking/LOA application, for testing activities occurring at Navy shipyards and piers, only system testing is included.

Testing activities are conducted throughout the life of a Navy ship, from construction through deactivation from the fleet, to verification of performance and mission capabilities. Activities include pierside and at-sea testing of ship systems, including sonar, acoustic countermeasures, radars, torpedoes, weapons, unmanned systems, and radio equipment; tests to determine how the ship performs at sea (sea trials); development and operational test and evaluation programs for new technologies and systems; and testing on all ships and systems that have undergone overhaul or maintenance.

Office of Naval Research Testing Activities

As the Department of the Navy's science and technology provider, the Office of Naval Research provides technology solutions for Navy and Marine Corps needs. The Office of Naval Research's mission is to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security. The Office of Naval Research manages the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation. The Office of Naval Research is also a parent organization for the Naval Research Laboratory, which operates as the Navy's corporate research laboratory and conducts a broad multidisciplinary program of scientific research and advanced technological development. Testing conducted by the Office of Naval Research in the HSTT Study Area includes acoustic and oceanographic research, large displacement unmanned underwater vehicle (an innovative naval prototype) research, and emerging mine countermeasure technology research.

Space and Naval Warfare Systems Command Testing Activities

Space and Naval Warfare Systems Command is the information warfare systems command for the U.S. Navy. The mission of the Space and Naval Warfare Systems Command is to acquire, develop, deliver, and sustain decision superiority for the warfighter. Space and Naval Warfare Systems Command Systems Center Pacific is the research and development part of Space and Naval Warfare Systems Command focused on developing and transitioning technologies in the area of command, control, communications, computers, intelligence, surveillance, and reconnaissance. Space and Naval Warfare Systems Command Systems Center Pacific conducts research, development, test, and evaluation projects to support emerging technologies for intelligence, surveillance, and reconnaissance; anti-terrorism and force protection; mine countermeasures; anti-submarine warfare; oceanographic research; remote sensing; and communications. These activities include, but are not limited to, the testing of surface and subsurface vehicles; intelligence, surveillance, and reconnaissance/information operations sensor systems; underwater surveillance technologies; and underwater communications.

The proposed training and testing activities were evaluated to identify specific components that could act as stressors (*e.g.*, acoustic and explosive) by having direct or indirect impacts on the environment. This analysis included identification of the spatial variation of the identified stressors.

Description of Acoustic and Explosive Stressors

The Navy uses a variety of sensors, platforms, weapons, and other devices, including ones used to ensure the safety of Sailors and Marines, to meet its mission. Training and testing with these systems may introduce acoustic (sound) energy or shock waves from explosives into the environment. The Navy's rulemaking/LOA application describes specific components that could act as stressors by having direct or indirect impacts on the environment. This analysis includes identification of the spatial variation of the identified stressors. The following subsections describe the acoustic and explosive stressors for biological resources within the Study Area. Stressor/resource interactions that were determined to have de minimus or no impacts (*i.e.*, vessel, aircraft, weapons noise, and explosions in air) were not carried forward for analysis in the Navy's rulemaking/LOA application. NMFS has reviewed the Navy's analysis and conclusions and finds them complete and supportable.

Acoustic Stressors

Acoustic stressors include acoustic signals emitted into the water for a specific purpose, such as sonar, other transducers (devices that convert energy from one form to another—in this case, to sound waves), and air guns, as well as incidental sources of broadband sound produced as a byproduct of impact pile driving and vibratory extraction. Explosives also produce broadband sound but are characterized separately from other acoustic sources due to their unique hazardous characteristics. Characteristics of each of these sound sources are described in the following sections.

In order to better organize and facilitate the analysis of approximately 300 sources of underwater sound used for training and testing by the Navy, including sonars, other transducers, air guns, and explosives, a series of source classifications, or source bins, was developed. The source classification bins do not include the broadband sounds produced incidental to pile driving, vessel or aircraft transits, weapons firing and bow shocks.

The use of source classification bins provides the following benefits: Provides the ability for new sensors or munitions to be covered under existing authorizations, as long as those sources fall within the parameters of a "bin;" improves efficiency of source utilization data collection and reporting requirements anticipated under the MMPA authorizations; ensures a conservative approach to all impact estimates, as all sources within a given class are modeled as the most impactful source (highest source level, longest duty cycle, or largest net explosive weight) within that bin; allows analyses to be conducted in a more efficient manner, without any compromise of analytical results; and provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total numbers of takes remain within the overall analyzed and authorized limits. This flexibility is required to support evolving Navy training and testing requirements, which are linked to real world events.

Sonar and Other Transducers

Active sonar and other transducers emit non-impulsive sound waves into the water to detect objects, safely navigate, and communicate. Passive sonars differ from active sound sources in that they do not emit acoustic signals; rather, they only receive acoustic information about the environment, or listen. In the Navy's rulemaking/LOA application, the terms sonar and other transducers are used to indicate active sound sources unless otherwise specified.

The Navy employs a variety of sonars and other transducers to obtain and transmit information about the undersea environment. Some examples are mid-frequency hull-mounted sonars used to find and track enemy submarines; high-frequency small object detection sonars used to detect mines; high frequency underwater modems used to transfer data over short ranges; and extremely high-frequency (>200 kilohertz (kHz)) Doppler sonars used for navigation, like those used on commercial and private vessels. The characteristics of these sonars and other transducers, such as source level, beam width, directivity, and frequency, depend on the purpose of the source. Higher frequencies can carry more information or provide more information about objects off which they reflect, but attenuate more rapidly. Lower frequencies attenuate less rapidly, so may detect objects over a longer distance, but with less detail.

Propagation of sound produced underwater is highly dependent on

environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity. The sound received at a particular location will be different than near the source due to the interaction of many factors, including propagation loss; how the sound is reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher-frequency sounds propagate. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the HSTT Study Area.

The sound sources and platforms typically used in naval activities analyzed in the Navy's rulemaking/LOA application are described in Appendix A (Navy Activity Descriptions) of the HSTT DEIS/OEIS. The effects of these factors are explained in Appendix D (Acoustic and Explosive Concepts) of the HSTT DEIS/OEIS. Sonars and other transducers used to obtain and transmit information underwater during Navy training and testing activities generally fall into several categories of use described below.

Anti-Submarine Warfare

Sonar used during ASW would impart the greatest amount of acoustic energy of any category of sonar and other transducers analyzed in the Navy's rulemaking/LOA application. Types of sonars used to detect enemy vessels include hull-mounted, towed, line array, sonobuoy, helicopter dipping, and torpedo sonars. In addition, acoustic targets and decoys (countermeasures) may be deployed to emulate the sound signatures of vessels or repeat received signals.

Most ASW sonars are mid frequency (1–10 kHz) because mid-frequency sound balances sufficient resolution to identify targets with distance over which threats can be identified. However, some sources may use higher or lower frequencies. Duty cycles (the percentage of time acoustic energy is transmitted) can vary widely, from intermittently active to continuously active. For the duty cycle for the AN/SQS–53C, nominally they produce a 1–2 sec ping every 50–60 sec. Continuous active sonars often have substantially lower source levels but transmit the sonar signal much more frequently (greater than 80 percent of the time) when they are on. The beam width of ASW sonars can be wide-ranging in a search mode or highly directional in a track mode.

Most ASW activities involving submarines or submarine targets would occur in waters greater than 600 feet (ft) deep due to safety concerns about running aground at shallower depths. Sonars used for ASW activities would typically be used in waters greater than 200 meters (m) which can vary from beyond three nautical miles (nmi) to 12 nmi or more from shore depending on local bathymetry. Exceptions include use of dipping sonar by helicopters, maintenance of vessel systems while in port, and system checks while vessels transit to or from port.

Mine Warfare, Small Object Detection, and Imaging

Sonars used to locate mines and other small objects, as well those used in imaging (*e.g.*, for hull inspections or imaging of the seafloor), are typically high frequency or very high frequency. Higher frequencies allow for greater resolution but, due to their greater attenuation, are most effective over shorter distances. Mine detection sonar can be deployed (towed or vessel hull-mounted) at variable depths on moving platforms (ships, helicopters, or unmanned vehicles) to sweep a suspected mined area. Most hull-mounted anti-submarine sonars can also be used in an object detection mode known as "Kingfisher" mode. Sonars used for imaging are usually used in close proximity to the area of interest, such as pointing downward near the seafloor.

Mine detection sonar use would be concentrated in areas where practice mines are deployed, typically in water depths less than 200 ft and at established minefields or temporary minefields close to strategic ports and harbors. Kingfisher mode on vessels is most likely to be used when transiting to and from port. Sound sources used for imaging could be used throughout the HSTT Study Area.

Navigation and Safety

Similar to commercial and private vessels, Navy vessels employ navigational acoustic devices including speed logs, Doppler sonars for ship positioning, and fathometers. These may be in use at any time for safe vessel operation. These sources are typically highly directional to obtain specific navigational data.

Communication

Sound sources used to transmit data (such as underwater modems), provide location (pingers), or send a single brief release signal to bottom-mounted devices (acoustic release) may be used throughout the HSTT Study Area. These sources typically have low duty cycles and are usually only used when it is desirable to send a detectable acoustic message.

Classification of Sonar and Other Transducers

Sonars and other transducers are grouped into classes that share an attribute, such as frequency range or purpose of use. Classes are further sorted by bins based on the frequency or bandwidth; source level; and, when warranted, the application in which the source would be used, as follows:

- Frequency of the non-impulsive acoustic source;
  - Low-frequency sources operate below 1 kHz;
  - Mid-frequency sources operate at and above 1 kHz, up to and including 10 kHz;
  - High-frequency sources operate above 10 kHz, up to and including 100 kHz;
  - Very high-frequency sources operate above 100 kHz but below 200 kHz;
- Sound pressure level of the non-impulsive source;
  - Greater than 160 decibels (dB) re 1 micro Pascal (µPa), but less than 180 dB re 1 µPa;
  - Equal to 180 dB re 1 µPa and up to 200 dB re 1 µPa;
  - Greater than 200 dB re 1 µPa;
- Application in which the source would be used;
  - Sources with similar functions that have similar characteristics, such as pulse length (duration of each pulse), beam pattern, and duty cycle.

The bins used for classifying active sonars and transducers that are quantitatively analyzed in the HSTT Study Area are shown in Table 1 below. While general parameters or source characteristics are shown in the table, actual source parameters are classified.

TABLE 1—SONAR AND TRANSDUCERS QUANTITATIVELY ANALYZED

Source class category	Bin	Description
Low-Frequency (LF): Sources that produce signals less than 1 kHz.	LF3	LF sources greater than 200 dB.
	LF4	LF sources equal to 180 dB and up to 200 dB.
	LF5	LF sources less than 180 dB.
	LF6	LF sources greater than 200 dB with long pulse lengths.
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1–10 kHz.	MF1	Hull-mounted surface ship sonars (*e.g.*, AN/SQS–53C and AN/SQS–60).
	MF1K	Kingfisher mode associated with MF1 sonars.
	MF3	Hull-mounted submarine sonars (*e.g.*, AN/BQQ–10).
	MF4	Helicopter-deployed dipping sonars (*e.g.*, AN/AQS–22).
	MF5	Active acoustic sonobuoys (*e.g.*, DICASS).
	MF6	Active underwater sound signal devices (*e.g.*, MK84).
	MF8	Active sources (greater than 200 dB) not otherwise binned.
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned.
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned.
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%.
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%.
	MF14	Oceanographic MF sonar.
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10–100 kHz.	HF1	Hull-mounted submarine sonars (*e.g.*, AN/BQQ–10).
	HF3	Other hull-mounted submarine sonars (classified).
	HF4	Mine detection, classification, and neutralization sonar (*e.g.*, AQS–20).
	HF5	Active sources (greater than 200 dB) not otherwise binned.
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned.
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned.
	HF8	Hull-mounted surface ship sonars (*e.g.*, AN/SQS–61).
Very High-Frequency Sonars (VHF): Non-tactical sources that produce signals between 100–200 kHz.	VHF1	VHF sources greater than 200 dB.
Anti-Submarine Warfare (ASW): Tactical sources (*e.g.*, active sonobuoys and acoustic counter-measures systems) used during ASW training and testing activities.	ASW1	MF systems operating above 200 dB.
	ASW2	MF Multistatic Active Coherent sonobuoy (*e.g.*, AN/SSQ–125).
	ASW3	MF towed active acoustic countermeasure systems (*e.g.*, AN/SLQ–25).
	ASW4	MF expendable active acoustic device countermeasures (*e.g.*, MK 3).
	ASW5	MF sonobuoys with high duty cycles.
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes.	TORP1	Lightweight torpedo (*e.g.*, MK 46, MK 54, or Anti-Torpedo Torpedo).
	TORP2	Heavyweight torpedo (*e.g.*, MK 48).
	TORP3	Heavyweight torpedo (*e.g.*, MK 48).
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars used for ship navigation and safety.	FLS2	HF sources with short pulse lengths, narrow beam widths, and focused beam patterns.
Acoustic Modems (M): Systems used to transmit data through the water.	M3	MF acoustic modems (greater than 190 dB).
Swimmer Detection Sonars (SD): Systems used to detect divers and submerged swimmers.	SD1–SD2	HF and VHF sources with short pulse lengths, used for the detection of swimmers and other objects for the purpose of port security.
Synthetic Aperture Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor.	SAS1	MF SAS systems.
	SAS2	HF SAS systems.
	SAS3	VHF SAS systems.
	SAS4	MF to HF broadband mine countermeasure sonar.
Broadband Sound Sources (BB): Sonar systems with large frequency spectra, used for various purposes.	BB1	MF to HF mine countermeasure sonar.
	BB2	HF to VHF mine countermeasure sonar.
	BB4	LF to MF oceanographic source.
	BB5	LF to MF oceanographic source.
	BB6	HF oceanographic source.
	BB7	LF oceanographic source.

Notes: ASW: Antisubmarine Warfare; BB: Broadband Sound Sources; FLS: Forward Looking Sonar; HF: High-Frequency; LF: Low-Frequency; M: Acoustic Modems; MF: Mid-Frequency; SAS: Synthetic Aperture Sonars; SD: Swimmer Detection Sonars; TORP: Torpedoes; VHF: Very High-Frequency.

Air Guns

Air guns are essentially stainless steel tubes charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water. Small air guns with capacities up to 60 cubic inches (in^3) would be used during testing activities in various offshore areas of the Southern California Range Complex and in the Hawaii Range Complex.

Generated impulses would have short durations, typically a few hundred milliseconds, with dominant frequencies below 1 kHz. The root-mean-square sound pressure level (SPL) and peak pressure (SPL peak) at a distance 1 m from the air gun would be approximately 215 dB re 1 µPa and 227 dB re 1 µPa, respectively, if operated at the full capacity of 60 in^3. The size of the air gun chamber can be adjusted, which would result in lower SPLs and sound exposure level (SEL) per shot.

Pile Driving/Extraction

Impact pile driving and vibratory pile removal would occur during construction of an Elevated Causeway System (ELCAS), a temporary pier that allows the offloading of ships in areas without a permanent port. Construction of the elevated causeway could occur in sandy shallow water coastal areas at Silver Strand Training Complex and at Camp Pendleton, both in the Southern California Range Complex.

Installing piles for elevated causeways would involve the use of an impact hammer (impulsive) mechanism with both it and the pile held in place by a crane. The hammer rests on the pile, and the assemblage is then placed in position vertically on the beach or, when offshore, positioned with the pile in the water and resting on the seafloor. When the pile driving starts, the hammer part of the mechanism is raised up and allowed to fall, transferring energy to the top of the pile. The pile is thereby driven into the sediment by a repeated series of these hammer blows. Each blow results in an impulsive sound emanating from the length of the pile into the water column as well as from the bottom of the pile through the sediment. Because the impact wave travels through the steel pile at speeds faster than the speed of sound in water, a steep-fronted acoustic shock wave is formed in the water (note this shock wave has very low peak pressure compared to a shock wave from an explosive) (Reinhall and Dahl, 2011). An impact pile driver generally operates on average 35 blows per minute.

Pile removal involves the use of vibratory extraction (non-impulsive), during which the vibratory hammer is suspended from the crane and attached to the top of a pile. The pile is then vibrated by hydraulic motors rotating eccentric weights in the mechanism, causing a rapid up and down vibration in the pile. This vibration causes the sediment particles in contact with the pile to lose frictional grip on the pile. The crane slowly lifts up on the vibratory driver and pile until the pile is free of the sediment. Vibratory removal creates continuous non-impulsive noise at low source levels for a short duration.

The source levels of the noise produced by impact pile driving and vibratory pile removal from an actual ELCAS pile driving and removal are shown in Table 2.

TABLE 2—ELEVATED CAUSEWAY SYSTEM PILE DRIVING AND REMOVAL UNDERWATER SOUND LEVELS

Pile size and type	Method	Average sound levels at 10 m
24-in. Steel Pipe Pile	Impact[1]	192 dB re 1 µPa SPL rms. 182 dB re 1 μPa^2s SEL (single strike).
24-in. Steel Pipe Pile	Vibratory[2]	146 dB re 1 µPa SPL rms. 145 dB re 1 μPa^2s SEL (per second of duration).

[1] Illingworth and Rodkin (2016).
[2] Illingworth and Rodkin (2015).
Notes: in = inch, SEL = Sound Exposure Level, SPL = Sound Pressure Level, rms = root mean squared, dB re 1 µPa = decibels referenced to 1 micropascal.

In addition to underwater noise, the installation and removal of piles also results in airborne noise in the environment. Impact pile driving creates in-air impulsive sound about 100 dBA re 20 µPa at a range of 15 m (Illingworth and Rodkin, 2016). During vibratory extraction, the three aspects that generate airborne noise are the crane, the power plant, and the vibratory extractor. The average sound level recorded in air during vibratory extraction was about 85 dBA re 20 µPa (94 dB re 20 µPa) within a range of 10–15 m (Illingworth and Rodkin, 2015).

The size of the pier and number of piles used in an ELCAS event is approximately 1,520 ft long, requiring 119 supporting piles. Construction of the ELCAS would involve intermittent impact pile driving over approximately 20 days. Crews work 24 hours (hrs) a day and would drive approximately 6 piles in that period. Each pile takes about 15 minutes to drive with time taken between piles to reposition the driver. When training events that use the ELCAS are complete, the structure would be removed using vibratory methods over approximately 10 days. Crews would remove about 12 piles per 24-hour period, each taking about 6 minutes to remove.

Pile driving for ELCAS training would occur in shallower water, and sound could be transmitted on direct paths through the water, be reflected at the water surface or bottom, or travel through bottom substrate. Soft substrates such as sand bottom at the proposed ELCAS locations would absorb or attenuate the sound more readily than hard substrates (rock), which may reflect the acoustic wave. Most acoustic energy would be concentrated below 1,000 hertz (Hz) (Hildebrand, 2009).

Explosive Stressors

This section describes the characteristics of explosions during naval training and testing. The activities analyzed in the Navy's rulemaking/LOA application that use explosives are described in Appendix A (Navy Activity Descriptions) of the HSTT DEIS/OEIS. Explanations of the terminology and metrics used when describing explosives in the Navy's rulemaking/LOA application are also in Appendix D (Acoustic and Explosive Concepts) of the HSTT DEIS/OEIS.

The near-instantaneous rise from ambient to an extremely high peak pressure is what makes an explosive shock wave potentially damaging. Farther from an explosive, the peak pressures decay and the explosive waves propagate as an impulsive, broadband sound. Several parameters influence the effect of an explosive: The weight of the explosive warhead, the type of explosive material, the boundaries and characteristics of the propagation medium, and, in water, the detonation depth. The net explosive weight, the explosive power of a charge expressed as the equivalent weight of trinitrotoluene (TNT), accounts for the first two parameters. The effects of these factors are explained in Appendix D (Acoustic and Explosive Concepts) of the HSTT DEIS/OEIS.

Explosions in Water

Explosive detonations during training and testing activities are associated with high-explosive munitions, including, but not limited to, bombs, missiles, rockets, naval gun shells, torpedoes, mines, demolition charges, and explosive sonobuoys. Explosive detonations during training and testing involving the use of high-explosive munitions (including bombs, missiles, and naval gun shells), could occur in the air or at the water's surface. Explosive detonations associated with torpedoes and explosive sonobuoys could occur in the water column; mines and demolition charges could be detonated in the water column or on the ocean bottom. Most detonations would occur in waters greater than 200 ft in depth, and greater than 3 nmi from shore, although most mine warfare, demolition, and some testing detonations would occur in shallow water close to shore. Those that occur close to shore are typically conducted on designated ranges.

In order to better organize and facilitate the analysis of explosives used by the Navy during training and testing that could detonate in water or at the water surface, explosive classification bins were developed. The use of explosive classification bins provides the same benefits as described for acoustic source classification bins in Section 1.4.1 (Acoustic Stressors) of the Navy's rulemaking/LOA application.

Explosives detonated in water are binned by net explosive weight. The bins of explosives that are proposed for use in the Study Area are shown in Table 3 below.

TABLE 3—EXPLOSIVES ANALYZED

Bin	Net explosive weight [1] (lb)	Example explosive source
E1	0.1–0.25	Medium-caliber projectile.
E2	>0.25–0.5	Medium-caliber projectile.
E3	>0.5–2.5	Large-caliber projectile.
E4	>2.5–5	Mine neutralization charge.
E5	>5–10	5-inch projectile.
E6	>10–20	Hellfire missile.
E7	>20–60	Demo block/shaped charge.
E8	>60–100	Light-weight torpedo.
E9	>100–250	500 lb. bomb.
E10	>250–500	Harpoon missile.
E11	>500–650	650 lb. mine.
E12	>650–1,000	2,000 lb. bomb.
E13 [2]	>1,000–1,740	Mat weave.

[1] Net Explosive Weight refers to the equivalent amount of TNT.
[2] E13 is not modeled for protected species impacts in water because most energy is lost into the air or to the bottom substrate due to detonation in very shallow water. In addition, activities are confined to small cove without regular marine mammal occurrence. These are not single charges, but multiple smaller charges detonated simultaneously or within a short time period.

Propagation of explosive pressure waves in water is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity, which affect how the pressure waves are reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher frequency components of explosive broadband noise can propagate. Appendix D (Acoustic and Explosive Concepts) of the HSTT DEIS/OEIS explains the characteristics of explosive detonations and how the above factors affect the propagation of explosive energy in the water. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the HSTT Study Area.

Explosive Fragments

Marine mammals could be exposed to fragments from underwater explosions associated with the specified activities. When explosive ordnance (*e.g.*, bomb or missile) detonates, fragments of the weapon are thrown at high-velocity from the detonation point, which can injure or kill marine mammals if they are struck. These fragments may be of variable size and are ejected at supersonic speed from the detonation. The casing fragments will be ejected at velocities much greater than debris from any target due to the proximity of the casing to the explosive material. Risk of fragment injury reduces exponentially with distance as the fragment density is reduced. Fragments underwater tend to be larger than fragments produced by in-air explosions (Swisdak and Montaro, 1992). Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat. Opposingly, the blast wave from an explosive detonation moves efficiently through the seawater. Because the ranges to mortality and injury due to exposure to the blast wave are likely to far exceed the zone where fragments could injure or kill an animal, the threshold are assumed to encompass risk due to fragmentation.

Other Stressor—Vessel Strike

There is a very small chance that a vessel utilized in training or testing activities could strike a large whale. Vessel strikes have the potential to result in incidental take from serious injury and/or mortality. Vessel strikes are not specific to any particular training or testing activity, but rather a limited, sporadic, and incidental result of Navy vessel movement within the Study Area. Vessel strikes from commercial, recreational, and military vessels are known to seriously injure and occasionally kill cetaceans (Abramson *et al.*, 2011; Berman-Kowalewski *et al.*, 2010; Calambokidis, 2012; Douglas *et al.*, 2008; Laggner, 2009; Lammers *et al.*, 2003; Van der Hoop *et al.*, 2012; Van der Hoop *et al.*, 2013), although reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (Jensen and Silber, 2003; Laist *et al.*, 2001). Vessel speed, size, and mass are all important factors in determining potential impacts of a vessel strike to marine mammals (Conn and Silber, 2013; Gende *et al.*, 2011; Silber *et al.*, 2010; Vanderlaan and Taggart, 2007;

Wiley *et al.*, 2016). For large vessels, speed and angle of approach can influence the severity of a strike. The average speed of large Navy ships ranges between 10 and 15 knots (kn) and submarines generally operate at speeds in the range of 8–13 kn, while a few specialized vessels can travel at faster speeds. By comparison, this is slower than most commercial vessels where full speed for a container ship is typically 24 kn (Bonney and Leach, 2010). Additional information on Navy vessel movements is provided in the Specified Activities section.

The Center for Naval Analysis conducted studies to determine traffic patterns of Navy and non-Navy vessels in the HSTT Study Area (Mintz, 2016; Mintz and Filadelfo, 2011; Mintz, 2012; Mintz and Parker, 2006). The most recent analysis covered the 5-year period from 2011 to 2015 for vessels over 65 ft in length (Mintz, 2016). Categories of vessels included in the study were U.S. Navy surface ship traffic and non-military civilian traffic such as cargo vessels, bulk carriers, commercial fishing vessels, oil tankers, passenger vessels, tugs, and research vessels (Mintz, 2016). In the Hawaii Range Complex, civilian commercial shipping comprised 89 percent of total vessel traffic while Navy ship traffic accounted for eight percent (Mintz, 2016). In the Southern California Range Complex civilian commercial shipping comprised 96 percent of total vessel traffic while Navy ship traffic accounted for four percent (Mintz, 2016).

Navy ships transit at speeds that are optimal for fuel conservation or to meet training and testing requirements. Small craft (for purposes of this analysis, less than 18 m in length) have much more variable speeds (0–50+ kn, dependent on the activity). Submarines generally operate at speeds in the range of 8–13 kn. While these speeds are considered averages and representative of most events, some vessels need to operate outside of these parameters for certain times or during certain activities. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier engaged in flight operations must adjust its speed through the water accordingly. Also, there are other instances such as launch and recovery of a small rigid hull inflatable boat; vessel boarding, search, and seizure training events; or retrieval of a target when vessels would be dead in the water or moving slowly ahead to maintain steerage. There are a few specific events, including high-speed tests of newly constructed vessels, where vessels would operate at higher speeds.

Large Navy vessels (greater than 18 m in length) within the offshore areas of range complexes and testing ranges operate differently from commercial vessels in ways that may reduce potential whale collisions. Surface ships operated by or for the Navy have multiple personnel assigned to stand watch at all times, when a ship or surfaced submarine is moving through the water (underway). A primary duty of personnel standing watch on surface ships is to detect and report all objects and disturbances sighted in the water that may indicate a threat to the vessel and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per vessel safety requirements, personnel standing watch also report any marine mammals sighted in the path of the vessel as a standard collision avoidance procedure. All vessels proceed at a safe speed so they can take proper and effective action to avoid a collision with any sighted object or disturbance, and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

Specified Activities

Proposed Training Activities

The Navy's Specified Activities are presented and analyzed as a representative year of training to account for the natural fluctuation of training cycles and deployment schedules that generally influences the actual level of training that occurs year after year in any five-year period. Using a representative level of activity rather than a maximum tempo of training activity in every year is more reflective of the amount of hull-mounted mid-frequency active sonar estimated to be necessary to meet training requirements. It also means that the Navy is requesting fewer hours of hull-mounted mid-frequency active sonar. Both unit-level training and major training exercises have been adjusted to meet this representative year, as discussed below. For the purposes of the Navy's rulemaking/LOA application, the Navy assumes that some unit-level training would be conducted using synthetic means (*e.g.*, simulators). Additionally, the Specified Activities analysis assumes that some unit-level active sonar training will be accounted for during the conduct of coordinated and major training exercises.

The Optimized Fleet Response Plan and various training plans identify the number and duration of training cycles that could occur over a five-year period. The Specified Activities considers fluctuations in training cycles and deployment schedules that do not follow a traditional annual calendar but instead are influenced by in-theater demands and other external factors. Similar to unit-level training, the Specified Activities does not analyze a maximum number carrier strike group Composite Training Unit Exercises (one type of major exercise) every year, but instead assumes a maximum number of exercises would occur during two years of any five-year period and that a lower number of exercises would occur in the other 3 years (described in Estimate Take section).

The training activities that the Navy proposes to conduct in the HSTT Study Area are summarized in Table 4. The table is organized according to primary mission areas and includes the activity name, associated stressors applicable to the Navy's rulemaking/LOA application, description of the activity, sound source bin, the locations of those activities in the HSTT Study Area, and the number of Specified Activities. For further information regarding the primary platform used (*e.g.*, ship or aircraft type) see Appendix A (Navy Activity Descriptions) of the HSTT DEIS/OEIS.

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Table 4. Proposed Training Activities Analyzed within the HSTT Study Area.

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*	*Duration per Activity*
Major Training Exercises – Large Integrated Anti-Submarine Warfare							
Acoustic	Composite Training Unit Exercise[1]	Aircraft carrier and carrier air wing integrates with surface and submarine units in a challenging multi-threat operational environment that certifies them ready to deploy	ASW1, ASW2, ASW3, ASW4, ASW5, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	SOCAL	2-3	12	21 days
Acoustic	Rim of the Pacific Exercise[1]	A biennial multinational training exercise in which navies from Pacific Rim nations and others assemble in Pearl Harbor, Hawaii, to conduct training throughout the Hawaiian Islands in a number of warfare areas. Marine mammal systems may be used during a Rim of the Pacific exercise. Components of a Rim of the Pacific exercise, such as certain mine warfare and amphibious training, may be conducted in the Southern California Range Complex.	ASW2, ASW3, ASW4, HF1, HF3, HF4, M3, MF1, MF3, MF4, MF5, MF11	HRC	0-1	2	30 days
				SOCAL	0-1	2	

Major Training Exercises – Medium Integrated Anti-Submarine Warfare							
Acoustic	Fleet Exercise/Sustainment Exercise[1]	Aircraft carrier and carrier air wing integrates with surface and submarine units in a challenging multi-threat operational environment to maintain ability to deploy.	ASW1, ASW2, ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	HRC	1	3	Up to 10 days
				SOCAL	5	22	
Acoustic	Undersea Warfare Exercise	Elements of the anti-submarine warfare tracking exercise combine in this exercise of multiple air, surface, and subsurface units, over a period of several days. Sonobuoys are released from aircraft. Active and passive sonar used.	ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	HRC	3	12	4 days
Integrated/Coordinated Training – Small Integrated Anti-Submarine Warfare Training							
Acoustic	Navy Undersea Warfare Training and Assessment Course Surface Warfare Advanced Tactical Training	Multiple ships, aircraft, and submarines integrate the use of their sensors to search for, detect, classify, localize, and track a threat submarine in order to launch an exercise torpedo.	ASW3, ASW4, HF1, MF1, MF3, MF4, MF5	HRC	1	2	2-5 days
				SOCAL	2-3	12	
Integrated/Coordinated Training – Medium Coordinated Anti-Submarine Warfare Training							
Acoustic	Submarine Commanders Course	Train prospective submarine Commanding Officers to operate against surface, air, and subsurface threats.	ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, TORP1, TORP2	HRC	2	10	2-3 days
				SOCAL	2	2	

Integrated/Coordinated Training – Small Coordinated Anti-Submarine Warfare Training							
Acoustic	Amphibious Ready Group/Marine Expeditionary Unit Exercise Group Sail Independent Deployer Certification Exercise/Tailored Anti-Submarine Warfare Training	Small-scale, short duration, coordinated anti-submarine warfare exercises	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11	HRC	2	10	2-3 days
				SOCAL	10-14	58	
Amphibious Warfare							
Explosive	Naval Surface Fire Support Exercise – at Sea	Surface ship uses large-caliber gun to support forces ashore; however, land target simulated at sea. Rounds impact water and are scored by passive acoustic hydrophones located at or near target area.	Large-caliber HE rounds (E5)	HRC (W188)	15	75	8 hours
Acoustic	Amphibious Marine Expeditionary Unit Exercise	Navy and Marine Corps forces conduct advanced integration training in preparation for deployment certification.	ASW1, LF6, MF1, MF3, MF11, MF12, HF1	SOCAL	2-3	12	5-7 days
Acoustic	Amphibious Marine Expeditionary Unit Integration Exercise	Navy and Marine Corps forces conduct integration training at sea in preparation for deployment certification.	None	SOCAL	2-3	12	Up to 21 days

Acoustic	Marine Expeditionary Unit Composite Training Unit Exercise	Amphibious Ready Group exercises are conducted to validate the Marine Expeditionary Unit's readiness for deployment and includes small boat raids; visit, board, search, and seizure training; helicopter and mechanized amphibious raids; and a non-combatant evacuation operation.	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11	SOCAL	2-3	12	Up to 21 days
Anti-Submarine Warfare							
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Helicopter	Helicopter crews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF4, MF5, TORP1	HRC	6	30	2-5 hours
				SOCAL	104	520	
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft crews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF5, TORP1	HRC	10	50	2-8 hours
				SOCAL	25	125	
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Ship	Surface ship crews search for, track, and detect submarines. Exercise torpedoes are used during this event.	ASW3, MF1, TORP1	HRC	50	250	2-5 hours
				SOCAL	117	585	
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Submarine	Submarine crews search for, track, and detect submarines. Exercise torpedoes are used during this event.	ASW4, HF1, MF3, TORP2	HRC	48	240	8 hours
				SOCAL	13	65	
Acoustic	Anti-Submarine Warfare Tracking Exercise –	Helicopter crews search for, track, and detect submarines.	MF4, MF5	HRC	159	795	2-4 hours
				SOCAL, PMSR	524	2,620	

	Helicopter			HSTT Transit Corridor	6	30	
Acoustic	Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft aircrews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF5	HRC	32	160	2-8 hours
				SOCAL, PMSR	56	280	
Acoustic	Anti-Submarine Warfare Tracking Exercise – Ship	Surface ship crews search for, track, and detect submarines.	ASW3, MF1, MF11, MF12	HRC	224	1,120	2-4 hours
				SOCAL, PMSR	423	2,115	
Acoustic	Anti-Submarine Warfare Tracking Exercise – Submarine	Submarine crews search for, track, and detect submarines.	ASW4, HF1, HF3, MF3	HRC	200	1,000	8 hours
				SOCAL, PMSR	50	250	
				HSTT Transit Corridor	7	35	
Explosive, Acoustic	Service Weapons Test	Air, surface, or submarine crews employ explosive torpedoes against virtual targets.	HF1, MF3, MF6, TORP2, Explosive torpedoes (E11)	HRC	2	10	8 hours
				SOCAL	1	5	
Mine Warfare							
Acoustic	Airborne Mine Countermeasure – Mine Detection	Helicopter aircrews detect mines using towed or laser mine detection systems.	HF4	SOCAL	10	50	2 hours
Explosive, Acoustic	Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises	Maritime security personnel train to protect civilian ports against enemy efforts to interfere with access to those ports.	HF4, SAS2 E2, E4	Pearl Harbor, HI	1	5	Multiple days
				San Diego, CA	1-3	12	

Explosive	Marine Mammal Systems	The Navy deploys trained bottlenose dolphins (*Tursiops truncatus*) and California sea lions (*Zalophus californianus*) as part of the marine mammal mine-hunting and object-recovery system.	E7	HRC	10	50	Varies
				SOCAL	175	875	
Acoustic	Mine Countermeasure Exercise – Ship Sonar	Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.	HF4, HF8, MF1K	HRC	30	150	Up to 15 hours
				SOCAL	92	460	
Acoustic	Mine Countermeasure Exercise - Surface	Mine countermeasure ship crews detect, locate, identify, and avoid mines while navigating restricted areas or channels, such as while entering or leaving port.	HF4	SOCAL	266	1,330	Up to 15 hours
Explosive, Acoustic	Mine Countermeasures Mine Neutralization Remotely Operated Vehicle	Ship, small boat, and helicopter crews locate and disable mines using remotely operated underwater vehicles.	HF4, E4	HRC	6	30	1.5 to 4 hours
				SOCAL	372	1,860	
Explosive	Mine Neutralization Explosive Ordnance Disposal	Personnel disable threat mines using explosive charges.	E4, E5, E6, E7	HRC (Panloa)	20	100	Up to 4 hours
				SOCAL (IB, TAR 2, TAR 3, TAR 21, SWAT 3, SOAR)	194	970	
Acoustic	Submarine Mine Exercise	Submarine crews practice detecting mines in a designated area	HF1	HRC	40	200	6 hours
				SOCAL	12	60	

Acoustic	Surface Ship Object Detection	Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.	MF1K, HF8	HRC	42	210	Up to 15 hours
				SOCAL	164	820	
Explosive	Underwater Demolitions Multiple Charge – Mat Weave and Obstacle Loading	Military personnel use explosive charges to destroy barriers or obstacles to amphibious vehicle access to beach areas.	E10, E13	SOCAL (TAR 2, TAR 3)	18	90	4 hours
Explosive	Underwater Demolition Qualification and Certification	Navy divers conduct various levels of training and certification in placing underwater demolition charges.	E6, E7	HRC (Panlau)	25	125	Varies
				SOCAL (TAR 2)	120	600	
Surface Warfare							
Explosive	Bombing Exercise Air-to-Surface	Fixed-wing aircrews deliver bombs against surface targets.	E12[2]	HRC	187	935	1 hour
				SOCAL	640	3,200	
				HSTT Transit Corridor	5	25	
Explosive	Gunnery Exercise Surface-to-Surface Boat Medium-Caliber	Small boat crews fire medium-caliber guns at surface targets.	E1, E2	HRC	10	50	1 hour
				SOCAL	14	70	
Explosive	Gunnery Exercise Surface-to-Surface Ship Large-caliber	Surface ship crews fire large-caliber guns at surface targets.	E5	HRC	32	160	Up to 3 hours
				SOCAL	200	1,000	
				HSTT Transit Corridor	13	65	
Explosive	Gunnery Exercise Surface-to-Surface Ship Medium-Caliber	Surface ship crews fire medium-caliber guns at surface targets.	E1, E2	HRC	50	250	2-3 hours
				SOCAL	180	900	
				HSTT Transit Corridor	40	200	

Explosive, Acoustic	Independent Deployer Certification Exercise/Tailored Surface Warfare Training	Multiple ships, aircraft and submarines conduct integrated multi-warfare training with a surface warfare emphasis. Serves as a ready-to-deploy certification for individual surface ships tasked with surface warfare missions	E1, E3, E6, E10	SOCAL	1	5	15 days
Explosive	Integrated Live Fire Exercise	Naval Forces defend against a swarm of surface threats (ships or small boats) with bombs, missiles, rockets, and small-, medium- and large-caliber guns.	E1, E3, E6, E10	HRC (W188A)	1	5	6-8 hours
				SOCAL (SOAR)	1	5	
Explosive	Missile Exercise Air-to-Surface	Fixed-wing and helicopter aircrews fire air-to-surface missiles at surface targets.	E6, E8, E10	HRC	10	50	1 hour
				SOCAL	210	1,050	
Explosive	Missile Exercise Air-to-Surface Rocket	Helicopter aircrews fire both precision-guided and unguided rockets at surface targets.	E3	HRC	227	1,135	1 hour
				SOCAL	246	1,230	
Explosive	Missile Exercise Surface-to-Surface	Surface ship crews defend against surface threats (ships or small boats) and engage them with missiles.	E6, E10	HRC (W188)	20	100	2-5 hours
				SOCAL (W291)	10	50	
Explosive, Acoustic	Sinking Exercise	Aircraft, ship, and submarine crews	TORP2, E5, E10.	HRC	1-3	7	4-8 hours over 1-2

		deliberately sink a seaborne target, usually a decommissioned ship made environmentally safe for sinking according to U.S. Environmental Protection Agency standards, with a variety of munitions.	E12	SOCAL	0–1	1	days
Pile driving	Elevated Causeway System	A pier is constructed off of the beach. Piles are driven into the bottom with an impact hammer. Piles are removed from seabed via vibratory extractor. Only in-water impacts are analyzed.	Impact hammer or vibratory extractor	SOCAL	2	10	Up to 30 days
Acoustic	Kilo Dip	Functional check of the dipping sonar prior to conducting a full test or training event on the dipping sonar.	MF4	HRC	60	300	1.5 hours
				SOCAL	2,400	12,000	
Acoustic	Submarine Navigation Exercise	Submarine crews operate sonar for navigation and object detection while transiting into and out of port during reduced visibility.	HF1, MF3	Pearl Harbor, HI	220	1,100	Up to 2 hours
				San Diego Bay, CA	80	400	
Acoustic	Submarine Sonar Maintenance and Systems Checks	Maintenance of submarine sonar systems is conducted pierside or at sea.	MF3	HRC	260	1,300	Up to 1 hour
				Pearl Harbor, HI	260	1,300	
				SOCAL	93	465	
				San Diego Bay, CA	92	460	
				HSTT Transit Corridor	10	50	

Acoustic	Submarine Under Ice Certification	Submarine crews train to operate under ice. Ice conditions are simulated during training and certification events.	HF1	HRC	12	60	5 days
				SOCAL	6	30	
Acoustic	Surface Ship Sonar Maintenance and Systems Checks	Maintenance of surface ship sonar systems is conducted pierside or at sea.	HF8, MF1	HRC	75	375	Up to 4 hours
				Pearl Harbor, HI	80	400	
				SOCAL	250	1,250	
				San Diego, CA	250	1,250	
				HSTT Transit Corridor	8	40	
Acoustic	Unmanned Underwater Vehicle Training – Certification and Development	Unmanned underwater vehicle certification involves training with unmanned platforms to ensure submarine crew proficiency. Tactical development involves training with various payloads for multiple purposes to ensure that the systems can be employed effectively in an operational environment.	FLS2, M3, SAS2	HRC	25	125	2 days
				SOCAL	10	50	

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex, HSTT = Hawaii-Southern California Training and Testing, PMRF = Pacific Missile Range Facility, BARSTUR = Barking Sands Tactical Underwater Range, BSURE = Barking Sands Underwater Range Expansion, PMSR = Point Mugu Sea Range Overlap, TAR = Training Area and Range, SOAR = Southern California Anti-Submarine Warfare Range, IB = Imperial Beach Minefield

1. Any non-antisubmarine warfare activity that could occur is captured in the individual activities.

2. For the Bombing Exercise Air-to-Surface, all activities were analyzed with exact bins NEW.

Proposed Testing Activities

Testing activities covered in the Navy's rulemaking/LOA application are described in Table 5 through Table 8. The five-year Specified Activities presented here is based on the level of testing activities anticipated to be conducted into the reasonably foreseeable future, with adjustments that account for changes in the types and tempo (increases or decreases) of testing activities to meet current and future military readiness requirements. The Specified Activities includes the testing of new platforms, systems, and related equipment that will be introduced after December 2018 and during the period of the rule. The majority of testing activities that would be conducted under the Specified Activities are the same or similar as those conducted currently or in the past. The Specified Activities includes the testing of some new systems using new technologies and takes into account inherent uncertainties in this type of testing.

Under the Specified Activities, the Navy proposes a range of annual levels of testing that reflects the fluctuations in testing programs by recognizing that the maximum level of testing will not be conducted each year, but further indicates a five-year maximum for each activity that will not be exceeded. The Specified Activities contains a more realistic annual representation of activities, but includes years of a higher maximum amount of testing to account for these fluctuations.

The tables include the activity name, associated stressor(s), description of the activity, sound source bin, the areas where the activity is conducted, and the number of activities per year and per five years. Not all sound sources are used with each activity. Under the "Annual # of Activities" column, activities show either a single number or a range of numbers to indicate the number of times that activity could occur during any single year. The "5-Year # of Activities" is the maximum times an activity would occur over the 5-year period of this request. More detailed activity descriptions can be found in the HSTT DEIS/OEIS.

Naval Air Systems Command

Table 5 summarizes the proposed testing activities for the Naval Air Systems Command analyzed within the HSTT Study Area.

Table 5. Proposed Naval Air Systems Command Testing Activities Analyzed within the HSTT Study Area.

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*	*Typical Duration per Activity*
Anti-Submarine Warfare							
Acoustic	Anti-Submarine Warfare Torpedo Test	This event is similar to the training event torpedo exercise. Test evaluates anti-submarine warfare systems onboard rotary-wing and fixed-wing aircraft and the ability to search for, detect, classify, localize, track, and attack a submarine or similar target.	MF5, TORP1	HRC	17-22	95	2-6 hrs
				SOCAL	35-71	247	
Explosive, Acoustic	Anti-Submarine Warfare Tracking Test – Helicopter	This event is similar to the training event anti-submarine tracking exercise – helicopter. The test evaluates the sensors and systems used to detect and track submarines and to ensure that helicopter systems used to deploy the tracking systems perform to specifications.	MF4, MF5, E3	SOCAL	30-132	252	2 hrs
Explosive, Acoustic	Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft	The test evaluates the sensors and systems used by maritime patrol aircraft to detect and track submarines and to ensure that aircraft systems used to deploy the tracking systems perform to specifications and meet operational requirements.	ASW2, ASW5, MF5, MF6, E1, E3	HRC	54-61	284	4-6 hrs
				SOCAL	58-68	310	
Explosive, Acoustic	Sonobuoy Lot Acceptance Test	Sonobuoys are deployed from surface vessels and aircraft to verify the integrity and performance of a lot or group of sonobuoys in advance of delivery to the fleet for operational use.	ASW2, ASW5, HF5, HF6, LF4, MF5, MF6, E1, E3, E4	SOCAL	160	800	6 hrs
Mine Warfare							
Acoustic	Airborne Dipping Sonar Minehunting Test	A mine-hunting dipping sonar system that is deployed from a helicopter and uses high-frequency sonar for the detection and classification of bottom and moored mines.	HF4	SOCAL	0-12	12	2 hrs

Explosive	Airborne Mine Neutralization System Test	A test of the airborne mine neutralization system that evaluates the system's ability to detect and destroy mines from an airborne mine countermeasures capable helicopter (e.g., MH-60). The airborne mine neutralization system uses up to four unmanned underwater vehicles equipped with high-frequency sonar, video cameras, and explosive and non-explosive neutralizers.	E4	SOCAL	11-31	75	2.5 hrs
Acoustic	Airborne Sonobuoy Minehunting Test	A mine-hunting system made up of sonobuoys deployed from a helicopter. A field of sonobuoys, using high-frequency sonar, is used for detection and classification of bottom and moored mines.	HF6	SOCAL	3-9	21	2 hrs
Surface Warfare							
Explosive	Air-to-Surface Bombing Test	This event is similar to the training event bombing exercise air-to-surface. Fixed-wing aircraft test the delivery of bombs against surface maritime targets with the goal of evaluating the bomb, the bomb carry and delivery system, and any associated systems that may have been newly developed or enhanced.	E9	HRC	8	40	2 hrs
				SOCAL	14	70	
Explosive	Air-to-Surface Gunnery Test	This event is similar to the training event gunnery exercise air-to-surface. Fixed-wing and rotary-wing aircrews evaluate new or enhanced aircraft guns against surface maritime targets to test that the gun, gun ammunition, or associated systems meet required specifications or to train aircrew in the operation of a new or enhanced weapons system.	E1	HRC	5	25	1-2.5 hrs
				SOCAL	30-60	240	
Explosive	Air-to-Surface Missile Test	This event is similar to the training event missile exercise air-to-surface. Test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapons system or as part of another systems integration test.	E6, E9, E10	HRC	18	90	3-4 hrs
				SOCAL	48-60	276	
Explosive	Rocket Test	Rocket tests are conducted to evaluate the integration, accuracy,	E3	HRC	2	10	1.5-2.5 hrs

		performance, and safe separation of guided and unguided 2.75-inch rockets fired from a hovering or forward flying helicopter or tilt rotor aircraft.		SOCAL	18-22	102	
Other Testing Activities							
Acoustic	Kilo Dip	Functional check of a helicopter deployed dipping sonar system (e.g., AN/AQS-22) prior to conducting a testing or training event using the dipping sonar system.	MF4	SOCAL	0-6	6	1.5 hrs
Acoustic	Undersea Range System Test	Post installation node survey and test and periodic testing of range Node transmit functionality.	MF9	HRC	11-28	90	8 hrs

Table 6 summarizes the proposed testing activities for the Naval Sea Systems Command analyzed within the HSTT Study Area.

Table 6. Proposed Naval Sea Systems Command Testing Activities Analyzed within the HSTT Study Area.

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*	*Typical Duration per Activity*
Anti-Submarine Warfare							
Acoustic	Anti-Submarine Warfare Mission Package Testing	Ships and their supporting platforms (e.g., rotary-wing aircraft and unmanned aerial systems) detect, localize, and prosecute submarines	ASW1, ASW2, ASW3, ASW5, MF1, MF4, MF5, MF12, TORP1	HRC	22	110	4-8 hrs per day over 1-2 weeks
				SOCAL	23	115	
Acoustic	At-Sea Sonar Testing	At-sea testing to ensure systems are fully functional in an open ocean environment	ASW3, ASW4, HF1, LF4, LF5, M3, MF1, MF1K, MF2, MF3, MF5, MF9, MF10, MF11	HRC	16	78	4 hrs-11 days
				HRC - SOCAL	1	5	
				SOCAL	20-21	99	
Acoustic	Countermeasure Testing	Countermeasure testing involves the testing of systems that will detect, localize, and track incoming weapons, including marine vessel targets. Testing includes surface ship torpedo defense systems and marine vessel stopping payloads	ASW3, ASW4, HF5, TORP1, TORP2	HRC	8	40	4 hrs-6 days
				HRC - SOCAL	4	20	
				SOCAL	11	55	
				HSTT Transit Corridor	2	10	
Acoustic	Pierside Sonar Testing	Pierside testing to ensure systems are fully functional in a controlled pierside environment prior to at-sea test activities	HF1, HF3, HF8, M3, MF1, MF3, MF9	Pearl Harbor, HI	7	35	Up to 3 weeks, intermittent sonar use
				San Diego, CA	7	35	
Acoustic	Submarine Sonar Testing/Maintenance	Pierside and at-sea testing of submarine systems occurs periodically following major maintenance periods and for routine maintenance.	HF1, HF3, M3, MF3	HRC	4	20	Up to 3 weeks, intermittent sonar use
				Pearl Harbor, HI	17	85	
				San Diego, CA	24	120	

Acoustic	Surface Ship Sonar Testing/Maintenance	Pierside and at-sea testing of ship systems occurs periodically following major maintenance periods and for routine maintenance.	ASW3, MF1, MF1K, MF9, MF10	HRC	3	15	Up to 3 weeks, intermittent sonar use
				Pearl Harbor, HI	3	15	
				San Diego, CA	3	15	
				SOCAL	3	15	
Explosive, Acoustic	Torpedo (Explosive) Testing	Air, surface, or submarine crews employ explosive and non-explosive torpedoes against artificial targets.	ASW3, HF1, HF5, HF6, MF1, MF3, MF4, MF5, MF6, TORP1, TORP2, E8, E11	HRC	8	40	1-2 days, daylight hours only
				HRC SOCAL	3	15	
				SOCAL	8	40	
Acoustic	Torpedo (Non-Explosive) Testing	Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels.	ASW3, ASW4, HF1, HF6, M3, MF1, MF3, MF4, MF5, MF6, TORP1, TORP2, TORP3	HRC	8	40	Up to 2 weeks
				HRC SOCAL	9	45	
				SOCAL	8	40	
Mine Warfare							
Explosive, Acoustic	Mine Countermeasure and Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines and mine-like objects.	HF4, E4	SOCAL	11	55	1-10 days, intermittent use of systems
Explosive, Acoustic	Mine Countermeasure Mission Package Testing	Vessels and associated aircraft conduct mine countermeasure operations.	HF4, SAS2, E4	HRC	19	80	1-2 weeks, intermittent use of systems
				SOCAL	58	290	
Acoustic	Mine Detection and Classification Testing	Air, surface, and subsurface vessels and systems detect and classify and avoid mines and mine-like objects. Vessels also assess their potential susceptibility to mines and mine-like objects.	HF1, HF8, MF1, MF5	HRC	2	10	Up to 24 days, up to 12 hrs acoustic daily
				HRC SOCAL	2	6	
				SOCAL	11	55	
Surface Warfare							
Explosive	Gun Testing – Large-Caliber	Surface crews test large-caliber guns to defend against surface targets.	E3	HRC	7	35	1-2 weeks
				HRC - SOCAL	72	360	
				SOCAL	7	35	

Explosive	Gun Testing – Medium-Caliber	Surface crews test medium-caliber guns to defend against surface targets	E1	HRC	4	20	1-2 weeks
				HRC - SOCAL	48	240	
				SOCAL	4	20	
Explosive	Missile and Rocket Testing	Missile and rocket testing includes various missiles or rockets fired from submarines and surface combatants. Testing of the launching system and ship defense is performed.	E6	HRC	13	65	1 day-2 weeks
				HRC - SOCAL	24	120	
				SOCAL	20	100	
Unmanned Systems							
Acoustic	Unmanned Surface Vehicle System Testing	Testing involves the production or upgrade of unmanned surface vehicles. This may include tests of mine detection capabilities, evaluations of the basic functions of individual platforms, or complex events with multiple vehicles.	HF4, SAS2	HRC	3	15	Up to 10 days
				SOCAL	4	20	
Acoustic	Unmanned Underwater Vehicle Testing	Testing involves the production or upgrade of unmanned underwater vehicles. This may include tests of mine detection capabilities, evaluations of the basic functions of individual platforms, or complex events with multiple vehicles.	HF4, MF9	HRC	3	15	Up to 35 days
				SOCAL	291	1,455	
Vessel Evaluation							
Acoustic	Submarine Sea Trials – Weapons System Testing	Submarine weapons and sonar systems are tested at-sea to meet the integrated combat system certification requirements.	HF1, M3, MF3, MF9, MF10, TORP2	HRC	1	5	Up to 7 days
				SOCAL	1	5	
Explosive	Surface Warfare Testing	Tests the capabilities of shipboard sensors to detect, track, and engage surface targets. Testing may include ships defending against surface targets using explosive and non-explosive rounds, gun system structural test firing, and demonstration of the response to Call for Fire against land-based targets (simulated by sea-based locations).	E1, E5, E8	HRC	9	45	7 days
				HRC - SOCAL	63	313	
				SOCAL	14-16	72	
Acoustic	Undersea Warfare Testing	Ships demonstrate capability of countermeasure systems and underwater surveillance, weapons engagement, and communications systems. This tests ships ability to detect, track, and engage undersea targets.	ASW4, HF4, HF8, MF1, MF4, MF5, MF6, TORP1, TORP2	HRC	7	35	Up to 10 days
				HRC SOCAL	12-16	32	
				SOCAL	11	51	

Acoustic	Vessel Signature Evaluation	Surface ship, submarine and auxiliary system signature assessments. This may include electronic, radar, acoustic, infrared and magnetic signatures.	ASW3	HRC	4	20	Typically 1-5 days, up to 20 days
				HRC SOCAL	36	180	
				SOCAL	24	120	
Other Testing Activities							
Acoustic	Insertion/Extraction	Testing of submersibles capable of inserting and extracting personnel and payloads into denied areas from strategic distances	M3, MF9	HRC	1	5	Up to 30 days
				SOCAL	1	5	
Acoustic	Signature Analysis Operations	Surface ship and submarine testing of electromagnetic, acoustic, optical, and radar signature measurements.	HF1, M3, MF9	HRC	2	10	Multiple days
				SOCAL	1	5	

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex, HSTT = Hawaii-Southern California Training and Testing, CA = California, HI = Hawaii

Office of Naval Research

Table 7 summarizes the proposed testing activities for the Office of Naval Research analyzed within the HSTT Study Area.

Table 7. Proposed Office of Naval Research Testing Activities Analyzed within the HSTT Study Area.

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*	*Typical Duration per Activity*
Acoustic and Oceanographic Science and Technology							
Explosive, Acoustic	Acoustic and Oceanographic Research	Research using active transmissions from sources deployed from ships and unmanned underwater vehicles. Research sources can be used as proxies for current and future Navy systems.	AG, ASW2, BB4, BB9, LF3, LF4, LF5, MF8, MF9, MF9, MF9, E3	HRC	2	10	Up to 14 days
				SOCAL	4	20	
Acoustic	Long Range Acoustic Communications	Bottom mounted acoustic source off of the Hawaiian Island of Kauai will transmit a variety of acoustic communications sequences.	LF4	HRC	3	15	Year-round, 200 days of active transmission

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex

Space and Naval Warfare Systems Command

Table 8 summarizes the proposed testing activities for the Space and Naval Warfare Systems Command analyzed within the HSTT Study Area.

Table 8. Space and Naval Warfare Systems Command Proposed Testing Activities Within the HSTT Study Area.

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*	*Typical Duration per Activity*
Acoustic	Anti-Terrorism/Force Protection	Testing sensor systems that can detect threats to naval piers, ships, and shore infrastructure.	SD1	San Diego, CA	14	70	1 day
				SOCAL	16	80	
Acoustic	Communications	Testing of underwater communications and networks to extend the principles of FORCEnet below the ocean surface.	ASW2, ASW5, HF6, LF4	HRC	0-1	3	5 days, 6-8 hrs per day
				SOCAL	10	50	
Acoustic	Energy and Intelligence, Surveillance, and Reconnaissance Sensor Systems	Develop, integrate, and demonstrate Intelligence, Surveillance, and Reconnaissance systems and in-situ energy systems to support deployed systems.	AG, HF2, HF7, LF4, LF5, LF6, MF10	HRC	11-15	61	5 days, 6-8 hrs per day
				SOCAL	49-55	253	
				HSTT Transit Corridor	8	40	
Acoustic	Vehicle Testing	Testing of surface and subsurface vehicles and sensor systems, which may involve Unmanned Underwater Vehicles, gliders, and Unmanned Surface Vehicles.	BB4, FLS2, FLS3, HF6, LF3, M3, MF9, MF13, SAS1, SAS2, SAS3	HRC	4	20	5 days, 6-8 hrs per day
				SOCAL	166	830	
				HSTT Transit Corridor	2	10	

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex, HSTT = Hawaii-Southern California Training and Testing, CA = California

Summary of Acoustic and Explosive Sources Analyzed for Training and Testing

Table 9 through Table 12 show the acoustic source classes and numbers, explosive source bins and numbers, air gun sources, and pile driving and removal activities associated with Navy training and testing activities in the HSTT Study Area that were analyzed in the Navy's rulemaking/LOA application. Table 9 shows the acoustic source classes (*i.e.*, LF, MF, and HF) that could occur in any year under the Specified Activities for training and testing activities. Under the Specified Activities, acoustic source class use would vary annually, consistent with the number of annual activities summarized above. The five-year total for the Specified Activities takes into account that annual variability.

Table 9. Acoustic Source Classes Analyzed and Numbers Used During Training and Testing Activities in the HSTT Study Area.

Source Class Category	Bin	Description	Unit[1]	Training		Testing	
				Annual[2]	5-year Total	Annual[2]	5-year Total
Low-Frequency (LF): Sources that produce signals less than 1 kHz	LF3	LF sources greater than 200 dB	H	0	0	195	975
	LF4	LF sources equal to 180 dB and up to 200 dB	H	0	0	589 – 777	3,131
			C	0	0	20	100
	LF5	LF sources less than 180 dB	H	0	0	1,814 – 2,694	9,950
	LF6	LF sources greater than 200 dB with long pulse lengths	H	121 – 167	668	40–80	240
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 and 10 kHz	MF1	Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-61)	H	5,779 – 6,702	28,809	1,540	5,612
	MF1K	Kingfisher mode associated with MF1 sonars	H	100	500	14	70
	MF2[3]	Hull-mounted surface ship sonars (e.g., AN/SQS-56)	H	0	0	54	270
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	H	2,080 – 2,175	10,440	1,311	6,553
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22 and AN/AQS-13)	H	414 – 489	2,070	311 – 475	1,717
	MF5	Active acoustic sonobuoys (e.g., DICASS)	C	5,704 – 6,124	28,300	5,250 – 5,863	27,120
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 and 10 kHz	MF6	Active underwater sound signal devices (e.g., MK 84)	C	9	45	1,141 – 1,226	5,835
	MF8	Active sources (greater than 200 dB) not otherwise binned	H	0	0	70	350
	MF9	Active sources (equal to 180 dB	H	0	0	5,139 – 5,165	25,753

		and up to 200 dB) not otherwise binned					
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	1,824 – 1,992	9,288
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%	H	718 – 890	3,597	56	280
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%	H	161 – 215	884	660	3,300
	MF13	MF sonar source	H	0	0	300	1,500
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10 and 100 kHz	HF1	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	H	1,795 – 1,816	8,939	772	3,859
	HF2	HF Marine Mammal Monitoring System	H	0	0	120	600
	HF3	Other hull-mounted submarine sonars (classified)	H	287	1,345	110	549
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10 and 100 kHz	HF4	Mine detection, classification, and neutralization sonar (e.g., AN/SQS-20)	H	2,316	10,380	16,299 – 16,323	81,447
	HF5	Active sources (greater than 200 dB) not otherwise binned	H	0	0	960	4,800
			C	0	0	40	200
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	1,000 – 1,009	5,007
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	1,380	6,900
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)	H	118	588	1,032	3,072

Anti-Submarine Warfare (ASW): Tactical sources (e.g., active sonobuoys and acoustic countermeasures systems) used during ASW training and testing activities	ASW1	MF systems operating above 200 dB	H	194 – 261	1,048	470	2,350
	ASW2	MF Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)	C	688–790	3,346	4,334 – 5,191	23,375
	ASW3	MF towed active acoustic countermeasure systems (e.g., AN/SLQ-25)	H	5,005 – 6,425	25,955	2,741	13,705
Anti-Submarine Warfare (ASW): Tactical sources (e.g., active sonobuoys and acoustic countermeasures systems) used during ASW training and testing activities	ASW4	MF expendable active acoustic device countermeasures (e.g., MK 3)	C	1,284 – 1,332	6,407	2,244	10,910
	ASW5	MF sonobuoys with high duty cycles	H	220– 300	1,260	522–592	2,740
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes	TORP 1	Lightweight torpedo (e.g., MK 46, MK 54, or Anti-Torpedo Torpedo)	C	231–237	1,137	923 – 971	4,560
	TORP 2	Heavyweight torpedo (e.g., MK 48)	C	521 – 587	2,407	404	1,948
	TORP 3		C	0	0	45	225
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars used for ship navigation and safety	FLS2	HF sources with short pulse lengths, narrow beam widths, and focused beam patterns	H	28	140	448 – 544	2,432
	FLS3	VHF sources with short pulse lengths, narrow beam widths, and focused beam patterns	H	0	0	2,640	13,200
Acoustic Modems (M): Systems used to transmit data through the water	M3	MF acoustic modems (greater than 190 dB)	H	61	153	518	2,588
Swimmer Detection Sonars (SD): Systems used to detect divers and submerged swimmers	SD1	HF and VHF sources with short pulse lengths, used for the detection of swimmers and other objects for	H	0	0	10	50

		the purpose of port security					
Synthetic Aperture Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS1	MF SAS systems	H	0	0	1,960	9,800
	SAS2	HF SAS systems	H	900	4,498	8,584	42,920
	SAS3	VHF SAS systems	H	0	0	4,600	23,000
	SAS4	MF to HF broadband mine countermeasure sonar	H	42	210	0	0
Broadband Sound Sources (BB): Sonar systems with large frequency spectra, used for various purposes	BB4	LF to MF oceanographic source	H	0	0	810 – 1,170	4,434
	BB7	LF oceanographic source	C	0	0	28	140
	BB9	MF optoacoustic source	H	0	0	480	2,400

[1] H = hours; C = count (e.g., number of individual pings or individual sonobuoys).
[2] Expected annual use may vary per bin because the number of events may vary from year to year, as described in Section 1.5 (Specified Activities).
[3] MF2/MF2K are sources on frigate class ships, which were decommissioned during Phase II.
[4] Formerly ASW2 (H) in Phase II.
Notes: dB = decibel(s); kHz = kilohertz

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Table 10 shows the number of air guns shots proposed in the HSTT Study Area for training and testing activities.

TABLE 10—TRAINING AND TESTING AIR GUN SOURCES QUANTITATIVELY ANALYZED IN THE HSTT STUDY AREA

Source class category	Bin	Unit [1]	Training		Testing	
			Annual	5-year total	Annual	5-year total
Air Guns (AG): Small underwater air guns	AG	C	0	0	844	4,220

[1] C = count. One count (C) of AG is equivalent to 100 air gun firings.

Table 11 summarizes the impact pile driving and vibratory pile removal activities that would occur during a 24-hour period. Annually, for impact pile driving, the Navy will drive 119 piles, two times a year for a total of 238 piles. Over the 5-year period of the rule, the Navy will drive a total of 1190 piles by impact pile driving. Annually, for vibratory pile extraction, the Navy will extract 119 piles, two times a year for a total of 238 piles. Over the 5-year period of the rule, the Navy will extract a total of 1190 piles by vibratory pile extraction.

TABLE 11—SUMMARY OF PILE DRIVING AND REMOVAL ACTIVITIES PER 24-HOUR PERIOD IN THE HSTT STUDY AREA

Method	Piles per 24-hour period	Time per pile (minutes)	Total estimated time of noise per 24-hour period (minutes)
Pile Driving (Impact)	6	15	90
Pile Removal (Vibratory)	12	6	72

Table 12 shows the number of in-water explosives that could be used in any year under the Specified Activities for training and testing activities. Under the Specified Activities, bin use would vary annually, consistent with the number of annual activities summarized above. The five-year total for the Specified Activities takes into account that annual variability.

TABLE 12—EXPLOSIVE SOURCE BINS ANALYZED AND NUMBERS USED DURING TRAINING AND TESTING ACTIVITIES IN THE HSTT STUDY AREA

Bin	Net explosive weight (lb)	Example explosive source	Modeled underwater detonation depths (ft) [1]	Training		Testing	
				Annual	5-year total	Annual	5-year total
E1	0.1–0.25	Medium-caliber projectiles	0.3, 60	2,940	14,700	8,916–15,216	62,880
E2	>0.25–0.5	Medium-caliber projectiles	0.3, 50	1,746	8,730	0	0
E3	>0.5–2.5	Large-caliber projectiles	0.3, 60	2,797	13,985	2,880–3,124	14,844
E4	>2.5–5	Mine neutralization charge	10, 16, 33, 50, 61, 65, 650	38	190	634–674	3,065
E5	>5–10	5 in projectiles	0.3, 10, 50	4,730–4,830	23,750	1,400	7,000
E6	>10–20	Hellfire missile	0.3, 10, 50, 60	592	2,872	26–38	166
E7	>20–60	Demo block/shaped charge.	10, 50, 60	13	65	0	0
E8	>60–100	Lightweight torpedo	0.3, 150	33–88	170	57	285
E9	>100–250	500 lb bomb	0.3	410–450	2,090	4	20
E10	>250–500	Harpoon missile	0.3	219–224	1,100	30	150
E11	>500–650	650 lb mine	61, 150	7–17	45	12	60
E12	>650–1,000	2,000 lb bomb	0.3	16–21	77	0	0
E13	>1,000–1,740	Multiple Mat Weave charges.	NA [2]	9	45	0	0

[1] Net Explosive Weight refers to the amount of explosives; the actual weight of a munition may be larger due to other components.
[2] Not modeled because charge is detonated in surf zone; not a single E13 charge, but multiple smaller charges detonated in quick succession.
Notes: in = inch(es), lb = pound(s), ft = feet.

Vessel Movement

Vessels used as part of the Specified Activities include ships, submarines, unmanned vessels, and boats ranging in size from small, 22 ft (7 m) rigid hull inflatable boats to aircraft carriers with lengths up to 1,092 ft (333 m). Large Navy ships greater than 60 ft (18 m) generally operate at speeds in the range of 10 to 15 kn for fuel conservation. Submarines generally operate at speeds in the range of 8 to 13 kn in transits and less than those speeds for certain tactical maneuvers. Small craft, less than 60 ft (18 m) in length, have much more variable speeds (dependent on the activity). Speeds generally range from 10 to 14 kn. While these speeds for large and small craft are representative of most events, some vessels need to temporarily operate outside of these parameters.

The number of Navy vessels used in the HSTT Study Area varies based on military training and testing requirements, deployment schedules, annual budgets, and other unpredictable factors. Most training and testing activities involve the use of vessels. These activities could be widely dispersed throughout the HSTT Study Area, but would be typically conducted near naval ports, piers, and range areas. Navy vessel traffic would especially be concentrated near San Diego, California and Pearl Harbor, Hawaii. There is no seasonal differentiation in Navy vessel use. The majority of large vessel traffic occurs between the installations and the OPAREAS. Support craft would be more concentrated in the coastal waters in the areas of naval installations, ports and ranges. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks.

Standard Operating Procedures

For training and testing to be effective, personnel must be able to safely use their sensors and weapon systems as they are intended to be used in a real-world situation and to their optimum capabilities. While standard operating procedures are designed for the safety of personnel and equipment and to ensure the success of training and testing activities, their implementation often yields additional benefits to environmental, socioeconomic, public health and safety, and cultural resources.

Navy standard operating procedures have been developed and refined over years of experience and are broadcast via numerous naval instructions and manuals, including, but not limited to:

- Ship, submarine, and aircraft safety manuals;
- Ship, submarine, and aircraft standard operating manuals;
- Fleet Area Control and Surveillance Facility range operating instructions;
- Fleet exercise publications and instructions;
- Naval Sea Systems Command test range safety and standard operating instructions;
- Navy instrumented range operating procedures;
- Naval shipyard sea trial agendas;
- Research, development, test, and evaluation plans;
- Naval gunfire safety instructions;
- Navy planned maintenance system instructions and requirements;
- Federal Aviation Administration regulations; and
- International Regulations for Preventing Collisions at Sea.

Because standard operating procedures are essential to safety and mission success, the Navy considers them to be part of the Specified Activities, and has included them in the environmental analysis. Standard operating procedures that are recognized as providing a potential benefit to marine mammals during training and testing activities are noted below and discussed in more detail within the HSTT DEIS/OEIS.

- Vessel Safety
- Weapons Firing Safety
- Target Deployment Safety
- Towed In-Water Device Safety
- Pile Driving Safety

Standard operating procedures (which are implemented regardless of their secondary benefits) are different from mitigation measures (which are designed entirely for the purpose of avoiding or reducing potential impacts on the environment). Refer to Section 1.5.5 Standing Operating Procedures of the Navy's rulemaking/LOA application for greater detail.

Duration and Location

Training and testing activities would be conducted in the HSTT Study Area throughout the year from 2018 through 2023 for the five-year period covered by the regulations. The HSTT Study Area (see Figure 1.1–1 of the Navy's rulemaking/LOA application) is comprised of established operating and

warning areas across the north-central Pacific Ocean, from the mean high tide line in Southern California west to Hawaii and the International Date Line. The Study Area includes the at-sea areas of three existing range complexes (the Hawaii Range Complex, the SOCAL Range Complex, and the Silver Strand Training Complex), and overlaps a portion of the Point Mugu Sea Range (PMSR). Also included in the Study Area are Navy pierside locations in Hawaii and Southern California, Pearl Harbor, San Diego Bay, and the transit corridor [1] on the high seas where sonar training and testing may occur. A Navy range complex consists of geographic areas that encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. Range complexes include OPAREAs and special use airspace, which may be further divided to provide better control of the area and events being conducted for safety reasons. Please refer to the regional maps provided in the Navy's rulemaking/LOA application (Figures 2–1 through 2–8) for additional detail of the range complexes and testing ranges. The range complexes and testing ranges are described in the following sections.

Hawaii Range Complex

The Hawaii Range Complex encompasses ocean areas located around the Hawaiian Islands chain. The ocean areas extend from 16 degrees north latitude to 43 degrees north latitude and from 150 degrees west longitude to the International Date Line, forming an area approximately 1,700 nmi by 1,600 nmi. The largest component of the Hawaii Range Complex is the Temporary OPAREA, extending north and west from the island of Kauai, and comprising over two million square nautical miles (nmi^2) of air and sea space. The Temporary OPAREA is used primarily for missile testing by the Pacific Missile Range Facility (PMRF), and those missile tests are not part of the Navy's rulemaking/LOA application and are covered under other NEPA analysis. Other non-Navy entities such as various academic institutions and other Department of Defense agencies (DoD) such as the U.S. Air Force conduct activities in the PMRF. The PMRF activities referred to in the HSTT EIS/DEIS are very high altitude missile defense tests conducted by the Missile Defense Agency (MDA) (a non-Navy DoD command). For this rulemaking/LOA application, the area is used for Navy ship transits throughout the year. Despite the Temporary OPAREA's size, nearly all of the training and testing activities in the Hawaii Range Complex (HRC) take place within the smaller Hawaii OPAREA, that portion of the range complex immediately surrounding the island chain from Hawaii to Kauai (Figures 2–1 through 2–4 of the Navy's application). The Hawaii OPAREA consists of 235,000 nmi^2 of special use airspace and ocean areas. The HRC includes over 115,000 nmi^2 of combined special use airspace and air traffic control assigned airspace. As depicted in Figure 2–1 of the Navy's application, this airspace is almost entirely over the ocean and includes warning areas, air traffic controlled assigned airspace, and restricted areas.

The Hawaii Range Complex includes the ocean areas as described above, as well as specific training areas around the islands of Kauai, Oahu, and Maui (Figures 2–2, 2–3, and 2–4 respectively of the Navy's application). The Hawaii Range Complex also includes the ocean portion of the PMRF on Kauai, which is both a fleet training range and a fleet and DoD testing range. The facility includes 1,100 nmi^2 of instrumented ocean area at depths between 129 ft and 15,000 ft. The Hawaii Range Complex also includes the ocean areas around the designated Papahanaumokuakea Marine National Monument, referred hereafter as the Monument. Establishment of the Monument in June 2006 triggered a number of prohibitions on activities conducted in the Monument area. However, all military activities and exercises were specifically excluded from the listed prohibitions as long as the military exercises and activities are carried out in a manner that avoids, to the extent practicable and consistent with operational requirements, adverse impacts on monument resources and qualities. In 2016, the Monument was expanded from its original 139,818 square miles (mi^2) to 582,578 mi^2. The expansion of the Monument was primarily to the west—away from the portion of the Hawaii Range Complex where most training and testing activities are proposed to occur— and retained the military exclusion language contained in the monument designation.

Southern California Range Complex

The SOCAL Range Complex is located between Dana Point and San Diego, and extends southwest into the Pacific Ocean (Figures 2–5, 2–6, and 2–7 of the Navy's application). Although the range complex extends more than 600 nmi beyond land, most activities occur with 200 nmi of Southern California. The two primary components of the SOCAL Range Complex are the ocean OPAREAs and the special use airspace. These components encompass 120,000 nmi^2 of sea space and 113,000 nmi^2 of special use airspace. Most of the special use airspace in the SOCAL Range Complex is defined by W–291 (Figure 2–5 of the Navy's application). This warning area extends vertically from the ocean surface to 80,000 ft above mean sea level and encompasses 113,000 nmi^2 of airspace. The SOCAL Range Complex includes approximately 120,000 nmi^2 of sea and undersea space, largely defined as that ocean area underlying the Southern California special use airspace described above. The SOCAL Range Complex also extends beyond this airspace to include the surface and subsurface area from the northeastern border of W–291 to the coast of San Diego County, and includes San Diego Bay.

Point Mugu Sea Range Overlap

A small portion (approximately 1,000 nmi^2) of the Point Mugu Sea Range is included in the HSTT Study Area (Figure 2–5 of the Navy's application). Only that part of the Point Mugu Sea Range is used by the Navy for anti-submarine warfare training. This training uses sonar, is conducted in the course of major training exercises, and is analyzed in this request.

Silver Strand Training Complex

The Silver Strand Training Complex is an integrated set of training areas located on and adjacent to the Silver Strand, a narrow, sandy isthmus separating the San Diego Bay from the Pacific Ocean. It is divided into two non-contiguous areas: Silver Strand Training Complex-North and Silver Strand Training Complex-South (Figure 2–8 of the Navy's application). The Silver Strand Training Complex-North includes 10 oceanside boat training lanes (numbered as Boat Lanes 1–10), ocean anchorage areas (numbered 101–178), bayside water training areas (Alpha through Hotel), and the Lilly Ann drop zone. The boat training lanes are each 500 yards (yd) wide stretching 4,000 yd seaward and forming a 5,000

[1] Vessel transit corridors are the routes typically used by Navy assets to traverse from one area to another. The route depicted in Figure 1–1 of the Navy's rulemaking/LOA application is the shortest route between Hawaii and Southern California, making it the quickest and most fuel efficient. Depicted vessel transit corridor is notional and may not represent the actual routes used by ships and submarines transiting from Southern California to Hawaii and back. Actual routes navigated are based on a number of factors including, but not limited to, weather, training, and operational requirements.

yd long contiguous training area. The Silver Strand Training Complex-South includes four oceanside boat training lanes (numbered as Boat Lanes 11–14) and the TA-Kilo training area.

The anchorages lie offshore of Coronado in the Pacific Ocean and overlap a portion of Boat Lanes 1–10. The anchorages are each 654 yd in diameter and are grouped together in an area located primarily due west of Silver Strand Training Complex-North, east of Zuniga Jetty and the restricted areas on approach to the San Diego Bay entrance.

Ocean Operating Areas Outside the Bounds of Existing Range Complexes (Transit Corridor)

In addition to the range complexes that are part of the Study Area, a transit corridor outside the boundaries of the range complexes is also included as part of the Study Area in the analysis. Although not part of any defined range complex, this transit corridor is important to the Navy in that it provides adequate air, sea, and undersea space in which vessels and aircraft conduct training and some sonar maintenance and testing while enroute between Southern California and Hawaii. The transit corridor, notionally defined by the great circle route (*e.g.*, shortest distance) from San Diego to the center of the Hawaii Range Complex, as depicted in Figure 1–1 of the Navy's application, is generally used by ships transiting between the SOCAL Range Complex and Hawaii Range Complex. While in transit, ships and aircraft would, at times, conduct basic and routine unit level activities such as gunnery, bombing, and sonar training, testing, and maintenance, as long as the activities do not interfere with the primary objective of reaching their intended destination.

Pierside Locations, Pearl Harbor, and San Diego Bay

The Study Area includes select pierside locations where Navy surface ship and submarine sonar maintenance testing occur. For purposes of the Navy's application, pierside locations include channels and routes to and from Navy ports, and facilities associated with Navy ports and shipyards. These locations in the Study Area are located at Navy ports and naval shipyards in Pearl Harbor, Hawaii and in San Diego Bay, California (Figure 2–9 of the Navy's application). In addition, some training and testing activities occur throughout San Diego Bay.

Description of Marine Mammals and Their Habitat in the Area of the Specified Activities

Marine mammal species and their associated stocks that have the potential to occur in the HSTT Study Area are presented in Table 13 along with an abundance estimate, an associated coefficient of variation value, and best/minimum abundance estimates. The Navy proposes to take individuals of 39 marine mammal species by Level A and B harassment incidental to training and testing activities from the use of sonar and other transducers, in-water detonations, air guns, and impact pile driving/vibratory extraction activities. In addition, the Navy is requesting ten mortalities of two marine mammal stocks from explosives, and three takes of large whales by serious injury or mortality from vessel strikes over the five-year period. One marine mammal species, the Hawaiian monk seal, has critical habitat designated under the Endangered Species Act in the HSTT Study Area (described below).

Information on the status, distribution, abundance, population trends, and ecology of marine mammals in the HSTT Study Area may be found in Chapter 4 of the Navy's rulemaking/LOA application. Additional information on the general biology and ecology of marine mammals are included in the HSTT DEIS/OEIS. In addition, NMFS annually publishes Stock Assessment Reports (SARs) for all marine mammals in U.S. Exclusive Economic Zone (EEZ) waters, including stocks that occur within the HSTT Study Area and are found specifically in the U.S. Pacific Marine Mammal SAR (Carretta *et al.*, 2017) (see *https://www.fisheries.noaa.gov/resource/document/us-pacific-marine-mammal-stock-assessments-2016*).

The species carried forward for analysis (and described in Table 13 below) are those likely to be found in the HSTT Study Area based on the most recent data available, and do not include stocks or species that may have once inhabited or transited the area but have not been sighted in recent years (*e.g.*, species which were extirpated because of factors such as nineteenth and twentieth century commercial exploitation). Extralimital species, species that would not be considered part of the HSTT seasonal species assemblage (*e.g.*, North Pacific right whale, any tropical odontocete species in SOCAL), were not included in the analysis.

TABLE 13—MARINE MAMMALS OCCURRENCE WITHIN THE HSTT STUDY AREA

Common name	Scientific name	Stock	Status		Occurrence	Seasonal absence	Stock abundance (CV)/minimum population
			MMPA	ESA			
Blue whale	*Balaenoptera musculus.*	Eastern North Pacific.	Depleted	Endangered	Southern California.		1,647 (0.07)/1,551
		Central North Pacific.	Depleted	Endangered	Hawaii	Summer	81 (1.14)/38
Bryde's whale	*Balaenoptera brydei/edeni.*	Eastern Tropical Pacific.			Southern California.		unknown
		Hawaiian	Depleted		Hawaii		798 (0.28)/633
Fin whale	*Balaenoptera physalus.*	California, Oregon, and Washington.	Depleted	Endangered	Southern California.		9,029 (0.12)/8,127
		Hawaiian	Depleted	Endangered	Hawaii	Summer	58 (1.12)/27
Gray whale	*Eschrichtius robustus.*	Eastern North Pacific.			Southern California.		20,990 (0.05)/20,125
		Western North Pacific.	Depleted	Endangered	Southern California.		140 (0.04)/135
Humpback whale	*Megaptera novaeangliae.*	California, Oregon, and Washington.	Depleted	Threatened/Endangered [1].	Southern California.		1,918 (0.03)/1,876
		Central North Pacific.			Hawaii	Summer	10,103 (0.30)/7,890
Minke whale	*Balaenoptera acutorostrata.*	California, Oregon, and Washington.			Southern California.		636 (0.72)/369
		Hawaiian			Hawaii	Summer	unknown

TABLE 13—MARINE MAMMALS OCCURRENCE WITHIN THE HSTT STUDY AREA—Continued

Common name	Scientific name	Stock	Status		Occurrence	Seasonal absence	Stock abundance (CV)/minimum population
			MMPA	ESA			
Sei whale	*Balaenoptera borealis.*	Eastern North Pacific.	Depleted	Endangered	Southern California.		519 (0.4)/374
		Hawaii	Depleted	Endangered	Hawaii	Summer	178 (0.90)/93
Sperm whale	*Physeter macrocephalus.*	California, Oregon, and Washington.	Depleted	Endangered	Southern California.		2,106 (0.58)/1,332
		Hawaiian	Depleted	Endangered	Hawaii		3,354 (0.34)/2,539
Pygmy sperm whale.	*Kogia breviceps*	California, Oregon, and Washington.			Southern California.	Winter and Fall	4,111 (1.12)/1,924
		Hawaiian			Hawaii		unknown
Dwarf sperm whale.	*Kogia sima*	California, Oregon, and Washington.			Southern California.		unknown
		Hawaiian			Hawaii		unknown
Baird's beaked whale.	*Berardius bairdii*	California, Oregon, and Washington.			Southern California.		847 (0.81)/466
Blainville's beaked whale.	*Mesoplodon densirostris.*	Hawaiian			Hawaii		2,338 (1.13)/1,088
Cuvier's beaked whale.	*Ziphius cavirostris.*	California, Oregon, and Washington.			Southern California.		6,590 (0.55)/4,481
		Hawaiian			Hawaii		1,941 na/1,142
Longman's beaked whale.	*Indopacetus pacificus.*	Hawaiian			Hawaii		4,571 (0.65)/2,773
Mesoplodon beaked whales.	*Mesoplodon spp.*	California, Oregon, and Washington.			Southern California.		694 (0.65)/389
Common Bottlenose dolphin.	*Tursiops truncatus.*	California Coastal.			Southern California.		453 (0.06)/346
		California, Oregon, and Washington Offshore.					1,924 (0.54)/1,255
		Hawaiian Pelagic			Hawaii		5,950 (0.59)/3,755
		Kauai and Niihau			Hawaii		184 (0.11)/168
		Oahu			Hawaii		743 (0.54)/485
		4-Islands			Hawaii		191 (0.24)/156
		Hawaii Island			Hawaii		128 (0.13)/115
False killer whale	*Pseudorca crassidens.*	Main Hawaiian Islands Insular.	Depleted	Endangered	Hawaii		151 (0.20)/92
		Hawaii Pelagic			Hawaii		1,540 (0.66)/928
		Northwestern Hawaiian Islands.			Hawaii		617 (1.11)/290
Fraser's dolphin	*Lagenodelphis hosei.*	Hawaiian			Hawaii		16,992 (0.66)/10,241
Killer whale	*Orcinus orca*	Eastern North Pacific Offshore.			Southern California.		240 (0.49)/162
		Eastern North Pacific Transient/West Coast Transient[2].			Southern California.		243 unknown/243
		Hawaiian			Hawaii		101 (1.00)/50
Long-beaked common dolphin.	*Delphinus capensis.*	California			Southern California.		101,305 (0.49)/68,432
Melon-headed whale.	*Peponocephala electra.*	Hawaiian Islands			Hawaii		5,794 (0.20)/4,904
		Kohala Resident					447 (0.12)/404
Northern right whale dolphin.	*Lissodelphis borealis.*	California, Oregon, and Washington.			Southern California.		26,556 (0.44)/18,608
Pacific white-sided dolphin.	*Lagenorhynchus obliquidens.*	California, Oregon, and Washington.			Southern California.		26,814 (0.28)/21,195
Pantropical spotted dolphin.	*Stenella attenuata.*	Oahu			Hawaii		unknown
		4-Islands					unknown
		Hawaii Island			Hawaii		unknown
		Hawaii Pelagic			Hawaii		15,917 (0.40)/11,508
Pygmy killer whale	*Feresa attenuata*	Tropical			Southern California.	Winter & Spring	unknown
		Hawaiian			Hawaii		3,433 (0.52)/2,274
Risso's dolphins	*Grampus griseus*	California, Oregon, and Washington.			Southern California.		6,336 (0.32)/4,817
		Hawaiian			Hawaii		7,256 (0.41)/5,207
Rough-toothed dolphin.	*Steno bredanensis.*	na[3]			Southern California.		unknown
		Hawaiian			Hawaii		6,288 (0.39)/4,581

TABLE 13—MARINE MAMMALS OCCURRENCE WITHIN THE HSTT STUDY AREA—Continued

Common name	Scientific name	Stock	Status		Occurrence	Seasonal absence	Stock abundance (CV)/minimum population
			MMPA	ESA			
Short-beaked common dolphin.	*Delphinus delphis.*	California, Oregon, and Washington.			Southern California.		969,861 (0.17)/839,325
Short-finned pilot whale.	*Globicephala macrorhynchus.*	California, Oregon, and Washington.			Southern California.		836 (0.79)/466
		Hawaiian			Hawaii		12,422 (0.43)/8,782
Spinner dolphin	*Stenella longirostris.*	Hawaii Pelagic			Hawaii		unknown
		Hawaii Island					631 (0.04)/585
		Oahu and 4-Islands.			Hawaii		355 (0.09)/329
		Kauai and Niihau			Hawaii		601 (0)/509
		Kure and Midway			Hawaii		unknown
		Pearl and Hermes.			Hawaii		unknown
Striped dolphin	*Stenella coeruleoalba.*	California, Oregon, and Washington.			Southern California.		29,211 (0.20)/24,782
		Hawaiian			Hawaii		20,650 (0.36)/15,391
Dall's porpoise	*Phocoenoides dalli.*	California, Oregon, and Washington.			Southern California.		25,750 (0.45)/17,954
Harbor seal	*Phoca vitulina*	California			Southern California.		30,968 na/27,348
Hawaiian monk seal.	*Neomonachus schauinslandi.*	Hawaiian	Depleted	Endangered	Hawaii		1,272 na/1,205
Northern elephant seal.	*Mirounga angustirostris.*	California			Southern California.		179,000 na/81,368
California sea lion	*Zalophus californianus.*	U.S. Stock			Southern California.		296,750 na/153,337
Guadalupe fur seal.	*Arctocephalus townsendi.*	Mexico to California.	Depleted	Threatened	Southern California.		20,000 na/15,830
Northern fur seal	*Callorhinus ursinus.*	California			Southern California.		14,050 na/7,524

Notes:
[1] The two humpback whale Distinct Population Segments making up the California, Oregon, and Washington stock present in Southern California are the Mexico Distinct Population Segment, listed under ESA as Threatened, and the Central America Distinct Population Segment, which is listed under ESA as Endangered.
[2] This stock is mentioned briefly in the Pacific Stock Assessment Report (Carretta *et al.*, 2017) and referred to as the "Eastern North Pacific Transient" stock; however, the Alaska Stock Assessment Report contains assessments of all transient killer whale stocks in the Pacific and the Alaska Stock Assessment Report refers to this same stock as the "West Coast Transient" stock (Muto *et al.*, 2017).
[3] Rough-toothed dolphin has a range known to include the waters off Southern California, but there is no recognized stock or data available for the U.S west coast.

Below, we include additional information about the marine mammals in the area of the Specified Activities, where available, that will inform our analysis, such as identifying areas of important habitat or known behaviors, or where Unusual Mortality Events (UME) have been designated.

Critical Habitat

Currently there is one marine mammal, the ESA-listed Hawaiian monk seal, with designated critical habitat within the HSTT Study Area. However, critical habitat for ESA-listed Main Hawaiian Islands insular false killer whale was recently proposed in November 2017 (82 FR 51186; November 3, 2017), designating waters from the 45 m depth contour to the 3200 m depth contour around the main Hawaiian Islands from Niihau east to Hawaii. However, some areas were proposed for exclusion based on considerations of economic and national security impacts.

Critical habitat for Hawaiian monk seals was designated in 1986 (51 FR 16047; April 30, 1986) and later revised in 1988 (53 FR 18988; May 26, 1988) and in 2015 (80 FR 50925; August 21, 2015) (NOAA, 2015a) (Figure 4–1 of the Navy's application). The essential features of the critical habitat were identified as: (1) Adjacent terrestrial and aquatic areas with characteristics preferred by monk seals for pupping and nursing; (2) shallow, sheltered aquatic areas adjacent to coastal locations preferred by monk seals for pupping and nursing; (3) marine areas from 0 to 500 m in depth preferred by juvenile and adult monk seals for foraging; (4) areas with low levels of anthropogenic disturbance; (5) marine areas with adequate prey quantity and quality; and (6) significant areas used by monk seals for hauling out, resting, or molting (NOAA, 2015a).

In the Northwestern Hawaiian Islands Hawaiian monk seal critical habitat includes all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland as well as the seafloor and marine habitat 10 m in height above the seafloor from the shoreline out to the 200 m depth contour around Kure Atoll, Midway Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island and Nihoa Island. In the main Hawaiian Islands, Hawaiian monk seal critical habitat includes the seafloor and marine habitat to 10 m above the seafloor from the 200 m depth contour through the shoreline and extending into terrestrial habitat 5 m inland from the shoreline between identified boundary points around Kaula Island (includes marine habitat only, some excluded areas see areas, Niihau (includes marine habitat from 10 m–200 m in depth; some excluded areas), Kauai, Oahu, Maui Nui (including Kahoolawe, Lanai, Maui, and Molokai), Hawaii.

The approximate area encompassed by the Northwestern Hawaiian Islands was designated as the Papahanaumokuakea Monument in 2006, in part to protect the habitat of the Hawaiian monk seal. Hawaiian monk seals are managed as a single stock. There are six main reproductive subpopulations at: French Frigate Shoals, Laysan Island, Lisianski Island,

Pearl and Hermes Reef, Midway Island, and Kure Atoll in the northwestern Hawaiian Islands.

Biologically Important Areas

Biologically Important Areas (BIAs) include areas of known importance for reproduction, feeding, or migration, or areas where small and resident populations are known to occur (Van Parijs, 2015). Unlike critical habitat, these areas are not formally designated pursuant to any statute or law, but are a compilation of the best available science intended to inform impact and mitigation analyses. An interactive map of the BIAs may be found here: *https://cetsound.noaa.gov/biologically-important-area-map.*

In Hawaii, 21 BIAs fall within or overlap with the HSTT Study Area. These include 11 small and resident population areas for species including dwarf sperm whales, Blainville's beaked whales, Cuvier's beaked whales, pygmy killer whales, short-finned pilot whales, melon-headed whales, false killer whales, pantropical spotted dolphins, spinner dolphins, rough-toothed dolphins, and common bottlenose dolphins (see Appendix K of the HSTT DEIS/OEIS for figures depicting these areas). In addition, six non-contiguous areas located adjacent to the eight main Hawaiian Islands have been designated as a humpback whale reproductive BIA (Baird *et al.*, 2015c).

Five of the 28 BIAs that were identified for four species off the U.S. west coast (Calambokidis *et al.*, 2015a) are located within or overlapping the SOCAL portion of the Study Area (see Appendix K of the HSTT DEIS/OEIS for figures depicting these areas). These identified areas include four feeding areas for blue whales and a migration area for gray whales (Calambokidis *et al.*, 2015a).

Main Hawaiian Islands Humpback Whale Reproduction BIA

A single biologically important area around and between portions of eight islands was identified for breeding humpback whales in the Main Hawaiian Islands from December through April (Baird *et al.*, 2015a) (see Figure K.3–1 of the HSTT DEIS/OEIS). The Main Hawaiian Islands Humpback Whale Reproduction BIA contains several humpback whale breeding sub-areas off the coasts of Kauai, Niihau, Oahu, Maui, and Hawaii Island. The highest densities of whales occur in waters that are less than 200 m in depth. The Main Hawaiian Islands Humpback Whale Reproduction Area also overlaps the Navy's 4-Islands Region and Hawaii Island Mitigation Areas and Humpback Whale Special Reporting Areas described later in this document (and also shown in Appendix K of the HSTT DEIS/OEIS). The Main Hawaiian Islands Humpback Whale Reproduction BIA also encompasses the entire Humpback Whale National Marine Sanctuary.

Dwarf Sperm Whales Small and Resident Population

A year-round BIA has been identified for a small resident population of dwarf sperm whales located off the island of Hawaii (Mahaffy *et al.*, 2009; Baird *et al.*, 2013a) with sightings between 500 and 1,000 m in depth (Baird et *al.*, 2013a). This BIA also overlaps the Navy's Hawaii Island Mitigation Area described later in this document.

Blainville's Beaked Whales Small and Resident Population

A year-round BIA for a small resident population of Blainville's beaked whales has been identified off the island of Hawaii (McSweeney *et al.*, 2007; Schorr *et al.*, 2009a) with the highest density of groups in water between 500 and 1,500 m in depth, and density decreasing offshore (Baird *et al.*, 2015c). This BIA also overlaps the Navy's Hawaii Island Mitigation Area described later in this document.

Cuvier's Beaked Whales Small and Resident Population

A year-round BIA for a small resident population of Cuvier's beaked whales has been identified off the island of Hawaii with the highest density of groups in water between 1,500 and 4,000 m in depth, and density decreasing offshore (Baird *et al.*, 2015c). This BIA also mostly overlaps the Navy's Hawaii Island Mitigation Area described later in this document.

Pygmy Killer Whales Small and Resident Population

A year-round BIA for a small resident population of pygmy killer whales has been identified for the Hawaii Island resident population. This BIA includes the west side of the island of Hawaii, from northwest of Kawaihae south to the south point of the island, and along the southeast coast of the island. This BIA also overlaps the Navy's Hawaii Island Mitigation Area described later in this document.

Short-Finned Pilot Whales Small and Resident Population

A year- round BIA for a small resident population of short-finned pilot whales has been identified off the island of Hawaii (Baird *et al.*, 2011c, 2013a; Mahaffy, 2012). Short-finned pilot whales are primarily connected to slope habitats off the islands, with the highest density between 1,000 and 2,500 m in depth, dropping off significantly after 2,500 m (Baird *et al.*, 2013a). This BIA also overlaps the Navy's Hawaii Island Mitigation Area described later in this document.

Melon-Headed Whales Small and Resident Population

A year-round BIA has been identified for a small and resident population of melon-headed whales off the island of Hawaii, primarily using the Kohala area. This BIA also overlaps the Navy's Hawaii Island Mitigation Area described later in this document.

False Killer Whales Small and Resident Population

A year-round BIA has been identified for a small and resident insular population of false killer whales off the coasts of Oahu, Maui, Molokai, Lanai, and Hawaii Island. The known range of this population extends from west of Niihau to east of Hawaii, out to 122 km offshore (Baird *et al.*, 2012). This BIA also partially overlap the Navy's 4-Islands Region and Hawaii Island Mitigation Areas described later in this document.

Pantropical Spotted Dolphins Small and Resident Populations

Three year-round BIAs have been identified for small and resident populations of pantropical spotted dolphin. Three stocks of this species occurs around the main Hawaiian Islands (Oahu, the 4-Island Region, and off the main island of Hawaii). Two of these BIAs also overlap the Navy's 4-Islands Region and Hawaii Island Mitigation Areas described later in this document.

Spinner Dolphins Small and Resident Populations

Year-round BIAs have been identified for five small and resident populations of spinner dolphins. The boundaries of these populations are out to 10 nmi from shore around Kure and Midway Atolls, Pearl and Hermes Reef, Kauai and Niihau, Oahu and the 4-Islands Region and off the main island of Hawaii (Carretta *et al.*, 2014). Two of these BIAs also overlap the Navy's 4-Islands Region and Hawaii Island Mitigation Areas described later in this document.

Rough-Toothed Dolphins Small and Resident Population

A year-round BIA has been identified for a small demographically isolated resident population off the island of Hawaii (Baird *et al.*, 2008a; Albertson,

2015). This species is also found elsewhere among the Hawaiian Islands. The Navy's Hawaii Island Mitigation Area also overlaps with the majority of this BIA described later in this document.

Common Bottlenose Dolphins Small and Resident Populations

Year-round BIAs have been identified for the four insular stocks of bottlenose dolphins in Hawaiian waters. They are found both nearshore and offshore areas (Barlow, 2006), but around the main Hawaiian Islands they are primarily found in depths of less than 1,000 m (Baird *et al.*, 2013a). The Navy's 4-Islands Region Mitigation Area overlaps portions of the BIA off of Molokai, Maui, and Lanai and the Hawaii Island Mitigation Area (described later in this document) includes the entire BIA off of the Island of Hawaii.

Blue Whale Feeding BIAs

There are nine feeding area BIAs identified for blue whales off the U.S. west coast (Calambokidis *et al.*, 2015a), but only four overlap with the SOCAL portion of the HSTT Study Area (see Figure K.4–1 of the HSTT DEIS/OEIS). Two of these feeding areas (the Santa Monica Bay to Long Beach and the San Nicolas Island feeding area BIAs) are at the extreme northern edge and slightly overlap with the SOCAL portion of the HSTT Study Area. The remaining two feeding areas (the Tanner-Cortes Bank and the San Diego feeding area BIAs) are entirely within the SOCAL portion of the HSTT Study Area (Calambokidis *et al.*, 2015a). The feeding behavior for which these areas are designated occurs from June to October (Aquatic Mammals, 2015; Calambokidis *et al.*, 2015a). The San Diego blue whale feeding area overlaps with the Navy's San Diego Arc Mitigation Area as described later in this document.

Gray Whale Migration BIA

Calambokidis *et al.* (2015) identified a gray whale migration area off Southern California and overlapping with all the Southern California portion of the HSTT Study Area north of the border with Mexico (Figure K.4–7). This migration area covers approximately 22,300 km^2 of water space within the HSTT Study Area.

National Marine Sanctuaries

Under Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 (also known as the National Marine Sanctuaries Act (NMSA)), NOAA can establish as national marine sanctuaries (NMS), areas of the marine environment with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities. Sanctuary regulations prohibit destroying, causing the loss of, or injuring any sanctuary resource managed under the law or regulations for that sanctuary (15 CFR part 922). NMS are managed on a site-specific basis, and each sanctuary has site-specific regulations. Most, but not all sanctuaries have site-specific regulatory exemptions from the prohibitions for certain military activities. Separately, section 304(d) of the NMSA requires Federal agencies to consult with the Office of National Marine Sanctuaries whenever their Specified Activities are likely to destroy, cause the loss of, or injure a sanctuary resource. There are two national marine sanctuaries managed by the Office of National Marine Sanctuaries within the Study Area, the Hawaiian Islands Humpback Whale NMS and Channel Islands NMS (see Table 6.1–2 and Figures 6.1–3 and 6.1–4 of the HSTT DEIS/OEIS), which are described below.

Hawaiian Islands Humpback Whale NMS

The Hawaiian Islands Humpback Whale NMS is a single-species managed sanctuary, composed of 1,035 nmi^2 of the waters around Maui, Lanai, and Molokai; and smaller areas off the north shore of Kauai, off Hawaii's west coast, and off the north and southeast coasts of Oahu. The Sanctuary is entirely within the HRC of the HSTT Study Area and constitutes one of the world's most important Hawaii humpback whale Distinct Population Segment (DPS) habitats (81 FR 62259; September 8, 2016), and is a primary region for humpback reproduction in the United States (National Marine Sanctuaries Program, 2002). Scientists estimate that more than 50 percent of the entire North Pacific humpback whale population migrates to Hawaiian waters each winter to mate, calve, and nurse their young. The North Pacific humpback whale population has been split into two DPSs. The Hawaii humpback whale DPS migrates to Hawaiian waters each winter and is not listed under the ESA. In addition to protection under the MMPA, the Hawaii humpback whale DPS is protected in sanctuary waters by the Hawaiian Islands NMS. The sanctuary was created to protect humpback whales and shallow, protected waters important for calving and nursing (Office of National Marine Sanctuaries, 2010).

The Hawaiian Islands Humpback Whale NMS overlaps with the Main Hawaiian Islands Humpback Whale Reproduction Area (BIA) identified in Van Parijs (2015) and Baird et al. (2015) (shown in Figure K.3–1 of Appendix K and as discussed in Appendix K, Section K.3.1 (Main Hawaiian Islands Humpback Whale Reproduction Area of the HSTT DEIS/OEIS)).

Channel Islands NMS

The Channel Islands NMS is an ecosystem-based managed sanctuary consisting of an area of 1,109 nmi^2 around Anacapa Island, Santa Cruz Island, Santa Rosa Island, San Miguel Island, and Santa Barbara Island to the south. Only 92 nmi^2, or about 8 percent of the sanctuary, occurs within the SOCAL portion of the Study Area (see Figure 6.1–4 of the HSTT DEIS/OEIS). The Study Area overlaps with the sanctuary at Santa Barbara Island. In addition, the Navy has proposed to implement the Santa Barbara Island Mitigation Area around Santa Barbara Island out to 6 nmi as described later in this document (also see Section K.2.2, Mitigation Areas to be Implemented of the HSTT DEIS/OEIS). As an ecosystem-based managed sanctuary, key habitats include kelp forest, surfgrass and eelgrass, intertidal zone, nearshore subtidal, deepwater benthic, and water column habitat. The diversity of habitats onshore and offshore contributes to the high species diversity in the Channel Islands NMS, with more than 195 species of birds, at least 33 species of cetaceans, 4 species of sea turtles, at least 492 species of algae and 4 species of sea grasses, a variety of invertebrates (including two endangered species (black abalone and the white abalone)), and 481 species of fish (NMS, 2009b).

Unusual Mortality Events (UME)

A UME is defined under Section 410(6) of the MMPA as a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response. From 1991 to the present, there have been 16 formally recognized UMEs affecting marine mammals in California and Hawaii and involving species under NMFS's jurisdiction. Two UMEs that could be relevant to informing the current analysis are discussed below. Specifically, the California sea lion UME in California is still open, but will be closed soon. The Guadalupe fur seal UME in California is still active and involves an ongoing investigation.

California Sea Lion UME

Elevated strandings of California sea lion pups began in Southern California in January 2013. In 2013, over 1,600 California sea lions stranded alive along the Southern California coastline and

over 3,500 live stranded California sea lions stranded on beaches in 2015, which was the highest number on record. Approximately 13,000 California sea lions (both live and dead) stranded from January 1, 2013, through December 31, 2017. Strandings in 2017 have finally returned to baseline (approximately 1,400/yr). The UME is currently defined to include pup and yearling California sea lions (0–2 years of age). Many of the sea lions were emaciated, dehydrated, and very underweight for their age. Findings to date indicate that a likely contributor to the large number of stranded, malnourished pups was a change in the availability of sea lion prey, especially sardines, a high value food source for both weaned pups and nursing mothers. Current data show changes in availability of sea lion prey in Southern California waters was likely a contributor to the UME, and this change was most likely secondary to ecological factors (El Niño and Warm Water Blob). Sardine spawning grounds shifted further offshore in 2012 and 2013, and while other prey were available (market squid and rockfish), these may not have provided adequate nutrition in the milk of sea lion mothers supporting pups or for newly-weaned pups foraging on their own. Although the pups showed signs of some viruses and infections, findings indicate that this event was not caused by disease, but rather by the lack of high quality, close-by food sources for nursing mothers and weaned pups. Current evidence does not support that this UME was caused by a single infectious agent, though a variety of disease-causing bacteria and viruses were found in samples from sea lion pups. This investigation will soon be closed. Please refer to *https://www.fisheries.noaa.gov/national/marine-life-distress/2013-2017-california-sea-lion-unusual-mortality-event-california* for more information on this UME.

Guadalupe Fur Seal UME

Increased strandings of Guadalupe fur seals began along the entire coast of California in January 2015 and were eight times higher than the historical average (approximately 10 seals/yr). Strandings have continued since 2015 and have remained well above average through 2017. As of March 8, 2018, the total number of Guadalupe fur seals to date in the UME is 241. Strandings are seasonal and generally peak in April through June of each year. The Guadalupe fur seal strandings have been mostly weaned pups and juveniles (1–2 years old) with both live and dead strandings occurring. Current findings from the majority of stranded animals include primary malnutrition with secondary bacterial and parasitic infections. This UME is occurring in the same area as the ongoing 2013–2017 California sea lion UME. This investigation is ongoing. Please refer to *https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2018-guadalupe-fur-seal-unusual-mortality-event-california* for more information on this UME.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.*, Richardson *et al.*, 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.*, low-frequency cetaceans). Subsequently, NMFS (2016) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

- Low-frequency cetaceans (mysticetes): Generalized hearing is estimated to occur between approximately 7 Hz and 35 kHz;
- Mid-frequency cetaceans (larger toothed whales, beaked whales, and most delphinids): Generalized hearing is estimated to occur between approximately 150 Hz and 160 kHz;
- High-frequency cetaceans (porpoises, river dolphins, and members of the genera Kogia and Cephalorhynchus; including two members of the genus Lagenorhynchus, on the basis of recent echolocation data and genetic data): Generalized hearing is estimated to occur between approximately 275 Hz and 160 kHz;
- Pinnipeds in water; Phocidae (true seals): Generalized hearing is estimated to occur between approximately 50 Hz to 86 kHz; and
- Pinnipeds in water; Otariidae (eared seals): Generalized hearing is estimated to occur between 60 Hz and 39 kHz.

The pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.*, 2006; Kastelein *et al.*, 2009; Reichmuth and Holt, 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2016) for a review of available information.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The "Estimated Take of Marine Mammals" section later in this document includes a quantitative analysis of the number of instances of take that could occur from these activities. The "Negligible Impact Analysis and Determination" section considers the content of this section, the "Estimated Take of Marine Mammals" section, and the "Proposed Mitigation" section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and how those impacts on individuals are likely to impact marine mammal species or stocks.

The Navy has requested authorization for the take of marine mammals that may occur incidental to training and testing activities in the HSTT Study Area. The Navy analyzed potential impacts to marine mammals from acoustic and explosive sources as well as vessel strikes.

Other potential impacts to marine mammals from training and testing activities in the HSTT Study Area were analyzed in the HSTT DEIS/OEIS, in consultation with NMFS as a cooperating agency, and determined to be unlikely to result in marine mammal take. Therefore, the Navy has not requested authorization for take of marine mammals incidental to other components of their Specified Activities, and we agree that take is

unlikely to occur from those components. In this proposed rule, NMFS analyzes the potential effects on marine mammals from the activity components that may cause the take of marine mammals: Exposure to acoustic or explosive stressors including non-impulsive (sonar and other active acoustic sources) and impulsive (explosives, impact pile driving, and air guns) stressors, and vessel strikes.

For the purpose of MMPA incidental take authorizations, NMFS's effects assessments serve four primary purposes: (1) To prescribe the permissible methods of taking (*i.e.*, Level B harassment (behavioral harassment and temporary threshold shift (TTS), Level A harassment (permanent threshold shift (PTS) or non-auditory injury), serious injury, or mortality, including an identification of the number and types of take that could occur by harassment, serious injury, or mortality) and to prescribe other means of effecting the least practicable adverse impact on such species or stock and its habitat (*i.e.*, mitigation); (2) to determine whether the specified activities would have a negligible impact on the affected species or stocks of marine mammals (based on the likelihood that the activities would adversely affect the species or stock through effects on annual rates of recruitment or survival); (3) to determine whether the specified activities would have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (however, there are no subsistence communities that would be affected in the HSTT Study Area, so this determination is inapplicable to the HSTT rulemaking); and (4) to prescribe requirements pertaining to monitoring and reporting.

In the Potential Effects Section, NMFS provides a general description of the ways marine mammals may be affected by these activities in the form of mortality, physical trauma, sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral disturbance, or habitat effects. Explosives and vessel strikes, which have the potential to result in incidental take from serious injury and/or mortality, will be discussed in more detail in the Estimated Take of Marine Mammals section. The Estimated Take of Marine Mammals section also discusses how the potential effects on marine mammals from non-impulsive and impulsive sources relate to the MMPA definitions of Level A and Level B Harassment, and quantifies those effects that rise to the level of a take along with the potential effects from vessel strikes. The Negligible Impact Analysis Section assesses whether the proposed authorized take will have a negligible impact on the affected species and stocks.

Potential Effects of Underwater Sound

Note that, in the following discussion, we refer in many cases to a review article concerning studies of noise-induced hearing loss conducted from 1996–2015 (*i.e.*, Finneran, 2015). For study-specific citations, please see that work. Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can possibly result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Richardson *et al.*, 1995; Gordon *et al.*, 2004; Nowacek *et al.*, 2007; Southall *et al.*, 2007; Götz *et al.*, 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. We first describe specific manifestations of acoustic effects before providing discussion specific to the Navy's activities.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal, but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.*, when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We also describe more severe effects (*i.e.*, certain non-auditory physical or physiological effects). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.*, 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.*, change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.*, 2006; Southall *et al.*, 2007; Zimmer and Tyack, 2007; Tal *et al.*, 2015).

Acoustic Sources

Direct Physiological Effects

Based on the literature, there are two basic ways that non-impulsive sources might directly result in direct physiological effects. Noise-induced loss of hearing sensitivity (more commonly-called "threshold shift" (TS)) is the better-understood of these two effects, and the only one that is actually expected to occur. The second effect, acoustically mediated bubble growth and other pressure-related physiological impacts are addressed briefly below, but are not expected to result from the Navy's activities. Separately, an animal's behavioral reaction to an acoustic exposure might lead to physiological effects that might ultimately lead to injury or death, which is discussed later in the Stranding Section.

Threshold Shift (Noise-Induced Loss of Hearing)

When animals exhibit reduced hearing sensitivity within their auditory range (*i.e.*, sounds must be louder for an animal to detect them) following exposure to a sufficiently intense sound or a less intense sound for a sufficient duration, it is referred to as a noise-induced TS. An animal can experience a TTS and/or PTS. TTS can last from minutes or hours to days (*i.e.*, there is recovery back to baseline/pre-exposure levels), can occur within a specific frequency range (*i.e.*, an animal might only have a temporary loss of hearing sensitivity within a limited frequency band of its auditory range), and can be

of varying amounts (for example, an animal's hearing sensitivity might be reduced by only 6 dB or reduced by 30 dB). Repeated sound exposure that leads to TTS could cause PTS. In severe cases of PTS, there can be total or partial deafness, while in most cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985). When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.*, tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.*, 2007). PTS is permanent (*i.e.*, there is incomplete recovery back to baseline/pre-exposure levels), but also can occur in a specific frequency range and amount as mentioned above for TTS. In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.*, Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

The following physiological mechanisms are thought to play a role in inducing auditory TS: Effects to sensory hair cells in the inner ear that reduce their sensitivity; modification of the chemical environment within the sensory cells; residual muscular activity in the middle ear; displacement of certain inner ear membranes; increased blood flow; and post-stimulatory reduction in both efferent and sensory neural output (Southall *et al.*, 2007). The amplitude, duration, frequency, temporal pattern, and energy distribution of sound exposure all can affect the amount of associated TS and the frequency range in which it occurs. Generally, the amount of TS, and the time needed to recover from the effect, increase as amplitude and duration of sound exposure increases. Human non-impulsive noise exposure guidelines are based on the assumption that exposures of equal energy (the same SEL) produce equal amounts of hearing impairment regardless of how the sound energy is distributed in time (NIOSH, 1998). Previous marine mammal TTS studies have also generally supported this equal energy relationship (Southall *et al.*, 2007). However, some more recent studies concluded that for all noise exposure situations the equal energy relationship may not be the best indicator to predict TTS onset levels (Mooney *et al.*, 2009a and 2009b; Kastak *et al.*, 2007). These studies highlight the inherent complexity of predicting TTS onset in marine mammals, as well as the importance of considering exposure duration when assessing potential impacts. Generally, with sound exposures of equal energy, those that were quieter (lower SPL) with longer duration were found to induce TTS onset at lower levels than those of louder (higher SPL) and shorter duration. Less TS will occur from intermittent sounds than from a continuous exposure with the same energy (some recovery can occur between intermittent exposures) (Kryter *et al.*, 1966; Ward, 1997; Mooney *et al.*, 2009a, 2009b; Finneran *et al.*, 2010). For example, one short but loud (higher SPL) sound exposure may induce the same impairment as one longer but softer (lower SPL) sound, which in turn may cause more impairment than a series of several intermittent softer sounds with the same total energy (Ward, 1997). Additionally, though TTS is temporary, very prolonged or repeated exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold can cause PTS, at least in terrestrial mammals (Kryter, 1985; Lonsbury-Martin *et al.*, 1987).

PTS is considered auditory injury (Southall *et al.*, 2007). Irreparable damage to the inner or outer cochlear hair cells may cause PTS; however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.*, 2007).

Although the published body of scientific literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a loud sound, only a few studies provide empirical information on the levels at which noise-induced loss in hearing sensitivity occurs in nonhuman animals. The NMFS 2016 Acoustic Technical Guidance, which was used in the assessment of effects for this action, compiled, interpreted, and synthesized the best available scientific information for noise-induced hearing effects for marine mammals to derive updated thresholds for assessing the impacts of noise on marine mammal hearing, as noted above. For cetaceans, published data on the onset of TTS are limited to the captive bottlenose dolphin, beluga, harbor porpoise, and Yangtze finless porpoise (summarized in Finneran, 2015). TTS studies involving exposure to other Navy activities (*e.g.*, SURTASS LFA) or other low-frequency sonar (below 1 kHz) have never been conducted due to logistical difficulties of conducting experiments with low frequency sound sources. However, there are TTS measurements for exposures to other LF sources, such as seismic air guns. Finneran *et al.* (2015) suggest that the potential for air guns to cause hearing loss in dolphins is lower than previously predicted, perhaps as a result of the low-frequency content of air gun impulses compared to the high-frequency hearing ability of dolphins. Finneran *et al.* (2015) measured hearing thresholds in three captive bottlenose dolphins before and after exposure to ten pulses produced by a seismic air gun in order to study TTS induced after exposure to multiple pulses. Exposures began at relatively low levels and gradually increased over a period of several months, with the highest exposures at peak SPLs from 196 to 210 dB and cumulative (unweighted) SELs from 193–195 dB. No substantial TTS was observed. In addition, behavioral reactions were observed that indicated that animals can learn behaviors that effectively mitigate noise exposures (although exposure patterns must be learned, which is less likely in wild animals than for the captive animals considered in the study). The authors note that the failure to induce more significant auditory effects was likely due to the intermittent nature of exposure, the relatively low peak pressure produced by the acoustic source, and the low-frequency energy in air gun pulses as compared with the frequency range of best sensitivity for dolphins and other mid-frequency cetaceans. For pinnipeds in water, measurements of TTS are limited to harbor seals, elephant seals, and California sea lions (summarized in Finneran, 2015).

Marine mammal hearing plays a critical role in communication with conspecifics and in interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.*, recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious similar to those discussed in auditory masking, below. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that takes place during a time when the animal is traveling through the open ocean, where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during a time when communication is critical for successful mother/calf interactions could have more serious impacts if it

were in the same frequency band as the necessary vocalizations and of a severity that impeded communication. The fact that animals exposed to high levels of sound that would be expected to result in this physiological response would also be expected to have behavioral responses of a comparatively more severe or sustained nature is potentially more significant than simple existence of a TTS. However, it is important to note that TTS could occur due to longer exposures to sound at lower levels so that a behavioral response may not be elicited.

Depending on the degree and frequency range, the effects of PTS on an animal could also range in severity, although it is considered generally more serious than TTS because it is a permanent condition. Of note, reduced hearing sensitivity as a simple function of aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.*, 2007), so we can infer that strategies exist for coping with this condition to some degree, though likely not without some cost to the animal.

Acoustically Mediated Bubble Growth and Other Pressure-Related Injury

One theoretical cause of injury to marine mammals is rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process could be facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). The deeper and longer dives of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser *et al.*, 2001b). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration (in combination with the source levels) of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: Stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size. Recent research with *ex vivo* supersaturated bovine tissues suggested that, for a 37 kHz signal, a sound exposure of approximately 215 dB referenced to (re) 1 µPa would be required before microbubbles became destabilized and grew (Crum *et al.*, 2005). Assuming spherical spreading loss and a nominal sonar source level of 235 dB re 1 µPa at 1 m, a whale would need to be within 10 m (33 ft) of the sonar dome to be exposed to such sound levels. Furthermore, tissues in the study were supersaturated by exposing them to pressures of 400–700 kilopascals for periods of hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as 400–700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser *et al.*, 2001; Saunders *et al.*, 2008). It is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings because both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert.

Yet another hypothesis (decompression sickness) has speculated that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson *et al.*, 2003; Fernandez *et al.*, 2005; Fernández *et al.*, 2012). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Alternatively, Tyack *et al.* (2006) studied the deep diving behavior of beaked whales and concluded that: "Using current models of breath-hold diving, we infer that their natural diving behavior is inconsistent with known problems of acute nitrogen supersaturation and embolism." Collectively, these hypotheses can be referred to as "hypotheses of acoustically mediated bubble growth."

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004; Evans and Miller, 2003; Cox *et al.*, 2006; Rommel *et al.*, 2006). Crum and Mao (1996) hypothesized that received levels would have to exceed 190 dB in order for there to be the possibility of significant bubble growth due to supersaturation of gases in the blood (*i.e.*, rectified diffusion). Work conducted by Crum *et al.* (2005) demonstrated the possibility of rectified diffusion for short duration signals, but at SELs and tissue saturation levels that are highly improbable to occur in diving marine mammals. To date, energy levels (ELs) predicted to cause in vivo bubble formation within diving cetaceans have not been evaluated (NOAA, 2002b). Jepson *et al.* (2003, 2005) and Fernandez *et al.* (2004, 2005, 2012) concluded that in vivo bubble formation, which may be exacerbated by deep, long-duration, repetitive dives may explain why beaked whales appear to be relatively vulnerable to MF/HF sonar exposures. It has also been argued that traumas from some beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson *et al.*, 2003); however, there is no conclusive evidence of this (Rommel *et al.*, 2006).

In 2009, Hooker *et al.* tested two mathematical models to predict blood and tissue tension N2 (P_{N2}) using field data from three beaked whale species: northern bottlenose whales, Cuvier's beaked whales, and Blainville's beaked whales. The researchers aimed to determine if physiology (body mass, diving lung volume, and dive response) or dive behavior (dive depth and duration, changes in ascent rate, and diel behavior) would lead to differences in P_{N2} levels and thereby decompression sickness risk between species.

In their study, they compared results for previously published time depth recorder data (Hooker and Baird, 1999; Baird *et al.*, 2006, 2008) from Cuvier's beaked whale, Blainville's beaked whale, and northern bottlenose whale. They reported that diving lung volume and extent of the dive response had a large effect on end-dive P_{N2}. Also, results showed that dive profiles had a larger influence on end-dive P_{N2} than body mass differences between species. Despite diel changes (*i.e.*, variation that occurs regularly every day or most days) in dive behavior, P_{N2} levels showed no consistent trend. Model output suggested that all three species live with tissue P_{N2} levels that would cause a significant proportion of decompression sickness cases in terrestrial mammals. The authors concluded that the dive behavior of Cuvier's beaked whale was different from both Blainville's beaked whale, and northern bottlenose whale,

and resulted in higher predicted tissue and blood N2 levels (Hooker *et al.*, 2009) and suggested that the prevalence of Cuvier's beaked whales stranding after naval sonar exercises could be explained by either a higher abundance of this species in the affected areas or by possible species differences in behavior and/or physiology related to MF active sonar (Hooker *et al.*, 2009).

Bernaldo de Quiros *et al.* (2012) showed that, among stranded whales, deep diving species of whales had higher abundances of gas bubbles compared to shallow diving species. Kvadsheim *et al.* (2012) estimated blood and tissue P_{N2} levels in species representing shallow, intermediate, and deep diving cetaceans following behavioral responses to sonar and their comparisons found that deep diving species had higher end-dive blood and tissue N_2 levels, indicating a higher risk of developing gas bubble emboli compared with shallow diving species. Fahlmann *et al.* (2014) evaluated dive data recorded from sperm, killer, long-finned pilot, Blainville's beaked and Cuvier's beaked whales before and during exposure to low, as defined by the authors, (1–2 kHz) and mid (2–7 kHz) frequency active sonar in an attempt to determine if either differences in dive behavior or physiological responses to sonar are plausible risk factors for bubble formation. The authors suggested that CO_2 may initiate bubble formation and growth, while elevated levels of N_2 may be important for continued bubble growth. The authors also suggest that if CO_2 plays an important role in bubble formation, a cetacean escaping a sound source may experience increased metabolic rate, CO_2 production, and alteration in cardiac output, which could increase risk of gas bubble emboli. However, as discussed in Kvadsheim *et al.* (2012), the actual observed behavioral responses to sonar from the species in their study (sperm, killer, long-finned pilot, Blainville's beaked, and Cuvier's beaked whales) did not imply any significantly increased risk of decompression sickness due to high levels of N_2. Therefore, further information is needed to understand the relationship between exposure to stimuli, behavioral response (discussed in more detail below), elevated N_2 levels, and gas bubble emboli in marine mammals. The hypotheses for gas bubble formation related to beaked whale strandings is that beaked whales potentially have strong avoidance responses to MF active sonars because they sound similar to their main predator, the killer whale (Cox *et al.*, 2006; Southall *et al.*, 2007; Zimmer and Tyack, 2007; Baird *et al.*, 2008; Hooker *et al.*, 2009). Further investigation is needed to assess the potential validity of these hypotheses.

To summarize, while there are several hypotheses, there is little data to support the potential for strong, anthropogenic underwater sounds to cause non-auditory physical effects in marine mammals. The available data do not support identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.*, 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in these ways. In addition, such effects, if they occur at all, would be expected to be limited to situations where marine mammals were exposed to high powered sounds at very close range over a prolonged period of time, which is not expected to occur based on the speed of the vessels operating sonar in combination with the speed and behavior of marine mammals in the vicinity of sonar.

Acoustic Masking

Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.*, those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.*, 1995; Erbe and Farmer, 2000; Tyack, 2000; Erbe *et al.*, 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.*, snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.*, shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.*, signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.*, sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

In humans, significant masking of tonal signals occurs as a result of exposure to noise in a narrow band of similar frequencies. As the sound level increases, though, the detection of frequencies above those of the masking stimulus decreases also. This principle is expected to apply to marine mammals as well because of common biomechanical cochlear properties across taxa.

Under certain circumstances, marine mammals experiencing significant masking could also be impaired from maximizing their performance fitness in survival and reproduction. Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting or altering critical behaviors. It is important to distinguish TTS and PTS, which persist after the sound exposure from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in determining any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.*, Clark *et al.*, 2009; Matthews *et al.*, 2016) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.*, Miller *et al.*, 2000; Foote *et al.*, 2004; Parks *et al.*, 2007; Di Iorio and Clark, 2009; Holt *et al.*, 2009). Masking can be reduced in situations where the signal and noise come from different directions (Richardson *et al.*, 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.*, Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.*, Branstetter *et al.*, 2013).

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean

from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.*, from commercial vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Richardson *et al.* (1995b) argued that the maximum radius of influence of an industrial noise (including broadband low-frequency sound transmission) on a marine mammal is the distance from the source to the point at which the noise can barely be heard. This range is determined by either the hearing sensitivity of the animal or the background noise level present. Industrial masking is most likely to affect some species' ability to detect communication calls and natural sounds (*i.e.*, surf noise, prey noise, etc.; Richardson *et al.*, 1995).

The echolocation calls of toothed whales are subject to masking by high-frequency sound. Human data indicate low-frequency sound can mask high-frequency sounds (*i.e.*, upward masking). Studies on captive odontocetes by Au *et al.* (1974, 1985, 1993) indicate that some species may use various processes to reduce masking effects (*e.g.*, adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high-frequencies these cetaceans use to echolocate, but not at the low-to-moderate frequencies they use to communicate (Zaitseva *et al.*, 1980). A study by Nachtigall and Supin (2008) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals. Holt *et al.* (2009) measured killer whale call source levels and background noise levels in the one to 40 kHz band and reported that the whales increased their call source levels by one dB SPL for every one dB SPL increase in background noise level. Similarly, another study on St. Lawrence River belugas reported a similar rate of increase in vocalization activity in response to passing vessels (Scheifele *et al.*, 2005).

Parks *et al.* (2007) provided evidence of behavioral changes in the acoustic behaviors of the endangered North Atlantic right whale, and the South Atlantic southern right whale, and suggested that these were correlated to increased underwater noise levels. The study indicated that right whales might shift the frequency band of their calls to compensate for increased in-band background noise. The significance of their result is the indication of potential species-wide behavioral change in response to gradual, chronic increases in underwater ambient noise. Di Iorio and Clark (2010) showed that blue whale calling rates vary in association with seismic sparker survey activity, with whales calling more on days with survey than on days without surveys. They suggested that the whales called more during seismic survey periods as a way to compensate for the elevated noise conditions.

Risch *et al.* (2012) documented reductions in humpback whale vocalizations in the Stellwagen Bank National Marine Sanctuary concurrent with transmissions of the Ocean Acoustic Waveguide Remote Sensing (OAWRS) low-frequency fish sensor system at distances of 200 km (124 mi) from the source. The recorded OAWRS produced a series of frequency modulated pulses and the signal received levels ranged from 88 to 110 dB re: 1 µPa (Risch, *et al.*, 2012). The authors hypothesized that individuals did not leave the area but instead ceased singing and noted that the duration and frequency range of the OAWRS signals (a novel sound to the whales) were similar to those of natural humpback whale song components used during mating (Risch *et al.*, 2012). Thus, the novelty of the sound to humpback whales in the Navy's Study Area (Navy's Atlantic Fleet Study Area) provided a compelling contextual probability for the observed effects (Risch *et al.*, 2012). However, the authors did not state or imply that these changes had long-term effects on individual animals or populations (Risch *et al.*, 2012).

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-noise ratio.

The functional hearing ranges of mysticetes, odontocetes, and pinnipeds underwater all overlap the frequencies of the sonar sources used in the Navy's low-frequency active sonar (LFAS)/mid-frequency active sonar (MFAS)/high-frequency active sonar (HFAS) training and testing exercises. Additionally, almost all species' vocal repertoires span across the frequencies of these sonar sources used by the Navy. The closer the characteristics of the masking signal to the signal of interest, the more likely masking is to occur. Although hull-mounted sonar accounts for a large portion of the area ensonified by Navy activities (because of the source strength and number of hours it is conducted), the pulse length and low duty cycle of the MFAS/HFAS signal makes it less likely that masking would occur as a result.

Impaired Communication

In addition to making it more difficult for animals to perceive acoustic cues in their environment, anthropogenic sound presents separate challenges for animals that are vocalizing. When they vocalize, animals are aware of environmental conditions that affect the "active space" of their vocalizations, which is the maximum area within which their vocalizations can be detected before it drops to the level of ambient noise (Brenowitz, 2004; Brumm *et al.*, 2004; Lohr *et al.*, 2003). Animals are also aware of environmental conditions that affect whether listeners can discriminate and recognize their vocalizations from other sounds, which is more important than simply detecting that a vocalization is occurring (Brenowitz, 1982; Brumm *et al.*, 2004; Dooling, 2004, Marten and Marler, 1977; Patricelli *et al.*, 2006). Most species that vocalize have evolved with an ability to make adjustments to their vocalizations to increase the signal-to-noise ratio, active space, and recognizability/distinguishability of their vocalizations in the face of temporary changes in background noise (Brumm *et al.*, 2004; Patricelli *et al.*, 2006). Vocalizing animals can make adjustments to vocalization characteristics such as the frequency structure, amplitude, temporal structure, and temporal delivery.

Many animals will combine several of these strategies to compensate for high levels of background noise. Anthropogenic sounds that reduce the signal-to-noise ratio of animal vocalizations, increase the masked auditory thresholds of animals listening for such vocalizations, or reduce the active space of an animal's vocalizations impair communication between animals. Most animals that vocalize have evolved strategies to compensate for the effects of short-term or temporary increases in background or ambient noise on their songs or calls. Although the fitness consequences of these vocal adjustments are not directly known in all instances, like most other trade-offs animals must make, some of these

strategies probably come at a cost (Patricelli *et al.*, 2006). Shifting songs and calls to higher frequencies may also impose energetic costs (Lambrechts, 1996). For example in birds, vocalizing more loudly in noisy environments may have energetic costs that decrease the net benefits of vocal adjustment and alter a bird's energy budget (Brumm, 2004; Wood and Yezerinac, 2006).

Stress Response

Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Sapolsky *et al.*, 2005; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses.

According to Moberg (2000), in the case of many stressors, an animal's first and sometimes most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical "fight or flight" response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with "stress." These responses have a relatively short duration and may or may not have significant long-term effect on an animal's welfare.

An animal's third line of defense to stressors involves its neuroendocrine systems or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987; Rivier and Rivest, 1991), altered metabolism (Elasser *et al.*, 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance (Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano *et al.*, 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic function, which impairs those functions that experience the diversion. For example, when a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When a stress response diverts energy from a fetus, an animal's reproductive success and its fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called "distress" (Seyle, 1950) or "allostatic loading" (McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiments in terrestrial vertebrates; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.*, 1996; Hood *et al.*, 1998; Jessop *et al.*, 2003; Krausman *et al.*, 2004; Lankford *et al.*, 2005; Reneerkens *et al.*, 2002; Thompson and Hamer, 2000).

Information has also been collected on the physiological responses of marine mammals to exposure to anthropogenic sounds (Fair and Becker, 2000; Romano *et al.*, 2002; Wright *et al.*, 2008). Various efforts have been undertaken to investigate the impact from vessels (both whale-watching and general vessel traffic noise), and demonstrated impacts do occur (Bain, 2002; Erbe, 2002; Noren *et al.*, 2009; Williams *et al.*, 2006, 2009, 2014a, 2014b; Read *et al.*, 2014; Rolland *et al.*, 2012; Pirotta *et al.*, 2015). This body of research for the most part has investigated impacts associated with the presence of chronic stressors, which differ significantly from the proposed Navy training and testing activities in the HSTT Study Area. For example, in an analysis of energy costs to killer whales, Williams *et al.* (2009) suggested that whale-watching in Canada's Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance, which could carry higher costs than other measures of behavioral change might suggest. Ayres *et al.* (2012) recently reported on research in the Salish Sea (Washington state) involving the measurement of southern resident killer whale fecal hormones to assess two potential threats to the species recovery: Lack of prey (salmon) and impacts to behavior from vessel traffic. Ayres *et al.* (2012) suggested that the lack of prey overshadowed any population-level physiological impacts on southern resident killer whales from vessel traffic. Rolland *et al.* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. In a conceptual model developed by the Population Consequences of Acoustic Disturbance (PCAD) working group, serum hormones were identified as possible indicators of behavioral effects that are translated into altered rates of reproduction and mortality (NRC, 2005). The Office of Naval Research hosted a workshop (Effects of Stress on Marine Mammals Exposed to Sound) in 2009 that focused on this very topic (ONR, 2009). Ultimately, the PCAD working group issued a report (Cochrem, 2014) that summarized information compiled from 239 papers or book chapters relating to stress in marine mammals and concluded that stress responses can last from minutes to hours and, while we typically focus on adverse stress responses, stress response is part of a natural process to help animals adjust to changes in their environment and can also be either neutral or beneficial.

Despite the lack of robust information on stress responses for marine mammals exposed to anthropogenic sounds, studies of other marine animals and terrestrial animals would also lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as

"distress" upon exposure to high frequency, mid-frequency, and low-frequency sounds. For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (*e.g.*, elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiological stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (*i.e.*, goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Behavioral Response/Disturbance

Behavioral responses to sound are highly variable and context-specific. Many different variables can influence an animal's perception of and response to (nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately pre-disposed to respond to certain sounds in certain ways) (Southall *et al.*, 2007). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.*, calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al.*, 2007, DeRuiter *et al.*, 2013). Individuals (of different age, gender, reproductive status, etc.) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.*, proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone. For example, Goldbogen *et al.* (2013) demonstrated that individual behavioral state was critically important in determining response of blue whales to sonar, noting that some individuals engaged in deep (>50 m) feeding behavior had greater dive responses than those in shallow feeding or non-feeding conditions. Some blue whales in the Goldbogen *et al.* (2013) study that were engaged in shallow feeding behavior demonstrated no clear changes in diving or movement even when RLs were high (~160 dB re 1µPa) for exposures to 3–4 kHz sonar signals, while others showed a clear response at exposures at lower RLs of sonar and pseudorandom noise.

Studies by DeRuiter *et al.* (2012) indicate that variability of responses to acoustic stimuli depends not only on the species receiving the sound and the sound source, but also on the social, behavioral, or environmental contexts of exposure. Another study by DeRuiter *et al.* (2013) examined behavioral responses of Cuvier's beaked whales to MF sonar and found that whales responded strongly at low received levels (RL of 89–127 dB re 1µPa) by ceasing normal fluking and echolocation, swimming rapidly away, and extending both dive duration and subsequent non-foraging intervals when the sound source was 3.4–9.5 km away. Importantly, this study also showed that whales exposed to a similar range of RLs (78–106 dB re 1µPa) from distant sonar exercises (118 km away) did not elicit such responses, suggesting that context may moderate reactions.

Ellison *et al.* (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. The authors recommend considering not just the received level of sound, but also the activity the animal is engaged in at the time the sound is received, the nature and novelty of the sound (*i.e.*, is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this "exposure context," as described, greatly influences the type of behavioral response exhibited by the animal. This sort of contextual information is challenging to predict with accuracy for ongoing activities that occur over large spatial and temporal expanses. However, distance is one contextual factor for which data exist to quantitatively inform a take estimate, and the new method for predicting Level B harassment proposed in this notice does consider distance to the source. Other factors are often considered qualitatively in the analysis of the likely consequences of sound exposure, where supporting information is available.

Friedlaender *et al.* (2016) provided the first integration of direct measures of prey distribution and density variables incorporated into across-individual analyses of behavior responses of blue whales to sonar, and demonstrated a five-fold increase in the ability to quantify variability in blue whale diving behavior. These results illustrate that responses evaluated without such measurements for foraging animals may be misleading, which again illustrates the context-dependent nature of the probability of response.

Exposure of marine mammals to sound sources can result in, but is not limited to, no response or any of the following observable response: Increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al.*, 2007). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson (1995). More recent reviews (Nowacek *et al.*, 2007; DeRuiter *et al.*, 2012 and 2013; Ellison *et al.*, 2012) address studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. Southall *et al.* (2016) states that results demonstrate that some individuals of different species display clear yet varied responses, some of which have negative implications, while others appear to tolerate high levels, and that responses may not be fully predicable with simple acoustic exposure metrics (*e.g.*, received sound level). Rather, the authors state that differences among species and individuals along with contextual aspects of exposure (*e.g.*, behavioral state) appear to affect response probability. The following sub-sections provide examples of behavioral responses that provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Predictions about of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists, along with contextual factors.

Flight Response

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (Evans and England, 2001). If marine mammals respond to Navy vessels that are transmitting active sonar in the same way that they might respond to a predator, their probability of flight responses should increase when they perceive that Navy vessels are approaching them directly, because a direct approach may convey detection and intent to capture (Burger and Gochfeld, 1981, 1990; Cooper, 1997, 1998). There are limited data on flight response for marine mammals; however, there are examples of this response in terrestrial species. For instance, the probability of flight responses in Dall's sheep *Ovis dalli dalli* (Frid, 2001), hauled-out ringed seals *Phoca hispida* (Born *et al.*, 1999), Pacific brant (*Branta bernicl nigricans*), and Canada geese (*B. canadensis*) increased as a helicopter or fixed-wing aircraft more directly approached groups of these animals (Ward *et al.*, 1999). Bald eagles (*Haliaeetus leucocephalus*) perched on trees alongside a river were also more likely to flee from a paddle raft when their perches were closer to the river or were closer to the ground (Steidl and Anthony, 1996).

Response to Predator

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke *et al.*, 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

Alteration of Diving or Movement

Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.*, foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (*e.g.*, increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek *et al.* (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung, 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach, and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung, 2003). Low frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000) or to overtly affect elephant seal dives (Costa *et al.*, 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them. Lastly, as noted previously, DeRuiter *et al.* (2013) noted that distance from a sound source may moderate marine mammal reactions in their study of Cuvier's beaked whales showing the whales swimming rapidly and silently away when a sonar signal was 3.4–9.5 km away while showing no such reaction to the same signal when the signal was 118 km away even though the RLs were similar.

Foraging

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.*, bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western grey whales off the coast of Russia (Yazvenko *et al.*, 2007). Visual tracking, passive acoustic monitoring, and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to air gun arrays at received levels in the range 140–160 dB at distances of 7–13 km, following a phase-in of sound intensity and full array exposures at 1–13 km (Madsen *et al.*, 2006a; Miller *et al.*, 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal (buzz) rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the air guns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were six percent lower during exposure than control periods (Miller *et al.*, 2009). These data raise concerns that air gun surveys may impact foraging behavior in sperm whales, although more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior (Miller *et al.*, 2009). Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity (Croll *et al.*, 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek *et al.*, 2004). Although the received SPLs were similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. Blue whales exposed to mid-frequency sonar in the Southern California Bight were

less likely to produce low frequency calls usually associated with feeding behavior (Melcón *et al.*, 2012). However, Melcón *et al.* (2012) were unable to determine if suppression of low frequency calls reflected a change in their feeding performance or abandonment of foraging behavior and indicated that implications of the documented responses are unknown. Further, it is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, passive acoustic monitoring buoys. In contrast, blue whales increased their likelihood of calling when ship noise was present, and decreased their likelihood of calling in the presence of explosive noise, although this result was not statistically significant (Melcón *et al.*, 2012). Additionally, the likelihood of an animal calling decreased with the increased received level of mid-frequency sonar, beginning at a SPL of approximately 110–120 dB re 1 µPa (Melcón *et al.*, 2012). Results from the 2010–2011 field season of an ongoing behavioral response study in Southern California waters indicated that, in some cases and at low received levels, tagged blue whales responded to mid-frequency sonar but that those responses were mild and there was a quick return to their baseline activity (Southall *et al.*, 2011; Southall *et al.*, 2012b). Information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal will help better inform a determination of whether foraging disruptions incur fitness consequences. Goldbogen *et al.* (2013) monitored behavioral responses of tagged blue whales located in feeding areas when exposed to simulated MFA sonar. Responses varied depending on behavioral context, with some deep feeding whales being more significantly affected (*i.e.*, generalized avoidance; cessation of feeding; increased swimming speeds; or directed travel away from the source) compared to surface feeding individuals that typically showed no change in behavior. The authors indicate that disruption of feeding and displacement could impact individual fitness and health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this is the case, particularly since unconsumed prey would likely still be available in the environment in most cases following the cessation of acoustic exposure.

Breathing

Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey *et al.*, 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein *et al.*, 2001; Kastelein *et al.*, 2006a) and emissions for underwater data transmission (Kastelein *et al.*, 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein *et al.*, 2006a), again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Social Relationships

Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships therefore depends on the disruption of other behaviors (*e.g.*, caused avoidance, masking, etc.). Sperm whales responded to military sonar, apparently from a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent, and becoming difficult to approach (Watkins *et al.*, 1985). In contrast, sperm whales in the Mediterranean that were exposed to submarine sonar continued calling (J. Gordon pers. comm. cited in Richardson *et al.*, 1995). Long-finned pilot whales exposed to three types of disturbance—playbacks of killer whale sounds, naval sonar exposure, and tagging all resulted in increased group sizes (Visser *et al.*, 2016). In response to sonar, pilot whales also spent more time at the surface with other members of the group (Visser *et al.*, 2016). However, social disruptions must be considered in context of the relationships that are affected. While some disruptions may not have deleterious effects, others, such as long-term or repeated disruptions of mother/calf pairs or interruption of mating behaviors, have the potential to affect the growth and survival or reproductive effort/success of individuals.

Vocalizations (Also See Masking Section)

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active sonar, humpback whales have been observed to increase the length of their "songs" (Miller *et al.*, 2000; Fristrup *et al.*, 2003), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. A similar compensatory effect for the presence of low-frequency vessel noise has been suggested for right whales; right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al.*, 2007; Roland *et al.*, 2012). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (*e.g.*, whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote *et al.*, 2004; NOAA, 2014b). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles *et al.*, 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Cerchio *et al.* (2014) used passive acoustic monitoring to document the presence of singing humpback whales off the coast of northern Angola and to opportunistically test for the effect of seismic survey activity on the number of singing whales. Two recording units were deployed between March and December 2008 in the offshore environment; numbers of singers were counted every hour. Generalized Additive Mixed Models were used to assess the effect of survey day (seasonality), hour (diel variation), moon phase, and received levels of

noise (measured from a single pulse during each ten-minute sampled period) on singer number. The number of singers significantly decreased with increasing received level of noise, suggesting that humpback whale communication was disrupted to some extent by the survey activity.

Castellote *et al.* (2012) reported acoustic and behavioral changes by fin whales in response to shipping and air gun noise. Acoustic features of fin whale song notes recorded in the Mediterranean Sea and northeast Atlantic Ocean were compared for areas with different shipping noise levels and traffic intensities and during an air gun survey. During the first 72 hrs of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the acoustic source and out of a Navy Study Area. This displacement persisted for a time period well beyond the 10-day duration of air gun activity, providing evidence that fin whales may avoid an area for an extended period in the presence of increased noise. The authors hypothesize tha fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement.

Seismic pulses at average received levels of 131 dB re 1 micropascal squared per second (μPa2-s) caused blue whales to increase call production (Di Iorio and Clark, 2010). In contrast, McDonald *et al.* (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the seismic vessel (estimated received level 143 dB re 1 μPa peak-to-peak). Blackwell *et al.* (2013) found that bowhead whale call rates dropped significantly at onset of air gun use at sites with a median distance of 41–45 km from the survey. Blackwell *et al.* (2015) expanded this analysis to show that whales actually increased calling rates as soon as air gun signals were detectable before ultimately decreasing calling rates at higher received levels (*i.e.*, 10-minute cSEL of ~127 dB). Overall, these results suggest that bowhead whales may adjust their vocal output in an effort to compensate for noise before ceasing vocalization effort and ultimately deflecting from the acoustic source (Blackwell *et al.*, 2013, 2015). Captive bottlenose dolphins sometimes vocalized after an exposure to impulse sound from a seismic water gun (Finneran *et al.*, 2010a). These studies demonstrate that even low levels of noise received far from the noise source can induce behavioral responses.

Avoidance

Avoidance is the displacement of an individual from an area as a result of the presence of a sound. Richardson *et al.* (1995) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals. Avoidance is qualitatively different from the flight response, but also differs in the magnitude of the response (*i.e.*, directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. However, longer term displacement is possible and can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Blackwell *et al.*, 2004; Bejder *et al.*, 2006; Teilmann *et al.*, 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein *et al.*, 2001; Finneran *et al.*, 2003; Kastelein *et al.*, 2006a; Kastelein *et al.*, 2006b). Short-term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents have also been noted in wild populations of odontocetes (Bowles *et al.*, 1994; Goold, 1996; 1998; Stone *et al.*, 2000; Morton and Symonds, 2002) and to some extent in mysticetes (Gailey *et al.*, 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell *et al.*, 2007; Miksis-Olds *et al.*, 2007). Gray whales have been reported deflecting from customary migratory paths in order to avoid noise from air gun surveys (Malme *et al.*, 1984). Humpback whales showed avoidance behavior in the presence of an active air gun array during observational studies and controlled exposure experiments in western Australia (McCauley *et al.*, 2000a).

In 1998, the Navy conducted a Low Frequency Sonar Scientific Research Program (LFS SRP) specifically to study behavioral responses of several species of marine mammals to exposure to LF sound, including one phase that focused on the behavior of gray whales to low frequency sound signals. The objective of this phase of the LFS SRP was to determine whether migrating gray whales respond more strongly to received levels, sound gradient, or distance from the source, and to compare whale avoidance responses to an LF source in the center of the migration corridor versus in the offshore portion of the migration corridor. A single source was used to broadcast LFA sonar sounds at received levels of 170–178 dB re 1μPa. The Navy reported that the whales showed some avoidance responses when the source was moored one mile (1.8 km) offshore, and located within in the migration path, but the whales returned to their migration path when they were a few kilometers beyond the source. When the source was moored two miles (3.7 km) offshore, responses were much less even when the source level was increased to achieve the same RLs in the middle of the migration corridor as whales received when the source was located within the migration corridor (Clark *et al.*, 1999). In addition, the researchers noted that the offshore whales did not seem to avoid the louder offshore source.

Also during the LFS SRP, researchers sighted numerous odontocete and pinniped species in the vicinity of the sound exposure tests with LFA sonar. The MF and HF hearing specialists present in California and Hawaii showed no immediately obvious responses or changes in sighting rates as a function of source conditions. Consequently, the researchers concluded that none of these species had any obvious behavioral reaction to LFA sonar signals at received levels similar to those that produced only minor short-term behavioral responses in the baleen whales (*i.e.*, LF hearing specialists). Thus, for odontocetes, the chances of injury and/or significant behavioral responses to LFA sonar would be low given the MF/HF specialists' observed lack of response to LFA sounds during the LFS SRP and due to the MF/HF frequencies to which these animals are adapted to hear (Clark and Southall, 2009).

Maybaum (1993) conducted sound playback experiments to assess the effects of MFAS on humpback whales in Hawaiian waters. Specifically, she exposed focal pods to sounds of a 3.3-kHz sonar pulse, a sonar frequency sweep from 3.1 to 3.6 kHz, and a control (blank) tape while monitoring behavior, movement, and underwater vocalizations. The two types of sonar signals differed in their effects on the humpback whales, but both resulted in avoidance behavior. The whales responded to the pulse by increasing their distance from the sound source and responded to the frequency sweep by increasing their swimming speeds and track linearity. In the Caribbean, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range of 1000 Hz to 10,000 Hz (IWC, 2005).

Kvadsheim *et al.* (2007) conducted a controlled exposure experiment in which killer whales fitted with D-tags were exposed to mid-frequency active sonar (Source A: A 1.0 second upsweep 209 dB @1–2 kHz every 10 seconds for 10 minutes; Source B: With a 1.0 second upsweep 197 dB @6–7 kHz every 10 seconds for 10 minutes). When exposed to Source A, a tagged whale and the group it was traveling with did not appear to avoid the source. When exposed to Source B, the tagged whales along with other whales that had been carousel feeding, where killer whales cooperatively herd fish schools into a tight ball towards the surface and feed on the fish which have been stunned by tailslaps and subsurface feeding (Simila, 1997), ceased feeding during the approach of the sonar and moved rapidly away from the source. When exposed to Source B, Kvadsheim *et al.* (2007) reported that a tagged killer whale seemed to try to avoid further exposure to the sound field by the following behaviors: Immediately swimming away (horizontally) from the source of the sound; engaging in a series of erratic and frequently deep dives that seemed to take it below the sound field; or swimming away while engaged in a series of erratic and frequently deep dives. Although the sample sizes in this study are too small to support statistical analysis, the behavioral responses of the killer whales were consistent with the results of other studies.

Southall *et al.* (2007) reviewed the available literature on marine mammal hearing and physiological and behavioral responses to human-made sound with the goal of proposing exposure criteria for certain effects. This peer-reviewed compilation of literature is very valuable, though Southall *et al.* (2007) note that not all data are equal, some have poor statistical power, insufficient controls, and/or limited information on received levels, background noise, and other potentially important contextual variables. Such data were reviewed and sometimes used for qualitative illustration, but no quantitative criteria were recommended for behavioral responses. All of the studies considered, however, contain an estimate of the received sound level when the animal exhibited the indicated response.

In the Southall *et al.* (2007) publication, for the purposes of analyzing responses of marine mammals to anthropogenic sound and developing criteria, the authors differentiate between single pulse sounds, multiple pulse sounds, and non-pulse sounds. LFAS/MFAS/HFAS are considered non-pulse sounds. Southall *et al.* (2007) summarize the studies associated with low-frequency, mid-frequency, and high-frequency cetacean and pinniped responses to non-pulse sounds, based strictly on received level, in Appendix C of their article (included in this preamble by reference and summarized in the following paragraphs below).

The studies that address responses of low-frequency cetaceans to non-pulse sounds include data gathered in the field and related to several types of sound sources (of varying similarity to MFAS/HFAS) including: Vessel noise, drilling and machinery playback, low-frequency M-sequences (sine wave with multiple phase reversals) playback, tactical low-frequency active sonar playback, drill ships, Acoustic Thermometry of Ocean Climate (ATOC) source, and non-pulse playbacks. These studies generally indicate no (or very limited) responses to received levels in the 90 to 120 dB re: 1 µPa range and an increasing likelihood of avoidance and other behavioral effects in the 120 to 160 dB re: 1 µPa range. As mentioned earlier, though, contextual variables play a very important role in the reported responses and the severity of effects are not linear when compared to received level. Also, few of the laboratory or field datasets had common conditions, behavioral contexts or sound sources, so it is not surprising that responses differ.

The studies that address responses of mid-frequency cetaceans to non-pulse sounds include data gathered both in the field and the laboratory and related to several different sound sources (of varying similarity to MFAS/HFAS) including: Pingers, drilling playbacks, ship and ice-breaking noise, vessel noise, Acoustic Harassment Devices (AHDs), Acoustic Deterrent Devices (ADDs), MFAS, and non-pulse bands and tones. Southall *et al.* (2007) were unable to come to a clear conclusion regarding the results of these studies. In some cases, animals in the field showed significant responses to received levels between 90 and 120 dB re: 1 µPa, while in other cases these responses were not seen in the 120 to 150 dB re: 1 µPa range. The disparity in results was likely due to contextual variation and the differences between the results in the field and laboratory data (animals typically responded at lower levels in the field).

The studies that address responses of high-frequency cetaceans to non-pulse sounds include data gathered both in the field and the laboratory and related to several different sound sources (of varying similarity to MFAS/HFAS) including: Pingers, AHDs, and various laboratory non-pulse sounds. All of these data were collected from harbor porpoises. Southall *et al.* (2007) concluded that the existing data indicate that harbor porpoises are likely sensitive to a wide range of anthropogenic sounds at low received levels (~90 to 120 dB re: 1 µPa), at least for initial exposures. All recorded exposures above 140 dB re: 1 µPa induced profound and sustained avoidance behavior in wild harbor porpoises (Southall *et al.*, 2007). Rapid habituation was noted in some but not all studies. There are no data to indicate whether other high frequency cetaceans are as sensitive to anthropogenic sound as harbor porpoises.

The studies that address the responses of pinnipeds in water to non-impulsive sounds include data gathered both in the field and the laboratory and related to several different sound sources including: AHDs, ATOC, various non-pulse sounds used in underwater data communication, underwater drilling, and construction noise. Few studies exist with enough information to include them in the analysis. The limited data suggested that exposures to non-pulse sounds between 90 and 140 dB re: 1 µPa generally do not result in strong behavioral responses in pinnipeds in water, but no data exist at higher received levels.

In 2007, the first in a series of behavioral response studies (BRS) on deep diving odontocetes conducted by NMFS, Navy, and other scientists showed one Blainville's beaked whale responding to an MFAS playback. Tyack *et al.* (2011) indicates that the playback began when the tagged beaked whale was vocalizing at depth (at the deepest part of a typical feeding dive), following a previous control with no sound exposure. The whale appeared to stop clicking significantly earlier than usual, when exposed to MF signals in the 130–140 dB (rms) received level range. After a few more minutes of the playback, when the received level reached a maximum of 140–150 dB, the whale ascended on the slow side of normal ascent rates with a longer than normal ascent, at which point the exposure was terminated. The results are from a single experiment and a greater sample size is needed before robust and definitive conclusions can be drawn. Tyack *et al.* (2011) also indicates that Blainville's beaked whales appear to be sensitive to noise at levels well below expected TTS (~160 dB re1µPa). This sensitivity was manifested by an adaptive movement away from a sound source. This response was observed irrespective of whether the signal transmitted was within the band width of MFAS, which suggests that beaked whales may not

respond to the specific sound signatures. Instead, they may be sensitive to any pulsed sound from a point source in this frequency range of the MF active sonar transmission. The response to such stimuli appears to involve the beaked whale increasing the distance between it and the sound source. Overall the results from the 2007–2008 study conducted showed a change in diving behavior of the Blainville's beaked whale to playback of MFAS and predator sounds (Boyd *et al.*, 2008; Southall *et al.*, 2009; Tyack *et al.*, 2011).

Stimpert *et al.* (2014) tagged a Baird's beaked whale, which was subsequently exposed to simulated MFAS. Received levels of sonar on the tag increased to a maximum of 138 dB re 1µPa, which occurred during the first exposure dive. Some sonar received levels could not be measured due to flow noise and surface noise on the tag.

Reaction to mid-frequency sounds included premature cessation of clicking and termination of a foraging dive, and a slower ascent rate to the surface. Results from a similar behavioral response study in southern California waters have been presented for the 2010–2011 field season (Southall *et al.*, 2011; DeRuiter *et al.*, 2013b). DeRuiter *et al.* (2013b) presented results from two Cuvier's beaked whales that were tagged and exposed to simulated MFAS during the 2010 and 2011 field seasons of the southern California behavioral response study. The 2011 whale was also incidentally exposed to MFAS from a distant naval exercise. Received levels from the MFAS signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 µPa rms, respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure to distant naval sonar exercises at comparable received levels, indicating that context of the exposures (*e.g.*, source proximity, controlled source ramp-up) may have been a significant factor. Specifically, this result suggests that caution is needed when using marine mammal response data collected from smaller, nearer sound sources to predict at what received levels animals may respond to larger sound sources that are significantly farther away—as the distance of the source appears to be an important contextual variable and animals may be less responsive to sources at notably greater distances.

Cuvier's beaked whale responses suggested particular sensitivity to sound exposure as consistent with results for Blainville's beaked whale. Similarly, beaked whales exposed to sonar during British training exercises stopped foraging (DSTL, 2007), and preliminary results of controlled playback of sonar may indicate feeding/foraging disruption of killer whales and sperm whales (Miller *et al.*, 2011).

In the 2007–2008 Bahamas study, playback sounds of a potential predator—a killer whale—resulted in a similar but more pronounced reaction, which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km from the area (Boyd *et al.*, 2008; Southall *et al.*, 2009; Tyack *et al.*, 2011). The authors noted, however, that the magnified reaction to the predator sounds could represent a cumulative effect of exposure to the two sound types since killer whale playback began approximately two hours after MF source playback. Pilot whales and killer whales off Norway also exhibited horizontal avoidance of a transducer with outputs in the mid-frequency range (signals in the 1–2 kHz and 6–7 kHz ranges) (Miller *et al.*, 2011). Additionally, separation of a calf from its group during exposure to MFAS playback was observed on one occasion (Miller *et al.*, 2011, 2012). Miller *et al.* (2012) noted that this single observed mother-calf separation was unusual for several reasons, including the fact that the experiment was conducted in an unusually narrow fjord roughly one km wide and that the sonar exposure was started unusually close to the pod including the calf. Both of these factors could have contributed to calf separation. In contrast, preliminary analyses suggest that none of the pilot whales or false killer whales in the Bahamas showed an avoidance response to controlled exposure playbacks (Southall *et al.*, 2009).

In the 2010 BRS study, researchers again used controlled exposure experiments (CEE) to carefully measure behavioral responses of individual animals to sound exposures of MF active sonar and pseudo-random noise. For each sound type, some exposures were conducted when animals were in a surface feeding (approximately 164 ft (50 m) or less) and/or socializing behavioral state and others while animals were in a deep feeding (greater than 164 ft (50 m)) and/or traveling mode. The researchers conducted the largest number of CEEs on blue whales (n=19) and of these, 11 CEEs involved exposure to the MF active sonar sound type. For the majority of CEE transmissions of either sound type, they noted few obvious behavioral responses detected either by the visual observers or on initial inspection of the tag data. The researchers observed that throughout the CEE transmissions, up to the highest received sound level (absolute RMS value approximately 160 dB re: 1µPa with signal-to-noise ratio values over 60 dB), two blue whales continued surface feeding behavior and remained at a range of around 3,820 ft (1,000 m) from the sound source (Southall *et al.*, 2011). In contrast, another blue whale (later in the day and greater than 11.5 mi (18.5 km; 10 nmi) from the first CEE location) exposed to the same stimulus (MFA) while engaged in a deep feeding/travel state exhibited a different response. In that case, the blue whale responded almost immediately following the start of sound transmissions when received sounds were just above ambient background levels (Southall *et al.*, 2011). The authors note that this kind of temporary avoidance behavior was not evident in any of the nine CEEs involving blue whales engaged in surface feeding or social behaviors, but was observed in three of the ten CEEs for blue whales in deep feeding/travel behavioral modes (one involving MFA sonar; two involving pseudo-random noise) (Southall *et al.*, 2011). The results of this study, as well as the results of the DeRuiter *et al.* (2013) study of Cuvier's beaked whales discussed above, further illustrate the importance of behavioral context in understanding and predicting behavioral responses.

Through analysis of the behavioral response studies, a preliminary overarching effect of greater sensitivity to all anthropogenic exposures was seen in beaked whales compared to the other odontocetes studied (Southall *et al.*, 2009). Therefore, recent studies have focused specifically on beaked whale responses to active sonar transmissions or controlled exposure playback of simulated sonar on various military ranges (Defence Science and Technology Laboratory, 2007; Claridge and Durban, 2009; Moretti *et al.*, 2009; McCarthy *et al.*, 2011; Miller *et al.*, 2012; Southall *et al.*, 2011, 2012a, 2012b, 2013, 2014; Tyack *et al.*, 2011). In the Bahamas, Blainville's beaked whales located on the instrumented range will move off-range during sonar use and return only after the sonar transmissions have stopped, sometimes taking several days to do so (Claridge and Durban 2009; Moretti *et al.*, 2009; McCarthy *et al.*, 2011; Tyack *et al.*, 2011). Moretti *et al.* (2014) used recordings from seafloor-mounted

hydrophones at the Atlantic Undersea Test and Evaluation Center (AUTEC) to analyze the probability of Blainsville's beaked whale dives before, during, and after Navy sonar exercises.

Southall *et al.* (2016) indicates that results from Tyack *et al.* (2011); Miller *et al.* (2015), Stimpert *et al.* (2014), and DeRuiter *et al.* (2013) beaked whale studies all demonstrate clear, strong, and pronounced but varied behavioral changes including sustained avoidance with associated energetic swimming and cessation of feeding behavior at quite low received levels (–100 to 135 dB re 1Pa) for exposures to simulated or active MF military sonars (1 to 8 kHz) with sound sources approximately 2 to 5 km away.

Baleen whales have shown a variety of responses to impulse sound sources, including avoidance, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Richardson *et al.*, 1995; Gordon *et al.*, 2003; Southall, 2007). While most bowhead whales did not show active avoidance until within 8 km of seismic vessels (Richardson *et al.*, 1995), some whales avoided vessels by more than 20 km at received levels as low as 120 dB re 1 µPa rms. Additionally, Malme *et al.* (1988) observed clear changes in diving and respiration patterns in bowheads at ranges up to 73 km from seismic vessels, with received levels as low as 125 dB re 1 µPa.

Gray whales migrating along the U.S. west coast showed avoidance responses to seismic vessels by 10 percent of animals at 164 dB re 1 µPa, and by 90 percent of animals at 190 dB re 1 µPa, with similar results for whales in the Bering Sea (Malme, 1986; 1988). In contrast, noise from seismic surveys was not found to impact feeding behavior or exhalation rates while resting or diving in western gray whales off the coast of Russia (Yazvenko *et al.*, 2007; Gailey *et al.*, 2007).

Humpback whales showed avoidance behavior at ranges of five to eight km from a seismic array during observational studies and controlled exposure experiments in western Australia (McCauley, 1998; Todd *et al.*, 1996). Todd found no clear short-term behavioral responses by foraging humpbacks to explosions associated with construction operations in Newfoundland, but did see a trend of increased rates of net entanglement and a shift to a higher incidence of net entanglement closer to the noise source.

Orientation

A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

Continued Pre-Disturbance Behavior and Habituation

Under some circumstances, some of the individual marine mammals that are exposed to active sonar transmissions will continue their normal behavioral activities. In other circumstances, individual animals will respond to sonar transmissions at lower received levels and move to avoid additional exposure or exposures at higher received levels (Richardson *et al.*, 1995).

It is difficult to distinguish between animals that continue their pre-disturbance behavior without stress responses, animals that continue their behavior but experience stress responses (that is, animals that cope with disturbance), and animals that habituate to disturbance (that is, they may have experienced low-level stress responses initially, but those responses abated over time). Watkins (1986) reviewed data on the behavioral reactions of fin, humpback, right and minke whales that were exposed to continuous, broadband low-frequency shipping and industrial noise in Cape Cod Bay. He concluded that underwater sound was the primary cause of behavioral reactions in these species of whales and that the whales responded behaviorally to acoustic stimuli within their respective hearing ranges. Watkins also noted that whales showed the strongest behavioral reactions to sounds in the 15 Hz to 28 kHz range, although negative reactions (avoidance, interruptions in vocalizations, etc.) were generally associated with sounds that were either unexpected, too loud, suddenly louder or different, or perceived as being associated with a potential threat (such as an approaching ship on a collision course). In particular, whales seemed to react negatively when they were within 100 m of the source or when received levels increased suddenly in excess of 12 dB relative to ambient sounds. At other times, the whales ignored the source of the signal and all four species habituated to these sounds. Nevertheless, Watkins concluded that whales ignored most sounds in the background of ambient noise, including sounds from distant human activities even though these sounds may have had considerable energies at frequencies well within the whales' range of hearing. Further, he noted that of the whales observed, fin whales were the most sensitive of the four species, followed by humpback whales; right whales were the least likely to be disturbed and generally did not react to low-amplitude engine noise. By the end of his period of study, Watkins (1986) concluded that fin and humpback whales have generally habituated to the continuous and broad-band noise of Cape Cod Bay while right whales did not appear to change their response. As mentioned above, animals that habituate to a particular disturbance may have experienced low-level stress responses initially, but those responses abated over time. In most cases, this likely means a lessened immediate potential effect from a disturbance. However, there is cause for concern where the habituation occurs in a potentially more harmful situation. For example, animals may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.*, 1993; Wiley *et al.*, 1995).

Aicken *et al.* (2005) monitored the behavioral responses of marine mammals to a new low-frequency active sonar system used by the British Navy (the United States Navy considers this to be a mid-frequency source as it operates at frequencies greater than 1,000 Hz). During those trials, fin whales, sperm whales, Sowerby's beaked whales, long-finned pilot whales, Atlantic white-sided dolphins, and common bottlenose dolphins were observed and their vocalizations were recorded. These monitoring studies detected no evidence of behavioral responses that the investigators could attribute to exposure to the low-frequency active sonar during these trials.

Explosive Sources

Underwater explosive detonations send a shock wave and sound energy through the water and can release gaseous by-products, create an oscillating bubble, or cause a plume of water to shoot up from the water surface. The shock wave and accompanying noise are of most concern to marine animals. Depending on the intensity of the shock wave and size, location, and depth of the animal, an animal can be injured, killed, suffer non-lethal physical effects, experience hearing related effects with or without behavioral responses, or exhibit temporary behavioral responses or tolerance from hearing the blast sound. Generally, exposures to higher levels of impulse and pressure levels would result in greater impacts to an individual animal.

Injuries resulting from a shock wave take place at boundaries between tissues of different densities. Different velocities are imparted to tissues of different densities, and this can lead to their physical disruption. Blast effects are greatest at the gas-liquid interface (Landsberg, 2000). Gas-containing organs, particularly the lungs and gastrointestinal tract, are especially susceptible (Goertner, 1982; Hill, 1978; Yelverton *et al.*, 1973). Intestinal walls can bruise or rupture, with subsequent hemorrhage and escape of gut contents into the body cavity. Less severe gastrointestinal tract injuries include contusions, petechiae (small red or purple spots caused by bleeding in the skin), and slight hemorrhaging (Yelverton *et al.*, 1973).

Because the ears are the most sensitive to pressure, they are the organs most sensitive to injury (Ketten, 2000). Sound-related damage associated with sound energy from detonations can be theoretically distinct from injury from the shock wave, particularly farther from the explosion. If a noise is audible to an animal, it has the potential to damage the animal's hearing by causing decreased sensitivity (Ketten, 1995). Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source and are not, technically, pure acoustic trauma (Ketten, 1995). Sublethal impacts include hearing loss, which is caused by exposures to perceptible sounds. Severe damage (from the shock wave) to the ears includes tympanic membrane rupture, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear. Moderate injury implies partial hearing loss due to tympanic membrane rupture and blood in the middle ear. Permanent hearing loss also can occur when the hair cells are damaged by one very loud event, as well as by prolonged exposure to a loud noise or chronic exposure to noise. The level of impact from blasts depends on both an animal's location and, at outer zones, on its sensitivity to the residual noise (Ketten, 1995).

Further Potential Effects of Behavioral Disturbance on Marine Mammal Fitness

The different ways that marine mammals respond to sound are sometimes indicators of the ultimate effect that exposure to a given stimulus will have on the well-being (survival, reproduction, etc.) of an animal. There are few quantitative marine mammal data relating the exposure of marine mammals to sound to effects on reproduction or survival, though data exists for terrestrial species to which we can draw comparisons for marine mammals. Several authors have reported that disturbance stimuli may cause animals to abandon nesting and foraging sites (Sutherland and Crockford, 1993); may cause animals to increase their activity levels and suffer premature deaths or reduced reproductive success when their energy expenditures exceed their energy budgets (Daan *et al.*, 1996; Feare, 1976; Mullner *et al.*, 2004); or may cause animals to experience higher predation rates when they adopt risk-prone foraging or migratory strategies (Frid and Dill, 2002). Each of these studies addressed the consequences of animals shifting from one behavioral state (*e.g.*, resting or foraging) to another behavioral state (*e.g.*, avoidance or escape behavior) because of human disturbance or disturbance stimuli.

One consequence of behavioral avoidance results in the altered energetic expenditure of marine mammals because energy is required to move and avoid surface vessels or the sound field associated with active sonar (Frid and Dill, 2002). Most animals can avoid that energetic cost by swimming away at slow speeds or speeds that minimize the cost of transport (Miksis-Olds, 2006), as has been demonstrated in Florida manatees (Miksis-Olds, 2006).

Those energetic costs increase, however, when animals shift from a resting state, which is designed to conserve an animal's energy, to an active state that consumes energy the animal would have conserved had it not been disturbed. Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting to active behavioral states, which would imply that they incur an energy cost.

Morete *et al.* (2007) reported that undisturbed humpback whale cows that were accompanied by their calves were frequently observed resting while their calves circled them (milling). When vessels approached, the amount of time cows and calves spent resting and milling, respectively, declined significantly. These results are similar to those reported by Scheidat *et al.* (2004) for the humpback whales they observed off the coast of Ecuador.

Constantine and Brunton (2001) reported that bottlenose dolphins in the Bay of Islands, New Zealand engaged in resting behavior just 5 percent of the time when vessels were within 300 m, compared with 83 percent of the time when vessels were not present. However, Heenehan *et al.* (2016) report that results of a study of the response of Hawaiian spinner dolphins to human disturbance suggest that the key factor is not the sheer presence or magnitude of human activities, but rather the directed interactions and dolphin-focused activities that elicit responses from dolphins at rest. This information again illustrates the importance of context in regard to whether an animal will respond to a stimulus. Miksis-Olds (2006) and Miksis-Olds *et al.* (2005) reported that Florida manatees in Sarasota Bay, Florida, reduced the amount of time they spent milling and increased the amount of time they spent feeding when background noise levels increased. Although the acute costs of these changes in behavior are not likely to exceed an animal's ability to compensate, the chronic costs of these behavioral shifts are uncertain.

Attention is the cognitive process of selectively concentrating on one aspect of an animal's environment while ignoring other things (Posner, 1994). Because animals (including humans) have limited cognitive resources, there is a limit to how much sensory information they can process at any time. The phenomenon called "attentional capture" occurs when a stimulus (usually a stimulus that an animal is not concentrating on or attending to) "captures" an animal's attention. This shift in attention can occur consciously or subconsciously (for example, when an animal hears sounds that it associates with the approach of a predator) and the shift in attention can be sudden (Dukas, 2002; van Rij, 2007). Once a stimulus has captured an animal's attention, the animal can respond by ignoring the stimulus, assuming a "watch and wait" posture, or treat the stimulus as a disturbance and respond accordingly, which includes scanning for the source of the stimulus or "vigilance" (Cowlishaw *et al.*, 2004).

Vigilance is normally an adaptive behavior that helps animals determine the presence or absence of predators, assess their distance from conspecifics, or to attend cues from prey (Bednekoff and Lima, 1998; Treves, 2000). Despite those benefits, however, vigilance has a cost of time; when animals focus their attention on specific environmental cues, they are not attending to other activities such as foraging. These costs have been documented best in foraging animals, where vigilance has been shown to substantially reduce feeding rates (Saino, 1994; Beauchamp and Livoreil, 1997; Fritz *et al.*, 2002). Animals will spend more time being vigilant, which may translate to less time foraging or resting, when disturbance stimuli approach them more directly, remain at closer distances, have a greater group size (*e.g.*,

multiple surface vessels), or when they co-occur with times that an animal perceives increased risk *(e.g.,* when they are giving birth or accompanied by a calf). Most of the published literature, however, suggests that direct approaches will increase the amount of time animals will dedicate to being vigilant. An example of this concept with terrestrial species involved bighorn sheep and Dall's sheep, which dedicated more time being vigilant, and less time resting or foraging, when aircraft made direct approaches over them (Frid, 2001; Stockwell *et al.,* 1991). Vigilance has also been documented in pinnipeds at haul out sites where resting may be disturbed when seals become alerted and/or flush into the water due to a variety of disturbances, which may be anthropogenic (noise and/or visual stimuli) or due to other natural causes such as other pinnipeds (Richardson *et al.,* 1995; Southall *et al.,* 2007; VanBlaricom, 2010; and Lozano and Hente, 2014).

Several authors have established that long-term and intense disturbance stimuli can cause population declines by reducing the physical condition of individuals that have been disturbed, followed by reduced reproductive success, reduced survival, or both (Daan *et al.,* 1996; Madsen, 1994; White, 1985). For example, Madsen (1994) reported that pink-footed geese (*Anser brachyrhynchus*) in undisturbed habitat gained body mass and had about a 46 percent reproductive success rate compared with geese in disturbed habitat (being consistently scared off the fields on which they were foraging) which did not gain mass and had a 17 percent reproductive success rate. Similar reductions in reproductive success have been reported for mule deer (*Odocoileus hemionus*) disturbed by all-terrain vehicles (Yarmoloy *et al.,* 1988), caribou (*Rangifer tarandus caribou*) disturbed by seismic exploration blasts (Bradshaw *et al.,* 1998), and caribou disturbed by low-elevation military jet fights (Luick *et al.,* 1996, Harrington and Veitch, 1992). Similarly, a study of elk (*Cervus elaphus*) that were disturbed experimentally by pedestrians concluded that the ratio of young to mothers was inversely related to disturbance rate (Phillips and Alldredge, 2000).

The primary mechanism by which increased vigilance and disturbance appear to affect the fitness of individual animals is by disrupting an animal's time budget and, as a result, reducing the time they might spend foraging and resting (which increases an animal's activity rate and energy demand while decreasing their caloric intake/energy). Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period in open-air, open-water enclosures in San Diego Bay did not cause any sleep deprivation or stress effects such as changes in cortisol or epinephrine levels. An example of this concept with terrestrial species involved a study of grizzly bears (*Ursus horribilis*) that reported that bears disturbed by hikers reduced their energy intake by an average of 12 kilocalories/min (50.2 × 103 kiloJoules/min), and spent energy fleeing or acting aggressively toward hikers (White *et al.,* 1999).

Lusseau and Bejder (2007) present data from three long-term studies illustrating the connections between disturbance from whale-watching boats and population-level effects in cetaceans. In Sharks Bay Australia, the abundance of bottlenose dolphins was compared within adjacent control and tourism sites over three consecutive 4.5-year periods of increasing tourism levels. Between the second and third time periods, in which tourism doubled, dolphin abundance decreased by 15 percent in the tourism area and did not change significantly in the control area. In Fiordland, New Zealand, two populations (Milford and Doubtful Sounds) of bottlenose dolphins with tourism levels that differed by a factor of seven were observed and significant increases in travelling time and decreases in resting time were documented for both. Consistent short-term avoidance strategies were observed in response to tour boats until a threshold of disturbance was reached (average 68 minutes between interactions), after which the response switched to a longer-term habitat displacement strategy. For one population, tourism only occurred in a part of the home range. However, tourism occurred throughout the home range of the Doubtful Sound population and once boat traffic increased beyond the 68-minute threshold (resulting in abandonment of their home range/preferred habitat), reproductive success drastically decreased (increased stillbirths) and abundance decreased significantly (from 67 to 56 individuals in short period). Last, in a study of northern resident killer whales off Vancouver Island, exposure to boat traffic was shown to reduce foraging opportunities and increase traveling time. A simple bioenergetics model was applied to show that the reduced foraging opportunities equated to a decreased energy intake of 18 percent, while the increased traveling incurred an increased energy output of 3–4 percent, which suggests that a management action based on avoiding interference with foraging might be particularly effective.

On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hr cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant for fitness if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). It is important to note the difference between behavioral reactions lasting or recurring over multiple days and anthropogenic activities lasting or recurring over multiple days. For example, just because an at-sea exercises last for multiple days does not necessarily mean that individual animals will be exposed to those exercises for multiple days or exposed in a manner that would result in a sustained behavioral response.

In order to understand how the effects of activities may or may not impact species and stocks of marine mammals, it is necessary to understand not only what the likely disturbances are going to be, but how those disturbances may affect the reproductive success and survivorship of individuals, and then how those impacts to individuals translate to population-level effects. Following on the earlier work of a committee of the U.S. National Research Council (NRC, 2005), New *et al.* (2014), in an effort termed the Potential Consequences of Disturbance (PCoD), outline an updated conceptual model of the relationships linking disturbance to changes in behavior and physiology, health, vital rates, and population dynamics. In this framework, behavioral and physiological changes can either have direct (acute) effects on vital rates, such as when changes in habitat use or increased stress levels raise the probability of mother-calf separation or predation; they can have indirect and long-term (chronic) effects on vital rates, such as when changes in time/energy budgets or increased disease susceptibility affect health, which then affects vital rates; or they can have no effect to vital rates (New *et al.,* 2014). In addition to outlining this general framework and compiling the relevant literature that supports it, authors have

chosen four example species for which extensive long-term monitoring data exist (southern elephant seals, North Atlantic right whales, Ziphidae beaked whales, and bottlenose dolphins) and developed state-space energetic models that can be used to effectively forecast longer-term, population-level impacts from behavioral changes. While these are very specific models with very specific data requirements that cannot yet be applied broadly to project-specific risk assessments for the majority of species, they are a critical first step towards being able to quantify the likelihood of a population level effect.

Stranding and Mortality

The definition for a stranding under title IV of the MMPA is that (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance (16 U.S.C. 1421h).

Marine mammal strandings have been linked to a variety of causes, such as illness from exposure to infectious agents, biotoxins, or parasites; starvation; unusual oceanographic or weather events; or anthropogenic causes including fishery interaction, ship strike, entrainment, entrapment, sound exposure, or combinations of these stressors sustained concurrently or in series. Historically, the cause or causes of most strandings have remained unknown (Geraci *et al.*, 1976; Eaton, 1979, Odell *et al.*, 1980; Best, 1982), but the development of trained, professional stranding response networks and improved analyses have led to a greater understanding of marine mammal stranding causes (Simeone and Moore in press).

Numerous studies suggest that the physiology, behavior, habitat, social, relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Chroussos, 2000; Creel, 2005; DeVries *et al.*, 2003; Fair and Becker, 2000; Foley *et al.*, 2001; Moberg, 2000; Relyea, 2005a; 2005b, Romero, 2004; Sih *et al.*, 2004).

Historically, stranding reporting and response efforts have been inconsistent, although significant improvements have occurred over the last 25 years. Reporting forms for basic ("Level A") information, rehabilitation disposition, and Human Interaction have been standardized nationally (available at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/level-data-collection-marine-mammal-stranding-events*). However, data collected beyond basic information varies by region (and may vary from case to case), and are not standardized across the United States. Logistical conditions such as weather, time, location, and decomposition state may also affect the ability of the stranding network to thoroughly examine a specimen (Carretta *et al.*, 2016b; Moore *et al.*, 2013). While the investigation of stranded animals provides insight into the types of threats marine mammal populations face, full investigations are only possible and conducted on a small fraction of the total number of strandings that occur, limiting our understanding of the causes of strandings (Carretta *et al.*, 2016a). Additionally, and due to the variability in effort and data collected, the ability to interpret long-term trends in stranded marine mammals is complicated.

Along the coasts of the continental United States and Alaska between 2001 and 2009, there were on average approximately 12,545 cetacean strandings and 39,104 pinniped strandings (51,649 total) per year (National Marine Fisheries Service, 2016i). Several mass strandings (strandings that involve two or more individuals of the same species, excluding a single mother-calf pair) that have occurred over the past two decades have been associated with anthropogenic activities that introduced sound into the marine environment such as naval operations and seismic surveys. An in-depth discussion of strandings is in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Navy Marine Mammal Program & Space and Naval Warfare Systems Command Center Pacific, 2017).

Worldwide, there have been several efforts to identify relationships between cetacean mass stranding events and military active sonar (Cox *et al.*, 2006, Hildebrand, 2004; IWC, 2005; Taylor *et al.*, 2004). For example, based on a review of mass stranding events around the world consisting of two or more individuals of Cuvier's beaked whales, records from the International Whaling Commission (IWC)(2005) show that a quarter (9 of 41) were associated with concurrent naval patrol, explosion, maneuvers, or MFAS. D'Amico *et al.* (2009) reviewed beaked whale stranding data compiled primarily from the published literature, which provides an incomplete record of stranding events, as many are not written up for publication, along with unpublished information from some regions of the world.

Most of the stranding events reviewed by the IWC involved beaked whales. A mass stranding of Cuvier's beaked whales in the eastern Mediterranean Sea occurred in 1996 (Frantzis, 1998) and mass stranding events involving Gervais' beaked whales, Blainville's beaked whales, and Cuvier's beaked whales occurred off the coast of the Canary Islands in the late 1980s (Simmonds and Lopez-Jurado, 1991). The stranding events that occurred in the Canary Islands and Kyparissiakos Gulf in the late 1990s and the Bahamas in 2000 have been the most intensively-studied mass stranding events and have been associated with naval maneuvers involving the use of tactical sonar. Other cetacean species with naval sonar implicated in stranding events include harbor porpoise (*Phocoena phocoena*) (Norman *et al.*, 2004, Wright *et al.*, 2013) and common dolphin (*Delphinus delphis*) (Jepson and Deaville 2009).

Strandings Associated With Impulsive Sound

Silver Strand

During a Navy training event on March 4, 2011 at the Silver Strand Training Complex in San Diego, California, three or possibly four dolphins were killed in an explosion. During an underwater detonation training event, a pod of 100 to 150 long-beaked common dolphins were observed moving towards the 700-yd (640.1 m) exclusion zone around the explosive charge, monitored by personnel in a safety boat and participants in a dive boat. Approximately five minutes remained on a time-delay fuse connected to a single 8.76 lb (3.97 kg) explosive charge (C–4 and detonation cord). Although the dive boat was placed between the pod and the explosive in an effort to guide the dolphins away from the area, that effort was unsuccessful and three long-beaked common dolphins near the

explosion died. In addition to the three dolphins found dead on March 4, the remains of a fourth dolphin were discovered on March 7, 2011 near Oceanside, California (3 days later and approximately 68 km north of the detonation), which might also have been related to this event. Association of the fourth stranding with the training event is uncertain because dolphins strand on a regular basis in the San Diego area. Details such as the dolphins' depth and distance from the explosive at the time of the detonation could not be estimated from the 250 yd (228.6 m) standoff point of the observers in the dive boat or the safety boat.

These dolphin mortalities are the only known occurrence of a U.S. Navy training or testing event involving impulsive energy (underwater detonation) that caused mortality or injury to a marine mammal. Despite this being a rare occurrence, the Navy has reviewed training requirements, safety procedures, and possible mitigation measures and implemented changes to reduce the potential for this to occur in the future. Discussions of procedures associated with underwater explosives training and other training events are presented in the Proposed Mitigation section.

Kyle of Durness, Scotland

On July 22, 2011 a mass stranding event involving long-finned pilot whales occurred at Kyle of Durness, Scotland. An investigation by Brownlow *et al.* (2015) considered unexploded ordnance detonation activities at a Ministry of Defense bombing range, conducted by the Royal Navy prior to and during the strandings, as a plausible contributing factor in the mass stranding event. While Brownlow *et al.* (2015) concluded that the serial detonations of underwater ordnance were an influential factor in the mass stranding event (along with presence of a potentially compromised animal and navigational error in a topographically complex region) they also suggest that mitigation measures—which included observations from a zodiac only and by personnel not experienced in marine mammal observation, among other deficiencies—were likely insufficient to assess if cetaceans were in the vicinity of the detonations. The authors also cite information from the Ministry of Defense indicating "an extraordinarily high level of activity" (*i.e.*, frequency and intensity of underwater explosions) on the range in the days leading up to the stranding.

Gulf of California, Mexico

One stranding event was contemporaneous with and reasonably associated spatially with the use of seismic air guns. This event occurred in the Gulf of California, coincident with seismic reflection profiling by the R/V Maurice Ewing operated by Columbia University's Lamont-Doherty Earth Observatory and involved two Cuvier's beaked whales (Hildebrand, 2004). The vessel had been firing an array of 20 air guns with a total volume of 8,500 in^3 (Hildebrand, 2004; Taylor *et al.*, 2004).

Strandings Associated With Active Sonar

Over the past 21 years, there have been five stranding events coincident with military MF active sonar use in which exposure to sonar is believed to have been a contributing factor: Greece (1996); the Bahamas (2000); Madeira (2000); Canary Islands (2002); and Spain (2006) (Cox et al., 2006; Fernandez, 2006; U.S. Navy Marine Mammal Program & Space and Naval Warfare Systems Command Center Pacific, 2017). These five mass strandings have resulted in about 40 known cetacean deaths consisting mostly of beaked whales and with close linkages to mid-frequency active sonar activity. In these circumstances, exposure to non-impulsive acoustic energy was considered a potential indirect cause of death of the marine mammals (Cox *et al.*, 2006). Only one of these stranding events, the Bahamas (2000), was associated with exercises conducted by the U.S. Navy. Additionally, in 2004, during the Rim of the Pacific (RIMPAC) exercises, between 150 and 200 usually pelagic melon-headed whales occupied the shallow waters of Hanalei Bay, Kauai, Hawaii for over 28 hours. NMFS determined that MFAS was a plausible, if not likely, contributing factor in what may have been a confluence of events that led to the Hanalei Bay stranding. A number of other stranding events coincident with the operation of MFAS, including the death of beaked whales or other species (minke whales, dwarf sperm whales, pilot whales), have been reported; however, the majority have not been investigated to the degree necessary to determine the cause of the stranding. Most recently, the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales in Antsohihy, Madagascar released its final report suggesting that the stranding was likely initially triggered by an industry seismic survey. This report suggests that the operation of a commercial high-powered 12 kHz multi-beam echosounder during an industry seismic survey was a plausible and likely initial trigger that caused a large group of melon-headed whales to leave their typical habitat and then ultimately strand as a result of secondary factors such as malnourishment and dehydration. The report indicates that the risk of this particular convergence of factors and ultimate outcome is likely very low, but recommends that the potential be considered in environmental planning. Because of the association between tactical mid-frequency active sonar use and a small number of marine mammal strandings, the Navy and NMFS have been considering and addressing the potential for strandings in association with Navy activities for years. In addition to the proposed mitigation measures intended to more broadly minimize impacts to marine mammals, the Navy will abide by the Notification and Reporting Plan, which sets out notification, reporting, and other requirements when dead, injured, or stranding whales are detected in certain circumstances.

Greece (1996)

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

Necropsies of eight of the animals were performed but were limited to basic external examination and sampling of stomach contents, blood, and skin. No ears or organs were collected, and no histological samples were preserved. No apparent abnormalities or wounds were found. Examination of photos of the animals, taken soon after their death, revealed that the eyes of at least four of the individuals were bleeding. Photos were taken soon after their death (Frantzis, 2004). Stomach contents contained the flesh of cephalopods, indicating that feeding had recently taken place (Frantzis, 1998).

All available information regarding the conditions associated with this stranding event were compiled, and many potential causes were examined including major pollution events, prominent tectonic activity, unusual

physical or meteorological events, magnetic anomalies, epizootics, and conventional military activities (International Council for the Exploration of the Sea, 2005a). However, none of these potential causes coincided in time or space with the mass stranding, or could explain its characteristics (International Council for the Exploration of the Sea, 2005a). The robust condition of the animals, plus the recent stomach contents, is inconsistent with pathogenic causes. In addition, environmental causes can be ruled out as there were no unusual environmental circumstances or events before or during this time period and within the general proximity (Frantzis, 2004).

Because of the rarity of this mass stranding of Cuvier's beaked whales in the Kyparissiakos Gulf (first one in historical records), the probability for the two events (the military exercises and the strandings) to coincide in time and location, while being independent of each other, was thought to be extremely low (Frantzis, 1998). However, because full necropsies had not been conducted, and no abnormalities were noted, the cause of the strandings could not be precisely determined (Cox *et al.*, 2006). A Bioacoustics Panel convened by NATO concluded that the evidence available did not allow them to accept or reject sonar exposures as a causal agent in these stranding events. The analysis of this stranding event provided support for, but no clear evidence for, the cause-and-effect relationship of tactical sonar training activities and beaked whale strandings (Cox *et al.*, 2006).

Bahamas (2000)

NMFS and the Navy prepared a joint report addressing the multi-species stranding in the Bahamas in 2000, which took place within 24 hrs of U.S. Navy ships using MFAS as they passed through the Northeast and Northwest Providence Channels on March 15–16, 2000. The ships, which operated both AN/SQS–53C and AN/SQS–56, moved through the channel while emitting sonar pings approximately every 24 seconds. Of the 17 cetaceans that stranded over a 36-hr period (Cuvier's beaked whales, Blainville's beaked whales, minke whales, and a spotted dolphin), seven animals died on the beach (five Cuvier's beaked whales, one Blainville's beaked whale, and the spotted dolphin), while the other 10 were returned to the water alive (though their ultimate fate is unknown). As discussed in the Bahamas report (DOC/DON, 2001), there is no likely association between the minke whale and spotted dolphin strandings and the operation of MFAS.

Necropsies were performed on five of the stranded beaked whales. All five necropsied beaked whales were in good body condition, showing no signs of infection, disease, ship strike, blunt trauma, or fishery related injuries, and three still had food remains in their stomachs. Auditory structural damage was discovered in four of the whales, specifically bloody effusions or hemorrhaging around the ears. Bilateral intracochlear and unilateral temporal region subarachnoid hemorrhage, with blood clots in the lateral ventricles, were found in two of the whales. Three of the whales had small hemorrhages in their acoustic fats (located along the jaw and in the melon).

A comprehensive investigation was conducted and all possible causes of the stranding event were considered, whether they seemed likely at the outset or not. Based on the way in which the strandings coincided with ongoing naval activity involving tactical MFAS use, in terms of both time and geography, the nature of the physiological effects experienced by the dead animals, and the absence of any other acoustic sources, the investigation team concluded that MFAS aboard U.S. Navy ships that were in use during the active sonar exercise in question were the most plausible source of this acoustic or impulse trauma to beaked whales. This sound source was active in a complex environment that included the presence of a surface duct, unusual and steep bathymetry, a constricted channel with limited egress, intensive use of multiple, active sonar units over an extended period of time, and the presence of beaked whales that appear to be sensitive to the frequencies produced by these active sonars. The investigation team concluded that the cause of this stranding event was the confluence of the Navy MFAS and these contributory factors working together, and further recommended that the Navy avoid operating MFAS in situations where these five factors would be likely to occur. This report does not conclude that all five of these factors must be present for a stranding to occur, nor that beaked whales are the only species that could potentially be affected by the confluence of the other factors. Based on this, NMFS believes that the operation of MFAS in situations where surface ducts exist, or in marine environments defined by steep bathymetry and/or constricted channels may increase the likelihood of producing a sound field with the potential to cause cetaceans (especially beaked whales) to strand, and therefore, suggests the need for increased vigilance while operating MFAS in these areas, especially when beaked whales (or potentially other deep divers) are likely present.

Madeira, Portugal (2000)

From May 10–14, 2000, three Cuvier's beaked whales were found atypically stranded on two islands in the Madeira archipelago, Portugal (Cox *et al.*, 2006). A fourth animal was reported floating in the Madeiran waters by fisherman but did not come ashore (Woods Hole Oceanographic Institution, 2005). Joint NATO amphibious training peacekeeping exercises involving participants from 17 countries and 80 warships, took place in Portugal during May 2–15, 2000.

The bodies of the three stranded whales were examined post mortem (Woods Hole Oceanographic Institution, 2005), though only one of the stranded whales was fresh enough (24 hours after stranding) to be necropsied (Cox *et al.*, 2006). Results from the necropsy revealed evidence of hemorrhage and congestion in the right lung and both kidneys (Cox *et al.*, 2006). There was also evidence of intercochlear and intracranial hemorrhage similar to that which was observed in the whales that stranded in the Bahamas event (Cox *et al.*, 2006). There were no signs of blunt trauma, and no major fractures (Woods Hole Oceanographic Institution, 2005). The cranial sinuses and airways were found to be clear with little or no fluid deposition, which may indicate good preservation of tissues (Woods Hole Oceanographic Institution, 2005).

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

Even though no definitive causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004): Exercises were conducted in areas of at least 547 fathoms (1,000 m) depth near a shoreline where there is a rapid

change in bathymetry on the order of 547 to 3,281 fathoms (1,000 to 6,000 m) occurring across a relatively short horizontal distance (Freitas, 2004); multiple ships were operating around Madeira, though it is not known if MFAS was used, and the specifics of the sound sources used are unknown (Cox *et al.*, 2006, Freitas, 2004); and exercises took place in an area surrounded by landmasses separated by less than 35 nmi (65 km) and at least 10 nmi (19 km) in length, or in an embayment. Exercises involving multiple ships employing MFAS near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004).

Canary Islands, Spain (2002)

The southeastern area within the Canary Islands is well known for aggregations of beaked whales due to its ocean depths of greater than 547 fathoms (1,000 m) within a few hundred meters of the coastline (Fernandez *et al.*, 2005). On September 24, 2002, 14 beaked whales were found stranded on Fuerteventura and Lanzarote Islands in the Canary Islands (International Council for Exploration of the Sea, 2005a). Seven whales died, while the remaining seven live whales were returned to deeper waters (Fernandez *et al.*, 2005). Four beaked whales were found stranded dead over the next three days either on the coast or floating offshore. These strandings occurred within near proximity of an international naval exercise that utilized MFAS and involved numerous surface warships and several submarines. Strandings began about four hours after the onset of MFAS activity (International Council for Exploration of the Sea, 2005a; Fernandez *et al.*, 2005).

Eight Cuvier's beaked whales, one Blainville's beaked whale, and one Gervais' beaked whale were necropsied, 6 of them within 12 hours of stranding (Fernandez *et al.*, 2005). No pathogenic bacteria were isolated from the carcasses (Jepson *et al.*, 2003). The animals displayed severe vascular congestion and hemorrhage especially around the tissues in the jaw, ears, brain, and kidneys, displaying marked disseminated microvascular hemorrhages associated with widespread fat emboli (Jepson *et al.*, 2003; International Council for Exploration of the Sea, 2005a). Several organs contained intravascular bubbles, although definitive evidence of gas embolism in vivo is difficult to determine after death (Jepson *et al.*, 2003). The livers of the necropsied animals were the most consistently affected organ, which contained macroscopic gas-filled cavities and had variable degrees of fibrotic encapsulation. In some animals, cavitary lesions had extensively replaced the normal tissue (Jepson *et al.*, 2003). Stomachs contained a large amount of fresh and undigested contents, suggesting a rapid onset of disease and death (Fernandez *et al.*, 2005). Head and neck lymph nodes were enlarged and congested, and parasites were found in the kidneys of all animals (Fernandez *et al.*, 2005).

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

Hanalei Bay (2004)

On July 3 and 4, 2004, approximately 150 to 200 melon-headed whales occupied the shallow waters of the Hanalei Bay, Kauai, Hawaii for over 28 hrs. Attendees of a canoe blessing observed the animals entering the Bay in a single wave formation at 7 a.m. on July 3, 2004. The animals were observed moving back into the shore from the mouth of the Bay at 9 a.m. The usually pelagic animals milled in the shallow bay and were returned to deeper water with human assistance beginning at 9:30 a.m. on July 4, 2004, and were out of sight by 10:30 a.m.

Only one animal, a calf, was known to have died following this event. The animal was noted alive and alone in the Bay on the afternoon of July 4, 2004, and was found dead in the Bay the morning of July 5, 2004. A full necropsy, magnetic resonance imaging, and computerized tomography examination were performed on the calf to determine the manner and cause of death. The combination of imaging, necropsy and histological analyses found no evidence of infectious, internal traumatic, congenital, or toxic factors. Cause of death could not be definitively determined, but it is likely that maternal separation, poor nutritional condition, and dehydration contributed to the final demise of the animal. Although it is not known when the calf was separated from its mother, the animals' movement into the Bay and subsequent milling and re-grouping may have contributed to the separation or lack of nursing, especially if the maternal bond was weak or this was an inexperienced mother with her first calf.

Environmental factors, abiotic and biotic, were analyzed for any anomalous occurrences that would have contributed to the animals entering and remaining in Hanalei Bay. The Bay's bathymetry is similar to many other sites within the Hawaiian Island chain and dissimilar to sites that have been associated with mass strandings in other parts of the U.S. The weather conditions appeared to be normal for that time of year with no fronts or other significant features noted. There was no evidence of unusual distribution, occurrence of predator or prey species, or unusual harmful algal blooms, although Mobley *et al.* (2007) suggested that the full moon cycle that occurred at that time may have influenced a run of squid into the Bay. Weather patterns and bathymetry that have been associated with mass strandings elsewhere were not found to occur in this instance.

The Hanalei event was spatially and temporally correlated with RIMPAC. Official sonar training and tracking exercises in the Pacific Missile Range Facility (PMRF) warning area did not commence until approximately 8 a.m. on July 3 and were thus ruled out as a possible trigger for the initial movement into the Bay. However, six naval surface vessels transiting to the operational area on July 2 intermittently transmitted active sonar (for approximately nine hours total from 1:15 p.m. to 12:30 a.m.) as they approached from the south. The potential for these transmissions to have triggered the whales' movement into Hanalei Bay was investigated. Analyses with the information available indicated that animals to the south and east of Kaua'i could have detected active sonar transmissions on July 2, and reached Hanalei Bay on or before 7 a.m. on July 3. However, data limitations regarding the position of the whales prior to their arrival in the Bay, the magnitude of sonar exposure, behavioral responses of melon-headed whales to acoustic stimuli, and other possible relevant factors preclude a conclusive finding regarding the role of sonar in triggering this event. Propagation modeling suggests that transmissions from sonar use during the July 3 exercise in the

PMRF warning area may have been detectable at the mouth of the Bay. If the animals responded negatively to these signals, it may have contributed to their continued presence in the Bay. The U.S. Navy ceased all active sonar transmissions during exercises in this range on the afternoon of July 3. Subsequent to the cessation of sonar use, the animals were herded out of the Bay.

While causation of this stranding event may never be unequivocally determined, NMFS consider the active sonar transmissions of July 2–3, 2004, a plausible, if not likely, contributing factor in what may have been a confluence of events. This conclusion is based on the following: (1) The evidently anomalous nature of the stranding; (2) its close spatiotemporal correlation with wide-scale, sustained use of sonar systems previously associated with stranding of deep-diving marine mammals; (3) the directed movement of two groups of transmitting vessels toward the southeast and southwest coast of Kauai; (4) the results of acoustic propagation modeling and an analysis of possible animal transit times to the Bay; and (5) the absence of any other compelling causative explanation. The initiation and persistence of this event may have resulted from an interaction of biological and physical factors. The biological factors may have included the presence of an apparently uncommon, deep-diving cetacean species (and possibly an offshore, non-resident group), social interactions among the animals before or after they entered the Bay, and/or unknown predator or prey conditions. The physical factors may have included the presence of nearby deep water, multiple vessels transiting in a directed manner while transmitting active sonar over a sustained period, the presence of surface sound ducting conditions, and/or intermittent and random human interactions while the animals were in the Bay.

A separate event involving melon-headed whales and rough-toothed dolphins took place over the same period of time in the Northern Mariana Islands (Jefferson *et al.*, 2006), which is several thousand miles from Hawaii. Some 500 to 700 melon-headed whales came into Sasanhaya Bay on July 4, 2004, near the island of Rota and then left of their own accord after 5.5 hours; no known active sonar transmissions occurred in the vicinity of that event. The Rota incident led to scientific debate regarding what, if any, relationship the event had to the simultaneous events in Hawaii and whether they might be related by some common factor (*e.g.*, there was a full moon on July 2, 2004, as well as during other melon-headed whale strandings and nearshore aggregations (Brownell *et al.*, 2009; Lignon *et al.*, 2007; Mobley *et al.*, 2007). Brownell *et al.* (2009) compared the two incidents, along with one other stranding incident at Nuka Hiva in French Polynesia and normal resting behaviors observed at Palmyra Island, in regard to physical features in the areas, melon-headed whale behavior, and lunar cycles. Brownell *et al.*, (2009) concluded that the rapid entry of the whales into Hanalei Bay, their movement into very shallow water far from the 100-m contour, their milling behavior (typical pre-stranding behavior), and their reluctance to leave the bay constituted an unusual event that was not similar to the events that occurred at Rota (but was similar to the events at Palmyra), which appear to be similar to observations of melon-headed whales resting normally at Palmyra Island. Additionally, there was no correlation between lunar cycle and the types of behaviors observed in the Brownell *et al.* (2009) examples.

Spain (2006)

The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26, 2006, on the southeast coast of Spain, near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered during the day on January 27, but had already died. The first three animals were located near the town of Mojacar and the fourth animal was found dead, a few kilometers north of the first three animals. From January 25–26, 2006, Standing NATO Response Force Maritime Group Two (five of seven ships including one U.S. ship under NATO Operational Control) had conducted active sonar training against a Spanish submarine within 50 nmi (93 km) of the stranding site.

Veterinary pathologists necropsied the two male and two female Cuvier's beaked whales. According to the pathologists, the most likely primary cause of this type of beaked whale mass stranding event was anthropogenic acoustic activities, most probably anti-submarine MFAS used during the military naval exercises. However, no positive acoustic link was established as a direct cause of the stranding. Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004): Exercises were conducted in areas of at least 547 fathoms (1,000 m) depth near a shoreline where there is a rapid change in bathymetry on the order of 547 to 3,281 fathoms (1,000 to 6,000 m) occurring across a relatively short horizontal distance (Freitas, 2004); multiple ships (in this instance, five) were operating MFAS in the same area over extended periods of time (in this case, 20 hours) in close proximity; and exercises took place in an area surrounded by landmasses, or in an embayment. Exercises involving multiple ships employing MFAS near land may have produced sound directed towards a channel or embayment that may have cut off the lines of egress for the affected marine mammals (Freitas, 2004).

Behaviorally Mediated Responses to MFAS That May Lead to Stranding

Although the confluence of Navy MFAS with the other contributory factors noted in the report was identified as the cause of the 2000 Bahamas stranding event, the specific mechanisms that led to that stranding (or the others) are not understood, and there is uncertainty regarding the ordering of effects that led to the stranding. It is unclear whether beaked whales were directly injured by sound (*e.g.*, acoustically mediated bubble growth, as addressed above) prior to stranding or whether a behavioral response to sound occurred that ultimately caused the beaked whales to be injured and strand.

Although causal relationships between beaked whale stranding events and active sonar remain unknown, several authors have hypothesized that stranding events involving these species in the Bahamas and Canary Islands may have been triggered when the whales changed their dive behavior in a startled response to exposure to active sonar or to further avoid exposure (Cox *et al.*, 2006; Rommel *et al.*, 2006). These authors proposed three mechanisms by which the behavioral responses of beaked whales upon being exposed to active sonar might result in a stranding event. These include the following: Gas bubble formation caused by excessively fast surfacing; remaining at the surface too long when tissues are supersaturated with nitrogen; or diving prematurely when extended time at the surface is necessary to eliminate excess nitrogen. More specifically, beaked whales that occur in deep waters that are in close proximity to shallow waters (for example, the ''canyon areas'' that are cited in the Bahamas stranding event;

see D'Spain and D'Amico, 2006), may respond to active sonar by swimming into shallow waters to avoid further exposures and strand if they were not able to swim back to deeper waters. Second, beaked whales exposed to active sonar might alter their dive behavior. Changes in their dive behavior might cause them to remain at the surface or at depth for extended periods of time which could lead to hypoxia directly by increasing their oxygen demands or indirectly by increasing their energy expenditures (to remain at depth) and increase their oxygen demands as a result. If beaked whales are at depth when they detect a ping from an active sonar transmission and change their dive profile, this could lead to the formation of significant gas bubbles, which could damage multiple organs or interfere with normal physiological function (Cox *et al.*, 2006; Rommel *et al.*, 2006; Zimmer and Tyack, 2007). Baird *et al.* (2005) found that slow ascent rates from deep dives and long periods of time spent within 50 m of the surface were typical for both Cuvier's and Blainville's beaked whales, the two species involved in mass strandings related to naval sonar. These two behavioral mechanisms may be necessary to purge excessive dissolved nitrogen concentrated in their tissues during their frequent long dives (Baird *et al.*, 2005). Baird *et al.* (2005) further suggests that abnormally rapid ascents or premature dives in response to high-intensity sonar could indirectly result in physical harm to the beaked whales, through the mechanisms described above (gas bubble formation or non-elimination of excess nitrogen).

Because many species of marine mammals make repetitive and prolonged dives to great depths, it has long been assumed that marine mammals have evolved physiological mechanisms to protect against the effects of rapid and repeated decompressions. Although several investigators have identified physiological adaptations that may protect marine mammals against nitrogen gas supersaturation (alveolar collapse and elective circulation; Kooyman *et al.*, 1972; Ridgway and Howard, 1979), Ridgway and Howard (1979) reported that bottlenose dolphins that were trained to dive repeatedly had muscle tissues that were substantially supersaturated with nitrogen gas. Houser *et al.* (2001) used these data to model the accumulation of nitrogen gas within the muscle tissue of other marine mammal species and concluded that cetaceans that dive deep and have slow ascent or descent speeds would have tissues that are more supersaturated with nitrogen gas than other marine mammals. Based on these data, Cox *et al.* (2006) hypothesized that a critical dive sequence might make beaked whales more prone to stranding in response to acoustic exposures. The sequence began with (1) very deep (to depths as deep as 2 km) and long (as long as 90 minutes) foraging dives; (2) relatively slow, controlled ascents; and (3) a series of "bounce" dives between 100 and 400 m in depth (also see Zimmer and Tyack, 2007). They concluded that acoustic exposures that disrupted any part of this dive sequence (for example, causing beaked whales to spend more time at surface without the bounce dives that are necessary to recover from the deep dive) could produce excessive levels of nitrogen supersaturation in their tissues, leading to gas bubble and emboli formation that produces pathologies similar to decompression sickness.

Zimmer and Tyack (2007) modeled nitrogen tension and bubble growth in several tissue compartments for several hypothetical dive profiles and concluded that repetitive shallow dives (defined as a dive where depth does not exceed the depth of alveolar collapse, approximately 72 m for Ziphius), perhaps as a consequence of an extended avoidance reaction to sonar sound, could pose a risk for decompression sickness and that this risk should increase with the duration of the response. Their models also suggested that unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected. Tyack *et al.* (2006) suggested that emboli observed in animals exposed to mid-frequency range sonar (Jepson *et al.*, 2003; Fernandez *et al.*, 2005; Fernández *et al.*, 2012) could stem from a behavioral response that involves repeated dives shallower than the depth of lung collapse. Given that nitrogen gas accumulation is a passive process (*i.e.*, nitrogen is metabolically inert), a bottlenose dolphin was trained to repetitively dive a profile predicted to elevate nitrogen saturation to the point that nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of asymptomatic nitrogen gas bubbles (Houser *et al.*, 2007). Baird *et al.* (2008), in a beaked whale tagging study off Hawaii, showed that deep dives are equally common during day or night, but "bounce dives" are typically a daytime behavior, possibly associated with visual predator avoidance. This may indicate that "bounce dives" are associated with something other than behavioral regulation of dissolved nitrogen levels, which would be necessary day and night.

If marine mammals respond to a Navy vessel that is transmitting active sonar in the same way that they might respond to a predator, their probability of flight responses could increase when they perceive that Navy vessels are approaching them directly, because a direct approach may convey detection and intent to capture (Burger and Gochfeld, 1981, 1990; Cooper, 1997, 1998). The probability of flight responses could also increase as received levels of active sonar increase (and the ship is, therefore, closer) and as ship speeds increase (that is, as approach speeds increase). For example, the probability of flight responses in Dall's sheep (*Ovis dalli dalli*) (Frid 2001a, b), ringed seals (*Phoca hispida*) (Born *et al.*, 1999), Pacific brant (*Branta bernic nigricans*) and Canada geese (*B. canadensis*) increased as a helicopter or fixed-wing aircraft approached groups of these animals more directly (Ward *et al.*, 1999). Bald eagles (*Haliaeetus leucocephalus*) perched on trees alongside a river were also more likely to flee from a paddle raft when their perches were closer to the river or were closer to the ground (Steidl and Anthony, 1996).

Despite the many theories involving bubble formation (both as a direct cause of injury (see Acoustically Mediated Bubble Growth Section) and an indirect cause of stranding (See Behaviorally Mediated Bubble Growth Section), Southall *et al.* (2007) summarizes that there is either scientific disagreement or a lack of information regarding each of the following important points: (1) Received acoustical exposure conditions for animals involved in stranding events; (2) pathological interpretation of observed lesions in stranded marine mammals; (3) acoustic exposure conditions required to induce such physical trauma directly; (4) whether noise exposure may cause behavioral reactions (such as atypical diving behavior) that secondarily cause bubble formation and tissue damage; and (5) the extent the post mortem artifacts introduced by decomposition before sampling, handling, freezing, or necropsy procedures affect interpretation of observed lesions.

Strandings Along Southern California and Hawaii

Stranding events, specifically UMEs that occurred along Southern California or Hawaii (inclusive of the HSTT Study

Area) were previously discussed in the Description of Marine Mammals section.

Data were gathered from stranding networks that operate within and adjacent to the HSTT Study Area and reviewed in an attempt to better understand the frequency that marine mammal strandings occur and what major causes of strandings (both human-related and natural) exist in areas around the HSTT Study Area (NMFS, 2015a). From 2010 through 2014, there were 314 cetacean and phocid strandings reported in Hawaii, an annual average of 63 strandings per year. Twenty-seven species stranded in this region. The most common species reported include the Hawaiian monk seal, humpback whale, sperm whale, striped and spinner dolphin. Although many marine mammals likely strand due to natural or anthropogenic causes, the majority of reported type of occurrences in marine mammal strandings in the HSTT Study Area include fisheries interactions, entanglement, vessel strike and predation. Bradford and Lyman (2015) address overall threats from human activities and industries on stocks in Hawaii.

In 2004, a mass out-of-habitat aggregation of melon-headed whales occurred in Hanalei Bay (see discussion above under "Strandings Associated with Active Sonar"). It is speculated that sonar operated during a major training exercise may be related to the incident. Upon further investigation, sonar was only considered as a plausible, but not sole, contributing factor among many factors in the event. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (*e.g.*, specific traumas, species composition, etc.) (Southall *et al.*, 2006; U.S. Navy Marine Mammal Program & Space and Naval Warfare Systems Command Center Pacific, 2017). Additional information on this event is available in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Navy Marine Mammal Program & Space and Naval Warfare Systems Command Center Pacific, 2017). In addition, on October 31, 2017, at least five pilot whales live-stranded in Nawiliwili Harbor on Kauai. NMFS has yet to determine a cause for that stranding, but Navy activities can be dismissed from consideration given there were no Navy training or testing stressors present in the area before or during the stranding (National Marine Fisheries Service, 2017b).

Records for strandings in San Diego County (covering the shoreline for the Southern California portion of the HSTT Study Area) indicate that there were 143 cetacean and 1,235 pinniped strandings between 2010 and 2014, an annual average of about 29 and 247 per year, respectively. A total of 16 different species have been reported as stranded within this time frame. The majority of species reported include long-beaked common dolphins and California sea lions, but there were also reports of pacific white-sided, bottlenose and Risso's dolphins, gray, humpback, and fin whales, harbor seals and Northern elephant seals (National Marine Fisheries Service, 2015b, 2016a). However, stranded marine mammals are reported along the entire western coast of the United States each year. Within the same timeframe, there were 714 cetacean and 11,132 pinniped strandings reported outside of the Study Area, an annual average of about 142 and 2,226 respectively. Species that strand along the entire west coast are similar to those that typically strand within the Study Area with additional reports of harbor porpoise, Dall's porpoise, Steller sea lions, and various fur seals. The most common reported type of occurrence in stranded marine mammals in this region include fishery interactions, illness, predation, and vessel strikes (NMFS, 2016a). It is important to note that the mass stranding of pinnipeds along the west coast considered part of a NMFS declared UME are still being evaluated. The likely cause of this event is the lack of available prey near rookeries due to warming ocean temperatures (NOAA, 2016a). Carretta *et al.* (2013b; 2016b) provide additional information and data on the threats from human-related activities and the potential causes of strandings for the U.S. Pacific coast marine mammal stocks.

Potential Effects of Vessel Strike

Vessel collisions with marine mammals, also referred to as vessel strikes or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. Lethal interactions are typically associated with large whales, which are occasionally found draped across the bulbous bow of large commercial ships upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.*, 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.*, 2010; Gende *et al.*, 2011).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (*e.g.*, the sperm whale). In addition, some baleen whales, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.*, 2004). These species are primarily large, slow moving whales. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death or serious injury (Knowlton and Kraus, 2001; Laist *et al.*, 2001; Jensen and Silber, 2003; Pace and Silber, 2005; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 kn.

Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these 58 cases, 39 (or 67 percent) resulted in serious injury or death (19 of those resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 kn. The majority (79 percent) of these strikes occurred at speeds of 13 kn or greater. The average speed that resulted in serious injury or death was 18.6 kn. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 kn, and exceeded 90 percent at 17 kn. Higher

speeds during collisions result in greater force of impact and also appear to increase the chance of severe injuries or death. While modeling studies have suggested that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne, 1999; Knowlton *et al.*, 1995), this is inconsistent with Silber *et al.* (2010), which demonstrated that there is no such relationship (*i.e.*, hydrodynamic forces are independent of speed).

In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn. The chances of a lethal injury decline from approximately 80 percent at 15 kn to approximately 20 percent at 8.6 kn. At speeds below 11.8 kn, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward 100 percent above 15 kn.

The Jensen and Silber (2003) report notes that the database represents a minimum number of collisions, because the vast majority probably goes undetected or unreported. In contrast, Navy vessels are likely to detect any strike that does occur because of the required personnel training and lookouts (as described in the Proposed Mitigation Measures section), and they are required to report all ship strikes involving marine mammals. Overall, the percentage of Navy traffic relative to overall large shipping traffic are very small (on the order of two percent) and therefore represent a correspondingly smaller threat of potential ship strikes when compared to commercial shipping.

In the SOCAL portion of the HSTT Study Area, the Navy has struck a total of 16 marine mammals in the 20-year period from 1991 through 2010 for an average of one per year. Of the 16 Navy vessel strikes over the 20-year period in SOCAL, there were seven mortalities and nine injuries reported. The vessel struck species include: Two mortalities and eight injuries of unknown species, three mortalities of gray whales (one in 1993 and two in 1998), one mortality of a blue whale in 2004, and one morality and one injury of fin whales in 2009.

In the HRC portion of the HSTT Study Area, the Navy struck a total of five marine mammals in the 20-year period from 1991 through 2010, for an average of zero to one per year. Of the five Navy vessel strikes over the 20-year period in the HRC, all were reported as injuries. The vessel struck species include: one humpback whale in 1998, one unknown species and one humpback whale in 2003, one sperm whale in 2007, and an unknown species in 2008. No more than two whales were struck by Navy vessels in any given year in the HRC portion of the HSTT within the last 20 years. There was only one 12-month period in 20 years in the HRC when two whales were struck in a single year (2003).

Overall, there have been zero documented vessel strikes associated with training and testing in the SOCAL and HRC portions of the HSTT Study Area since 2010 and 2008, respectively.

Between 2007 and 2009, the Navy developed and distributed additional training, mitigation, and reporting tools to Navy operators to improve marine mammal protection and to ensure compliance with permit requirements. In 2009, the Navy implemented Marine Species Awareness Training designed to improve effectiveness of visual observation for marine resources including marine mammals. In subsequent years, the Navy issued refined policy guidance on ship strikes in order to collect the most accurate and detailed data possible in response to a possible incident (also see the Notification and Reporting Plan for this proposed rule). For over a decade, the Navy has implemented the Protective Measures Assessment Protocol software tool, which provides operators with notification of the required mitigation and a visual display of the planned training or testing activity location overlaid with relevant environmental data.

Marine Mammal Habitat

The Navy's proposed training and testing activities could potentially affect marine mammal habitat through the introduction of impacts to the prey species of marine mammals, acoustic habitat (sound in the water column), water quality, and important habitat for marine mammals. Each of these components was considered in the HSTT DEIS/OEIS and was determined by the Navy to have no effect on marine mammal habitat. Based on the information below and the supporting information included in the HSTT DEIS/OEIS, NMFS has determined that the proposed training and training activities would not have adverse or long-term impacts on marine mammal habitat.

Effects to Prey

Sound may affect marine mammals through impacts on the abundance, behavior, or distribution of prey species (*e.g.*, crustaceans, cephalopods, fish, zooplankton). Marine mammal prey varies by species, season, and location and, for some, is not well documented. Here, we describe studies regarding the effects of noise on known marine mammal prey. Fish utilize the soundscape and components of sound in their environment to perform important functions such as foraging, predator avoidance, mating, and spawning (*e.g.*, Zelick *et al.*, 1999; Fay, 2009). The most likely effects on fishes exposed to loud, intermittent, low-frequency sounds are behavioral responses (*i.e.*, flight or avoidance). Short duration, sharp sounds (such as pile driving or air guns) can cause overt or subtle changes in fish behavior and local distribution. The reaction of fish to acoustic sources depends on the physiological state of the fish, past exposures, motivation (*e.g.*, feeding, spawning, migration), and other environmental factors. Key impacts to fishes may include behavioral responses, hearing damage, barotrauma (pressure-related injuries), and mortality.

Fishes, like other vertebrates, have variety of different sensory systems to glean information from ocean around them (Astrup and Mohl, 1993; Astrup, 1999; Braun and Grande, 2008; Carroll *et al.*, 2017; Hawkins and Johnstone, 1978; Ladich and Popper, 2004; Ladich and Schulz-Mirbach, 2016; Mann, 2016; Nedwell *et al.*, 2004; Popper *et al.*, 2003; Popper *et al.*, 2005). Depending on their hearing anatomy and peripheral sensory structures, which vary among species, fishes hear sounds using pressure and particle motion sensitivity capabilities and detect the motion of surrounding water (Fay *et al.*, 2008) (terrestrial vertebrates generally only detect pressure). Most marine fishes primarily detect particle motion using the inner ear and lateral line system, while some fishes possess additional morphological adaptations or specializations that can enhance their sensitivity to sound pressure, such as a gas-filled swim bladder (Braun and Grande, 2008; Popper and Fay, 2011).

Hearing capabilities vary considerably between different fish species with data only available for just over 100 species out of the 34,000 marine and freshwater fish species (Eschmeyer and Fong 2016). In order to better understand acoustic impacts on fishes, fish hearing groups are defined by species that possess a similar continuum of anatomical features which result in varying degrees of hearing sensitivity (Popper and Hastings, 2009a). There are four hearing groups defined for all fish species (modified from Popper *et al.*, 2014) within this analysis and they include: Fishes without a swim bladder (*e.g.*, flatfish, sharks, rays, etc.); fishes with a

swim bladder not involved in hearing (*e.g.*, salmon, cod, pollock, etc.); fishes with a swim bladder involved in hearing (*e.g.*, sardines, anchovy, herring, etc.); and fishes with a swim bladder involved in hearing and high-frequency hearing (*e.g.*, shad and menhaden). Most marine mammal fish prey species would not be likely to perceive or hear Navy mid- or high-frequency sonars (see Figure 9–1 of the Navy's rulemaking/LOA application). Within Southern California, the Clupeiformes order of fish include the Pacific sardine (Clupeidae), and northern anchovy (Engraulidae), key forage fish in Southern California. While hearing studies have not been done on sardines and northern anchovies, it would not be unexpected for them to have hearing similarities to Pacific herring (up to 2–5 kHz) (Mann *et al.*, 2005). Currently, less data are available to estimate the range of best sensitivity for fishes without a swim bladder. In terms of physiology, multiple scientific studies have documented a lack of mortality or physiological effects to fish from exposure to low- and mid-frequency sonar and other sounds (Halvorsen *et al.*, 2012; Jørgensen *et al.*, 2005; Juanes *et al.*, 2017; Kane *et al.*, 2010; Kvadsheim and Sevaldsen, 2005; Popper *et al.*, 2007; Popper *et al.*, 2016; Watwood *et al.*, 2016). Techer *et al.* (2017) exposed carp in floating cages for up to 30 days to low-power 23 and 46 kHz source without any significant physiological response. Other studies have documented either a lack of TTS in species whose hearing range cannot perceive Navy sonar, or for those species that could perceive sonar-like signals, any TTS experienced would be recoverable (Halvorsen *et al.*, 2012; Ladich and Fay, 2013; Popper and Hastings, 2009a, 2009b; Popper *et al.*, 2014; Smith, 2016). Only fishes that have specializations that enable them to hear sounds above about 2,500 Hz (2.5 kHz) such as herring (Halvorsen *et al.*, 2012; Mann *et al.*, 2005; Mann, 2016; Popper *et al.*, 2014) would have the potential to receive TTS or exhibit behavioral responses from exposure to mid-frequency sonar. In addition, any sonar induced TTS to fish whose hearing range could perceive sonar would only occur in the narrow spectrum of the source (*e.g.*, 3.5 kHz) compared to the fish's total hearing range (*e.g.*, 0.01 kHz to 5 kHz). Overall, Navy sonar sources are much narrower in terms of source frequency compared to a given fish species full hearing range (see examples in Figure 9–1 of the Navy's rulemaking/LOA application).

In terms of behavioral responses, Juanes *et al.* (2017) discuss the potential for negative impacts from anthropogenic soundscapes on fish, but the author's focus was on broader based sounds such as ship and boat noise sources. Watwood *et al.* (2016) also documented no behavioral responses by reef fish after exposure to mid-frequency active sonar. Doksaeter *et al.* (2009; 2012) reported no behavioral responses to mid-frequency naval sonar by Atlantic herring, specifically, no escape reactions (vertically or horizontally) observed in free swimming herring exposed to mid-frequency sonar transmissions. Based on these results (Doksaeter *et al.*, 2009; Doksaeter *et al.*, 2012; Sivle *et al.*, 2012), Sivle *et al.* (2014) created a model in order to report on the possible population-level effects on Atlantic herring from active naval sonar. The authors concluded that the use of naval sonar poses little risk to populations of herring regardless of season, even when the herring populations are aggregated and directly exposed to sonar. Finally, Bruintjes *et al.* (2016) commented that fish exposed to any short-term noise within their hearing range might initially startle, but would quickly return to normal behavior.

The potential effects of air gun noise on fishes depends on the overlapping frequency range, distance from the sound source, water depth of exposure, and species-specific hearing sensitivity, anatomy, and physiology. Some studies have shown no or slight reaction to air gun sounds (*e.g.*, Pena *et al.*, 2013; Wardle *et al.*, 2001; Jorgenson and Gyselman, 2009; Cott *et al.*, 2012). More commonly, though, the impacts of noise on fish are temporary. Investigators reported significant, short-term declines in commercial fishing catch rate of gadid fishes during and for up to five days after survey operations, but the catch rate subsequently returned to normal (Engas *et al.*, 1996; Engas and Lokkeborg, 2002); other studies have reported similar findings (Hassel *et al.*, 2004). However, even temporary effects to fish distribution patterns can impact their ability to carry out important life-history functions (Paxton *et al.*, 2017). SPLs of sufficient strength have been known to cause injury to fish and fish mortality and, in some studies, fish auditory systems have been damaged by air gun noise (McCauley *et al.*, 2003; Popper *et al.*, 2005; Song *et al.*, 2008). However, in most fish species, hair cells in the ear continuously regenerate and loss of auditory function likely is restored when damaged cells are replaced with new cells. Halvorsen *et al.* (2012a) showed that a TTS of 4–6 dB was recoverable within 24 hrs for one species. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long. No mortality occurred to fish in any of these studies.

Occasional behavioral reactions to intermittent explosions and impulsive sound sources are unlikely to cause long-term consequences for individual fish or populations. Fish that experience hearing loss as a result of exposure to explosions and impulsive sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. However, PTS has not been known to occur in fishes and any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (Popper *et al.*, 2005; Popper *et al.*, 2014; Smith *et al.*, 2006). It is not known if damage to auditory nerve fibers could occur, and if so, whether fibers would recover during this process. It is also possible for fish to be injured or killed by an explosion in the immediate vicinity of the surface from dropped or fired ordnance, or near the bottom from shallow water bottom-placed underwater mine warfare detonations. Physical effects from pressure waves generated by underwater sounds (*e.g.*, underwater explosions) could potentially affect fish within proximity of training or testing activities. The shock wave from an underwater explosion is lethal to fish at close range, causing massive organ and tissue damage and internal bleeding (Keevin and Hempen, 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors including fish size, body shape, orientation, and species (Keevin and Hempen, 1997; Wright, 1982). At the same distance from the source, larger fish are generally less susceptible to death or injury, elongated forms that are round in cross-section are less at risk than deep-bodied forms, and fish oriented sideways to the blast suffer the greatest impact (Edds-Walton and Finneran, 2006; O'Keeffe, 1984; O'Keeffe and Young, 1984; Wiley *et al.*, 1981; Yelverton *et al.*, 1975). Species with gas-filled organs are more susceptible to injury and mortality than those without them (Gaspin, 1975; Gaspin *et al.*, 1976; Goertner *et al.*, 1994). Barotrauma injuries have been documented during controlled exposure to impact pile driving (an impulsive noise source, as are explosives and air guns) (Halvorsen *et al.*, 2012b; Casper *et al.*, 2013). For seismic surveys, the sound source is constantly moving, and most fish would likely avoid the sound

source prior to receiving sound of sufficient intensity to cause physiological or anatomical damage.

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright, 1982). However, Navy explosive use avoids hard substrate to the best extent practical during underwater detonations, or deep-water surface detonations (distance from bottom). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation. The abundances of various fish (and invertebrates) near the detonation point for explosives could be altered for a few hours before animals from surrounding areas repopulate the area. However, these populations would likely be replenished as waters near the detonation point are mixed with adjacent waters. Repeated exposure of individual fish to sounds from underwater explosions is not likely and are expected to be short-term and localized. Long-term consequences for fish populations would not be expected. Several studies have demonstrated that air gun sounds might affect the distribution and behavior of some fishes, potentially impacting foraging opportunities or increasing energetic costs (*e.g.*, Fewtrell and McCauley, 2012; Pearson *et al.*, 1992; Skalski *et al.*, 1992; Santulli *et al.*, 1999; Paxton *et al.*, 2017).

In conclusion, for fishes exposed to Navy sonar, there would be limited sonar use spread out in time and space across large offshore areas such that only small areas are actually ensonified (10's of miles) compared to the total life history distribution of fish prey species. There would be no probability for mortality and physical injury from sonar, and for most species, no or little potential for hearing or behavioral effects, except to a few select fishes with hearing specializations (*e.g.*, herring) that could perceive mid-frequency sonar. Training and testing exercises involving explosions are dispersed in space and time; therefore, repeated exposure of individual fishes are unlikely. Morality and injury effects to fishes from explosives would be localized around the area of a given in-water explosion, but only if individual fish and the explosive (and immediate pressure field) were co-located at the same time. Fishes deeper in the water column or on the bottom would not be affected by water surface explosions. Repeated exposure of individual fish to sound and energy from underwater explosions is not likely given fish movement patterns, especially schooling prey species. Most acoustic effects, if any, are expected to be short-term and localized. Long-term consequences for fish populations including key prey species within the HSTT Study Area would not be expected.

Invertebrates appear to be able to detect sounds (Pumphrey, 1950; Frings and Frings, 1967) and are most sensitive to low-frequency sounds (Packard *et al.*, 1990; Budelmann and Williamson, 1994; Lovell *et al.*, 2005; Mooney *et al.*, 2010). Data on response of invertebrates such as squid, another marine mammal prey species, to anthropogenic sound is more limited (de Soto, 2016; Sole *et al.*, 2017b). Data suggest that cephalopods are capable of sensing the particle motion of sounds and detect low frequencies up to 1–1.5 kHz, depending on the species, and so are likely to detect air gun noise (Kaifu *et al.*, 2008; Hu *et al.*, 2009; Mooney *et al.*, 2010; Samson *et al.*, 2014). Sole *et al.* (2017b) reported physiological injuries to cuttlefish in cages placed at-sea when exposed during a controlled exposure experiment to low-frequency sources (315 Hz, 139 to 142 dB re 1 μPa^2 and 400 Hz, 139 to 141 dB re 1 μPa^2). Fewtrell and McCauley (2012) reported squids maintained in cages displayed startle responses and behavioral changes when exposed to seismic air gun sonar (136–162 re 1 μPa^2-s). However, the sources Sole *et al.* (2017a) and Fewtrell and McCauley (2012) used are not similar and much lower than typical Navy sources within the HSTT Study Area. Nor do the studies address the issue of individual displacement outside of a zone of impact when exposed to sound. Cephalopods have a specialized sensory organ inside the head called a statocyst that may help an animal determine its position in space (orientation) and maintain balance (Budelmann, 1992). Packard *et al.* (1990) showed that cephalopods were sensitive to particle motion, not sound pressure, and Mooney et al. (2010) demonstrated that squid statocysts act as an accelerometer through which particle motion of the sound field can be detected. Auditory injuries (lesions occurring on the statocyst sensory hair cells) have been reported upon controlled exposure to low-frequency sounds, suggesting that cephalopods are particularly sensitive to low-frequency sound (Andre *et al.*, 2011; Sole *et al.*, 2013). Behavioral responses, such as inking and jetting, have also been reported upon exposure to low-frequency sound (McCauley *et al.*, 2000b; Samson *et al.*, 2014). Squids, like most fish species, are likely more sensitive to low frequency sounds, and may not perceive mid- and high-frequency sonars such as Navy sonars. Cumulatively for squid as a prey species, individual and population impacts from exposure to Navy sonar and explosives, like fish, are not likely to be significant, and explosive impacts would be short-term and localized.

Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. Exposure of fishes to vessel strike stressors is limited to those fish groups that are large, slow-moving, and may occur near the surface, such as ocean sunfish, whale sharks, basking sharks, and manta rays. These species are distributed widely in offshore portions of the Study Area. Any isolated cases of a Navy vessel striking an individual could injure that individual, impacting the fitness of an individual fish. Vessel strikes would not pose a risk to most of the other marine fish groups, because many fish can detect and avoid vessel movements, making strikes rare and allowing the fish to return to their normal behavior after the ship or device passes. As a vessel approaches a fish, they could have a detectable behavioral or physiological response (*e.g.*, swimming away and increased heart rate) as the passing vessel displaces them. However, such reactions are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of these marine fish groups at the population level and therefore would not have an impact on marine mammals species as prey items.

In addition to fish, prey sources such as marine invertebrates could potentially be impacted by sound stressors as a result of the proposed activities. However, most marine invertebrates' ability to sense sounds is very limited. In most cases, marine invertebrates would not respond to impulsive and non-impulsive sounds, although they may detect and briefly respond to nearby low-frequency sounds. These short-term responses would likely be inconsequential to invertebrate populations. Impacts to benthic communities from impulsive sound generated by active acoustic sound sources are not well documented. (*e.g.*, Andriguetto-Filho *et al.*, 2005; Payne *et al.*, 2007; 2008; Boudreau *et al.*, 2009). There are no published data that indicate whether temporary or permanent threshold shifts, auditory masking, or behavioral effects occur in benthic invertebrates (Hawkins *et al.*, 2014) and some studies showed no

short-term or long-term effects of air gun exposure (*e.g.*, Andriguetto-Filho *et al.*, 2005; Payne *et al.*, 2007; 2008; Boudreau *et al.*, 2009). Exposure to air gun signals was found to significantly increase mortality in scallops, in addition to causing significant changes in behavioral patterns during exposure (Day *et al.*, 2017). However, the authors state that the observed levels of mortality were not beyond naturally occurring rates. Explosions and pile driving could potentially kill or injure nearby marine invertebrates; however, mortality or long-term consequences for a few animals is unlikely to have measurable effects on overall stocks or populations.

Vessels also have the potential to impact marine invertebrates by disturbing the water column or sediments, or directly striking organisms (Bishop, 2008). The propeller wash (water displaced by propellers used for propulsion) from vessel movement and water displaced from vessel hulls can potentially disturb marine invertebrates in the water column and is a likely cause of zooplankton mortality (Bickel *et al.*, 2011). The localized and short-term exposure to explosions or vessels could displace, injure, or kill zooplankton, invertebrate eggs or larvae, and macro-invertebrates. However, mortality or long-term consequences for a few animals is unlikely to have measurable effects on overall stocks or populations.

There is little information concerning potential impacts of noise on zooplankton populations. However, one recent study (McCauley *et al.*, 2017) investigated zooplankton abundance, diversity, and mortality before and after exposure to air gun noise, finding that the exposure resulted in significant depletion for more than half the taxa present and that there were two to three times more dead zooplankton after air gun exposure compared with controls for all taxa. The majority of taxa present were copepods and cladocerans; for these taxa, the range within which effects on abundance were detected was up to approximately 1.2 km. In order to have significant impacts on *r*-selected species such as plankton, the spatial or temporal scale of impact must be large in comparison with the ecosystem concerned (McCauley *et al.*, 2017). Therefore, the large scale of effect observed here is of concern—particularly where repeated noise exposure is expected—and further study is warranted.

Overall, the combined impacts of sound exposure, explosions, vessel strikes, and military expended materials resulting from the proposed activities would not be expected to have measurable effects on populations of marine mammal prey species. Prey species exposed to sound might move away from the sound source, experience TTS, experience masking of biologically relevant sounds, or show no obvious direct effects. Mortality from decompression injuries is possible in close proximity to a sound, but only limited data on mortality in response to air gun noise exposure are available (Hawkins *et al.*, 2014). The most likely impacts for most prey species in a given area would be temporary avoidance of the area. Surveys using towed air gun arrays move through an area relatively quickly, limiting exposure to multiple impulsive sounds. In all cases, sound levels would return to ambient once a survey ends and the noise source is shut down and, when exposure to sound ends, behavioral and/or physiological responses are expected to end relatively quickly (McCauley *et al.*, 2000b). The duration of fish avoidance of a given area after survey effort stops is unknown, but a rapid return to normal recruitment, distribution, and behavior is anticipated. While the potential for disruption of spawning aggregations or schools of important prey species can be meaningful on a local scale, the mobile and temporary nature of most surveys and the likelihood of temporary avoidance behavior suggest that impacts would be minor. Long-term consequences to marine invertebrate populations would not be expected as a result of exposure to sounds or vessels in the Study Area. Military expended materials resulting from training and testing activities could potentially result in minor long-term changes to benthic habitat. Military expended materials may be colonized over time by benthic organisms that prefer hard substrate and would provide structure that could attract some species of fish or invertebrates.

Acoustic Habitat

Acoustic habitat is the soundscape which encompasses all of the sound present in a particular location and time, as a whole when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.*, produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic, may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of air gun arrays), or for Navy training and testing purposes (as in the use of sonar and explosives and other acoustic sources). Anthropogenic noise varies widely in its frequency, content, duration, and loudness and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please also see the previous discussion on "Masking"), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). For more detail on these concepts see, *e.g.*, Barber *et al.*, 2009; Pijanowski *et al.*, 2011; Francis and Barber, 2013; Lillis *et al.*, 2014.

The term "listening area" refers to the region of ocean over which sources of sound can be detected by an animal at the center of the space. Loss of communication space concerns the area over which a specific animal signal, used to communicate with conspecifics in biologically-important contexts (*e.g.*, foraging, mating), can be heard, in noisier relative to quieter conditions (Clark *et al.*, 2009). Lost listening area concerns the more generalized contraction of the range over which animals would be able to detect a variety of signals of biological importance, including eavesdropping on predators and prey (Barber *et al.*, 2009). Such metrics do not, in and of themselves, document fitness consequences for the marine animals that live in chronically noisy environments. Long-term population-level consequences mediated through changes in the ultimate survival and reproductive success of individuals are difficult to study, and particularly so underwater. However, it is increasingly well documented that aquatic species rely on qualities of natural acoustic

habitats, with researchers quantifying reduced detection of important ecological cues (*e.g.*, Francis and Barber, 2013; Slabbekoorn *et al.*, 2010) as well as survivorship consequences in several species (*e.g.*, Simpson *et al.*, 2014; Nedelec *et al.*, 2015).

Sound produced from training and testing activities in the HSTT Study Area is temporary and transitory. The sounds produced during training and testing activities can be widely dispersed or concentrated in small areas for varying periods. Any anthropogenic noise attributed to training and testing activities in the HSTT Study Area would be temporary and the affected area would be expected to immediately return to the original state when these activities cease.

Water Quality

The HSTT DEIS/OEIS analyzed the potential effects on water quality from military expended materials. Training and testing activities may introduce water quality constituents into the water column. Based on the analysis of the HSTT DEIS/OEIS, military expended materials (*e.g.*, undetonated explosive materials) would be released in quantities and at rates that would not result in a violation of any water quality standard or criteria. High-order explosions consume most of the explosive material, creating typical combustion products. For example, in the case of Royal Demolition Explosive, 98 percent of the products are common seawater constituents and the remainder is rapidly diluted below threshold effect level. Explosion by-products associated with high order detonations present no secondary stressors to marine mammals through sediment or water. However, low order detonations and unexploded ordnance present elevated likelihood of impacts on marine mammals.

Indirect effects of explosives and unexploded ordnance to marine mammals via sediment is possible in the immediate vicinity of the ordnance. Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo, 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6–12 in (0.15–0.3 m) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3–6 ft (1–2 m) from the degrading ordnance. Taken together, it is possible that marine mammals could be exposed to degrading explosives, but it would be within a very small radius of the explosive (1–6 ft (0.3–2 m)).

Equipment used by the Navy within the HSTT Study Area, including ships and other marine vessels, aircraft, and other equipment, are also potential sources of by-products. All equipment is properly maintained in accordance with applicable Navy or legal requirements. All such operating equipment meets Federal water quality standards, where applicable.

Estimated Take of Marine Mammals

This section indicates the number of takes that NMFS is proposing to authorize which is based on the amount of take that NMFS anticipates could or is likely to occur, depending on the type of take and the methods used to estimate it, as described in detail below. NMFS coordinated closely with the Navy in the development of their incidental take application, and with one exception, preliminarily agrees that the methods the Navy has put forth described herein to estimate take (including the model, thresholds, and density estimates), and the resulting numbers estimated for authorization, are appropriate and based on the best available science.

Takes are predominantly in the form of harassment, but a small number of mortalities are also estimated. For a military readiness activity, the MMPA defines ''harassment'' as (i) Any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (ii) Any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered (Level B Harassment).

Authorized takes would primarily be in the form of Level B harassment, as use of the acoustic and explosive sources (*i.e.*, sonar, air guns, pile driving, explosives) is likely to result in the disruption of natural behavioral patterns to a point where they are abandoned or significantly altered (as defined specifically at the beginning of this section, but referred to generally as behavioral disruption) or TTS for marine mammals. There is also the potential for Level A harassment, in the form of auditory injury and/or tissue damage (latter for explosives only) to result from exposure to the sound sources utilized in training and testing activities. Lastly, a limited number of serious injuries or mortalities could occur for California sea lion and short-beaked common dolphin (10 mortalities total between the two species over the 5-year period) from explosives, and no more than three serious injuries or mortalities total (over the five-year period) of large whales through vessel collisions. Although we analyze the impacts of these potential serious injuries or mortalities that are proposed for authorization, the proposed mitigation and monitoring measures are expected to minimize the likelihood (*i.e.*, further lower the already low probability) that ship strike or these explosive exposures (and the associated serious injury or mortality) occur.

Described in the most basic way, we estimate the amount and type of harassment by considering: (1) Acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed (in this case, as defined in the military readiness definition included above) or incur some degree of temporary or permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days during which activities might occur. Below, we describe these components in more detail and present the proposed take estimate.

Acoustic Thresholds

Using the best available science, and in coordination with the Navy, NMFS has established acoustic thresholds above which exposed marine mammals would reasonably be expected to experience a disruption in behavioral patterns to a point where they are abandoned or significantly altered, or to incur TTS (equated to Level B harassment) or PTS of some degree (equated to Level A harassment). Thresholds have also been developed to identify the pressure levels above which animals may incur different types of tissue damage from exposure to pressure waves from explosive detonation.

Hearing Impairment (TTS/PTS and Tissue Damage and Mortality)

Non-Impulsive and Impulsive

NMFS's Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Technical Guidance, 2016) identifies dual criteria to assess auditory injury (Level A harassment) to five different

marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). The Technical Guidance also identifies criteria to predict TTS, which is not considered injury and falls into the Level B Harassment category. The Navy's Specified Activities includes the use of non-impulsive (sonar, vibratory pile driving/removal) sources and impulsive (explosives, air guns, impact pile driving) sources.

These thresholds (Tables 14–15) were developed by compiling and synthesizing the best available science and soliciting input multiple times from both the public and peer reviewers to inform the final product, and are provided in the table below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2016 Technical Guidance, which may be accessed at: *http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm*.

TABLE 14—ACOUSTIC THRESHOLDS IDENTIFYING THE ONSET OF TTS AND PTS FOR NON-IMPULSIVE SOUND SOURCES BY FUNCTIONAL HEARING GROUPS

Functional hearing group	Non-impulsive	
	TTS threshold SEL (weighted)	PTS threshold SEL (weighted)
Low-Frequency Cetaceans	179	199
Mid-Frequency Cetaceans	178	198
High-Frequency Cetaceans	153	173
Phocid Pinnipeds (Underwater)	181	201
Otarid Pinnipeds (Underwater)	199	219

Note: SEL thresholds in dB re 1 μPa^2s.

Based on the best available science, the Navy (in coordination with NMFS) used the acoustic and pressure thresholds indicated in Table 15 to predict the onset of TTS, PTS, tissue damage, and mortality for explosives (impulsive) and other impulsive sound sources.

TABLE 15—ONSET OF TTS, PTS, TISSUE DAMAGE, AND MORTALITY THRESHOLDS FOR MARINE MAMMALS FOR EXPLOSIVES AND OTHER IMPULSIVE SOURCES

Functional hearing group	Species	Weighted onset TTS	Weighted onset PTS	Mean onset slight GI tract injury	Mean onset slight lung injury	Mean onset mortality
Low-frequency cetaceans	All mysticetes	168 dB SEL or 213 dB Peak SPL.	183 dB SEL or 219 dB Peak SPL.	237 dB Peak SPL.	Equation 1 ..	Equation 2.
Mid-frequency cetaceans	Most delphinids, medium and large toothed whales.	170 dB SEL or 224 dB Peak SPL.	185 dB SEL or 230 dB Peak SPL.	237 dB Peak SPL.		
High-frequency cetaceans	Porpoises and *Kogia spp*	140 dB SEL or 196 dB Peak SPL.	155 dB SEL or 202 dB Peak SPL.	237 dB Peak SPL.		
Phocidae	Harbor seal, Hawaiian monk seal, Northern elephant seal.	170 dB SEL or 212 dB Peak SPL.	185 dB SEL or 218 dB Peak SPL.	237 dB Peak SPL.		
Otariidae	California sea lion, Guadalupe fur seal, Northern fur seal.	188 dB SEL or 226 dB Peak SPL.	203 dB SEL or 232 dB Peak SPL.	237 dB Peak SPL.		

Notes:
Equation 1: $47.5M^{1/3}$ $(1 + [D_{Rm} / 10.1])^{1/6}$ Pa-sec.
Equation 2: $103M^{1/3}$ $(1 + [D_{Rm} / 10.1])^{1/6}$ Pa-sec.
M = mass of the animals in kg.
D_{Rm} = depth of the receiver (animal) in meters.
SPL = sound pressure level.

Impulsive—Air Guns and Impact Pile Driving

Impact pile driving produces impulsive noise; therefore, the criteria used to assess the onset of TTS and PTS are identical to those used for air guns, as well as explosives (see Table 15 above) (see Hearing Loss from air guns in Section 6.4.3.1, Methods for Analyzing Impacts from air guns in the Navy's rulemaking/LOA application). Refer to the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived.

Non-Impulsive—Sonar and Vibratory Pile Driving/Removal

Vibratory pile removal (that will be used during the ELCAS) creates continuous non-impulsive noise at low source levels for a short duration. Therefore, the criteria used to assess the onset of TTS and PTS due to exposure to sonars (non-impulsive, see Table 14 above) are also used to assess auditory impacts to marine mammals from vibratory pile driving (see Hearing Loss from Sonar and Other Transducers in Section 6.4.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers in the Navy's rulemaking/LOA application). Refer to the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived. Non-auditory injury (*i.e.*, other than PTS) and mortality from sonar and other transducers is so unlikely as to be discountable under normal conditions for the reasons explained in the Potential Effects of Specified Activities on Marine Mammals and Their Habitat

section under "*Acoustically Mediated Bubble Growth and other Pressure-related Injury*" and is therefore not considered further in this analysis.

Behavioral Harassment

Marine mammal responses (some of which are considered disturbances that rise to the level of a take) to sound are highly variable and context specific (affected by differences in acoustic conditions, differences between species and populations; differences in gender, age, reproductive status, or social behavior; or other prior experience of the individuals), which means that there is support for alternative approaches for estimating behavioral harassment. Although the statutory definition of Level B harassment for military readiness activities requires that the natural behavior patterns of a marine mammal be significantly altered or abandoned in order to qualify as a take, the current state of science for determining those thresholds is still evolving and indefinite. In its analysis of impacts associated with sonar acoustic sources (which was coordinated with NMFS), the Navy proposes, and NMFS supports, an updated conservative approach that likely overestimates the number of takes by Level B harassment due to behavioral disturbance and response. Many of the responses estimated using the Navy's quantitative analysis are most likely to be moderate severity (see Southall *et al.*, 2007 for behavior response severity scale). Moderate severity responses would be considered significant if they were sustained for a duration long enough that it caused an animal to be outside of normal variation in daily behavioral patterns in feeding, reproduction, resting, migration/movement, or social cohesion. Many of the behavioral reactions predicted by the Navy's quantitative analysis are only expected to exceed an animal's behavioral threshold for a single exposure lasting several minutes. It is therefore likely that some of the exposures that are included in the estimated behavioral harassment takes would not actually constitute significant alterations or abandonment of natural behavior patterns. The Navy and NMFS have used the best available science to address the challenge of differentiating between behavioral reactions that rise to the level of a take and those that do not, but have erred on the side of caution where uncertainty exists (*e.g.*, counting these lower duration reactions as take). This conservative choice likely results in some degree of overestimation of behavioral harassment take. Therefore, this analysis includes the maximum number of behavioral disturbances and responses that are reasonably possible to occur.

Air Guns and Pile Driving

Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.*, frequency, predictability, duty cycle), the environment (*e.g.*, bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.*, 2007, Ellison *et al.*, 2011). Based on what the available science indicates and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 µPa (rms) for continuous (*e.g.*, vibratory pile-driving, drilling) and above 160 dB re 1 µPa (rms) for non-explosive impulsive (*e.g.*, seismic air guns) or intermittent (*e.g.*, scientific sonar) sources. To estimate behavioral effects from air guns, the existing NMFS Level B harassment threshold of 160 dB re 1 µPa (rms) is used. The root mean square calculation for air guns is based on the duration defined by 90 percent of the cumulative energy in the impulse.

The existing NMFS Level B harassment thresholds were also applied to estimate behavioral effects from impact and vibratory pile driving (Table 16).

TABLE 16—PILE DRIVING LEVEL B THRESHOLDS USED IN THIS ANALYSIS TO PREDICT BEHAVIORAL RESPONSES FROM MARINE MAMMALS

Pile driving criteria (SPL, dB re 1 µPa) Level B disturbance threshold	
Underwater vibratory	Underwater impact
120 dB rms	160 dB rms.

Notes: Root mean square calculation for impact pile driving is based on the duration defined by 90 percent of the cumulative energy in the impulse. Root mean square for vibratory pile driving is calculated based on a representative time series long enough to capture the variation in levels, usually on the order of a few seconds.

dB: decibel; dB re 1 µPa: decibel referenced to 1 micropascal; rms: root mean square.

Sonar

As noted, the Navy coordinated with NMFS to propose behavioral harassment thresholds specific to their military readiness activities utilizing active sonar. Behavioral response criteria are used to estimate the number of animals that may exhibit a behavioral response to sonar and other transducers. The way the criteria were derived is discussed in detail in the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c). Developing the new behavioral criteria involved multiple steps. All peer-reviewed published behavioral response studies conducted both in the field and on captive animals were examined in order to understand the breadth of behavioral responses of marine mammals to sonar and other transducers. NMFS supported the development of this methodology and considered it appropriate to calculate take and support the preliminary determinations made in the proposed rule.

In the Navy acoustic impact analyses during Phase II, the likelihood of behavioral effects to sonar and other transducers was based on a probabilistic function (termed a behavioral response function—BRF), that related the likelihood (*i.e.*, probability) of a behavioral response to the received SPL. The BRF was used to estimate the percentage of an exposed population that is likely to exhibit altered behaviors or behavioral disturbance at a given received SPL. This BRF relied on the assumption that sound poses a negligible risk to marine mammals if they are exposed to SPL below a certain "basement" value. Above the basement exposure SPL, the probability of a response increased with increasing SPL. Two BRFs were used in Navy acoustic impact analyses: BRF1 for mysticetes and BRF2 for other species. BRFs were not used for beaked whales during Phase II analyses. Instead, step functions at SPLs of 120 dB re 1 µPa and 140 dB re 1 µPa were used for harbor porpoises and beaked whales, respectively, as thresholds to predict behavioral disturbance. It should be noted that in the HSTT Study Area there are no harbor porpoise.

Developing the new behavioral criteria for Phase III involved multiple steps: All available behavioral response studies conducted both in the field and on captive animals were examined in order to better understand the breadth of behavioral responses of marine mammals to sonar and other transducers. Marine mammal species

were placed into behavioral criteria groups based on their known or suspected behavioral sensitivities to sound. In most cases these divisions were driven by taxonomic classifications (*e.g.*, mysticetes, pinnipeds). The data from the behavioral studies were analyzed by looking for significant responses, or lack thereof, for each experimental session.

The Navy used cutoff distances beyond which the potential of significant behavioral responses (and therefore Level B harassment) is considered to be unlikely (see Table 16 below). For animals within the cutoff distance, a behavioral response function based on a received SPL as presented in Section 3.1.0 of the Navy's rulemaking/LOA application was used to predict the probability of a potential significant behavioral response. For training and testing events that contain multiple platforms or tactical sonar sources that exceed 215 dB re 1 µPa @1 1 m, this cutoff distance is substantially increased (*i.e.*, doubled) from values derived from the literature. The use of multiple platforms and intense sound sources are factors that probably increase responsiveness in marine mammals overall. There are currently few behavioral observations under these circumstances; therefore, the Navy conservatively predicted significant behavioral responses at farther ranges as shown in Table 17, versus less intense events.

TABLE 17—CUTOFF DISTANCES FOR MODERATE SOURCE LEVEL, SINGLE PLATFORM TRAINING AND TESTING EVENTS AND FOR ALL OTHER EVENTS WITH MULTIPLE PLATFORMS OR SONAR WITH SOURCE LEVELS AT OR EXCEEDING 215 dB re 1 µPa @1 m

Criteria group	Moderate SL/ single platform cutoff distance (km)	High SL/ multi-platform cutoff distance (km)
Odontocetes	10	20
Pinnipeds	5	10
Mysticetes	10	20
Beaked Whales	25	50
Harbor Porpoise	20	40

Notes: dB re 1 µPa @1 m: Decibels referenced to 1 micropascal at 1 meter; km: kilometer; SL: source level.
There are no harbor porpoise in the HSTT Study Area, but are included in Table 16 for consistency with other Navy Proposed Rules.

Tables 18–22 show the range to received sound levels in 6-dB steps from 5 representative sonar bins and the percentage of animals that may be taken under each behavioral response function. Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group and therefore are not included in the estimated take. See Section 6.4.2.1.1 (Methods for Analyzing Impacts from Sonars and Other Transducers) of the Navy's application for further details on the derivation and use of the behavioral response functions, thresholds, and the cutoff distances, which were coordinated with NMFS. Table 18 illustrates the potentially significant behavioral response for LFAS.

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Table 18. Ranges to a Potentially Significant Behavioral Response for Sonar Bin LF5 over a Representative Range of Environments within the HSTT Study Area.

Received Level (dB re 1 µPa-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin LF5M*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
178	1 (1–1)	97%	59%	92%	100%
172	2 (1–2)	91%	30%	76%	99%
166	3 (1–5)	78%	20%	48%	97%
160	7 (1–13)	58%	18%	27%	93%
154	16 (1–30)	40%	17%	18%	83%
148	35 (1–85)	29%	16%	16%	66%
142	81 (1–230)	25%	13%	15%	45%
136	183 (1–725)	23%	9%	15%	28%
130	404 (1–1,525)	20%	5%	15%	18%
124	886 (1–3,025)	17%	2%	14%	14%
118	1,973 (725–5,775)	12%	1%	13%	12%
112	4,472 (900–18,275)	6%	0%	9%	11%
106	8,936 (900–54,525)	3%	0%	5%	11%
100	27,580 (900–88,775)	1%	0%	3%	8%

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

Tables 19 through Table 21 illustrates the potentially significant behavioral response for MFAS.

Table 19. Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF1 over a Representative Range of Environments within the HSTT Study Area.

Received Level (dB re 1 µPa-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin MF1*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	109 (100–110)	100%	100%	100%	100%
190	239 (190–250)	100%	98%	99%	100%
184	502 (310–575)	99%	88%	98%	100%
178	1,024 (550–2,025)	97%	59%	92%	100%
172	2,948 (625–5,775)	91%	30%	76%	99%
166	6,247 (625–10,025)	78%	20%	48%	97%
160	11,919 (650–20,525)	58%	18%	27%	93%
154	20,470 (650–62,025)	40%	17%	18%	83%
148	33,048 (725–63,525)	29%	16%	16%	66%
142	43,297 (2,025–71,775)	25%	13%	15%	45%
136	52,912 (2,275–91,525)	23%	9%	15%	28%
130	61,974 (2,275–100,000*)	20%	5%	15%	18%
124	66,546 (2,275–100,000*)	17%	2%	14%	14%
118	69,637 (2,525–100,000*)	12%	1%	13%	12%
112	73,010 (2,525–100,000*)	6%	0%	9%	11%
106	75,928 (2,525–100,000*)	3%	0%	5%	11%
100	78,899 (2,525–100,000*)	1%	0%	2%	8%

Note. Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Table 20. Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF4 over a Representative Range of Environments within the HSTT Study Area.

Received Level (dB re 1 µPa-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin MF4*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	8 (1–8)	100%	100%	100%	100%
190	17 (1–17)	100%	98%	99%	100%
184	34 (1–35)	99%	88%	98%	100%
178	68 (1–75)	97%	59%	92%	100%
172	145 (130–300)	91%	30%	76%	99%
166	388 (270–875)	78%	20%	48%	97%
160	841 (470–1,775)	58%	18%	27%	93%
154	1,748 (700–6,025)	40%	17%	18%	83%
148	3,163 (1,025–13,775)	29%	16%	16%	66%
142	5,564 (1,275–27,025)	25%	13%	15%	45%
136	8,043 (1,525–54,275)	23%	9%	15%	28%
130	17,486 (1,525–65,525)	20%	5%	15%	18%
124	27,276 (1,525–84,775)	17%	2%	14%	14%
118	33,138 (2,775–85,275)	12%	1%	13%	12%
112	39,864 (3,775–100,000*)	6%	0%	9%	11%
106	45,477 (5,275–100,000*)	3%	0%	5%	11%
100	48,712 (5,275–100,000*)	1%	0%	2%	8%

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Table 21. Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF5 over a Representative Range of Environments within the HSTT Study Area.

Received Level (dB re 1 µPa-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin MF5*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	0 (0–0)	100%	100%	100%	100%
190	2 (1–3)	100%	98%	99%	100%
184	4 (1–7)	99%	88%	98%	100%
178	14 (1–15)	97%	59%	92%	100%
172	29 (1–30)	91%	30%	76%	99%
166	59 (1–70)	78%	20%	48%	97%
160	133 (1–340)	58%	18%	27%	93%
154	309 (1–950)	40%	17%	18%	83%
148	688 (430–2,275)	29%	16%	16%	66%
142	1,471 (650–4,025)	25%	13%	15%	45%
136	2,946 (700–7,525)	23%	9%	15%	28%
130	5,078 (725–11,775)	20%	5%	15%	18%
124	7,556 (725–19,525)	17%	2%	14%	14%
118	10,183 (725–27,775)	12%	1%	13%	12%
112	13,053 (725–63,025)	6%	0%	9%	11%
106	16,283 (1,025–64,525)	3%	0%	5%	11%
100	20,174 (1,025–70,525)	1%	0%	2%	8%

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Table 22 illustrates the potentially significant behavioral response for HFAS.

Table 22. Ranges to a Potentially Significant Behavioral Response for Sonar Bin HF4 over a Representative Range of Environments within the HSTT Study Area.

Received Level (dB re 1 µPa-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin HF4*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	3 (1–6)	100%	100%	100%	100%
190	8 (1–16)	100%	98%	99%	100%
184	17 (1–35)	99%	88%	98%	100%
178	34 (1–90)	97%	59%	92%	100%
172	68 (1–180)	91%	30%	76%	99%
166	133 (12–430)	78%	20%	48%	97%
160	255 (30–750)	58%	18%	27%	93%
154	439 (50–1,525)	40%	17%	18%	83%
148	694 (85–2,275)	29%	16%	16%	66%
142	989 (110–3,525)	25%	13%	15%	45%
136	1,378 (170–4,775)	23%	9%	15%	28%
130	1,792 (270–6,025)	20%	5%	15%	18%
124	2,259 (320–7,525)	17%	2%	14%	14%
118	2,832 (320–8,525)	12%	1%	13%	12%
112	3,365 (320–10,525)	6%	0%	9%	11%
106	3,935 (320–12,275)	3%	0%	5%	11%
100	4,546 (320–16,775)	1%	0%	2%	8%

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts. dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

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Explosives

Phase III explosive criteria for behavioral thresholds for marine mammals is the hearing groups' TTS threshold minus 5 dB (see Table 23 below and Table 15 for the TTS thresholds for explosives) for events that contain multiple impulses from explosives underwater. This was the same approach as taken in Phase II for explosive analysis. See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived.

TABLE 23—PHASE III BEHAVIORAL THRESHOLDS FOR EXPLOSIVES FOR MARINE MAMMALS

Medium	Functional hearing group	SEL (weighted)
Underwater	LF	163
Underwater	MF	165
Underwater	HF	135
Underwater	PW	165
Underwater	OW	183

Note: Weighted SEL thresholds in dB re 1 μPa^2s underwater.

Navy's Acoustic Effects Model

Sonar and Other Transducers and Explosives

The Navy's Acoustic Effects Model calculates sound energy propagation from sonar and other transducers and explosives during naval activities and the sound received by animat dosimeters. Animat dosimeters are virtual representations of marine mammals distributed in the area around the modeled naval activity that each records its individual sound "dose." The model bases the distribution of animats over the HSTT Study Area on the density values in the *Navy Marine Species Density Database* and distributes animats in the water column proportional to the known time that species spend at varying depths.

The model accounts for environmental variability of sound propagation in both distance and depth when computing the received sound level received by the animats. The model conducts a statistical analysis based on multiple model runs to compute the estimated effects on animals. The number of animats that exceed the thresholds for effects is tallied to provide an estimate of the number of marine mammals that could be affected.

Assumptions in the Navy model intentionally err on the side of overestimation when there are unknowns. Naval activities are modeled as though they would occur regardless of proximity to marine mammals meaning that no mitigation is considered (*i.e.*, no power down or shut down modeled) and without any avoidance of the activity by the animal. The final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation and the possibility that marine mammals would avoid continued or repeated sound exposures. For more information on this process, see the discussion in the "Take Requests" subsection below. Many explosions from ordnance such as bombs and missiles actually occur upon impact with above-water targets. However, for this analysis, sources such as these were modeled as exploding underwater. This overestimates the amount of explosive and acoustic energy entering the water.

The model estimates the impacts caused by individual training and testing exercises. During any individual modeled event, impacts to individual animats are considered over 24-hour periods. The animats do not represent actual animals, but rather they represent a distribution of animals based on density and abundance data, which allows for a statistical analysis of the number of instances that marine mammals may be exposed to sound levels resulting in an effect. Therefore, the model estimates the number of instances in which an effect threshold was exceeded over the course of a year, but does not estimate the number of individual marine mammals that may be impacted over a year (*i.e.*, some marine mammals could be impacted several times, while others would not experience any impact). A detailed explanation of the Navy's Acoustic Effects Model is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing report* (U.S. Department of the Navy, 2017b).

Air Guns and Pile Driving

The Navy's quantitative analysis estimates the sound and energy received by marine mammals distributed in the area around planned Navy activities involving air guns. The analysis for air guns was similar to explosives as an impulsive source, except explosive impulsive sources were placed into bins based on net explosive weights, while each non-explosive impulsive source (air guns) was assigned its own unique bin. The impulsive model used in the Navy's analysis used metrics to describe the sound received by the animats and the SPL_{rms} criteria was only applied to air guns. See the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing report* (U.S. Department of the Navy, 2017b) for additional details.

Underwater noise effects from pile driving and vibratory pile extraction were modeled using actual measures of impact pile driving and vibratory removal during construction of an Elevated Causeway System (Illingworth and Rodkin, 2015, 2016). A conservative estimate of spreading loss of sound in shallow coastal waters (*i.e.*, transmission loss = 16.5 * Log10 (radius)) was applied based on spreading loss observed in actual measurements. Inputs used in the model are provided in Section 1.4.1.3 (Pile Driving) of the Navy's rulemaking/LOA application, including source levels; the number of strikes required to drive a pile and the duration of vibratory removal per pile; the number of piles driven or removed per day; and the number of days of pile driving and removal.

Range to Effects

The following section provides range to effects for sonar and other active acoustic sources as well as explosives to specific acoustic thresholds determined using the Navy Acoustic Effects Model. Marine mammals exposed within these ranges for the shown duration are predicted to experience the associated effect. Range to effects is important information not only for predicting acoustic impacts, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects to marine mammals.

Sonar

The range to received sound levels in 6-dB steps from 5 representative sonar bins and the percentage of the total number of animals that may exhibit a significant behavioral response (and therefore Level B harassment) under each behavioral response function are shown in Table 18 through Table 22 above, respectively. See Section 6.4.2.1.1 (Impact Ranges for Sonar and Other Transducers) of the Navy's rulemaking/LOA application for additional details on the derivation and use of the behavioral response functions, thresholds, and the cutoff distances.

The ranges to the PTS for five representative sonar systems for an

exposure of 30 seconds is shown in Table 24 relative to the marine mammal's functional hearing group. This period (30 seconds) was chosen based on examining the maximum amount of time a marine mammal would realistically be exposed to levels that could cause the onset of PTS based on platform (*e.g.*, ship) speed and a nominal animal swim speed of approximately 1.5 m per second. The ranges provided in the table include the average range to PTS, as well as the range from the minimum to the maximum distance at which PTS is possible for each hearing group.

TABLE 24—RANGE TO PERMANENT THRESHOLD SHIFT (METERS) FOR FIVE REPRESENTATIVE SONAR SYSTEMS

Functional hearing group	Approximate range in meters for PTS from 30 seconds exposure				
	Sonar bin LF	Sonar bin MF1	Sonar bin MF4	Sonar bin MF5	Sonar bin HF4
Low-frequency Cetacean	0 (0–0)	65 (65–65)	14 (0–15)	0 (0–0)	0 (0–0)
Mid-frequency Cetacean	0 (0–0)	16 (16–16)	3 (3–3)	0 (0–0)	1 (0–2)
High-frequency Cetacean	0 (0–0)	181 (180–190)	30 (30–30)	9 (8–10)	30 (8–80)
Otariidae	0 (0–0)	6 (6–6)	0 (0–0)	0 (0–0)	0 (0–0)
Phocinae	0 (0–0)	45 (45–45)	11 (11–11)	0 (0–0)	0 (0–0)

[1] PTS ranges extend from the sonar or other active acoustic sound source to the indicated distance. The average range to PTS is provided as well as the range from the estimated minimum to the maximum range to PTS in parenthesis.

The tables below illustrate the range to TTS for 1, 30, 60, and 120 seconds from 5 representative sonar systems (see Table 25 through Table 29).

TABLE 25—RANGES TO TEMPORARY THRESHOLD SHIFT FOR SONAR BIN LF5 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE HSTT STUDY AREA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin LF5M (low frequency sources <180 dB source level)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	3 (0–4)	3 (0–4)	3 (0–4)	3 (0–4)
Mid-frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
High-frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocinae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

TABLE 26—RANGES TO TEMPORARY THRESHOLD SHIFT FOR SONAR BIN MF1 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE HSTT STUDY AREA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin MF1 (*e.g.*, SQS–53 ASW hull-mounted sonar)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	903 (850–1,025)	903 (850–1,025)	1,264 (1,025–2,275)	1,839 (1,275–3,025)
Mid-frequency Cetacean	210 (210–210)	210 (210–210)	302 (300–310)	379 (370–390)
High-frequency Cetacean	3,043 (1,525–4,775)	3,043 (1,525–4,775)	4,739 (2,025–6,275)	5,614 (2,025–7,525)
Otariidae	65 (65–65)	65 (65–65)	106 (100–110)	137 (130–140)
Phocinae	669 (650–725)	669 (650–725)	970 (900–1,025)	1,075 (1,025–1,525)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

TABLE 27—RANGES TO TEMPORARY THRESHOLD SHIFT (METERS) FOR SONAR BIN MF4 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE HSTT STUDY AREA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin MF4 (*e.g.*, AQS–22 ASW dipping sonar)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	77 (0–85)	162 (150–180)	235 (220–290)	370 (310–600)
Mid-frequency Cetacean	22 (22–22)	35 (35–35)	49 (45–50)	70 (70–70)
High-frequency Cetacean	240 (220–300)	492 (440–775)	668 (550–1,025)	983 (825–2,025)
Otariidae	8 (8–8)	15 (15–15)	19 (19–19)	25 (25–25)
Phocinae	65 (65–65)	110 (110–110)	156 (150–170)	269 (240–460)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

TABLE 28—RANGES TO TEMPORARY THRESHOLD SHIFT (METERS) FOR SONAR BIN MF5 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE HSTT STUDY AREA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin MF5 (*e.g.*, SSQ–62 ASW sonobuoy)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	10 (0–12)	10 (0–12)	14 (0–18)	21 (0–25)
Mid-frequency Cetacean	6 (0–9)	6 (0–9)	12 (0–13)	17 (0–21)
High-frequency Cetacean	118 (100–170)	118 (100–170)	179 (150–480)	273 (210–700)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocinae	9 (8–10)	9 (8–10)	14 (14–16)	21 (21–25)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

TABLE 29—RANGES TO TEMPORARY THRESHOLD SHIFT (METERS) FOR SONAR BIN HF4 OVER A REPRESENTATIVE RANGE OF ENVIRONMENTS WITHIN THE HSTT STUDY AREA

Hearing group	Approximate TTS ranges (meters) [1]			
	Sonar bin HF4 (*e.g.*, SQS–20 mine hunting sonar)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	1 (0–3)	2 (0–5)	4 (0–7)	6 (0–11)
Mid-frequency Cetacean	10 (4–17)	17 (6–35)	24 (7–60)	34 (9–90)
High-frequency Cetacean	168 (25–550)	280 (55–775)	371 (80–1,275)	470 (100–1,525)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–1)
Phocinae	2 (0–5)	5 (2–8)	8 (3–13)	11 (4–22)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

Explosives

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the explosive criteria (see Chapter 6.5.2.1.1 of the Navy's rulemaking/LOA application and the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* report (U.S. Department of the Navy, 2017c) and the explosive propagation calculations from the Navy Acoustic Effects Model (see Chapter 6.5.2.1.3, Navy Acoustic Effects Model of the Navy's rulemaking/LOA application). The range to effects are shown for a range of explosive bins, from E1 (up to 0.25 lb net explosive weight) to E12 (up to 1,000 lb net explosive weight) (Tables 30 through 35). Ranges are determined by modeling the distance that noise from an explosion will need to propagate to reach exposure level thresholds specific to a hearing group that will cause behavioral response (to the degree of a take), TTS, PTS, and non-auditory injury. Ranges are provided for a representative source depth and cluster size for each bin. For events with multiple explosions, sound from successive explosions can be expected to accumulate and increase the range to the onset of an impact based on SEL thresholds. Range to effects is important information in not only

predicting impacts from explosives, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects to marine mammals. For additional information on how ranges to impacts from explosions were estimated, see the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Navy, 2017b).

Table 30 shows the minimum, average, and maximum ranges to onset of auditory and behavioral effects for high-frequency cetaceans based on the developed thresholds.

TABLE 30—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR HIGH-FREQUENCY CETACEANS

	Range to effects for explosives: high frequency cetacean[1]				
Bin	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E1	0.1	1	353 (130–825)	1,234 (290–3,025)	2,141 (340–4,775)
		25	1,188 (280–3,025)	3,752 (490–8,525)	5,196 (675–12,275)
E2	0.1	1	425 (140–1,275)	1,456 (300–3,525)	2,563 (390–5,275)
		10	988 (280–2,275)	3,335 (480–7,025)	4,693 (650–10,275)
E3	0.1	1	654 (220–1,525)	2,294 (350–4,775)	3,483 (490–7,775)
		12	1,581 (300–3,525)	4,573 (650–10,275)	6,188 (725–14,775)
	18.25	1	747 (550–1,525)	3,103 (950–6,025)	5,641 (1,000–9,275)
		12	1,809 (875–4,025)	7,807 (1,025–12,775)	10,798 (1,025–17,775)
E4	3	2	2,020 (1,025–3,275)	3,075 (1,025–6,775)	3,339 (1,025–9,775)
	15.25	2	970 (600–1,525)	4,457 (1,025–8,525)	6,087 (1,275–12,025)
	19.8	2	1,023 (1,000–1,025)	4,649 (2,275–8,525)	6,546 (3,025–11,025)
	198	2	959 (875–1,525)	4,386 (3,025–7,525)	5,522 (3,025–9,275)
E5	0.1	25	2,892 (440–6,275)	6,633 (725–16,025)	8,925 (800–22,775)
	15.25	25	4,448 (1,025–7,775)	10,504 (1,525–18,275)	13,605 (1,775–24,775)
E6	0.1	1	1,017 (280–2,525)	3,550 (490–7,775)	4,908 (675–12,275)
	3	1	2,275 (2,025–2,525)	6,025 (4,525–7,275)	7,838 (6,275–9,775)
	15.25	1	1,238 (625–2,775)	5,613 (1,025–10,525)	7,954 (1,275–14,275)
E7	3	1	3,150 (2,525–3,525)	7,171 (5,525–8,775)	8,734 (7,275–10,525)
	18.25	1	2,082 (925–3,525)	6,170 (1,275–10,525)	8,464 (1,525–16,525)
E8	0.1	1	1,646 (775–2,525)	4,322 (1,525–9,775)	5,710 (1,525–14,275)
	45.75	1	1,908 (1,025–4,775)	5,564 (1,525–12,525)	7,197 (1,525–18,775)
E9	0.1	1	2,105 (850–4,025)	4,901 (1,525–12,525)	6,700 (1,525–16,775)
E10	0.1	1	2,629 (875–5,275)	5,905 (1,525–13,775)	7,996 (1,525–20,025)
E11	18.5	1	3,034 (1,025–6,025)	7,636 (1,525–16,525)	9,772 (1,775–21,525)
	45.75	1	2,925 (1,525–6,025)	7,152 (2,275–18,525)	9,011 (2,525–24,525)
E12	0.1	1	2,868 (975–5,525)	6,097 (2,275–14,775)	8,355 (4,275–21,275)
		3	3,762 (1,525–8,275)	7,873 (3,775–20,525)	10,838 (4,275–26,525)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location.

Table 31 shows the minimum, average, and maximum ranges to onset of auditory and behavioral effects for mid-frequency cetaceans based on the developed thresholds.

TABLE 31—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR MID-FREQUENCY CETACEANS

	Range to effects for explosives: mid-frequency cetacean[1]				
Bin	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E1	0.1	1	25 (25–25)	118 (80–210)	178 (100–320)
		25	107 (75–170)	476 (150–1,275)	676 (240–1,525)
E2	0.1	1	30 (30–35)	145 (95–240)	218 (110–400)
		10	88 (65–130)	392 (140–825)	567 (190–1,275)
E3	0.1	1	50 (45–65)	233 (110–430)	345 (130–600)
		12	153 (90–250)	642 (220–1,525)	897 (270–2,025)
	18.25	1	38 (35–40)	217 (190–900)	331 (290–850)
		12	131 (120–250)	754 (550–1,525)	1,055 (600–2,525)
E4	3	2	139 (110–160)	1,069 (525–1,525)	1,450 (875–1,775)
	15.25	2	71 (70–75)	461 (400–725)	613 (470–750)
	19.8	2	69 (65–70)	353 (350–360)	621 (600–650)
	198	2	49 (0–55)	275 (270–280)	434 (430–440)
E5	0.1	25	318 (130–625)	1,138 (280–3,025)	1,556 (310–3,775)
	15.25	25	312 (290–725)	1,321 (675–2,525)	1,980 (850–4,275)

TABLE 31—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR MID-FREQUENCY CETACEANS—Continued

Range to effects for explosives: mid-frequency cetacean [1]					
Bin	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E6	0.1	1	98 (70–170)	428 (150–800)	615 (210–1,525)
	3	1	159 (150–160)	754 (650–850)	1,025 (1,025–1,025)
	15.25	1	88 (75–180)	526 (450–875)	719 (500–1,025)
E7	3	1	240 (230–260)	1,025 (1,025–1,025)	1,900 (1,775–2,275)
	18.25	1	166 (120–310)	853 (500–1,525)	1,154 (550–1,775)
E8	0.1	1	160 (150–170)	676 (500–725)	942 (600–1,025)
	45.75	1	128 (120–170)	704 (575–2,025)	1,040 (750–2,525)
E9	0.1	1	215 (200–220)	861 (575–950)	1,147 (650–1,525)
E10	0.1	1	275 (250–480)	1,015 (525–2,275)	1,424 (675–3,275)
E11	18.5	1	335 (260–500)	1,153 (650–1,775)	1,692 (775–3,275)
	45.75	1	272 (230–825)	1,179 (825–3,025)	1,784 (1,000–4,275)
E12	0.1	1	334 (310–350)	1,151 (700–1,275)	1,541 (800–3,525)
	0.1	3	520 (450–550)	1,664 (800–3,525)	2,195 (925–4,775)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location.

Table 32 shows the minimum, average, and maximum ranges to onset of auditory and behavioral effects for low-frequency cetaceans based on the developed thresholds.

TABLE 32—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR LOW-FREQUENCY CETACEANS

Range to effects for explosives: low frequency cetacean [1]					
Bin	Source depth (m)	Cluster size	PTS	TTS	Behavioral
E1	0.1	1	51 (40–70)	227 (100–320)	124 (70–160)
		25	205 (95–270)	772 (270–1,275)	476 (190–725)
E2	0.1	1	65 (45–95)	287 (120–400)	159 (80–210)
		10	176 (85–240)	696 (240–1,275)	419 (160–625)
E3	0.1	1	109 (65–150)	503 (190–1,000)	284 (120–430)
		12	338 (130–525)	1,122 (320–7,775)	761 (240–6,025)
	18.25	1	205 (170–340)	996 (410–2,275)	539 (330–1,275)
		12	651 (340–1,275)	3,503 (600–8,275)	1,529 (470–3,275)
E4	3	2	493 (440–1,000)	2,611 (1,025–4,025)	1,865 (950–2,775)
	15.25	2	583 (350–850)	3,115 (1,275–5,775)	1,554 (1,000–2,775)
	19.8	2	378 (370–380)	1,568 (1,275–1,775)	926 (825–950)
	198	2	299 (290–300)	2,661 (1,275–3,775)	934 (900–950)
E5	0.1	25	740 (220–6,025)	2,731 (460–22,275)	1,414 (350–14,275)
	15.25	25	1,978 (1,025–5,275)	8,188 (3,025–19,775)	4,727 (1,775–11,525)
E6	0.1	1	250 (100–420)	963 (260–7,275)	617 (200–1,275)
	3	1	711 (525–825)	3,698 (1,525–4,275)	2,049 (1,025–2,525)
	15.25	1	718 (390–2,025)	3,248 (1,275–8,525)	1,806 (950–4,525)
E7	3	1	1,121 (850–1,275)	5,293 (2,025–6,025)	3,305 (1,275–4,025)
	18.25	1	1,889 (1,025–2,775)	6,157 (2,775–11,275)	4,103 (2,275–7,275)
E8	0.1	1	460 (170–950)	1,146 (380–7,025)	873 (280–3,025)
	45.75	1	1,049 (550–2,775)	4,100 (1,025–14,275)	2,333 (800–7,025)
E9	0.1	1	616 (200–1,275)	1,560 (450–12,025)	1,014 (330–5,025)
E10	0.1	1	787 (210–2,525)	2,608 (440–18,275)	1,330 (330–9,025)
E11	18.5	1	4,315 (2,025–8,025)	10,667 (4,775–26,775)	7,926 (3,275–21,025)
	45.75	1	1,969 (775–5,025)	9,221 (2,525–29,025)	4,594 (1,275–16,025)
E12	0.1	1	815 (250–3,025)	2,676 (775–18,025)	1,383 (410–8,525)
	0.1	3	1,040 (330–6,025)	4,657 (1,275–31,275)	2,377 (700–16,275)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location.

Table 33 shows the minimum, average, and maximum ranges to onset of auditory and behavioral effects for phocids based on the developed thresholds.

TABLE 33—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR PHOCIDS

Bin	Source depth (m)	Cluster size	Range to effects for explosives: phocids [1] PTS	TTS	Behavioral
E1	0.1	1	45 (40–65)	210 (100–290)	312 (130–430)
		25	190 (95–260)	798 (280–1,275)	1,050 (360–2,275)
E2	0.1	1	58 (45–75)	258 (110–360)	383 (150–550)
		10	157 (85–240)	672 (240–1,275)	934 (310–1,525)
E3	0.1	1	96 (60–120)	419 (160–625)	607 (220–900)
		12	277 (120–390)	1,040 (370–2,025)	1,509 (525–6,275)
	18.25	1	118 (110–130)	621 (500–1,275)	948 (700–2,025)
		12	406 (330–875)	1,756 (1,025–4,775)	3,302 (1,025–6,275)
E4	3	2	405 (300–430)	1,761 (1,025–2,775)	2,179 (1,025–3,275)
	15.25	2	265 (220–430)	1,225 (975–1,775)	1,870 (1,025–3,275)
	19.8	2	220 (220–220)	991 (950–1,025)	1,417 (1,275–1,525)
	198	2	150 (150–150)	973 (925–1,025)	2,636 (2,025–3,525)
E5	0.1	25	569 (200–850)	2,104 (725–9,275)	2,895 (825–11,025)
	15.25	25	920 (825–1,525)	5,250 (2,025–10,275)	7,336 (2,275–16,025)
E6	0.1	1	182 (90–250)	767 (270–1,275)	1,011 (370–1,775)
	3	1	392 (340–440)	1,567 (1,275–1,775)	2,192 (2,025–2,275)
	15.25	1	288 (250–600)	1,302 (1,025–3,275)	2,169 (1,275–5,775)
E7	3	1	538 (450–625)	2,109 (1,775–2,275)	2,859 (2,775–3,275)
	18.25	1	530 (460–750)	2,617 (1,025–4,525)	3,692 (1,525–5,275)
E8	0.1	1	311 (290–330)	1,154 (625–1,275)	1,548 (725–2,275)
	45.75	1	488 (380–975)	2,273 (1,275–5,275)	3,181 (1,525–8,025)
E9	0.1	1	416 (350–470)	1,443 (675–2,025)	1,911 (800–3,525)
E10	0.1	1	507 (340–675)	1,734 (725–3,525)	2,412 (800–5,025)
E11	18.5	1	1,029 (775–1,275)	5,044 (2,025–8,775)	6,603 (2,525–14,525)
	45.75	1	881 (700–2,275)	3,726 (2,025–8,775)	5,082 (2,025–13,775)
E12	0.1	1	631 (450–750)	1,927 (800–4,025)	2,514 (925–5,525)
	0.1	3	971 (550–1,025)	2,668 (1,025–6,275)	3,541 (1,775–9,775)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location.

Table 34 shows the minimum, average, and maximum ranges to onset of auditory and behavioral effects for otariids based on the developed thresholds.

TABLE 34—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR OTARIIDS

Bin	Source depth (m)	Cluster size	Range to effects for explosives: otariids [1] range to effects for explosives: mid-frequency cetacean PTS	TTS	Behavioral
E1	0.1	1	7 (7–7)	34 (30–40)	56 (45–70)
		25	30 (25–35)	136 (80–180)	225 (100–320)
E2	0.1	1	9 (9–9)	41 (35–55)	70 (50–95)
		10	25 (25–30)	115 (70–150)	189 (95–250)
E3	0.1	1	16 (15–19)	70 (50–95)	115 (70–150)
		12	45 (35–65)	206 (100–290)	333 (130–450)
	18.25	1	15 (15–15)	95 (90–100)	168 (150–310)
		12	55 (50–60)	333 (280–750)	544 (440–1,025)
E4	3	2	64 (40–85)	325 (240–340)	466 (370–490)
	15.25	2	30 (30–35)	205 (170–300)	376 (310–575)
	19.8	2	25 (25–25)	170 (170–170)	290 (290–290)
	198	2	17 (0–25)	117 (110–120)	210 (210–210)
E5	0.1	25	98 (60–120)	418 (160–575)	626 (240–1,000)
	15.25	25	151 (140–260)	750 (650–1,025)	1,156 (975–2,025)
E6	0.1	1	30 (25–35)	134 (75–180)	220 (100–320)
	3	1	53 (50–55)	314 (280–390)	459 (420–525)
	15.25	1	36 (35–40)	219 (200–380)	387 (340–625)
E7	3	1	93 (90–100)	433 (380–500)	642 (550–800)
	18.25	1	73 (70–75)	437 (360–525)	697 (600–850)
E8	0.1	1	50 (50–50)	235 (220–250)	385 (330–450)
	45.75	1	55 (55–60)	412 (310–775)	701 (500–1,525)
E9	0.1	1	68 (65–70)	316 (280–360)	494 (390–625)
E10	0.1	1	86 (80–95)	385 (240–460)	582 (390–800)
E11	18.5	1	158 (150–200)	862 (750–975)	1,431 (1,025–2,025)
	45.75	1	117 (110–130)	756 (575–1,525)	1,287 (950–2,775)
E12	0.1	1	104 (100–110)	473 (370–575)	709 (480–1,025)

TABLE 34—SEL-BASED RANGES (METERS) TO ONSET PTS, ONSET TTS, AND BEHAVIORAL REACTION FOR OTARIIDS—Continued

Range to effects for explosives: otariids [1] range to effects for explosives: mid-frequency cetacean					
Bin	Source depth (m)	Cluster size	PTS	TTS	Behavioral
	0.1	3	172 (170–180)	694 (480–1,025)	924 (575–1,275)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location.

Table 35 which show the minimum, average, and maximum ranges due to varying propagation conditions to non-auditory injury as a function of animal mass and explosive bin (*i.e.*, net explosive weight). These ranges represent the larger of the range to slight lung injury or gastrointestinal tract injury for representative animal masses ranging from 10 to 72,000 kg and different explosive bins ranging from 0.25 to 1,000 lb net explosive weight. Animals within these water volumes would be expected to receive minor injuries at the outer ranges, increasing to more substantial injuries, and finally mortality as an animal approaches the detonation point.

TABLE 35—RANGES [1] TO 50 PERCENT NON-AUDITORY INJURY RISK FOR ALL MARINE MAMMAL HEARING GROUPS AS A FUNCTION OF ANIMAL MASS

[10–72,000 kg]

Bin	Range (m) (min-max)
E1	12 (11–13)
E2	15 (15–20)
E3	25 (25–30)
E4	32 (0–75)
E5	40 (35–140)
E6	52 (40–120)
E7	145 (100–500)
E8	117 (75–400)
E9	120 (90–290)
E10	174 (100–480)
E11	443 (350–1,775)

TABLE 35—RANGES [1] TO 50 PERCENT NON-AUDITORY INJURY RISK FOR ALL MARINE MAMMAL HEARING GROUPS AS A FUNCTION OF ANIMAL MASS—Continued

[10–72,000 kg]

Bin	Range (m) (min-max)
E12	232 (110–775)

Note:
[1] Average distance (m) to mortality is depicted above the minimum and maximum distances which are in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location. Differences between bins E11 and E12 due to different ordnance types and differences in model parameters.

Ranges to mortality, based on animal mass, are show in Table 36 below.

TABLE 36—RANGES [1] TO 50 PERCENT MORTALITY RISK FOR ALL MARINE MAMMAL HEARING GROUPS AS A FUNCTION OF ANIMAL MASS

Bin	Animal mass intervals (kg) [1]					
	10	250	1,000	5,000	25,000	72,000
E1	3 (2–3)	0 (0–3)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
E2	4 (3–5)	1 (0–4)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
E3	8 (6–10)	4 (2–8)	1 (0–2)	0 (0–0)	0 (0–0)	0 (0–0)
E4	15 (0–35)	9 (0–30)	4 (0–8)	2 (0–6)	0 (0–3)	0 (0–2)
E5	13 (11–45)	7 (4–35)	3 (3–12)	2 (0–8)	0 (0–2)	0 (0–2)
E6	18 (14–55)	10 (5–45)	5 (3–15)	3 (2–10)	0 (0–3)	0 (0–2)
E7	67 (55–180)	35 (18–140)	16 (12–30)	10 (8–20)	5 (4–9)	4 (3–7)
E8	50 (24–110)	27 (9–55)	13 (0–20)	9 (4–13)	4 (0–6)	3 (0–5)
E9	32 (30–35)	20 (13–30)	10 (8–12)	7 (6–9)	4 (3–4)	3 (2–3)
E10	56 (40–190)	25 (16–130)	13 (11–16)	9 (7–11)	5 (4–5)	4 (3–4)
E11	211 (180–500)	109 (60–330)	47 (40–100)	30 (25–65)	15 (0–25)	13 (11–22)
E12	94 (50–300)	35 (20–230)	16 (13–19)	11 (9–13)	6 (5–8)	5 (4–8)

Note:
[1] Average distance (m) to mortality is depicted above the minimum and maximum distances which are in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location.
Differences between bins E11 and E12 due to different ordnance types and differences in model parameters (see Table 6–42 for details).

Air Guns

Table 37 and Table 38 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for air guns for 1 and 10 pulses, respectively. Ranges are specific to the HSTT Study Area and also to each marine mammal hearing group, dependent upon their criteria and the specific locations where animals from the hearing groups and the air gun activities could overlap. Small air guns (12–60 in^3) would be used during testing activities in the offshore areas of the Southern California Range Complex and in the Hawaii Range Complex. Generated impulses would have short durations, typically a few hundred milliseconds, with dominant frequencies below 1 kHz. The SPL and SPL peak (at a distance 1 m from the air gun) would be approximately 215 dB re 1 µPa and 227 dB re 1 µPa, respectively, if operated at the full capacity of 60 in^3. The size of the air gun chamber can be adjusted, which would result in lower SPLs and SEL per shot. Single, small air guns lack the peak pressures that could cause non-auditory injury (see Finneran

et al., (2015)); therefore, potential impacts could include PTS, TTS, and behavioral reactions.

TABLE 37—RANGE TO EFFECTS (METERS) FROM AIR GUNS FOR 1 PULSE

	Range to effects for air guns [1] for 1 pulse (m)				
Hearing group	PTS (SEL)	PTS (peak SPL)	TTS (SEL)	TTS (peak SPL)	Behavioral [2]
High-Frequency Cetacean	0 (0–0)	18 (15–25)	1 (0–2)	33 (25–80)	702 (290–1,525)
Low-Frequency Cetacean	3 (3–4)	2 (2–3)	27 (23–35)	5 (4–7)	651 (200–1,525)
Mid-Frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	689 (290–1,525)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	590 (290–1,525)
Phocids	0 (0–0)	2 (2–3)	0 (0–0)	5 (4–8)	668 (290–1,525)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. PTS and TTS values depict the range produced by SEL and Peak SPL (as noted) hearing threshold criteria levels.
[2] Behavioral values depict the ranges produced by RMS hearing threshold criteria levels.

TABLE 38—RANGE TO EFFECTS (METERS) FROM AIR GUNS FOR 10 PULSES

	Range to effects for air guns [1] for 10 pulses (m)				
Hearing group	PTS (SEL)	PTS (Peak SPL)	TTS (SEL)	TTS (Peak SPL)	Behavioral [2]
High-Frequency Cetacean	0 (0–0)	18 (15–25)	3 (0–9)	33 (25–80)	702 (290–1,525)
Low-Frequency Cetacean	15 (12–20)	2 (2–3)	86 (70–140)	5 (4–7)	651 (200–1,525)
Mid-Frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	689 (290–1,525)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	590 (290–1,525)
Phocids	0 (0–0)	2 (2–3)	4 (3–5)	5 (4–8)	668 (290–1,525)

[1] Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. PTS and TTS values depict the range produced by SEL and Peak SPL (as noted) hearing threshold criteria levels.
[2] Behavioral values depict the ranges produced by RMS hearing threshold criteria levels.

Pile Driving

Table 39 and Table 40 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for impact pile driving and vibratory pile removal, respectively. Non-auditory injury is not predicted for pile driving activities.

TABLE 39—AVERAGE RANGES TO EFFECTS (METERS) FROM IMPACT PILE DRIVING

Hearing group	PTS (m)	TTS (m)	Behavioral (m)
Low-frequency Cetaceans	65	529	870
Mid-frequency Cetaceans	2	16	870
High-frequency Cetaceans	65	529	870
Phocids	19	151	870
Otariids	2	12	870

Note: PTS: Permanent threshold shift; TTS: Temporary threshold shift.

TABLE 40—AVERAGE RANGES TO EFFECT (METERS) FROM VIBRATORY PILE EXTRACTION

Hearing group	PTS (m)	TTS (m)	Behavioral (m)
Low-frequency Cetaceans	0	3	376
Mid-frequency Cetaceans	0	4	376
High-frequency Cetaceans	7	116	376
Phocids	0	2	376
Otariids	0	0	376

Note: PTS: Permanent threshold shift; TTS: Temporary threshold shift.

Serious Injury or Mortality From Ship Strikes

There have been two recorded Navy vessel strikes of marine mammals (two fin whales off San Diego, CA in 2009) in the HSTT Study Area from 2009 through 2017 (nine years), the period in which Navy began implementing effective mitigation measures to reduce the likelihood of vessel strikes. From unpublished NMFS data, the most commonly struck whales in Hawaii are humpback whales, and the most commonly struck whales in California are gray whales, fin whales, and humpback whales. The majority of these strikes are from non-Navy commercial shipping. For both areas (Hawaii and California), the higher strike rates to these species is largely attributed to

higher species abundance in these areas. Prior to 2009, the Navy had struck multiple species of whales off California or Hawaii, but also individuals that were not identified to species. Further, because the overall number of Navy strikes is small, it is appropriate to consider the larger record of known ship strikes (by other types of vessels) in predicting what species may potentially be involved in a Navy ship strike. Based on this information, and as described in more detail in Navy's rulemaking/LOA application and below, the Navy proposes, and NMFS preliminary agrees, to three ship strike takes to select large whale species and stocks over the five years of the authorization, with no more than two takes to several specific stocks with a higher likelihood of being struck and no more than one take of other specific stocks with a lesser likelihood of being struck (described in detail below in the Vessel Strike section).

Marine Mammal Density

A quantitative analysis of impacts on a species requires data on their abundance and distribution that may be affected by anthropogenic activities in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. Marine species density estimation requires a significant amount of effort to both collect and analyze data to produce a reasonable estimate. Unlike surveys for terrestrial wildlife, many marine species spend much of their time submerged, and are not easily observed. In order to collect enough sighting data to make reasonable density estimates, multiple observations are required, often in areas that are not easily accessible (*e.g.*, far offshore). Ideally, marine mammal species sighting data would be collected for the specific area and time period (*e.g.*, season) of interest and density estimates derived accordingly. However, in many places, poor weather conditions and high sea states prohibit the completion of comprehensive visual surveys.

For most cetacean species, abundance within U.S. waters is estimated using line-transect surveys or mark-recapture studies (*e.g.*, Barlow, 2010, Barlow and Forney, 2007, Calambokidis *et al.*, 2008). The result provides one single density estimate value for each species across a broad geographic area. This is the general approach applied in estimating cetacean abundance in the NMFS SARS. Although the single value provides a good average estimate of abundance (total number of individuals) for a specified area, it does not provide information on the species distribution or concentrations within that area, and it does not estimate density for other timeframes, areas, or seasons that were not surveyed. More recently, habitat modeling has been used to estimate cetacean densities (*e.g.*, Barlow *et al.*, 2009; Becker *et al.*, 2010; 2012a; 2014; Becker *et al.*, 2016; Ferguson *et al.*, 2006; Forney *et al.*, 2012; 2015; Redfern *et al.*, 2006). These models estimate cetacean density as a continuous function of habitat variables (*e.g.*, sea surface temperature, seafloor depth, etc.) and thus allow predictions of cetacean densities on finer spatial scales than traditional line-transect or mark recapture analyses and for areas that have not been surveyed. Within the geographic area that was modeled, densities can be predicted wherever these habitat variables can be measured or estimated.

To characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. The Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal species present within the HSTT Study Area. This database is described in the technical report titled *U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area* (U.S. Department of the Navy, 2017e), hereafter referred to as the Density Technical Report.

A variety of density data and density models are needed in order to develop a density database that encompasses the entirety of the HSTT Study Area. Because this data is collected using different methods with varying amounts of accuracy and uncertainty, the Navy has developed a model hierarchy to ensure the most accurate data is used when available. The Density Technical Report describes these models in detail and provides detailed explanations of the models applied to each species density estimate. The below list describes models in order of preference.

1. Spatial density models are preferred and used when available because they provide an estimate with the least amount of uncertainty by deriving estimates for divided segments of the sampling area. These models (see Becker *et al.*, 2016; Forney *et al.*, 2015) predict spatial variability of animal presence as a function of habitat variables (*e.g.*, sea surface temperature, seafloor depth, etc.). This model is developed for areas, species, and, when available, specific timeframes (months or seasons) with sufficient survey data.

2. Stratified designed-based density estimates use line-transect survey data with the sampling area divided (stratified) into sub-regions, and a density is predicted for each sub-region (see Barlow, 2016; Becker *et al.*, 2016; Bradford *et al.*, 2017; Campbell *et al.*, 2014; Jefferson *et al.*, 2014). While geographically stratified density estimates provide a better indication of a species' distribution within the study area, the uncertainty is typically high because each sub-region estimate is based on a smaller stratified segment of the overall survey effort.

3. Design-based density estimations use line-transect survey data from land and aerial surveys designed to cover a specific geographic area (see Carretta *et al.*, 2015). These estimates use the same survey data as stratified design-based estimates, but are not segmented into sub-regions and instead provide one estimate for a large surveyed area.

Although relative environmental suitability (RES) models provide estimates for areas of the oceans that have not been surveyed using information on species occurrence and inferred habitat associations and have been used in past density databases, these models were not used in the current quantitative analysis. In the HSTT analysis, due to the availability of other density methods along the hierarchy the use of RES model was not necessary.

When interpreting the results of the quantitative analysis, as described in the Density Technical Report, "it is important to consider that even the best estimate of marine species density is really a model representation of the values of concentration where these animals might occur. Each model is limited to the variables and assumptions considered by the original data source provider. No mathematical model representation of any biological population is perfect, and with regards to marine mammal biodiversity, any single model method will not completely explain the actual distribution and abundance of marine mammal species. It is expected that there would be anomalies in the results that need to be evaluated, with independent information for each case, to support if we might accept or reject a model or portions of the model (U.S. Department of the Navy, 2017a)."

The Navy's estimate of abundance (based on the density estimates used) in the HSTT Study Area may differ from population abundances estimated in the NMFS's SARS for a variety of reasons.

Mainly because the Pacific SAR overlaps only 35 percent of the Hawaii part of HSTT and only about 14 percent of SOCAL. The Alaska SAR covering humpbacks present in Hawaii is another complicating factor. For some species, the stock assessment for a given species may exceed the Navy's density prediction because those species' home range extends beyond the Study Area boundaries. For other species, the stock assessment abundance may be much less than the number of animals in the Navy's modeling given the HSTT Study Area extends well beyond the U.S waters covered by the SAR abundance estimate. The primary source of density estimates are geographically specific survey data and either peer-reviewed line-transect estimates or habitat-based density models that have been extensively validated to provide the most accurate estimates possible.

These factors and others described in the Density Technical Report should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock. For a detailed description of the density and assumptions made for each species, see the Density Technical Report.

NMFS coordinated with the Navy in the development of its take estimates and concurs that the Navy's proposed approach for density appropriately utilizes the best available science. Later, in the Negligible Impact Determination Section, we assess how the estimated take numbers compare to stock abundance in order to better understand the potential number of individuals impacted—and the rationale for which abundance estimate is used is included there.

Take Requests

The HSTT DEIS/OEIS considered all training and testing activities proposed to occur in the HSTT Study Area that have the potential to result in the MMPA defined take of marine mammals. The Navy determined that the following three stressors could result in the incidental taking of marine mammals. NMFS has reviewed the Navy's data and analysis and determined that it is complete and accurate and agrees that the following stressors have the potential to result in takes of marine mammals from the Specified Activities.

- Acoustics (sonar and other transducers; air guns; pile driving/extraction).
- Explosives (explosive shock wave and sound (assumed to encompass the risk due to fragmentation).
- Physical Disturbance and Strike (vessel strike).

Acoustic and explosive sources have the potential to result in incidental takes of marine mammals by harassment, injury, or mortality. Vessel strikes have the potential to result in incidental take from injury, serious injury and/or mortality.

The quantitative analysis process used for the HSTT DEIS/OEIS and the Navy's request in the rulemaking/LOA application to estimate potential exposures to marine mammals resulting from acoustic and explosive stressors is detailed in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing report* (U.S. Department of the Navy, 2017b). The Navy Acoustic Effects Model estimates acoustic and explosive effects without taking mitigation into account; therefore, the model overestimates predicted impacts on marine mammals within mitigation zones. To account for mitigation for marine species in the take estimates, the Navy conducts a quantitative assessment of mitigation. The Navy conservatively quantifies the manner in which mitigation is expected to reduce model-estimated PTS to TTS for exposures to sonar and other transducers, and reduce model-estimated mortality to injury for exposures to explosives. The Navy assessed the effectiveness of its mitigation measures on a per-scenario basis for four factors: (1) Species sightability, (2) a Lookout's ability to observe the range to PTS (for sonar and other transducers) and range to mortality (for explosives), (3) the portion of time when mitigation could potentially be conducted during periods of reduced daytime visibility (to include inclement weather and high sea-state) and the portion of time when mitigation could potentially be conducted at night, and (4) the ability for sound sources to be positively controlled (*e.g.*, powered down).

During the conduct of training and testing activities, there is typically at least one, if not numerous, support personnel involved in the activity (*e.g.*, range support personnel aboard a torpedo retrieval boat or support aircraft). In addition to the Lookout posted for the purpose of mitigation, these additional personnel observe for and disseminate marine species sighting information amongst the units participating in the activity whenever possible as they conduct their primary mission responsibilities. However, as a conservative approach to assigning mitigation effectiveness factors, the Navy elected to only account for the minimum number of required Lookouts used for each activity; therefore, the mitigation effectiveness factors may underestimate the likelihood that some marine mammals may be detected during activities that are supported by additional personnel who may also be observing the mitigation zone.

The Navy used the equations in the below sections to calculate the reduction in model-estimated mortality impacts due to implementing mitigation.

Equation 1:

Mitigation Effectiveness = Species Sightability × Visibility × Observation Area × Positive Control

Whereas, Species Sightability is the ability to detect marine mammals is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability. The Navy considered applicable data from the best available science to numerically approximate the sightability of marine mammals and determined that the standard "detection probability" referred to as g(0). Also, Visibility = 1 − sum of individual visibility reduction factors; Observation Area = portion of impact range that can be continuously observed during an event; and Positive Control = positive control factor of all sound sources involving mitigation. For further details on these mitigation effectiveness factors please refer to the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing report* (U.S. Department of the Navy, 2017b).

To quantify the number of marine mammals predicted to be sighted by Lookouts during implementation of mitigation in the range to injury (PTS) for sonar and other transducers, the species sightability is multiplied by the mitigation effectiveness scores and number of model-estimated PTS impacts, as shown in the equation below:

Equation 2:

Number of Animals Sighted by Lookouts = Mitigation Effectiveness × Model-Estimated Impacts

The marine mammals sighted by Lookouts during implementation of mitigation in the range to PTS, as calculated by the equation above, would avoid being exposed to these higher level impacts. The Navy corrects the category of predicted impact for the number of animals sighted within the mitigation zone (*e.g.*, shifts PTS to TTS), but does not modify the total number of

animals predicted to experience impacts from the scenario.

To quantify the number of marine mammals predicted to be sighted by Lookouts during implementation of mitigation in the range to mortality during events using explosives, the species sightability is multiplied by the mitigation effectiveness scores and number of model-estimated mortality impacts, as shown in equation 1 above. The marine mammals and sea turtles predicted to be sighted by Lookouts during implementation of mitigation in the range to mortality, as calculated by the above equation 2, are predicted to avoid exposure in these ranges. The Navy corrects the category of predicted impact for the number of animals sighted within the mitigation zone, but does not modify the total number of animals predicted to experience impacts from the scenario. For example, the number of animals sighted (*i.e.*, number of animals that will avoid mortality) is first subtracted from the model-predicted mortality impacts, and then added to the model-predicted injurious impacts.

NMFS coordinated with the Navy in the development of this quantitative method to address the effects of mitigation on acoustic exposures and explosive takes, and NMFS concurs with the Navy that it is appropriate to incorporate into the take estimates based on the best available science. For additional information on the quantitative analysis process and mitigation measures, refer to the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing report* (U.S. Department of the Navy, 2017b) and Section 6 (Take Estimates for Marine Mammals) and Section 11 (Mitigation Measures) of the Navy's rulemaking/LOA application.

Summary of Proposed Authorized Take From Training and Testing Activities

Based on the methods outlined in the previous sections and the Navy's model and the quantitative assessment of mitigation, the Navy summarizes the take request for acoustic and explosive sources for training and testing activities both annually (based on the maximum number of activities per 12-month period) and over a 5-year period. NMFS has reviewed the Navy's data and analysis and preliminary determined that it is complete and accurate and that the takes by harassment proposed for authorization are reasonably expected to occur and that the takes by mortality could occur as in the case of vessel strikes. Five-year total impacts may be less than the sum total of each year because although the annual estimates are based on the maximum estimated takes, five-year estimates are based on the sum of two maximum years and three nominal years.

Nonlethal Take Reasonably Expected To Occur From Training Activities

Table 41 summarizes the Navy's take request and the amount and type of take that is reasonably likely to occur (Level A and Level B harassment) by species associated with all training activities. Note that Level B harassment take includes both behavioral disruption and TTS. Figures 6–12 through 6–50 in Section 6 of the Navy's rulemaking/LOA application illustrate the comparative amounts of TTS and behavioral disruption (at the level of a take) for each species, noting that if a "taken" animat was exposed to both TTS and behavioral disruption in the model, it was recorded as a TTS.

TABLE 41—SPECIES-SPECIFIC PROPOSED TAKE AUTHORIZATION FOR ACOUSTIC AND EXPLOSIVE EFFECTS FOR ALL TRAINING ACTIVITIES IN THE HSTT STUDY AREA

Species	Stock	Annual		5-Year total **	
		Level B	Level A	Level B	Level A
Suborder Mysticeti (baleen whales)					
Family Balaenopteridae (rorquals)					
Blue whale *	Central North Pacific	34	0	139	0
	Eastern North Pacific	1,155	1	5,036	3
Bryde's whale †	Eastern Tropical Pacific	27	0	118	0
	Hawaiian †	105	0	429	0
Fin whale *	California, Oregon, and Washington	1,245	0	5,482	0
	Hawaiian	33	0	133	0
Humpback whale †	California, Oregon, and Washington †.	1,254	1	5,645	3
	Central North Pacific	5,604	1	23,654	5
Minke whale	California, Oregon, and Washington	649	1	2,920	4
	Hawaiian	3,463	1	13,664	2
Sei whale *	Eastern North Pacific	53	0	236	0
	Hawaiian	118	0	453	0
Family Eschrichtiidae					
Gray whale †	Eastern North Pacific	2,751	5	11,860	19
	Western North Pacific †	4	0	14	0
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale *	California, Oregon, and Washington	1,397	0	6,257	0
	Hawaiian	1,714	0	7,078	0
Family Kogiidae (sperm whales)					
Dwarf sperm whale	Hawaiian	13,961	35	57,571	148

TABLE 41—SPECIES-SPECIFIC PROPOSED TAKE AUTHORIZATION FOR ACOUSTIC AND EXPLOSIVE EFFECTS FOR ALL TRAINING ACTIVITIES IN THE HSTT STUDY AREA—Continued

Species	Stock	Annual		5-Year total **	
		Level B	Level A	Level B	Level A
Pygmy sperm whale	Hawaiian	5,556	16	22,833	64
Kogia whales	California, Oregon, and Washington	6,012	23	27,366	105
Family Ziphiidae (beaked whales)					
Baird's beaked whale	California, Oregon, and Washington	1,317	0	6,044	0
Blainville's beaked whale	Hawaiian	3,687	0	16,364	0
Cuvier's beaked whale	California, Oregon, and Washington	6,965	0	32,185	0
	Hawaiian	1,235	0	5,497	0
Longman's beaked whale	Hawaiian	13,010	0	57,172	0
Mesoplodon spp	California, Oregon, and Washington	3,750	0	17,329	0
Family Delphinidae (dolphins)					
Bottlenose dolphin	California Coastal	214	0	876	0
	California, Oregon, and Washington Offshore.	31,986	2	142,966	9
	Hawaiian Pelagic	2,086	0	9,055	0
	Kauai & Niihau	74	0	356	0
	Oahu	8,186	1	40,918	5
	4-Island	152	0	750	0
	Hawaii	42	0	207	0
False killer whale †	Hawaii Pelagic	701	0	3,005	0
	Main Hawaiian Islands Insular†	405	0	1,915	0
	Northwestern Hawaiian Islands	256	0	1,094	0
Fraser's dolphin	Hawaiian	28,409	1	122,784	3
Killer whale	Eastern North Pacific Offshore	73	0	326	0
	Eastern North Pacific Transient/ West Coast Transient.	135	0	606	0
	Hawaiian	84	0	352	0
Long-beaked common dolphin	California	128,994	14	559,540	69
Melon-headed whale	Hawaiian Islands	2,335	0	9,705	0
	Kohala Resident	182	0	913	0
Northern right whale dolphin	California, Oregon, and Washington	56,820	8	253,068	40
Pacific white-sided dolphin	California, Oregon, and Washington	43,914	3	194,882	12
Pantropical spotted dolphin	Hawaii Island	2,585	0	12,603	0
	Hawaii Pelagic	6,809	0	29,207	0
	Oahu	4,127	0	20,610	0
	4-Island	260	0	1,295	0
Pygmy killer whale	Hawaiian	5,816	0	24,428	0
	Tropical	471	0	2,105	0
Risso's dolphin	California, Oregon, and Washington	76,276	6	338,560	30
	Hawaiian	6,590	0	28,143	0
Rough-toothed dolphin	Hawaiian	4,292	0	18,506	0
	NSD [1]	0	0	0	0
Short-beaked common dolphin	California, Oregon, and Washington	932,453	46	4,161,283	222
Short-finned pilot whale	California, Oregon, and Washington	990	1	4,492	5
	Hawaiian	8,594	0	37,077	0
Spinner dolphin	Hawaii Island	89	0	433	0
	Hawaii Pelagic	3,138	0	12,826	0
	Kauai & Niihau	310	0	1,387	0
	Oahu & 4-Island	1,493	1	7,445	5
Striped dolphin	California, Oregon, and Washington	119,219	1	550,936	3
	Hawaiian	5,388	0	22,526	0
Family Phocoenidae (porpoises)					
Dall's porpoise	California, Oregon, and Washington	27,282	137	121,236	634
Suborder Pinnipedia					
Family Otariidae (eared seals)					
California sea lion	U.S	69,543	91	327,136	455
Guadalupe fur seal *	Mexico	518	0	2,386	0
Northern fur seal	California	9,786	0	44,017	0
Family Phocidae (true seals)					
Harbor seal	California	3,119	7	13,636	34

TABLE 41—SPECIES-SPECIFIC PROPOSED TAKE AUTHORIZATION FOR ACOUSTIC AND EXPLOSIVE EFFECTS FOR ALL TRAINING ACTIVITIES IN THE HSTT STUDY AREA—Continued

Species	Stock	Annual		5-Year total**	
		Level B	Level A	Level B	Level A
Hawaiian monk seal*	Hawaiian	139	1	662	3
Northern elephant seal	California	38,169	72	170,926	349

*ESA-listed species (all stocks) within the HSTT Study Area.
**5-year total impacts may be less than sum total of each year. Not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over course of a 5-year period.
†Only designated stocks are ESA-listed.
‡NSD: No stock designation.

Nonlethal Take Reasonably Expected To Occur From Testing Activities

Table 42 summarizes the Navy's take request and the amount and type of take that is reasonably likely to occur (Level A and Level B harassment) by species associated with all testing activities. Note that Level B harassment take includes both behavioral disruption and TTS. Figures 6–12 through 6–50 in Section 6 of the Navy's rulemaking/LOA application illustrate the comparative amounts of TTS and behavioral disruption (at the level of a take) for each species, noting that if a "taken" animal was exposed to both TTS and behavioral disruption in the model, it was recorded as a TTS.

TABLE 42—SPECIES-SPECIFIC PROPOSED TAKE AUTHORIZATION FOR ACOUSTIC AND EXPLOSIVE SOUND SOURCE EFFECTS FOR ALL TESTING ACTIVITIES IN THE HSTT STUDY AREA

Species	Stock	Annual		5-Year total**	
		Level B	Level A	Level B	Level A
Suborder Mysticeti (baleen whales)					
Family Balaenopteridae (rorquals)					
Blue whale*	Central North Pacific	14	0	65	0
	Eastern North Pacific	833	0	4,005	0
Bryde's whale†	Eastern Tropical Pacific	14	0	69	0
	Hawaiian†	41	0	194	0
Fin whale*	California, Oregon, and Washington	980	1	4,695	3
	Hawaiian	15	0	74	0
Humpback whale†	California, Oregon, and Washington†.	740	0	3,508	0
	Central North Pacific	3,522	2	16,777	10
Minke whale	California, Oregon, and Washington	276	0	1,309	0
	Hawaiian	1,467	1	6,918	4
Sei whale*	Eastern North Pacific	26	0	124	0
	Hawaiian	49	0	229	0
Family Eschrichtiidae					
Gray whale†	Eastern North Pacific	1,920	2	9,277	7
	Western North Pacific†	2	0	11	0
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale*	California, Oregon, and Washington	1,096	0	5,259	0
	Hawaiian	782	0	3,731	0
Family Kogiidae (sperm whales)					
Dwarf sperm whale	Hawaiian	6,459	29	30,607	140
Pygmy sperm whale	Hawaiian	2,595	13	12,270	60
Kogia whales	California, Oregon, and Washington	3,120	15	14,643	67
Family Ziphiidae (beaked whales)					
Baird's beaked whale	California, Oregon, and Washington	727	0	3,418	0
Blainville's beaked whale	Hawaiian	1,698	0	8,117	0
Cuvier's beaked whale	California, Oregon, and Washington	4,461	0	20,919	0
	Hawaiian	561	0	2,675	0
Longman's beaked whale	Hawaiian	6,223	0	29,746	0
Mesoplodon spp	California, Oregon, and Washington	2,402	0	11,262	0

TABLE 42—SPECIES-SPECIFIC PROPOSED TAKE AUTHORIZATION FOR ACOUSTIC AND EXPLOSIVE SOUND SOURCE EFFECTS FOR ALL TESTING ACTIVITIES IN THE HSTT STUDY AREA—Continued

Species	Stock	Annual		5-Year total **	
		Level B	Level A	Level B	Level A
Family Delphinidae (dolphins)					
Bottlenose dolphin	California Coastal	1,595	0	7,968	0
	California, Oregon, and Washington Offshore.	23,436	1	112,410	4
	Hawaiian Pelagic	1,242	0	6,013	0
	Kauai & Niihau	491	0	2,161	0
	Oahu	475	0	2,294	0
	4-Island	207	0	778	0
	Hawaii	38	0	186	0
False killer whale †	Hawaii Pelagic	340	0	1,622	0
	Main Hawaiian Islands Insular †	184	0	892	0
	Northwestern Hawaiian Islands	125	0	594	0
Fraser's dolphin	Hawaiian	12,664	1	60,345	5
Killer whale	Eastern North Pacific Offshore	34	0	166	0
	Eastern North Pacific Transient/ West Coast Transient.	64	0	309	0
	Hawaiian	40	0	198	0
Long-beaked common dolphin	California	118,278	6	568,020	24
Melon-headed whale	Hawaiian Islands	1,157	0	5,423	0
	Kohala Resident	168	0	795	0
Northern right whale dolphin	California, Oregon, and Washington	41,279	3	198,917	15
Pacific white-sided dolphin	California, Oregon, and Washington	31,424	2	151,000	8
Pantropical spotted dolphin	Hawaii Island	1,409	0	6,791	0
	Hawaii Pelagic	3,640	0	17,615	0
	Oahu	202	0	957	0
	4-Island	458	0	1,734	0
Pygmy killer whale	Hawaiian	2,708	0	13,008	0
	Tropical	289	0	1,351	0
Risso's dolphin	California, Oregon, and Washington	49,985	3	240,646	15
	Hawaiian	2,808	0	13,495	0
Rough-toothed dolphin	Hawaiian	2,193	0	10,532	0
	NSD ‡	0	0	0	0
Short-beaked common dolphin	California, Oregon, and Washington	560,120	45	2,673,431	222
Short-finned pilot whale	California, Oregon, and Washington	923	0	4,440	0
	Hawaiian	4,338	0	20,757	0
Spinner dolphin	Hawaii Island	202	0	993	0
	Hawaii Pelagic	1,396	0	6,770	0
	Kauai & Niihau	1,436	0	6,530	0
	Oahu & 4-Island	331	0	1,389	0
Striped dolphin	California, Oregon, and Washington	56,035	2	262,973	10
	Hawaiian	2,396	0	11,546	0
Family Phocoenidae (porpoises)					
Dall's porpoise	California, Oregon, and Washington	17,091	72	81,611	338
Suborder Pinnipedia					
Family Otariidae (eared seals)					
California sea lion	U.S.	48,665	6	237,870	23
Guadalupe fur seal *	Mexico	939	0	4,357	0
Northern fur seal	California	5,505	1	26,168	4
Family Phocidae (true seals)					
Harbor seal	California	2,325	1	11,258	5
Hawaiian monk seal *	Hawaiian	66	0	254	0
Northern elephant seal	California	22,702	27	107,343	131

* ESA-listed species (all stocks) within the HSTT Study Area.
** 5-year total impacts may be less than sum total of each year. Not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over course of a 5-year period.
† Only designated stocks are ESA-listed.
‡ NSD: No stock designation.

Take From Vessel Strikes and Explosives by Serious Injury or Mortality

Vessel Strike

A detailed analysis for vessel strike is contained in Chapters 5 and 6 the Navy's rulemaking/LOA application. Vessel strike to marine mammals is not associated with any specific training or testing activity but rather is a limited, sporadic, and incidental result of Navy vessel movement within the HSTT Study Area. To support the prediction of strikes that could occur in the five years covered by the rule, the Navy calculated probabilities derived from a Poisson distribution using ship strike data between 2009–2016 in the HSTT Study Area, as well as historical at-sea days in HSTT from 2009–2016 and estimated potential at-sea days for the period from 2019 to 2023 to determine the probabilities of a specific number of strikes (n=0, 1, 2, etc.) over the period from 2019 to 2023. The Navy struck two whales in 2009 (both fin whales) in the HSTT Study Area, and there have been no strikes since that time from activities in the HSTT study area that would be covered by these regulations. The Navy used those two fin whale strikes in their calculations and evaluated data beginning in 2009 as that was the start of the Navy's Marine Species Awareness Training and adoption of additional mitigation measures to address ship strike. However, there have been no incidents of vessel strikes between June 2009 and April 2018 from HSTT Study Area activities. Based on the resulting probabilities presented in the Navy's analysis, there is a 10 percent chance of three strikes over the period from 2019 to 2023. Therefore, the Navy estimates, and NMFS agrees, that there is some probability that it could strike, and take by serious injury or mortality, up to three large whales incidental to training and testing activities within the HSTT Study Area over the course of the five years.

The Navy then refined its take request based on the species/stocks most likely to be present in the HSTT Study Area based on documented abundance and where overlap is between a species' common occurrence and core Navy training and testing areas within the HSTT Study Area. To determine which species may be struck, a weight of evidence approach was used to qualitatively rank range complex specific species using historic and current stranding data from NMFS, relative abundance as derived by NMFS for the HSTT Phase II Biological Opinion, and the Navy funded monitoring within each range complex. Results of this approach are presented in Table 5–4 of the Navy's rulemaking/LOA application.

The Navy anticipates, and NMFS preliminarily concurs, based on the Navy's ship strike analysis presented in the Navy's rulemaking/LOA application, that three vessel strikes could occur over the course of five years, and that no more than two would involve (and therefore the Navy is requesting no more than two lethal takes from) the following species and stocks:

- Gray whale (Eastern North Pacific stock);
- Fin whale (California, Oregon, Washington stock);
- Humpback whale (California, Oregon, California stock or Mexico DPS);
- Humpback whale (Central Pacific stock or Hawaii DPS); and
- Sperm whale (Hawaiian stock).

Of the possibility for three vessel strikes over the five years, no more than one would involve the species below; therefore, the Navy is requesting no more than one lethal take from) the following species and stocks:

- Blue whale (Eastern North Pacific stock);
- Bryde's whale (Eastern Tropical Pacific stock);
- Bryde's whale (Hawaiian stock);
- Humpback whale (California, Oregon, California stock or Central America DPS);
- Minke whale (California, Oregon, Washington stock);
- Minke whale (Hawaiian stock);
- Sperm whale (California, Oregon, Washington stock);
- Sei whale (Hawaiian stock); and
- Sei whale (Eastern North Pacific stock).

Vessel strikes to the stocks below are very unlikely to occur due to their relatively low occurrence in the Study Area, particularly in core HSTT training and testing subareas, and therefore the Navy is not requesting lethal take authorization for the following species and stocks:

- Blue whale (Central North Pacific stock);
- Fin whale (Hawaiian stock); and
- Gray whale (Western North Pacific stock).

Explosives

The Navy's model and quantitative analysis process used for the HSTT DEIS/OEIS and in the Navy's rulemaking/LOA application to estimate potential exposures of marine mammals to explosive stressors is detailed in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing report* (U.S. Department of the Navy, 2017b). Specifically, over the course of a year, the Navy's model and quantitative analysis process estimates mortality of two short-beaked common dolphin and one California sea lion as a result of exposure to explosive training and testing activities (please refer to section 6 of the Navy's rule making/LOA application). Over the 5-year period of the regulations being requested, mortality of 10 marine mammals in total (6 short-beaked common dolphins and 4 California sea lions) is estimated as a result of exposure to explosive training and testing activities. NMFS coordinated with the Navy in the development of their take estimates and concurs with the Navy's proposed approach for estimating the number of animals from each species that could be affected by mortality takes from explosives.

Proposed Mitigation Measures

Under section 101(a)(5)(A) of the MMPA, NMFS must set forth the "permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for subsistence uses" ("least practicable adverse impact"). NMFS does not have a regulatory definition for least practicable adverse impact. The NDAA for FY 2004 amended the MMPA as it relates to military readiness activities and the incidental take authorization process such that a determination of "least practicable adverse impact" shall include consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the "military readiness activity."

In *Conservation Council for Hawaii* v. *National Marine Fisheries Service*, 97 F. Supp.3d 1210, 1229 (D. Haw. 2015), the Court stated that NMFS "appear[s] to think [it] satisf[ies] the statutory 'least practicable adverse impact' requirement with a 'negligible impact' finding." More recently, expressing similar concerns in a challenge to a U.S. Navy Operations of Surveillance Towed Array Sensor System Low Frequency Active Sonar (SURTASS LFA) incidental take rule (77 FR 50290), the Ninth Circuit Court of Appeals in *Natural Resources Defense Council (NRDC)* v. *Pritzker*, 828 F.3d 1125, 1134 (9th Cir. 2016), stated, "[c]ompliance with the 'negligible impact' requirement does not mean there [is] compliance with the 'least

practicable adverse impact' standard." As the Ninth Circuit noted in its opinion, however, the Court was interpreting the statute without the benefit of NMFS's formal interpretation. We state here explicitly that NMFS is in full agreement that the "negligible impact" and "least practicable adverse impact" requirements are distinct, even though both statutory standards refer to species and stocks. With that in mind, we provide further explanation of our interpretation of least practicable adverse impact, and explain what distinguishes it from the negligible impact standard. This discussion is consistent with, and expands upon, previous rules we have issued (such as the Navy Gulf of Alaska rule (82 FR 19530; April 27, 2017)).

Before NMFS can issue incidental take regulations under section 101(a)(5)(A) of the MMPA, it must make a finding that the total taking will have a "negligible impact" on the affected "species or stocks" of marine mammals. NMFS's and U.S. Fish and Wildlife Service's implementing regulations for section 101(a)(5) both define "negligible impact" as "an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival" (50 CFR 216.103 and 50 CFR 18.27(c)). Recruitment (*i.e.*, reproduction) and survival rates are used to determine population growth rates [2] and, therefore are considered in evaluating population level impacts.

As we stated in the preamble to the final rule for the incidental take implementing regulations, not every population-level impact violates the negligible impact requirement. The negligible impact standard does not require a finding that the anticipated take will have "no effect" on population numbers or growth rates: "The statutory standard does not require that the same recovery rate be maintained, rather that no significant effect on annual rates of recruitment or survival occurs. [T]he key factor is the significance of the level of impact on rates of recruitment or survival." (54 FR 40338, 40341–42; September 29, 1989).

While some level of impact on population numbers or growth rates of a species or stock may occur and still satisfy the negligible impact requirement—even without consideration of mitigation—the least practicable adverse impact provision separately requires NMFS to prescribe means of "effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance" 50 CFR 216.102(b), which are typically identified as mitigation measures.[3]

The negligible impact and least practicable adverse impact standards in the MMPA both call for evaluation at the level of the "species or stock." The MMPA does not define the term "species." However, Merriam-Webster Dictionary defines "species" to include "related organisms or *populations* potentially capable of interbreeding." See *www.merriam-webster.com/dictionary/species* (emphasis added). The MMPA defines "stock" as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature." 16 U.S.C. 1362(11). The definition of "population" is "a group of interbreeding organisms that represents the level of organization at which speciation begins." *www.merriam-webster.com/dictionary/population*. The definition of "population" is strikingly similar to the MMPA's definition of "stock," with both involving groups of individuals that belong to the same species and located in a manner that allows for interbreeding. In fact, the term "stock" in the MMPA is interchangeable with the statutory term "population stock." 16 U.S.C. 1362(11). Thus, the MMPA terms "species" and "stock" both relate to populations, and it is therefore appropriate to view both the negligible impact standard and the least practicable adverse impact standard, both of which call for evaluation at the level of the species or stock, as having a population-level focus.

This interpretation is consistent with Congress's statutory findings for enacting the MMPA, nearly all of which are most applicable at the species or stock (*i.e.*, population) level. See 16 U.S.C. 1361 (finding that it is species and population stocks that are or may be in danger of extinction or depletion; that it is species and population stocks that should not diminish beyond being significant functioning elements of their ecosystems; and that it is species and population stocks that should not be permitted to diminish below their optimum sustainable population level). Annual rates of recruitment (*i.e.*, reproduction) and survival are the key biological metrics used in the evaluation of population-level impacts, and accordingly these same metrics are also used in the evaluation of population level impacts for the least practicable adverse impact standard.

Recognizing this common focus of the least practicable adverse impact and negligible impact provisions on the "species or stock" does not mean we conflate the two standards; despite some common statutory language, we recognize the two provisions are different and have different functions. First, a negligible impact finding is required before NMFS can issue an incidental take authorization. Although it is acceptable to use the mitigation measures to reach a negligible impact finding (see 50 CFR 216.104(c)), no amount of mitigation can enable NMFS to issue an incidental take authorization for an activity that still would not meet the negligible impact standard. Moreover, even where NMFS can reach a negligible impact finding—which we emphasize does allow for the possibility of some "negligible" population-level impact—the agency must still prescribe measures that will affect the least practicable amount of adverse impact upon the affected species or stock.

Section 101(a)(5)(A)(i)(II) requires NMFS to issue, in conjunction with its authorization, binding—and enforceable—restrictions (in the form of regulations) setting forth how the activity must be conducted, thus ensuring the activity has the "least practicable adverse impact" on the affected species or stocks. In situations where mitigation is specifically needed to reach a negligible impact determination, section 101(a)(5)(A)(i)(II) also provides a mechanism for ensuring compliance with the "negligible impact" requirement. Finally, we reiterate that the least practicable adverse impact standard also requires consideration of measures for marine mammal habitat, with particular attention to rookeries, mating grounds, and other areas of similar significance, and for subsistence impacts; whereas the negligible impact standard is concerned solely with conclusions about the impact of an activity on annual rates of recruitment and survival.[4]

In *NRDC* v. *Pritzker*, the Court stated, "[t]he statute is properly read to mean that even if population levels are not threatened *significantly*, still the agency must adopt mitigation measures aimed at protecting *marine mammals* to the greatest extent practicable in light of

[2] A growth rate can be positive, negative, or flat.

[3] For purposes of this discussion we omit reference to the language in the standard for least practicable adverse impact that says we also must mitigate for subsistence impacts because they are not at issue in this rule.

[4] Outside of the military readiness context, mitigation may also be appropriate to ensure compliance with the "small numbers" language in MMPA sections 101(a)(5)(A) and (D).

military readiness needs." *Id.* at 1134 (emphases added). This statement is consistent with our understanding stated above that even when the effects of an action satisfy the negligible impact standard (*i.e.*, in the Court's words, "population levels are not threatened significantly"), still the agency must prescribe mitigation under the least practicable adverse impact standard. However, as the statute indicates, the focus of both standards is ultimately the impact on the affected "species or stock," and not solely focused on or directed at the impact on individual marine mammals.

We have carefully reviewed and considered the Ninth Circuit's opinion in *NRDC* v. *Pritzker* in its entirety. While the Court's reference to "marine mammals" rather than "marine mammal species or stocks" in the italicized language above might be construed as a holding that the least practicable adverse impact standard applies at the individual "marine mammal" level, *i.e.*, that NMFS must require mitigation to minimize impacts to each individual marine mammal unless impracticable, we believe such an interpretation reflects an incomplete appreciation of the Court's holding. In our view, the opinion as a whole turned on the Court's determination that NMFS had not given separate and independent meaning to the least practicable adverse impact standard apart from the negligible impact standard, and further, that the Court's use of the term "marine mammals" was not addressing the question of whether the standard applies to individual animals as opposed to the species or stock as a whole. We recognize that while consideration of mitigation can play a role in a negligible impact determination, consideration of mitigation measures extends beyond that analysis. In evaluating what mitigation measures are appropriate, NMFS considers the potential impacts of the Specified Activities, the availability of measures to minimize those potential impacts, and the practicability of implementing those measures, as we describe below.

Implementation of Least Practicable Adverse Impact Standard

Given the *NRDC* v. *Pritzker* decision, we discuss here how we determine whether a measure or set of measures meets the "least practicable adverse impact" standard. Our separate analysis of whether the take anticipated to result from Navy's activities meets the "negligible impact" standard appears in the section "Preliminary Negligible Impact Analysis and Determination" below.

Our evaluation of potential mitigation measures includes consideration of two primary factors:

(1) The manner in which, and the degree to which, implementation of the potential measure(s) is expected to reduce adverse impacts to marine mammal species or stocks, their habitat, and their availability for subsistence uses (where relevant). This analysis considers such things as the nature of the potential adverse impact (such as likelihood, scope, and range), the likelihood that the measure will be effective if implemented, and the likelihood of successful implementation; and

(2) The practicability of the measures for applicant implementation. Practicability of implementation may consider such things as cost, impact on operations, and, in the case of a military readiness activity, specifically considers personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity. 16 U.S.C. 1371(a)(5)(A)(ii).

While the language of the least practicable adverse impact standard calls for minimizing impacts to affected species or stocks, we recognize that the reduction of impacts to those species or stocks accrues through the application of mitigation measures that limit impacts to individual animals. Accordingly, NMFS's analysis focuses on measures designed to avoid or minimize impacts on marine mammals from activities that are likely to increase the probability or severity of population-level effects.

While complete information on impacts to species or stocks from a specified activity is not available for every activity type, and additional information would help NMFS and the Navy better understand how specific disturbance events affect the fitness of individuals of certain species, there have been significant improvements in understanding the process by which disturbance effects are translated to the population. With recent scientific advancements (both marine mammal energetic research and the development of energetic frameworks), the relative likelihood or degree of impacts on species or stocks may typically be predicted given a detailed understanding of the activity, the environment, and the affected species or stocks. This same information is used in the development of mitigation measures and helps us understand how mitigation measures contribute to lessening effects to species or stocks. We also acknowledge that there is always the potential that new information, or a new recommendation that we had not previously considered, becomes available and necessitates reevaluation of mitigation measures (which may be addressed through adaptive management) to see if further reductions of population impacts are possible and practicable.

In the evaluation of specific measures, the details of the specified activity will necessarily inform each of the two primary factors discussed above (expected reduction of impacts and practicability), and are carefully considered to determine the types of mitigation that are appropriate under the least practicable adverse impact standard. Analysis of how a potential mitigation measure may reduce adverse impacts on a marine mammal stock or species, consideration of personnel safety, practicality of implementation, and consideration of the impact on effectiveness of military readiness activities are not issues that can be meaningfully evaluated through a yes/no lens. The manner in which, and the degree to which, implementation of a measure is expected to reduce impacts, as well as its practicability in terms of these considerations, can vary widely. For example, a time/area restriction could be of very high value for decreasing population-level impacts (*e.g.*, avoiding disturbance of feeding females in an area of established biological importance) or it could be of lower value (*e.g.*, decreased disturbance in an area of high productivity but of less firmly established biological importance). Regarding practicability, a measure might involve restrictions in an area or time that impede the Navy's ability to certify a strike group (higher impact on mission effectiveness), or it could mean delaying a small in-port training event by 30 minutes to avoid exposure of a marine mammal to injurious levels of sound (lower impact). A responsible evaluation of "least practicable adverse impact" will consider the factors along these realistic scales. Accordingly, the greater the likelihood that a measure will contribute to reducing the probability or severity of adverse impacts to the species or stock or their habitat, the greater the weight that measure is given when considered in combination with practicability to determine the appropriateness of the mitigation measure, and vice versa. In the evaluation of specific measures, the details of the specified activity will necessarily inform each of the two primary factors discussed above (expected reduction of impacts and

practicability), and will be carefully considered to determine the types of mitigation that are appropriate under the least practicable adverse impact standard. We discuss consideration of these factors in greater detail below.

1. *Reduction of adverse impacts to marine mammal species or stocks and their habitat.*[5] The emphasis given to a measure's ability to reduce the impacts on a species or stock considers the degree, likelihood, and context of the anticipated reduction of impacts to individuals (and how many individuals) as well as the status of the species or stock.

The ultimate impact on any individual from a disturbance event (which informs the likelihood of adverse species- or stock-level effects) is dependent on the circumstances and associated contextual factors, such as duration of exposure to stressors. Though any proposed mitigation needs to be evaluated in the context of the specific activity and the species or stocks affected, measures with the following types of effects have greater value in reducing the likelihood or severity of adverse species- or stock-level impacts: Avoiding or minimizing injury or mortality; limiting interruption of known feeding, breeding, mother/young, or resting behaviors; minimizing the abandonment of important habitat (temporally and spatially); minimizing the number of individuals subjected to these types of disruptions; and limiting degradation of habitat. Mitigating these types of effects is intended to reduce the likelihood that the activity will result in energetic or other types of impacts that are more likely to result in reduced reproductive success or survivorship. It is also important to consider the degree of impacts that are expected in the absence of mitigation in order to assess the added value of any potential measures. Finally, because the least practicable adverse impact standard gives NMFS discretion to weigh a variety of factors when determining what should be included as appropriate mitigation measures and because the focus is on reducing impacts at the species or stock level, it does not compel mitigation for every kind of take, or every individual taken, even when practicable for implementation by the applicant.

The status of the species or stock is also relevant in evaluating the appropriateness of potential mitigation measures in the context of least practicable adverse impact. The following are examples of factors that may (either alone, or in combination) result in greater emphasis on the importance of a mitigation measure in reducing impacts on a species or stock: The stock is known to be decreasing or status is unknown, but believed to be declining; the known annual mortality (from any source) is approaching or exceeding the Potential Biological Removal (PBR) level (as defined in 16 U.S.C. 1362(20)); the affected species or stock is a small, resident population; or the stock is involved in a UME or has other known vulnerabilities, such as recovering from an oil spill.

Habitat mitigation, particularly as it relates to rookeries, mating grounds, and areas of similar significance, is also relevant to achieving the standard and can include measures such as reducing impacts of the activity on known prey utilized in the activity area or reducing impacts on physical habitat. As with species- or stock-related mitigation, the emphasis given to a measure's ability to reduce impacts on a species or stock's habitat considers the degree, likelihood, and context of the anticipated reduction of impacts to habitat. Because habitat value is informed by marine mammal presence and use, in some cases there may be overlap in measures for the species or stock and for use of habitat.

We consider available information indicating the likelihood of any measure to accomplish its objective. If evidence shows that a measure has not typically been effective nor successful, then either that measure should be modified or the potential value of the measure to reduce effects should be lowered.

2. *Practicability.* Factors considered may include cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity (16 U.S.C. 1371(a)(5)(A)(ii)).

NMFS reviewed the Specified Activities and the proposed mitigation measures as described in the Navy's rulemaking/LOA application and the HSTT DEIS/OEIS to determine if they would result in the least practicable adverse effect on marine mammals. NMFS worked with the Navy in the development of the Navy's initially proposed measures, which are informed by years of implementation and monitoring. A complete discussion of the evaluation process used to develop, assess, and select mitigation measures, which was informed by input from NMFS, can be found in Chapter 5 (Mitigation) and Appendix K (Geographic Mitigation Assessment) of the HSTT DEIS/OEIS and is summarized below. We agree that the process described in Chapter 5 and Appendix K of the HSTT DEIS/OEIS is an accurate and appropriate process for evaluating whether the mitigation measures proposed in this rule meet the least practicable adverse impact standard for the testing and training activities in this proposed rule. The Navy proposes to implement these mitigation measures to avoid potential impacts from acoustic, explosive, and physical disturbance and strike stressors.

In summary (and described in more detail below), the Navy proposes procedural mitigation measures that we find will reduce the probability and/or severity of impacts expected to result from acute exposure to acoustic sources or explosives, ship strike, and impacts to marine mammal habitat. Specifically, the Navy would use a combination of delayed starts, powerdowns, and shutdowns to minimize or avoid serious injury or mortality, minimize the likelihood or severity of PTS or other injury, and reduce instances of TTS or more severe behavioral disruption caused by acoustic sources or explosives. The Navy also proposes to implement multiple time/area restrictions (several of which have been added since the Phase II rule) that would reduce take of marine mammals in areas or at times where they are known to engage in important behaviors, such as feeding or calving, where the disruption of those behaviors would have a higher probability of resulting in impacts on reproduction or survival of individuals that could lead to population-level impacts. The Navy assessed the practicability of the measures it proposed in the context of personnel safety, practicality of implementation, and their impacts on the Navy's ability to meet their Title 10 requirements and found that the measures were supportable. As summarized in this paragraph and described in more detail below, NMFS has evaluated the measures the Navy has proposed in the manner described earlier in this section (*i.e.*, in consideration of their ability to reduce adverse impacts on marine mammal species or stocks and their habitat and their practicability for implementation) and has determined that the measures will both significantly and adequately reduce impacts on the affected marine

[5] We recognize the least practicable adverse impact standard requires consideration of measures that will address minimizing impacts on the availability of the species or stocks for subsistence uses where relevant. Because subsistence uses are not implicated for this action we do not discuss them. However, a similar framework would apply for evaluating those measures, taking into account the MMPA's directive that we make a finding of no unmitigable adverse impact on the availability of the species or stocks for taking for subsistence, and the relevant implementing regulations.

mammal species or stocks and their habitat and be practicable for Navy implementation. Therefore, the mitigation measures assure that Navy's activities will have the least practicable adverse impact on the species and stocks and their habitat.

The Navy also evaluated numerous measures in the Navy's HSTT DEIS/OEIS that are not included in the Navy's rulemaking/LOA application for the Specified Activities, and NMFS preliminarily concurs with Navy's analysis that their inclusion was not appropriate under the least practicable adverse impact standard based on our assessment. The Navy considers these additional potential mitigation measures in two groups. Chapter 5 of the HSTT DEIS/OEIS, in the "Measures Considered but Eliminated" section, includes an analysis of an array of different types of mitigation that have been recommended over the years by NGOs or the public, through scoping or public comment on environmental compliance documents. Appendix K of the HSTT DEIS/OEIS includes an in-depth analysis of time/area restrictions that have been recommended over time or previously implemented as a result of litigation. As described in Chapter 5 of the DEIS/OEIS, commenters sometimes recommend that the Navy reduce their overall amount of training, reduce explosive use, modify their sound sources, completely replace live training with computer simulation, or include time of day restrictions. All of these proposed measures could potentially reduce the number of marine mammals taken, via direct reduction of the activities or amount of sound energy put in the water. However, as the Navy has described in Chapter 5 of the HSTT DEIS/OEIS, they need to train and test in the conditions in which they fight—and these types of modifications fundamentally change the activity in a manner that would not support the purpose and need for the training and testing (*i.e.*, are entirely impracticable) and therefore are not considered further. NMFS finds the Navy's explanation for why adoption of these recommendations would unacceptably undermine the purpose of the testing and training persuasive. In addition, NMFS must rely on Navy's judgment to a great extent on issues such as its personnel's safety, practicability of Navy's implementation, and extent to which a potential measure would undermine the effectiveness of Navy's testing and training. For these reasons, NMFS finds that these measures do not meet the least practicable adverse impact standard because they are not practicable.

Second in Chapter 5 of the DEIS/OEIS, the Navy evaluated additional potential procedural mitigation measures, including increased mitigation zones, ramp-up measures, additional passive acoustic and visual monitoring, and decreased vessel speeds. Some of these measures have the potential to incrementally reduce take to some degree in certain circumstances, though the degree to which this would occur is typically low or uncertain. However, as described in the Navy's analysis, the impracticability of implementation outweighed the potential reduction of impacts to marine mammal species or stocks (see Chapter 5 of HSTT DEIS/OEIS). NMFS reviewed the Navy's evaluation and concurred with this assessment that this additional mitigation was not warranted.

Appendix K describes a comprehensive method for analyzing potential geographic mitigation that includes consideration of both a biological assessment of how the potential time/area limitation would benefit the species or stock and its habitat (*e.g.*, is a key area of biological importance or would result in avoidance or reduction of impacts) in the context of the stressors of concern in the specific area and an operational assessment of the practicability of implementation (*e.g.*, including an assessment of the specific importance of that area for training—considering proximity to training ranges and emergency landing fields and other issues). The analysis analyzes an extensive list of areas including Biologically Important Areas, areas agreed to under the HSTT settlement agreement, areas identified by the California Coastal Commission, and areas suggested during scoping. For the areas that were agreed to under the settlement agreement, the Navy notes two important facts that NMFS generally concurs with: (1) The measures were derived pursuant to negotiations with plaintiffs and were specifically not evaluated or selected based on the examination of the best available science that NMFS typically applies to a mitigation assessment and; (2) the Navy's adoption of restrictions on its activities as part of a relatively short-term settlement does not mean that those restrictions are practicable to implement over the longer term.

Navy has proposed several time/area mitigations that were not included in the Phase II HSTT regulations. For the areas that are not included in the proposed regulations, though, the Navy found that on balance, the mitigation was not warranted because the anticipated reduction of adverse impacts on marine mammal species or stock and their habitat was not sufficient to offset the impracticability of implementation (in some cases potential benefits to marine mammals were limited to non-existent, in others the consequences on mission effectiveness were too great). NMFS has reviewed the Navy's analysis (Chapter 5 and Appendix K referenced above), which considers the same factors that NMFS would consider to satisfy the least practical adverse impact standard, and has preliminarily concurred with the conclusions, and is not proposing to include any of the measures that the Navy ruled out in the proposed regulations. Below are the mitigation measures that NMFS determined will ensure the least practicable adverse impact on all affected species and stocks and their habitat, including the specific considerations for military readiness activities. The following sections summarize the mitigation measures that will be implemented in association with the training and testing activities analyzed in this document. The mitigation measures are organized into two categories: Procedural mitigation and mitigation areas.

Procedural Mitigation

Procedural mitigation is mitigation that the Navy will implement whenever and wherever an applicable training or testing activity takes place within the HSTT Study Area. The Navy customizes procedural mitigation for each applicable activity category or stressor. Procedural mitigation generally involves: (1) The use of one or more trained Lookouts to diligently observe for specific biological resources (including marine mammals) within a mitigation zone, (2) requirements for Lookouts to immediately communicate sightings of specific biological resources to the appropriate watch station for information dissemination, and (3) requirements for the watch station to implement mitigation (*e.g.*, halt an activity) until certain recommencement conditions have been met. The first procedural mitigation (Table 42) is designed to aid Lookouts and other applicable personnel with their observation, environmental compliance, and reporting responsibilities. The remainder of the procedural mitigations (Tables 43 through Tables 62) are organized by stressor type and activity category and includes acoustic stressors (*i.e.*, active sonar, air guns, pile driving, weapons firing noise), explosive stressors (*i.e.*, sonobuoys, torpedoes, medium-caliber and large-caliber

projectiles, missiles and rockets, bombs, sinking exercises, mines, underwater demolition multiple charge mat weave and obstacles loading, anti-swimmer grenades), and physical disturbance and strike stressors (*i.e.*, vessel movement, towed in-water devices, small-, medium-, and large-caliber non-explosive practice munitions, non-explosive missiles and rockets, non-explosive bombs and mine shapes).

TABLE 43—PROCEDURAL MITIGATION FOR ENVIRONMENTAL AWARENESS AND EDUCATION

Procedural mitigation description
Stressor or Activity: • All training and testing activities, as applicable. *Mitigation Zone Size and Mitigation Requirements:* • Appropriate personnel involved in mitigation and training or testing activity reporting under the Specified Activities will complete one or more modules of the U.S. Navy Afloat Environmental Compliance Training Series, as identified in their career path training plan. Modules include: • Introduction to the U.S. Navy Afloat Environmental Compliance Training Series. The introductory module provides information on environmental laws (*e.g.*, ESA, MMPA) and the corresponding responsibilities relevant to Navy training and testing. The material explains why environmental compliance is important in supporting the Navy's commitment to environmental stewardship. • Marine Species Awareness Training. All bridge watch personnel, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare and mine warfare rotary-wing aircrews, Lookouts, and equivalent civilian personnel must successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The Marine Species Awareness Training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures. Navy biologists developed Marine Species Awareness Training to improve the effectiveness of visual observations for biological resources, focusing on marine mammals and sea turtles, and including floating vegetation, jellyfish aggregations, and flocks of seabirds. • U.S. Navy Sonar Positional Reporting System and Marine Mammal Incident Reporting. This module provides instruction on the procedures and activity reporting requirements for the Sonar Positional Reporting System and marine mammal incident reporting. • U.S. Navy Protective Measures Assessment Protocol. This module provides the necessary instruction for accessing mitigation requirements during the event planning phase using the Protective Measures Assessment Protocol software tool. Also related are annual marine mammal awareness messages promulgated annually to Fleet units: *For Hawaii:* • Humpback Whale Awareness Notification Message Area (November 15–April 15): —The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including humpback whales. —To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including humpback whales), that when concentrated seasonally, may become vulnerable to vessel strikes. —Lookouts will use the information from the awareness notification message to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. *For Southern California:* • Blue Whale Awareness Notification Message Area (June 1–October 31): —The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including blue whales. —To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including blue whales), that when concentrated seasonally, may become vulnerable to vessel strikes. —Lookouts will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. • Gray Whale Awareness Notification Message Area (November 1–March 31): —The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including gray whales. —To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including gray whales), that when concentrated seasonally, may become vulnerable to vessel strikes. —Lookouts will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation. • Fin Whale Awareness Notification Message Area (November 1–May 31): —The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including fin whales. —To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including fin whales), that when concentrated seasonally, may become vulnerable to vessel strikes. —Lookouts will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in implementation of procedural mitigation.

Procedural Mitigation for Acoustic Stressors

Mitigation measures for acoustic stressors are provided in Tables 44 through 47.

Procedural Mitigation for Active Sonar

Procedural mitigation for active sonar is described in Table 44 below.

TABLE 44—PROCEDURAL MITIGATION FOR ACTIVE SONAR

Procedural mitigation description

Stressor or Activity:
• Low-frequency active sonar, mid-frequency active sonar, high-frequency active sonar.
• For vessel-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned surface vessels (*e.g.*, sonar sources towed from manned surface platforms).
• For aircraft-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned aircraft that do not operate at high altitudes (*e.g.*, rotary-wing aircraft). Mitigation does not apply to active sonar sources deployed from unmanned aircraft or aircraft operating at high altitudes (*e.g.*, maritime patrol aircraft).
Number of Lookouts and Observation Platform:
• Hull-mounted sources:
  • Platforms without space or manning restrictions while underway: 2 Lookouts at the forward part of the ship.
  • Platforms with space or manning restrictions while underway: 1 Lookout at the forward part of a small boat or ship
  • Platforms using active sonar while moored or at anchor (including pierside): 1 Lookout
• Sources that are not hull-mounted:
  • 1 Lookout on the ship or aircraft conducting the activity.
Mitigation Zone Size and Mitigation Requirements:
• Prior to the start of the activity (*e.g.*, when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence use of active sonar.
• Low-frequency active sonar at 200 dB or more, and hull-mounted mid-frequency active sonar will implement the following mitigation zones:
  • During the activity, observe for marine mammals; power down active sonar transmission by 6 dB if resource is observed within 1,000 yd of the sonar source; power down by an additional 4 dB (10 dB total) if resource is observed within 500 yd of the sonar source; and cease transmission if resource is observed within 200 yd of the sonar source.
• Low-frequency active sonar below 200 dB, mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar will implement the following mitigation zone:
  • During the activity, observe for marine mammals; cease active sonar transmission if resource is observed within 200 yd of the sonar source.
• To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence active sonar transmission until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the sonar source; (3) the mitigation zone has been clear from any additional sightings for 10 min for aircraft-deployed sonar sources or 30 min for vessel-deployed sonar sources; (4) for mobile activities, the active sonar source has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting; or (5) for activities using hull-mounted sonar, the Lookout concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave, and are therefore out of the main transmission axis of the sonar (and there are no other marine mammal sightings within the mitigation zone).

Procedural Mitigation for Air Guns

Procedural mitigation for air guns is described in Table 45 below.

TABLE 45—PROCEDURAL MITIGATION FOR AIR GUNS

Procedural mitigation description

Stressor or Activity:
• Air guns.
Number of Lookouts and Observation Platform:
• 1 Lookout positioned on a ship or pierside.
Mitigation Zone Size and Mitigation Requirements:
• 150 yd around the air gun:
  • Prior to the start of the activity (*e.g.*, when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence use of air guns.
  • During the activity, observe for marine mammals; if resource is observed, cease use of air guns.
  • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence the use of air guns until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the air gun; (3) the mitigation zone has been clear from any additional sightings for 30 min; or (4) for mobile activities, the air gun has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Procedural Mitigation for Pile Driving

Procedural mitigation for pile driving is described in Table 46 below.

TABLE 46—PROCEDURAL MITIGATION FOR PILE DRIVING

Procedural mitigation description
Stressor or Activity: • Pile driving and pile extraction sound during Elevated Causeway System Training. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned on the shore, the elevated causeway, or a small boat. *Mitigation Zone Size and Mitigation Requirements:* • 100 yd around the pile driver: • 30 min prior to the start of the activity, observe for floating vegetation and marine mammals; if resource is observed, do not commence impact pile driving or vibratory pile extraction. • During the activity, observe for marine mammals; if resource is observed, cease impact pile driving or vibratory pile extraction. • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence pile driving until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the pile driving location; or (3) the mitigation zone has been clear from any additional sightings for 30 min.

Procedural Mitigation for Weapons Firing Noise

Procedural mitigation for weapons firing noise is described in Table 47 below.

TABLE 47—PROCEDURAL MITIGATION FOR WEAPONS FIRING NOISE

Procedural mitigation description
Stressor or Activity: • Weapons firing noise associated with large-caliber gunnery activities. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned on the ship conducting the firing. • Depending on the activity, the Lookout could be the same as the one described in Table 50 (Procedural Mitigation for Explosive Medium-Caliber and Large-Caliber Projectiles) or Table 60 (Procedural Mitigation for Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions) *Mitigation Zone Size and Mitigation Requirements:* • 30 degrees on either side of the firing line out to 70 yd from the muzzle of the weapon being fired: • Prior to the start of the activity, observe for floating vegetation and marine mammals; if resource is observed, do not commence weapons firing. • During the activity, observe for marine mammals; if resource is observed, cease weapons firing. • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence weapons firing until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the firing ship; (3) the mitigation zone has been clear from any additional sightings for 30 min; or (4) for mobile activities, the firing ship has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Procedural Mitigation for Explosive Stressors

Mitigation measures for explosive stressors are provided in Tables 48 through 52.

Procedural Mitigation for Explosive Sonobuoys

Procedural mitigation for explosive sonobuoys is described in Table 48 below.

TABLE 48—PROCEDURAL MITIGATION FOR EXPLOSIVE SONOBUOYS

Procedural mitigation description
Stressor or Activity: • Explosive sonobuoys. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned in an aircraft or on small boat. *Mitigation Zone Size and Mitigation Requirements:* • 600 yd around an explosive sonobuoy: • Prior to the start of the activity (*e.g.*, during deployment of a sonobuoy field, which typically lasts 20–30 min), conduct passive acoustic monitoring for marine mammals, and observe for floating vegetation and marine mammals; if resource is visually observed, do not commence sonobuoy or source/receiver pair detonations. • During the activity, observe for marine mammals; if resource is observed, cease sonobuoy or source/receiver pair detonations.

TABLE 48—PROCEDURAL MITIGATION FOR EXPLOSIVE SONOBUOYS—Continued

Procedural mitigation description
• To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence the use of explosive sonobuoys until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the sonobuoy; or (3) the mitigation zone has been clear from any additional sightings for 10 min when the activity involves aircraft that have fuel constraints, or 30 min when the activity involves aircraft that are not typically fuel constrained.

Procedural Mitigation for Explosive Torpedoes

Procedural mitigation for explosive torpedoes is described in Table 49 below.

TABLE 49—PROCEDURAL MITIGATION FOR EXPLOSIVE TORPEDOES

Procedural mitigation description
Stressor or Activity: • Explosive torpedoes. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned in an aircraft. *Mitigation Zone Size and Mitigation Requirements:* • 2,100 yd around the intended impact location: • Prior to the start of the activity (*e.g.*, during deployment of the target), conduct passive acoustic monitoring for marine mammals, and observe for floating vegetation, jellyfish aggregations and marine mammals; if resource is visually observed, do not commence firing. • During the activity, observe for marine mammals and jellyfish aggregations; if resource is observed, cease firing. • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 min when the activity involves aircraft that have fuel constraints, or 30 min when the activity involves aircraft that are not typically fuel constrained. • After completion of the activity, observe for marine mammals; if any injured or dead resources are observed, follow established incident reporting procedures.

Procedural Mitigation for Medium- and Large-Caliber Projectiles

Procedural mitigation for medium- and large-caliber projectiles is described in Table 50 below.

TABLE 50—PROCEDURAL MITIGATION FOR EXPLOSIVE MEDIUM-CALIBER AND LARGE-CALIBER PROJECTILES

Procedural mitigation description
Stressor or Activity: • Gunnery activities using explosive medium-caliber and large-caliber projectiles. • Mitigation applies to activities using a surface target. *Number of Lookouts and Observation Platform:* • 1 Lookout on the vessel or aircraft conducting the activity. *Mitigation Zone Size and Mitigation Requirements:* • 200 yd around the intended impact location for air-to-surface activities using explosive medium-caliber projectiles, or • 600 yd around the intended impact location for surface-to-surface activities using explosive medium-caliber projectiles, or • 1,000 yd around the intended impact location for surface-to-surface activities using explosive large-caliber projectiles: • Prior to the start of the activity (*e.g.*, when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence firing. • During the activity, observe for marine mammals; if resource is observed, cease firing. • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 10 min for aircraft-based firing or 30 min for vessel-based firing; or (4) for activities using mobile targets, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Procedural Mitigation for Explosive Missiles and Rockets

Procedural mitigation for explosive missiles and rockets is described in Table 51 below.

TABLE 51—PROCEDURAL MITIGATION FOR EXPLOSIVE MISSILES AND ROCKETS

Procedural mitigation description
Stressor or Activity: • Aircraft-deployed explosive missiles and rockets. • Mitigation applies to activities using a surface target. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned in an aircraft. *Mitigation Zone Size and Mitigation Requirements:* • 900 yd around the intended impact location during activities for missiles or rockets with 0.6–20 lb net explosive weight, or • 2,000 yd around the intended impact location for missiles with 21–500 lb net explosive weight: • Prior to the start of the activity (*e.g.*, during a fly-over of the mitigation zone), observe for floating vegetation and marine mammals; if resource is observed, do not commence firing. • During the activity, observe for marine mammals; if resource is observed, cease firing. • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 min when the activity involves aircraft that have fuel constraints, or 30 min when the activity involves aircraft that are not typically fuel constrained.

Procedural Mitigation for Explosive Bombs

Procedural mitigation for explosive bombs is described in Table 52 below.

TABLE 52—PROCEDURAL MITIGATION FOR EXPLOSIVE BOMBS

Procedural mitigation description
Stressor or Activity: • Explosive bombs. *Number of Lookouts and Observation Platform:* • 1 Lookout positioned in the aircraft conducting the activity. *Mitigation Zone Size and Mitigation Requirements:* • 2,500 yd around the intended target: • Prior to the start of the activity (*e.g.*, when arriving on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence bomb deployment. • During target approach, observe for marine mammals; if resource is observed, cease bomb deployment. • To allow an observed marine mammal to leave the mitigation zone, the Navy will not recommence bomb deployment until one of the recommencement conditions has been met: (1) The animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended target; (3) the mitigation zone has been clear from any additional sightings for 10 min; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Procedural Mitigation for Sinking Exercises

Procedural mitigation for sinking exercises is described in Table 53 below.

TABLE 53—PROCEDURAL MITIGATION FOR SINKING EXERCISES

Procedural mitigation description
Stressor or Activity: • Sinking exercises. *Number of Lookouts and Observation Platform:* • 2 Lookouts (one positioned in an aircraft and one on a vessel). *Mitigation Zone Size and Mitigation Requirements:* • 2.5 nmi around the target ship hulk: • 90 min prior to the first firing, conduct aerial observations for floating vegetation, jellyfish aggregations and marine mammals; if resource is observed, do not commence firing.