Appendix I Military Expended Materials, Direct Strike, and Ship Strike Effects Analysis

Environmental Impact Statement/

Overseas Environmental Impact Statement

Hawaii-California Training and Testing

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APPENDIX I Military Expended Materials, Direct Strike, and Ship Strike Effects Analysis

I.1 Estimating the Effect 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 effect 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 effect of military expended materials or explosions on the substrate. The actual instantaneous effect 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 effects on the bottom are far more difficult to quantify—refer to Section 3.2 (Sediments and Water Quality) and Section 3.5 (Habitats) 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-California Training and Testing (HCTT) 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 I-1 through Table I-9 below. Appendix A (Activity Descriptions) of the HCTT Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) provides basic descriptions of military expended materials, and Section 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 I-1. The data for (2) comes from a compilation of abiotic substrate mapping presented in the Benthic Habitat Database Technical Report.

To determine the potential level of disturbance of military expended materials on marine substrates, it was assumed that the effect footprint of the expended material on the seafloor is twice the size of its footprint (unless specified otherwise in Appendix I 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 effect 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 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 Benthic Habitat Database Technical Report, 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 HCTT Study Area there are acreages of substrate that are included under Protective Measures Assessment Protocol (PMAP) categories from the Phase III HSTT EIS/OEIS. These PMAP categories indicate the amount of mapped substrate that may be protected by Navy mitigation measures. However, the PMAP areas were not excluded from the quantitative effects analysis due to how PMAP is implemented. For more information on the substrates protected under PMAP see Chapter 5 (Mitigation).

The percentage of affected substrate (Scenario 1) was calculated by totaling the effect footprint of individual activities divided by the total area of a given substrate in the training or testing area for which the effects could occur. The results are provided in Table I-6 through Table I-9.

Assumptions used in the Scenario 1 analysis included the following:

- 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 Effects), 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 effect 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 affect soft substrate if the majority of the analysis dimension was soft substrate. The results provided in the Table I-11 through Table I-14 scenario are considered more realistic than Scenario 1, yet still unlikely as they do not account for areas of concentrated training, nor do they 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 occur.

Table I-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	2.52	5.04	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 torpedoes are frequently recovered; assume all are non-recoverable for worst-case.
	Anti-torpedo Torpedo Accessories	NA	NA	1.01	2.02	
Explosive Charge	Flares	NA	NA	1.2196	4.8782	Assumed to not have parachutes.
	0.5 lb. explosive charges	50%	12	NA	NA	None
	2.5 lb. explosive charges	50%	30	NA	NA	None
	5 lb. explosive charges	50%	54	NA	NA	None

Table I-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)	10 lb. explosive charges	50%	85	NA	NA	None
	20 lb. explosive charges	50%	135	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 included 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 I-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.
	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 lb.
	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.
	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. One 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.

Table I-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)	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.
	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.
	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.

Table I-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)	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.
	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
	Ship Hulk	NA	NA	316,136.036	632,272.073	None

Table I-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	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.
	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.

Table I-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 (continued)	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
	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.

[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, ft. = foot/feet, $ft.^2$ = square feet, lb. = pound(s), NA = not applicable

I.1.1 Military Expended and Recovered Materials – Training Activities

Table I-2 through Table I-5 show annual military expended and recovered materials and effect footprints within the HCTT Study Area.

Table I-2: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Training Activities Under Alternative 1

Military Expended Materials	Size ($ft.^2$)	Effect Footprint ($ft.^2$)	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Bombs								
Bombs (Explosive)	8.1203	112.9048	35	0.0907	-	-	124	0.3214
Bombs (Non-Explosive)	8.1203	112.9048	41	0.1050	-	-	64	0.1646
Projectiles								
Grenade (non-explosive)	0.1044	0.2088	1,450	0.0070	-	-	10,030	0.0481
Large-Caliber (Casing)	0.5048	1.0097	228	0.0053	25	0.0006	626	0.0145
Large-Caliber (Explosive)	1.0097	4.0386	2,160	0.2003	448	0.0415	7,965	0.7385
Large-Caliber (Non-Explosive)	1.0097	4.0386	1,456	0.1350	42	0.0039	1,717	0.1592
Medium-Caliber (Explosive)	0.056	0.2239	14,319	0.0736	60	0.0003	20,262	0.1041
Medium-Caliber (Non-Explosive)	0.056	0.2239	329,480	1.6935	3,600	0.0185	825,820	4.2447
Medium-Caliber Projectile Casings	0.0300	0.0600	5,473	0.0075	183	0.0003	22,534	0.0310
Missiles (Explosive)	37.3669	74.7338	444	0.7617	-	-	437	0.7497
Missiles (Non-Explosive)	31.0011	62.0023	2,148	0.0788	-	-	2,492	0.0914
Rockets (Explosive)	0.7987	1.5974	851	0.0312	-	-	1,857	0.0681
Rockets (Non-Explosive)	0.7987	1.5974	81,925	9.1746	-	-	116,845	13.0852
Small-Caliber (Non-Explosive)	0.0301	0.1216	2,175,350	6.0726	96,000	0.2680	7,933,342	22.1463
Small-Caliber (Casing Only)	0.0151	0.0301	443,370	0.3064	19,200	0.0133	1,726,408	1.1929
Countermeasures								
Acoustic Countermeasures	0.3111	1.2432	486	0.0139	-	-	314	0.0090
Chaff (Air cartridge)	0.0011	0.0022	930	0.0000	-	-	4,590	0.0002
Chaff (Ship cartridge)	2	4	790	0.0725	-	-	2,700	0.2479
Flares	1.2196	4.8782	12	0.0013	-	-	62	0.0069

Table I-2: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Training Activities under Alternative 1 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Targets								
Air Target – Expended (Decoy)	14.0216	28.0432	11	0.0071	-	-	61	0.0393
Air Target – Expended (Drone)	95.6400	191.2800	186	0.8168	-	-	725	3.1848
Mine Shapes – (Non-Explosive)	25.7903	51.5807	115	0.1359	-	-	350	0.4139
Sub-Surface Targets (Maneuvering)	8.755	17.51	330	0.1328	1	0.0004	751	0.3019
Surface Target – Floating (Large)	98	196	53	0.2374	10	0.0450	94	0.4245
Surface Target – Floating (Medium)	2.615	5.2300	252	0.0302	10	0.0012	903	0.1084
Surface Target – Floating (Small)	0.365	0.7300	420	0.0070	-	-	1,384	0.0232
Other								
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	18	0.0013	-	-	64	0.0048
Anchor (Expendable)	6.2495	12.5001	358	0.1027	-	-	2,248	0.6451
Bathythermograph – Expended	0.2777	0.5544	1,838	0.0234	18	0.0002	2,182	0.0278
Canister	2.0000	4.0000	40	0.0037	-	-	40	0.0037
Compression Pad/Piston	0.0043	0.0086	930	0.0002	-	-	4,590	0.0009
Endcaps	0.0021	0.0043	3,822	0.0004	-	-	8,552	0.0008
Fiber Optic Can	0.0011	0.0022	58	0.0000	-	-	1,520	0.0001
Flare O-Ring	0.0043	0.0086	12	0.0000	-	-	62	0.0000
Heavyweight Torpedo (Explosive)	39.6155	79.2299	6	0.0109	-	-	1	0.0018
Heavyweight Torpedo Accessories	0.1615	3.2367	6	0.0004	-	-	1	0.0001
Illumination Flare	1.2196	4.8782	12	0.0013	-	-	62	0.0069
JATO Bottle	3.6061	7.2134	2	0.0003	-	-	26	0.0043
Lightweight Torpedo Accessories	1.1011	2.0215	61	0.0028	-	-	201	0.0093

Table I-2: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Training Activities under Alternative 1 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Other (continued)								
Marine Marker	0.9752	3.8987	-	-	-	-	6	0.0005
Decelerator/Parachute (Large)	5,026.50	10,053.09	45	4.0567	-	-	63	5.6794
Decelerator/Parachute (Medium)	1,963.50	3,926.90	12	0.1402	-	-	62	0.7243
Decelerator/Parachute (Small)	254.5	508.9	5,928	7.6950	-	-	14,964	19.4229
Ship Hulk	316,136	632,272	2	29.0299	-	-	1	7.2575
Sonobuoy (Non-Explosive)	1.2207	2.4413	6,067	0.3400	-	-	14,956	0.8382
Total			**3,081,567**	**61.6984**	**119,596**	**0.3931**	**10,732,056**	**82.5483**

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

Notes: HCTT = Hawaii-California Training and Testing, AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table I-3: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Training Activities Under Alternative 2

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Bombs								
Bombs (Explosive)	8.1203	112.9048	37	0.0959	-	-	126	0.3266
Bombs (Non-Explosive)	8.1203	112.9048	46	0.1192	-	-	69	0.1788
Projectiles								
Grenade (non-explosive)	0.1044	0.2088	1,450	0.0070	-	-	10,230	0.0490
Large-Caliber (Casing)	0.5048	1.0097	253	0.0059	25	0.0006	626	0.0145
Large-Caliber (Explosive)	1.0097	4.0386	2,428	0.2251	448	0.0415	7,937	0.7359
Large-Caliber (Non-Explosive)	1.0097	4.0386	1,684	0.1561	42	0.0039	1,729	0.1603
Medium-Caliber (Explosive)	0.056	0.2239	15,901	0.0817	400	0.0021	23,292	0.1197
Medium-Caliber (Non-Explosive)	0.056	0.2239	369,600	1.8998	24,000	0.1234	1,018,750	5.2364
Medium-Caliber Projectile Casings	0.0300	0.0600	7,134	0.0098	1,220	0.0017	30,677	0.0423
Missiles (Explosive)	37.3669	74.7338	572	0.9814	-	-	458	0.7858
Missiles (Non-Explosive)	31.0011	62.0023	14	0.0199	-	-	-	0.0000
Rockets (Explosive)	0.7987	1.5974	2,288	0.0839	-	-	2,632	0.0965
Rockets (Non-Explosive)	0.7987	1.5974	1,061	0.0389	-	-	1,997	0.0732
Sabot – Kinetic Energy Projectile	2.4392	4.8782	85,300	9.5526	3,000	0.3360	129,070	14.4543
Small-Caliber (Non-Explosive)	0.0301	0.1216	2,736,350	7.6387	96,000	0.2680	8,492,342	23.7068
Small-Caliber (Casing Only)	0.0151	0.0301	555,570	0.3839	19,200	0.0133	1,858,208	1.2840
Countermeasures								
Acoustic Countermeasures	0.3111	1.2432	494	0.0141	-	-	318	0.0091
Chaff (Air cartridge)	0.0011	0.0022	930	0.0000	-	-	4,590	0.0002
Chaff (Ship cartridge)	2	4	790	0.0725	-	-	2,700	0.2479
Flares	1.2196	4.8782	14	0.0016	-	-	62	0.0069

Table I-3: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Training Activities under Alternative 2 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Targets								
Air Target – Expended (Decoy)	14.0216	28.0432	14	0.0090	-	-	61	0.0393
Air Target – Expended (Drone)	95.6400	191.2800	204	0.8951	-	-	825	3.6237
Mine Shapes – (Non-Explosive)	25.7903	51.5807	122	0.1449	-	-	498	0.5895
Sub-Surface Targets (Maneuvering)	8.755	17.51	376	0.1513	1	0.0004	756	0.3037
Surface Target – Floating (Large)	98	196	75	0.3386	27	0.1215	176	0.7912
Surface Target – Floating (Medium)	2.615	5.2300	274	0.0329	10	0.0012	948	0.1138
Surface Target – Floating (Small)	0.365	0.7300	535	0.0090	-	-	1,661	0.0278
Other								
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	20	0.0015	-	-	74	0.0055
Anchor (Expendable)	6.2495	12.5001	434	0.1244	-	-	3,683	1.0570
Bathythermograph – Expended	0.2777	0.5544	2,683	0.0341	18	0.0002	3,300	0.0420
Canister	2.0000	4.0000	40	0.0037	-	-	40	0.0037
Compression Pad/Piston	0.0043	0.0086	930	0.0002	-	-	4,590	0.0009
Endcaps	0.0021	0.0043	4,184	0.0004	-	-	8,942	0.0009
Fiber Optic Can	0.0011	0.0022	68	0.0000	-	-	1,550	0.0001
Flare O-Ring	0.0043	0.0086	14	0.0000	-	-	62	0.0000
Heavyweight Torpedo (Explosive)	39.6155	79.2299	8	0.0146	-	-	3	0.0055
Heavyweight Torpedo Accessories	0.1615	3.2367	8	0.0006	-	-	3	0.0002
Illumination Flare	1.2196	4.8782	14	0.0016	-	-	62	0.0069
JATO Bottle	3.6061	7.2134	6	0.0011	-	-	26	0.0042
Lightweight Torpedo Accessories	1.1011	2.0215	131	0.0061	-	-	226	0.0105
Marine Marker	0.9752	3.8987	1	0.0001	-	-	5	0.0004

Table I-3: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Training Activities under Alternative 2 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Other (continued)								
Decelerator/Parachute (Large)	5,026.50	10,053.09	82	7.4103	-	-	63	5.6614
Decelerator/Parachute (Medium)	1,963.50	3,926.90	14	0.1636	-	-	62	0.7243
Decelerator/Parachute (Small)	254.5	508.9	11,226	14.5711	-	-	18,866	24.4876
Ship Hulk	316,136	632,272	3	43.5449	-	-	1	14.5150
Sonobuoy (Non-Explosive)	1.2207	2.4413	11,296	0.6331	-	-	18,832	1.0554
Total			**3,223,790**	**87.7077**	**123,990**	**0.8087**	**10,979,196**	**98.4579**

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

Notes: HCTT = Hawaii-California Training and Testing, AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table I-4: Number and Effects[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})*	*Effect Footprint (ft.^{2})*	*Hawaii Study Area*		*HCTT Transit Lane*		*California Study Area*	
			Number	*Effect (Acre)*	*Number*	*Effect (Acre)*	*Number*	*Effect (Acre)*
Alternative 1								
Mine Shape (Recovered)	25.7903	51.5807	115	0.1362	-	-	350	0.4144
Total			**115**	**0.1362**	**-**	**-**	**350**	**0.4144**
Alternative 2								
Mine Shape (Recovered)	25.7903	51.5807	122	0.1445	-	-	498	0.5897
Total			**122**	**0.1445**	**-**	**-**	**498**	**0.5897**

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

Table I-5: Annual Numbers of Recovered Materials Proposed for Use During Training Activities Under Alternatives 1 and 2

Recovered Materials	*Hawaii Study Area*		*HCTT Transit Lane*		*California Study Area*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*	*Alternative 1*	*Alternative 2*
Air Targets – Decoy	11	14	-		61	61
Air Targets – Supersonic Drone	0	4	-		-	-
Heavyweight Torpedo (Non-Explosive)	18	18	-		9	9
Lightweight Torpedo (Non-Explosive)	3	7	-		10	11
Sub-surface Target – Maneuvering*	330	376	1		751	756
Surface Device – Floating (Small)	110	110	-		580	580
Surface Target – Floating (Large)	53	75	10		94	176
Surface Target – Floating (Medium)	252	274	10		903	948
Surface Target – Floating (Small)	420	535	-		1,384	1,661

*Some portion of ASW targets are expendable and not recovered.

I.1.2 Military Expended and Recovered Materials – Testing Activities

Table I-6 through Table I-9 show annual military expended and recovered materials and effect footprints within the HCTT Study Area.

Table I-6: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Testing Activities Under Alternative 1

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Bombs								
Bombs (Explosive)	8.1203	112.9048	0	0.0000	-	-	54	0.1400
Bombs (Non-Explosive)	8.1203	112.9048	41	0.1050	-	-	64	0.1646
Projectiles								
Kinetic Energy Projectile (Explosive)	0.7400	1.4800	3	0.0001	-	-	3	0.0001
Large-Caliber (Casing)	0.5048	1.0097	84	0.0019	-	-	447	0.0104
Large-Caliber (Explosive)	1.0097	4.0386	480	0.0445	-	-	5,528	0.5125
Large-Caliber (Non-Explosive)	1.0097	4.0386	1,196	0.1109	-	-	3,408	0.3159
Medium-Caliber (Explosive)	0.056	0.2239	125	0.0006	-	-	24,757	0.1273
Medium-Caliber (Non-Explosive)	0.056	0.2239	35,000	0.1799	-	-	143,850	0.7394
Medium-Caliber Projectile Casings	0.0300	0.0600	901	0.0012	-	-	6,123	0.0084
Missiles (Explosive)	37.6691	74.7338	129	0.2207	-	-	848	1.4554
Missiles (Non-Explosive)	31.0012	62.0023	44	0.0626	-	-	255	0.3630
Rockets (Explosive)	0.7987	1.5974	3	0.0001	-	-	76	0.0028
Rockets (Non-Explosive)	0.7987	1.5974	157	0.0057	-	-	1,272	0.0466
Sabot – Kinetic Energy Projectile	2.4392	4.8782	-	0.0000	-	-	16,075	1.8002
Small-Caliber (Non-Explosive)	0.0301	0.1216	32,500	0.0907	-	-	189,500	0.5290
Small-Caliber (Casing Only)	0.0151	0.0301	6,500	0.0045	-	-	38,700	0.0267
Countermeasures								
Acoustic Countermeasures	0.3111	1.2432	448	0.0128	-	-	538	0.0154
Chaff (Air cartridge)	0.0011	0.0022	1,300	0.0001	-	-	3,696	0.0002
Chaff (Ship cartridge)	2	4	96	0.0088	-	-	144	0.0132
Flares	1.2196	4.8782	1,300	0.1456	-	-	6,456	0.7230

Table I-6: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Testing Activities Under Alternative 1 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Targets								
Air Target – Expended (Decoy)	14.0216	28.0432	-	-	-	-	18	0.0113
Air Target – Expended (Drone)	95.6400	191.2800	29	0.1256	-	-	308	1.3541
Mine Shapes – (Non-Explosive)	25.7903	51.5807	348	0.4123	-	-	1,365	1.6159
Sub-Surface Targets (Maneuvering)	8.755	17.51	206	0.0828	-	-	413	0.1660
Surface Target – Floating (Large)	98	196	13	0.0562	-	-	63	0.2835
Surface Target – Floating (Medium)	2.615	5.2300	34	0.0041	-	-	77	0.0093
Other								
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	72	0.0054	-	-	962	0.0719
Anchor (Recovered)	6.2495	12.5001	774	0.2221	-	-	2,097	0.6017
Anchors – Mine (Expended)	6.2495	12.5001	10	0.0029	-	-	160	0.0459
Anti-Torpedo Torpedo	10.0800	5.0400	4	0.0004	-	-	4	0.0004
Anti-Torpedo Torpedo Accessories	1.0100	2.0200	4	0.0002	-	-	4	0.0002
Bathythermograph – Expended	0.2777	0.5544	143	0.0018	-	-	421	0.0054
Buoy (Explosive)	0.9752	3.8987	360	0.0322	-	-	720	0.0644
Compression Pad/Piston	0.0043	0.0086	1,300	0.0003	-	-	3,696	0.0007
Endcaps	0.0021	0.0043	2,600	0.0003	-	-	10,152	0.0010
Fiber Optic Can	0.0011	0.0022	196	0.0000	-	-	220	0.0000
Flare O-Ring	0.0043	0.0086	1,300	0.0003	-	-	6,456	0.0013
Heavyweight Torpedo (Explosive)	39.6155	79.2299	0	0.0006	-	-	1	0.0012
Heavyweight Torpedo Accessories	0.1615	3.2367	222	0.0165	-	-	266	0.0197
JATO Bottle	3.6061	7.2134	63	0.0104	-	-	631	0.1045
Lightweight Torpedo Accessories	1.1011	2.0215	51	0.0024			144	0.0067

Table I-6: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Testing Activities Under Alternative 1 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Other (continued)								
Decelerator/Parachute (Large)	5,026.50	10,053.09	103	9.2836	-	-	713	64.2457
Decelerator/Parachute (Small)	254.5	508.9	16,925	21.9687	-	-	30,150	39.1346
Sonobuoy (Explosive)	1.2207	2.4413	864	0.0484	-	-	1,728	0.0968
Sonobuoy (Non-Explosive)	1.2207	2.4413	17,337	0.9717	-	-	30,682	1.7196
Total			**123,263**	**34.2450**	**0**	**0**	**533,241**	**116.5559**

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

Notes: HCTT = Hawaii-California Training and Testing, AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table I-7: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Testing Activities Under Alternative 2

Military Expended Materials	Size ($ft.^2$)	Effect Footprint ($ft.^2$)	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Bombs								
Bombs (Explosive)	8.1203	112.9048	-	0.0000	-	-	54	0.1400
Bombs (Non-Explosive)	8.1203	112.9048	46	0.1192	-	-	69	0.1788
Projectiles								
Kinetic Energy Projectile (Explosive)	0.7400	1.4800	10	0.0003	-	-	10	0.0003
Large-Caliber (Casing)	0.5048	1.0097	195	0.0045	-	-	631	0.0146
Large-Caliber (Explosive)	1.0097	4.0386	480	0.0445	-	-	8,092	0.7502
Large-Caliber (Non-Explosive)	1.0097	4.0386	3,408	0.3160	-	-	4,528	0.4198
Medium-Caliber (Explosive)	0.056	0.2239	250	0.0013	-	-	24,757	0.1273
Medium-Caliber (Non-Explosive)	0.056	0.2239	38,500	0.1979	-	-	167,950	0.8633
Medium-Caliber Projectile Casings	0.0300	0.0600	1,083	0.0015	-	-	7,328	0.0101
Missiles (Explosive)	37.6691	74.7338	133	0.2276	-	-	955	1.6390
Missiles (Non-Explosive)	31.0012	62.0023	51	0.0726	-	-	324	0.4612
Rockets (Explosive)	0.7987	1.5974	3	0.0001	-	-	82	0.0030
Rockets (Non-Explosive)	0.7987	1.5974	191	0.0070	-	-	1,804	0.0662
Sabot – Kinetic Energy Projectile	2.4392	4.8782	-	0.0000	-	-	18,025	2.0186
Small-Caliber (Non-Explosive)	0.0301	0.1216	32,500	0.0907	-	-	191,900	0.5357
Small-Caliber (Casing Only)	0.0151	0.0301	7,300	0.0050	-	-	40,340	0.0279
Countermeasures								
Acoustic Countermeasures	0.3111	1.2432	485	0.0138	-	-	562	0.0160
Chaff (Air cartridge)	0.0011	0.0022	1,464	0.0001	-	-	4,055	0.0002
Chaff (Ship cartridge)	2	4	144	0.0132	-	-	192	0.0176
Flares	1.2196	4.8782	1,390	0.1557	-	-	6,889	0.7715

Table I-7: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Testing Activities under Alternative 2 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Targets								
Air Target – Expended (Decoy)	14.0216	28.0432	-	0.0000	-	-	18	0.0113
Air Target – Expended (Drone)	95.6400	191.2800	40	0.1752	-	-	453	1.9870
Mine Shapes – (Non-Explosive)	25.7903	51.5807	490	0.5802	-	-	2,064	2.4444
Sub-Surface Targets (Maneuvering)	8.755	17.51	260	0.1044	-	-	633	0.2543
Surface Target – Floating (Large)	98	196	58	0.2610	-	-	104	0.4668
Surface Target – Floating (Medium)	2.615	5.2300	61	0.0073	-	-	102	0.0122
Other								
AMNS/EMNS Neutralizer (Explosive)	1.6286	3.2572	72	0.0054	-	-	2,260	0.1690
Anchor (Recovered)	6.2495	12.5001	1,384	0.3972	-	-	3,205	0.9198
Anchors – Mine (Expended)	6.2495	12.5001	10	0.0029	-	-	160	0.0459
Anti-Torpedo Torpedo	10.0800	5.0400	5	0.0006	-	-	5	0.0006
Anti-Torpedo Torpedo Accessories	1.0100	2.0200	5	0.0002	-	-	5	0.0002
Bathythermograph – Expended	0.2777	0.5544	209	0.0027	-	-	871	0.0111
Buoy (Explosive)	0.9752	3.8987	450	0.0403	-	-	900	0.0806
Compression Pad/Piston	0.0043	0.0086	1,464	0.0003	-	-	4,055	0.0008
Endcaps	0.0021	0.0043	2,854	0.0003	-	-	10,944	0.0011
Fiber Optic Can	0.0011	0.0022	208	0.0000	-	-	232	0.0000
Flare O-Ring	0.0043	0.0086	1,390	0.0003	-	-	6,889	0.0014
Heavyweight Torpedo (Explosive)	39.6155	79.2299	1	0.0012	-	-	1	0.0024
Heavyweight Torpedo Accessories	0.1615	3.2367	347	0.0258	-	-	434	0.0322
JATO Bottle	3.6061	7.2134	112	0.0185	-	-	696	0.1152
Lightweight Torpedo Accessories	1.1011	2.0215	63	0.0029	-	-	223	0.0103

Table I-7: Annual Number and Effects[1] of Military Expended Materials Proposed for Use During Testing Activities under Alternative 2 (continued)

Military Expended Materials	Size (ft.^{2})	Effect Footprint (ft.^{2})	Hawaii Study Area		HCTT Transit Lane		California Study Area	
			Number	Effect (Acre)	Number	Effect (Acre)	Number	Effect (Acre)
Other (continued)								
Decelerator/Parachute (Large)	5,026.50	10,053.09	137	12.3486	-	-	987	88.9588
Decelerator/Parachute (Small)	254.5	508.9	18,921	24.5595	-	-	33,961	44.0806
Sonobuoy (Explosive)	1.2207	2.4413	1,080	0.0605	-	-	2,160	0.1211
Sonobuoy (Non-Explosive)	1.2207	2.4413	19,379	1.0861	-	-	34,671	1.9431
Total			**136,633**	**40.9527**	**0**	**0**	**584,581**	**149.7317**

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

Notes: HCTT = Hawaii-California Training and Testing, AMNS/EMNS = Airborne Mine Neutralization System/Expendable Mine Neutralization System

Table I-8: Number and Effects[1] of Recovered Bottom-Placed Materials Proposed for Use During Testing Activities in a Single Year Under Alternatives 1 and 2

Recovered Materials	*Size (ft.^{2})*	*Effect Footprint (ft.^{2})*	*Hawaii Study Area*		*HCTT Transit Lane*		*California Study Area*	
			Number	*Effect (Acre)*	*Number*	*Effect (Acre)*	*Number*	*Effect (Acre)*
Alternative 1								
Mine Shape (Recovered)	25.7903	51.5807	348	0.4121	-	-	1,365	1.6163
Total			**348**	**0.4121**	**-**	**-**	**1,365**	**1.6163**
Alternative 2								
Mine Shape (Recovered)	25.7903	51.5807	490	0.5802	-	-	2,064	2.4440
Total			**490**	**0.5802**	**-**	**-**	**2,064**	**2.4440**

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

Table I-9: Annual Numbers of Recovered Materials Proposed for Use During Testing Activities Under Alternatives 1 and 2

Recovered Materials	*Hawaii Study Area*		*HCTT Transit Lane*		*California Study Area*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*	*Alternative 1*	*Alternative 2*
Air Targets – Decoy	0	0	-	-	3	5
Air Targets – Supersonic Drone	11	21	-	-	113	153
Heavyweight Torpedo (Non-Explosive)	53	100	-	-	41	76
Lightweight Torpedo (Non-Explosive)	3	3	-	-	7	11
Sub-surface Target – Maneuvering*	206	260	-	-	413	633
Surface Target – Floating (Large)	13	58	-	-	63	104
Surface Target – Floating (Medium)	34	61	-	-	77	102

*Some portion of ASW targets are expendable and not recovered.

I.2 Effects on Seafloor Habitats – Military Readiness Activities

Table I-10 shows the Study Area bottom types. Using the methodology and assumptions described under Section I.1 (Estimating the Effect of Military Expended Materials and Underwater Explosions on Abiotic Substrates as a Habitat for Biological Resources), Table I-11 through Table I-14 show single-year effects on applicable habitat types, from both explosive charges and military expended materials.

Table I-10: Area and Percent Coverage of Abiotic Substrate Types in the Study Area

Study Area	Habitat						Total Area (km^2)
	Hard		Mixed		Soft		
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	
Hawaii	421,755	5.37	132,133	1.68	7,300,565	92.95	7,854,453
California	1,960	0.22	98,532	11.06	790,400	88.72	890,893
Total	423,715	4.85	230,665	2.64	8,090,965	92.52	8,745,346

Table I-11: Effect from Explosives on or Near the Bottom for Training Activities in Alternative 1 in a Single Year

Training Areas	Net Explosive Weight (lb.)	Number of Charges	Total Effect Footprint (Acre)	Effect by Bottom Type (Acre)		
				Hard	Mixed	Soft
Hawaii Study Area	0.5	750	0.2066	0.01851	0.02138	0.16668
	2.5	397	0.2731	0.02447	0.02827	0.22034
	5	8	0.0099	0.00089	0.00102	0.00799
	10	3	0.0049	0.00044	0.00051	0.00395
	20	98	0.3022	0.02708	0.03128	0.24381
	1,367	1	0.0230	0.00206	0.00238	0.01856
Total	***NA***	**1,256**	**0.8196**	**0.07344**	**0.08483**	**0.66125**
California Study Area	0.5	50	0.0138	0.00003	0.00143	0.01113
	2.5	20	0.0138	0.00003	0.00143	0.01113
	5	32	0.0397	0.00009	0.00411	0.03203
	10	17	0.0332	0.00007	0.00344	0.02679
	20	558	1.7293	0.00380	0.17898	1.39520
	500	3	0.0413	0.00009	0.00427	0.03332
	1,367	4	0.0803	0.00018	0.00831	0.06479
Total	***NA***	**684**	**1.9514**	**0.00429**	**0.20197**	**1.57439**

Table I-12: Effect from Explosives on or Near the Bottom for Training Activities in Alternative 2 in a Single Year

Training Areas	Net Explosive Weight (lb.)	Number of Charges	Total Effect Footprint (Acre)	Effect by Bottom Type (Acre)		
				Hard	Mixed	Soft
Hawaii Study Area	0.5	750	0.2066	0.01851	0.02138	0.16668
	2.5	462	0.3178	0.02847	0.03289	0.25640
	5	10	0.0124	0.00111	0.00128	0.01000
	10	3	0.0049	0.00044	0.00051	0.00395
	20	102	0.3146	0.02819	0.03256	0.25382
	1,367	1	0.0230	0.00206	0.00238	0.01856
Total	***NA***	**1,327**	**0.8792**	**0.07878**	**0.09100**	**0.70934**
California Study Area	0.5	75	0.0207	0.00005	0.00214	0.01670
	2.5	20	0.0138	0.00003	0.00143	0.01113
	5	36	0.0446	0.00010	0.00462	0.03598
	10	22	0.0429	0.00009	0.00444	0.03461
	20	646	2.0021	0.00440	0.20722	1.61529
	500	3	0.0413	0.00009	0.00427	0.03332
	1,367	4	0.0918	0.00020	0.00950	0.07406
Total	***NA***	**806**	**2.2572**	**0.00497**	**0.23362**	**1.82111**

Table I-13: Effect from Explosives on or Near the Bottom for Testing Activities in Alternative 1 in a Single Year

Testing Areas	Net Explosive Weight (lb.)	Number of Charges	Total Effect Footprint (Acre)	Effect by Bottom Type (Acre)		
				Hard	Mixed	Soft
Hawaii Study Area	0.5	360	0.0992	0.00889	0.01027	0.08003
	2.5	180	0.1240	0.01111	0.01283	0.10004
	5	37	0.0452	0.00405	0.00468	0.03647
Total	***NA***	577	**0.2684**	**0.02405**	**0.02778**	**0.21655**
California Study Area	0.5	720	0.1983	0.00044	0.02052	0.15999
	2.5	360	0.2479	0.00055	0.02566	0.20001
	5	482	0.5969	0.00131	0.06178	0.48158
Total	***NA***	1,562	**1.0432**	**0.00230**	**0.10797**	**0.84165**

Table I-14: Effect from Explosives on or Near the Bottom for Testing Activities in Alternative 2 in a Single Year

Testing Areas	Net Explosive Weight (lb.)	Number of Charges	Total Effect Footprint (Acre)	Effect by Bottom Type (Acre)		
				Hard	Mixed	Soft
Hawaii Study Area	0.5	450	0.1240	0.01111	0.01283	0.10004
	2.5	225	0.1550	0.01389	0.01604	0.12505
	5	37	0.0459	0.00411	0.00475	0.03703
	60	6	0.0387	0.00347	0.00401	0.03122
Total	***NA***	718	**0.3635**	**0.03257**	**0.03762**	**0.29327**
California Study Area	0.5	900	0.2479	0.00055	0.02566	0.20001
	2.5	450	0.3099	0.00068	0.03207	0.25003
	5	1,131	1.4021	0.00308	0.14512	1.13121
	60	6	0.0387	0.00009	0.00401	0.03122
Total	***NA***	2,487	**1.9986**	**0.00440**	**0.20686**	**1.61247**

I.3 Statistical and Probability Analysis for Estimating Direct Strike Effect 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 a marine animal from any military items resulting 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 report, Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase IV Training and Testing (U.S. Department of the Navy, 2024). Table I-15 provides a list of symbols used in the equations located in the preceding sections.

Table I-15: A List of Symbols and Their Brief Descriptions as They Are Used in the Analysis

Symbol	Explanation
A_S	Area of an individual marine animal
L_S	Length of an individual marine animal
W_S	Width of an individual marine animal
N_S	Number of individual animals within a single marine species
D_S	Density of animals within a single marine species
A_{TotS}	The total footprint area of a single marine species
A_{RC}	The area of a single testing/training range
L_{mun}	The length of an individual piece of military expended material
W_{mun}	The width of an individual piece of military expended material
A_{mun}	The area of an individual piece of military expended material
N_{mun}	The total number of military expended materials used of a single type (e.g., non-explosive bomb)
A_I	The total area of military expended materials used of a single type (e.g., non-explosive bomb)
A_{TotI}	The area of impact for all types of military expended materials; the impact footprint
A_{BZ}	The area of the buffer zone around the impact footprint
A_{Final}	The total area of concern, including the buffer zone (A_{BZ}), the impact footprint (A_{TotI}), and the total animal footprint of a single marine species (A_{TotS})
R_{TotS}	The total footprint radius of a single marine species
R_{TotI}	The total footprint radius of the impact footprint for all types of military expended materials
R_{BZ}	The buffer zone radius of the impact footprint for all types of military expended materials
P	The probability of impacting a marine animal through a military expended material direct exposure impact
T	Total number of possible surface animal exposures associated with a direct impact from military expended materials

I.3.1 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 and sea turtles on the sea surface within the specified training or testing area (A_{RC}) in which the activities are occurring. The statistical probability analysis is based on probability theory with "footprint" areas for marine animals and total impact inscribed inside the training or testing area. 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 (e.g., Fonseca et al., 2022; Hochscheid, 2014; Irvine et al., 2017; Lagerquist et al., 2000; Mate et al., 1995), and (2) that the animals are stationary, which does not account for any movement or any potential avoidance of the training or testing activity area. There is some research that suggests marine mammals will avoid areas where there is sonar activity but not areas where there is just vessel traffic noise; so, avoidance behavior in marine mammals is situationally dependent (for review see (Ellison et al., 2011)). For sea turtles, research has demonstrated changes in behavior of sea turtles in response to anthropogenic sounds (O'Hara & Wilcox, 1990; Samuel et al., 2005), but more research is needed to determine if they portray avoidance behavior to any form of anthropogenic activity.

There are three types of areas incorporated into the analyses: species area (A_S), total impact footprint area (A_{TotI}), and the buffer zone of the impact area (A_{BZ}). For each calculation, a basic area is assessed using either the area calculation for a rectangle (A = length * width) or a circle ($A = \pi R^2$, where R is the radius of a circle). These area calculations were used in four different scenarios that make assumptions about the type of interaction between the marine animal and the military expended materials. For the initial three scenarios, all areas are calculated using the rectangular method. For the fourth scenario, all areas are calculated using the circular method.

- 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) with a military expended material directly hitting a marine animal. This scenario assumes the marine animal is fully inside the impact area when contact with the military expended material is made.
- Scenario 2: Dynamic scenario with end-on collision. It is assumed that the military expended material is moving through the water, in the same direction as the length of the impact zone, for a distance of six times the initial length of the impact area. The concept here is that the military expended material has forward momentum along the length of the impact area and can make contact with the marine animal at any point inside of this new impact footprint area.
- Scenario 3: Dynamic scenario with broadside collision. It is assumed that the military expended material is moving through the water, in the same direction as the width of the impact zone, for a distance of six times the initial width of the impact area. The concept here is that the military expended material has forward momentum along the width of the impact area and can make contact with the marine animal at any point inside of this new impact footprint area.
- Scenario 4: Purely static, radial scenario, in which the rectangular animal, buffer zone, and impact footprints are replaced with circular footprints. Basically, the assumption is that the animal and the military expended materials are moving in circular patterns, rather than straight paths. This scenario assumes the marine animal is fully inside the impact area when contact with the military expended material is made.

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 six times the impact area's length or width. Significantly different values may result from the static and dynamic orientation scenarios. Both 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).

The method of area (A_S, A_{TotI}, and A_{BZ}) calculation will vary slightly with each scenario. First, the basic concepts behind the area calculations are addressed below.

- The individual animal area (A_S) was calculated by multiplying the length and the width of the animal ($A_S = L_S * W_S$), where width was 20 percent of the length for marine mammals and 84% of the length for sea turtles. Then, the species density and the range complex (A_{RC}) size were incorporated to produce the species total area (A_{TotS}). A_S was multiplied by the number of animals (N_S) in the specified training or testing area, where N_S was the product of the highest average month animal density (D_S) and the area of the range complex ($A_{TotS} = A_S * N_S = A_S * D_S *$

A_{RC}). As a conservative scenario, the total animal footprint area was calculated for the species with the highest average monthly density in the training or testing area with the highest use of military items within the entire Study Area. For the remainder of the calculations A_{TotS} was used to represent the presence of the species within the area.

- To assess the impact footprint area (A_I) for a single type of munition used in the range complex, the area of the munition (A_{mun}) was calculated by multiplying the length and width of the munition ($A_{mun} = L_{mun} * W_{mun}$). Then, A_{mun} was multiplied by the total number of that munition type used in a year (N_{mun}). Thus, $A_I = N_{mun} * A_{mun}$ is the impact footprint for a single type of munition in a single range complex over a year.
- The A_I for each munition type used in the range complex was then summed across all munition types to get a total impact footprint (A_{TotI}) for a year within a single range complex. As a conservative scenario, the total impact footprint area was calculated for the training or testing area with the highest use of military items within the entire Study Area. This total impact footprint area was then converted back into the length-width assessment, with the ratio of the impact area mirroring the animal $\frac{W_S}{L_S} = \frac{W_{TotI}}{L_{TotI}}$.
- In addition to the impact footprint and the species footprint, a buffer zone around the impact area footprint was included in the analysis. The purpose of this buffer zone was to be overly protective of the species to ensure that any species just outside of the impact area were also included in the analysis. The buffer zone was simply calculated by taking half of the area of the total impact footprint ($A_{BZ} = A_{TotI} * 0.5$) for the rectangular scenarios. For the circular scenarios, an additional buffer zone radius (R_{BZ}) was calculated.

These calculations were then fed into the final calculation area (A_{Final}) for the three rectangular scenarios (Scenarios 1-3). So, $A_{Final1} = A_{BZ1} + A_{TotI1} + A_{TotS}$, where 1 designates Scenario 1. The same concept was applied for Scenarios 2 and 3, except the L_{TotI} for Scenario 2 was multiplied by 6 and the W_{TotI} for Scenario 3 was multiplied by 6, which influence both A_{TotI} and A_{BZ} for each of the scenarios. In each case, the buffer zone could also be calculated by simple subtraction $A_{BZ} = A_{Final} – A_{TotI} – A_S$, for each respective scenario. For Scenario 4, the radial scenario, the area calculation was based on a circle. $A_{Final4} = \pi * (R_{TotS} + R_{TotI} + R_{BZ})^2$. To calculate the buffer zone from the final area, the following equation could also be used: $A_{BZ4} = \sqrt{(\frac{A_{Final4}}{\pi})} - R_{TotI} - R_{TotS}$.

Impact probability (P) is the probability of impacting one animal at its species peak density, with the given number, type, and dimensions of all military items used in training or testing activities occurring in the area per year. Therefore, P is the ratio of the final area for each scenario, which includes the species area, the impact footprint, and the buffer zone of the impact footprint, and the range complex area ($P = \frac{A_{Final}}{A_{RC}}$, where A_{Final} is based on the value calculated in each scenario). The total number of possible exposures (T) within a given year is a product of the species density, the area of the range complex, and the impact probability ($T = (D_S * A_{RC})*P$). Using this procedure, P and T were calculated for each of the four scenarios, for the Endangered Species Act (ESA)-listed marine mammals and the non-ESA marine mammal and ESA-listed 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 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.

I.3.2 Parameters for Analysis

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

- Two action alternatives: Alternative 1 and Alternative 2. Animal densities, animal dimensions, and military item dimensions are the same for the two action alternatives.
- Two training or testing areas: Hawaii Study Area and California Study Area. Areas are approximately 806,027 square kilometers and 912,350 square kilometers, respectively.
- The following types of non-explosive munitions or other items:
    - **Small-caliber projectiles**: up to and including 0.50 caliber rounds
    - **Medium-caliber projectiles:** larger than 0.50 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, as well as mine shapes
    - **Lightweight torpedo accessories:** includes all accessories that are dropped along with the torpedo (e.g., nose cap, air stabilizer)
    - **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
- Animal species of interest: The species of ESA-listed marine mammals expected in the HCTT Study Area and the non-ESA listed marine mammal with the highest average month density in the Hawaii Study Area and the California Study Area.
- All sea turtles are ESA-listed and are included if their presence in each area is expected.

I.3.3 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 Table I-16 through Table I-19.

Table I-16: Estimated Representative Marine Mammal Exposures from Direct Strike of a High-Energy Laser by Area and Alternative in a Single Year

Hawaii Study Area				
Species	**Training**		**Testing**	
	Alternative 1	**Alternative 2**	**Alternative 1**	**Alternative 2**
Blue Whale	0.0000006	0.0000006	0.0000006	0.0000006
Fin Whale	0.0000026	0.0000026	0.0000027	0.0000027
Humpback Whale	0.0001250	0.0001250	0.0001273	0.0001277
Sperm Whale	0.0000683	0.0000683	0.0000699	0.0000702
Sei Whale	0.0000008	0.0000008	0.0000009	0.0000009
Killer Whale	0.0000017	0.0000017	0.0000019	0.0000019
False Killer Whale (MHI Insular DPS)	0.0000020	0.0000020	0.0000023	0.0000024
Hawaiian Monk Seal	0.0000460	0.0000460	0.0000507	0.0000516
Rough-toothed Dolphin	0.0022764	0.0022764	0.0040113	0.0047075
California Study Area				
Species	**Training**		**Testing**	
	Alternative 1	**Alternative 2**	**Alternative 1**	**Alternative 2**
Blue Whale	0.0021360	0.0021360	0.0026125	0.0027501
Fin Whale	0.0770323	0.0021360	0.0807100	0.0815756
Gray Whale	0.0398065	0.0021360	0.0452267	0.0466958
Humpback Whale	0.0016596	0.0021360	0.0022606	0.0024442
Sperm Whale	0.0001209	0.0021360	0.0002654	0.0003145
Sei Whale	0.0000006	0.0021360	0.0000078	0.0000106
Killer Whale	0.0000001	0.0021360	0.0000049	0.0000067
Guadalupe Fur Seal	0.0007741	0.0021360	0.0031727	0.0040357
Short-beaked Common Dolphin	1.4873838	1.4873838	1.5124785	1.5131423

Table I-17: Estimated Representative Sea Turtle Exposures from Direct Strike of a High-Energy Laser by Area and Alternative in a Single Year

Hawaii Study Area				
Species	**Training**		**Testing**	
	Alternative 1	**Alternative 2**	**Alternative 1**	**Alternative 2**
Green Turtle	0.0000001	0.0000001	0.0000002	0.0000002
Hawksbill Turtle	0.0000000	0.0000000	0.0000000	0.0000000
Leatherback Turtle	0.0000032	0.0000032	0.0000038	0.0000039
Loggerhead Turtle	0.0000029	0.0000029	0.0000037	0.0000039
Olive Ridley Turtle	0.0000014	0.0000014	0.0000021	0.0000023
California Study Area				
Species	**Training**		**Testing**	
	Alternative 1	**Alternative 2**	**Alternative 1**	**Alternative 2**
Green Turtle	0.0057387	0.0057387	0.0061786	0.0061921
Leatherback Turtle	0.0000019	0.0000019	0.0000042	0.0000043
Loggerhead Turtle	0.0001591	0.0001591	0.0002079	0.0002096

Table I-18: Estimated Representative Marine Mammal Exposures from Direct Strike of Military Expended Materials by Area and Alternative in a Single Year

Hawaii Study Area				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Blue Whale	0.0000040	0.0000045	0.0000024	0.0000032
Fin Whale	0.0000077	0.0000085	0.0000055	0.0000066
Humpback Whale	0.0002346	0.0002492	0.0001881	0.0002124
Sperm Whale	0.0001560	0.0001680	0.0001180	0.0001378
Sei Whale	0.0000076	0.0000086	0.0000044	0.0000060
Killer Whale	0.0000196	0.0000223	0.0000113	0.0000156
False Killer Whale (MHI Insular DPS)	0.0000330	0.0000377	0.0000185	0.0000260
Hawaiian Monk Seal	0.0004796	0.0005445	0.0002783	0.0003825
Rough-toothed Dolphin	0.0053458	0.0057675	0.0040113	0.0047075
California Study Area				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Blue Whale	0.0031050	0.0032710	0.0026125	0.0027501
Fin Whale	0.0836673	0.0845990	0.0807100	0.0815756
Gray Whale	0.0504150	0.0521321	0.0452267	0.0466958
Humpback Whale	0.0029248	0.0031521	0.0022606	0.0024442
Sperm Whale	0.0004465	0.0005101	0.0002654	0.0003145
Sei Whale	0.0000180	0.0000216	0.0000078	0.0000106
Killer Whale	0.0000118	0.0000143	0.0000049	0.0000067
Guadalupe Fur Seal	0.0063822	0.0075207	0.0031727	0.0040357
Short-beaked Common Dolphin	1.9583771	2.0361045	1.7250189	1.7907992

Table I-19: Estimated Representative Sea Turtle Exposures from Direct Strike of Military Expended Materials by Area and Alternative in a Single Year

Hawaii Study Area				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Green Turtle	0.0000139	0.0000161	0.0000073	0.0000107
Hawksbill Turtle	0.0000025	0.0000029	0.0000013	0.0000019
Leatherback Turtle	0.0000652	0.0000746	0.0000360	0.0000511
Loggerhead Turtle	0.0001002	0.0001151	0.0000540	0.0000778
Olive Ridley Turtle	0.0000940	0.0001083	0.0000498	0.0000726
California Study Area				
Species	Training		Testing	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Green Turtle	0.0202469	0.0230685	0.0121948	0.0143809
Leatherback Turtle	0.0001430	0.0001730	0.0000596	0.0000818
Loggerhead Turtle	0.0025325	0.0030239	0.0011550	0.0015238

I.4 Statistical and Probability Analysis for Estimating Navy and Coast Guard Vessel Strike of Large Whale Species

To conduct a statistical analysis of future Navy ship strikes within HCTT, three basic components are required:

1. Number of Navy or Coast Guard ship strikes to large whales for the seven-year period prior to the period for which new MMPA authorization is being sought (2017–2023 for Navy and 2018–2024 for Coast Guard).
2. Amount of Navy or Coast Guard at-sea surface vessel days for the seven-year period (2017–2023) prior to the period for which new MMPA authorization is being sought.
3. Estimate of future Navy or Coast Guard at-sea surface vessel days for the requested new authorization seven-year period (December 2025–December 2032).

HCTT Strikes. There were three large whale strikes within HCTT by Navy surface ships over the seven years between 2017 and 2023. For the Coast Guard, there were four strikes over the same time period.

HCTT Number of At-Sea Days (7 Years from 2017 to 2023). The most recent seven-year period from 2017–2023 is used as the appropriate time frame to calculate the potential probability of a large whale ship strike from Navy or Coast Guard vessels in the HCTT Study Area over the term of anticipated new seven-year permit (December 2025-December 2032). The marine California Current Ecosystem off California has experienced significant variation since 2014 from short- and long-term oceanographic and climate change fluctuations (Amaya et al., 2021; Amaya et al., 2020; Ingman et al., 2021; Szesciorka et al., 2019; Weber et al., 2021). Some whale species have adjusted primary occurrence northward due to changing prey availability. Other whale species have shown increases in populations or regional distribution shifts (Markowitz et al., 2024). The effects of climate change impacts on oceanography and resulting marine mammal distributions in Hawaii are more subtle. Over the next permit period, patterns of species occurrence are likely to remain more consistent in Hawaii than in California. To support this assessment and determine the amount of 2017–2023 at-sea days, the Navy conducted a vessel traffic analysis specific to the new HCTT Study area. From this analysis, cumulative Navy at-sea days from 2017 to 2023 were calculated to be 15,834 days for Navy manned vessels greater than 150 m (492 ft. or destroyer size and above) and various sizes of USVs. For Coast Guard vessels greater than 100 m (328 ft.) the cumulative total was 1,936 days. Annual tracking data is available for Navy and Coast Guard manned surface vessels and used in the cumulative totals above. There is no corresponding tracking data available for USVs, so the Phase III USV estimate of 300 at-sea days per year is included in the Navy's 2017–2023 totals.

This analysis is specific to Navy larger size class vessels over 150 m (492 ft.) that have been involved with HCTT strikes in the past. There have been no Navy reports over the last 30 years of vessel strikes to whales in HCTT from smaller vessel and boat classes (e.g., tugs, service craft, landing craft, special operations Rigid Hull Inflatable Boat [RHIBs]). Furthermore, no tracking data is available for these smaller craft. In addition, during the HSTT Phase III permit period there have been no whale strikes from various size classes of Navy USVs. Tracking data for Coast Guard vessels is only available for larger ship classes greater than 100 m (328 ft.). All Coast Guard strikes were from small craft between (40–100 ft.) for which tracking data is not available. For calculation purposes the larger Navy and Coast Guard vessel tracking data is sufficient for worst case serious injury or mortality probability predictions. Smaller vessel and craft sizes at-sea time is relatively similar in both the prior permit period and forecasted future permit period.

HCTT Estimate of Future At-Sea Days (7 Years from December 2025 to December 2032). Navy surface vessel traffic within the HCTT Study Area has been consistent over the years, although there was a decrease in days at-sea across the seven-year period from 2017 to 2023 (Navy unpublished data). At-sea days steadily decreased from a high of 2,734 days in 2017 to 1,953 in 2023, a drop of 32 percent. However, the Navy believes an average of the seven-year cumulative total from 2017 to 2023 is a sufficient prediction of future at-sea days for manned surface ships from December 2025 to December 2032. The 2017–2023 average is 2,262 days (i.e., 15,834/7). Therefore, 2,262 days per year was used as the starting point for an annual estimate for the cumulative total of future at-sea days over the pending HCTT authorization. A new category of vessel type is soon to be transferred to HCTT for testing during the upcoming permit period. These are larger sized USVs longer than 61 m (200 ft.) in length. Although there has not been a whale ship strikes from USVs, out of an abundance of caution for this newer larger class of USVs, the Navy is adding large USV annual at-sea days with the manned annual at-sea days above (final annual at-sea days 2,262+728=2,990). Therefore, the cumulative total for the Dec 2025–Dec 2032 period for Navy manned and large USV at-sea days is 17,940 (2,990 times 7). Coast Guard annual at-sea days was consistent between 2017–2023 with an average value of 277 days per year. Therefore, 277 days per year is used for the annual at-sea days between Dec 2025 and Dec 2032. Therefore, the cumulative total for this period is 1,659 (277 times 7).

Calculations series. The probability of a vessel strike to whales is influenced by the amount of time at-sea for Navy or Coast Guard surface vessels within the HCTT Study Area and the number of strikes over those years. This generates a specific strike rate. For the period 2017–2023, there were three Navy strikes over 15,834 at-sea days. Dividing the Navy reported strikes by ship at-sea days (i.e., 3/15,834) results in a strike rate of 0.000189 strikes per day. For the period 2018–2024, there were three Coast Guard strikes over 1,936 at-sea days. Dividing the Coast Guard reported strikes by ship at-sea days (i.e., 3/1,936) results in a strike rate of 0.00155 strikes per day.

Navy. Estimated Navy cumulative ship at-sea days within HCTT for the period from December 2025 to December 2032 is 17,940 days. The previously calculated strike rate (0.000189 strikes per day) can be multiplied by the estimated at-sea days from December 2025 to December 2032 to estimate the number of predicted whale strikes anticipated over this period (0.000189 strikes per day x 17,940 days). This formula calculates up to 3.399 strikes from December 2025 to December 2032.

The probabilities of a specific number of strikes (e.g., n=0, 1, 2) over the period from December 2025 to December 2032 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; for example, 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($n|\mu$) 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 December 2025–December 2032 strike rate of 2.571. Using this strike rate (2.571), the Poisson distribution can estimate the probability of *n* where n=0 (no strikes), 1 strike, 2 strikes, 3 strikes, 4 strikes, or 5 strikes for December 2025-December 2032:

P(0)= 0.034 or a 3 percent chance of zero strikes

P(1)= 0.113 or an 11 percent chance of one strike

P(2)= 0.193 or a 19 percent chance of two strikes

P(3)= 0.219 or a 22 percent chance of three strikes

P(4)= 0.186 or a 19 percent chance of four strikes

P(5)= 0.126 or a 13 percent chance of five strikes

(percentages above rounded to nearest whole value)

Coast Guard. Estimated Coast Guard cumulative ship at-sea days within HCTT for the period from December 2025–December 2032 is 1,659 days. The previously calculated strike rate (0. 00155 strikes per day) can be multiplied by the estimated at-sea days from December 2025 to December 2032 to estimate the number of predicted whale strikes anticipated over this period (0. 00155 strikes per day x 1,659 days). This calculation estimates up to 2.571 strikes from December 2025 to December 2032. Using this strike rate (2.571), the Poisson distribution can estimate the probability of *n* where n=0 (no strikes), 1 strike, 2 strikes, 3 strikes, 4 strikes, or 5 strikes for December 2025–December 2032:

P(0)= 0.076 or a 7 percent chance of zero strikes

P(1)= 0.197 or a 20 percent chance of one strike

P(2)= 0.253 or a 25 percent chance of two strikes

P(3)= 0.217 or a 22 percent chance of three strikes

P(4)= 0.139 or a 14 percent chance of four strikes

(percentages above rounded to nearest whole value)

I.4.1 Species

The Poisson distribution described above only calculates the probability of the number of strikes. It does not identify which species could be struck. Only some Navy and Coast Guard reported whale strikes are identified to the species level, making it difficult to predict which species of large whales are most likely to be struck during future training and testing activities.

From NMFS internal record keeping of ship strikes, 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 (Carretta et al., 2023a; Lammers et al., 2013; Scordino et al., 2023). Most of these strikes are from non-Navy commercial shipping. For Hawaii and California, higher strike rates to these species are largely attributed to higher species abundance in these areas.

To predict the likelihood of striking any species, NMFS compiled information from the latest NMFS SARs for each species or stock on detected annual rates of large whale serious injury and mortality from vessel collisions (National Marine Fisheries Service, 2018a). Not all instances of serious injury and mortality are represented in the annual rates reported in the SARs. However, the annual rates of large whale serious injury and mortality from vessel collisions in the SARs do provide a good representation of the relative susceptibility of large whale species to vessel strike in the Study Area. NMFS' analysis noted there were low probabilities of ship strikes to certain large whale species and stocks. NMFS further

concluded and the Navy agreed that the stocks listed below would be the most likely struck, if a Navy or Coast Guard ship strike were to occur:

California

- Blue whale (Eastern North Pacific Stock)
- Fin whale (California/Oregon/Washington Stock)
- Grey whale (Eastern North Pacific Stock)
- Humpback whale (Mainland Mexico-California-Oregon-Washington Stock)

Hawaii

- Humpback whale (Central North Pacific Stock)
- Sperm whale (Hawaii Stock)

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