Appendix F: Military Expended Material and Direct Strike Impact Analyses

Draft Environmental Impact Statement/Overseas Environmental Impact Statement

Hawaii-Southern California Training and Testing

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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 of Chapter 3 (Section 3.5-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 Tables 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%	14800.3763	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	316136.0367	632272.0734	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	381	0.9875	0	0.0000	368	0.9538
Bombs (Non-Explosive)	8.1203	112.9048	2,862	7.4181	90	0.2333	12	0.0311
Projectiles								
Small-Caliber (Non-Explosive)	0.0301	0.1216	1,774,450	4.9535	0	0.0000	11,615,600	32.4256
Small-Caliber (Casing Only)	0.0151	0.0301	300,000	0.2073	100,000	0.0691	2,375,000	1.6411
Medium-Caliber (Explosive)	0.056	0.2239	4,956	0.0255	400	0.0021	6,236	0.0321
Medium Caliber (Non-Explosive)	0.056	0.2239	208,565	1.0720	43,600	0.2241	757,950	3.8959
Large-Caliber (Explosive)	1.0097	4.0386	2,969	0.2753	32	0.0030	4,569	0.4236
Large-Caliber (Non-Explosive)	1.0097	4.0386	564	0.0523	384	0.0356	3,516	0.3260
Large-Caliber (Casing only)	0.5048	1.0097	0	0.0000	0	0.0000	9,900	0.2295
Missiles (Explosive)	37.6691	74.7338	212	0.3637	0	0.0000	194	0.3328
Missiles (Non-Explosive)	37.6691	74.7338	0	0.0000	0	0.0000	4	0.0069
Rockets (Explosive)	0.7987	1.5974	251	0.0092	0	0.0000	1,798	0.0659
Countermeasures								
Chaff (ship cartridge)	2	4	74	0.0068	0	0.0000	250	0.0230
Chaff (Air cartridge)	0.0011	0.0022	513	0.0000	0	0.0000	3,780	0.0002
Flares	1.2196	4.8782	1,933	0.2165	0	0.0000	11,690	1.3091
Targets								
Air Target - Expended (Non-Drone)	42.1622	84.3245	92	0.1781	0	0.0000	29	0.0561
Sub-Surface Targets (Mobile) - Expended	5.7522	11.5034	422	0.1114	13	0.0034	580	0.1532

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 (continued)								
Surface Targets - Expended	5.7522	11.5034	132	0.0349	0	0.0000	750	0.1981
Mine Shapes - Expended	25.7903	51.5807	18	0.0213	0	0.0000	187	0.2214
Ship Hulk	316,136	632,272	3	43.5449	0	0.0000	1	14.5150
Other								
ANMS/EMNS Neutralizer (Explosive)	1.6286	3.2572	6	0.0004	0	0.0000	32	0.0024
Anchor (Expendable)	6.2495	12.5001	39	0.0112	0	0.0000	24	0.0069
Buoy (Explosive)	0.9752	3.8987	6	0.0005	0	0.0000	3	0.0003
Endcaps	0.0021	0.0043	7,524	0.0007	0	0.0000	46,422	0.0046
Compression Pad/Piston	0.0043	0.0086	1,933	0.0004	0	0.0000	11,690	0.0023
Fiber Optic Can	0.0011	0.0022	32	0.0000	0	0.0000	578	0.0000
Flare O-Ring	0.0043	0.0086	3,990	0.0008	0	0.0000	23,388	0.0046
Illumination Flare	1.2196	4.8782	62	0.0069	0	0.0000	4	0.0004
Heavyweight Torpedo (Explosive)	39.6155	79.2299	8	0.0146	0	0.0000	3	0.0055
Heavyweight Torpedo Accessories	0.1615	3.2367	252	0.0187	0	0.0000	199	0.0148
Lightweight Torpedo Accessories	1.1011	2.0215	78	0.0036	0	0.0000	270	0.0125
Marine Marker	0.9752	3.8987	779	0.0697	11	0.0010	808	0.0723
Mine (Explosive)	25.7903	51.5807	0	0.0000	0	0.0000	78	0.0924
Parachutes - Medium	9.0417	18.0834	16	0.0066	0	0.0000	129	0.0536
Parachutes - Large	283.9961	567.9932	62	0.8084	0	0.0000	4	0.0522
Total			**2,313,094**	**61.81**	**144,777**	**0.79**	**14,832,530**	**63.48**

[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								
Countermeasures								
Acoustic Countermeasures	0.3311	1.2432	850	0.0243	14	0.0004	274	0.0078
Other								
Buoy (Non-Explosive)	0.9752	3.8987	7	0.0006	0	0.0000	83	0.0074
Small Decelerator/Parachute	2.8438	5.6876	10,836	1.4148	120	0.0157	26,676	3.4831
Sonobuoys (Non-Explosive)	1.2207	2.4413	10,836	0.6073	120	0.0067	26,676	1.4950
Bathythermograph - Expended	0.2771	0.5554	591	0.0075	7	0.0015	1,086	0.0138
Alternative 2								
Countermeasures								
Acoustic Countermeasures	0.3311	1.2432	850	0.0243	14	0.0004	278	0.0079
Other								
Buoy (Non-Explosive)	0.9752	3.8987	7	0.0006	0	0.0000	97	0.0087
Small Decelerator/Parachute	2.8438	5.6876	10,836	1.4148	120	0.0157	28,244	3.6878
Sonobuoys (Non-Explosive)	1.2207	2.4413	10,836	0.6073	120	0.0067	28,244	1.5829
Bathythermograph - Expended	0.2771	0.5554	594	0.0076	7	0.0001	1,089	0.0139

[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								
Large-Caliber (Casing only)	0.5048	1.0097	0	0.0000	0	0.0000	49,500	1.1474
Medium Caliber (Non-Explosive)	0.056	0.2239	1,042,825	5.3602	218,000	1.1205	3,789,750	19.4795
Medium-Caliber (Explosive)	0.056	0.2239	24,780	0.1274	2,000	0.0103	31,180	0.1603
Missiles (Non-Explosive)	37.6691	74.7338	0	0.0000	0	0.0000	20	0.0343
Rockets (Explosive)	0.7987	1.5974	1,255	0.0460	0	0.0000	8,990	0.3297
Small-Caliber (Casing Only)	0.0151	0.0301	1,500,000	1.0365	500,000	0.3455	11,875,000	8.2056
Targets								
Air Target - Expended (Non-Drone)	42.1622	84.3245	460	0.8905	0	0.0000	145	0.2807
Mine Shapes - Expended	25.7903	51.5807	90	0.1066	0	0.0000	935	1.1072
Sub-Surface Targets (Mobile) - Expended	5.7522	11.5034	2,108	0.5567	65	0.0172	2,898	0.7653
Surface Targets - Expended	5.7522	11.5034	660	0.1743	0	0.0000	3,750	0.9903
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	9,665	1.0824	0	0.0000	58,450	6.5457

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)
Other								
ANMS/EMNS Neutralizer (Explosive)	1.6286	3.2572	30	0.0022	0	0.0000	160	0.0120
Anchor (Expendable)	6.2495	12.5001	195	0.0560	0	0.0000	120	0.0344
Buoy (Explosive)	0.9752	3.8987	30	0.0027	0	0.0000	15	0.0013
Endcaps	0.0021	0.0043	12,540	0.0012	0	0.0000	77,370	0.0076
Compression Pad/Piston	0.0043	0.0086	9,665	0.0019	0	0.0000	58,450	0.0115
Fiber Optic Can	0.0011	0.0022	160	0.0000	0	0.0000	2,890	0.0001
Flare O-Ring	0.0043	0.0086	9,975	0.0020	0	0.0000	58,470	0.0115
Illumination Flare	1.2196	4.8782	310	0.0347	0	0.0000	20	0.0022
Lightweight Torpedo Accessories	1.1011	2.0215	390	0.0181	0	0.0000	1,254	0.0582
Marine Marker	0.9752	3.8987	3,895	0.3486	55	0.0049	4,040	0.3616
Mine (Explosive)	25.7903	51.5807	0	0.0000	0	0.0000	390	0.4618
Parachutes - Medium	9.0417	18.0834	80	0.0332	0	0.0000	645	0.2678
Parachutes - Large	283.9961	567.9932	310	4.0422	0	0.0000	20	0.2608
Total			**2,636,668**	**51.0480**	**720,570**	**2.6648**	**16,044,672**	**40.8082**

[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	4,192	0.1196	70	0.0020	1,340	0.0382
Other								
Bathythermograph - Expended	0.2771	0.5554	2,955	0.0377	35	0.0004	5,070	0.0646
Bomb (Explosive)	8.1203	112.9048	1,617	4.1912	0	0.0000	1,696	4.3959
Buoy (Non-Explosive)	0.9752	3.8987	21	0.0019	0	0.0000	346	0.0310
Heavyweight Torpedo (Explosive)	39.6155	79.2299	24	0.0437	0	0.0000	7	0.0127
Heavyweight Torpedo Accessories	0.1615	3.2367	1,244	0.0924	0	0.0000	507	0.0377
Large-Caliber (Explosive)	1.0097	4.0386	13,405	1.2428	160	0.0148	22,525	2.0884
Large-Caliber (Non-Explosive)	1.0097	4.0386	2,660	0.2466	1,920	0.1780	17,500	1.6225
Missiles (Explosive): Non-Fiber Optic Guided	37.6691	74.7338	852	1.4617	0	0.0000	866	1.4858
Ship Hulk	316,136	632,272	7	101.6048	0	0.0000	1	14.5150
Small Decelerator/Parachute	2.8438	5.6876	46,864	6.1190	600	0.0783	123,921	16.1803
Small-Caliber (Non-Explosive)	0.0301	0.1216	8,712,250	24.3207	0	0.0000	58,038,000	162.0161
Sonobuoys (Non-Explosive)	1.2207	2.4413	46,864	2.6265	600	0.0336	123,921	6.9451
Total			**8,832,955**	**142.1086**	**3,385**	**0.3073**	**58,335,700**	**209.4332**

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	4,220	0.1204	70	0.0020	1,391	0.0397
Other								
Bathythermograph - Expended	0.2771	0.5554	2,968	0.0378	35	0.0004	5,443	0.0694
Bomb (Explosive)	8.1203	112.9048	1,905	4.9376	0	0.0000	1,840	4.7692
Buoy (Non-Explosive)	0.9752	3.8987	35	0.0031	0	0.0000	485	0.0434
Heavyweight Torpedo (Explosive)	39.6155	79.2299	40	0.0728	0	0.0000	15	0.0273
Heavyweight Torpedo Accessories	0.1615	3.2367	1,260	0.0936	0	0.0000	515	0.0383
Large-Caliber (Explosive)	1.0097	4.0386	14,845	1.3763	160	0.0148	22,845	2.1180
Large-Caliber (Non-Explosive)	1.0097	4.0386	2,820	0.2615	1,920	0.1780	17,580	1.6299
Missiles (Explosive): Non-Fiber Optic Guided	37.6691	74.7338	1,060	1.8186	0	0.0000	970	1.6642
Ship Hulk	316,136	632,272	15	217.7245	0	0.0000	5	72.5748
Small Decelerator/Parachute	2.8438	5.6876	50,040	6.5337	600	0.0783	138,244	18.0504
Small-Caliber (Non-Explosive)	0.0301	0.1216	8,872,250	24.7673	0	0.0000	58,078,000	162.1278
Sonobuoys (Non-Explosive)	1.2207	2.4413	50,040	2.8045	600	0.0336	138,244	7.7478
Total			**9,001,498**	**260.5519**	**3,385**	**0.3073**	**58,405,577**	**270.9002**

[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	0	0.0000	0	0.0000	2	0.0006
Mine Shape (Recovered)	Alternative 1	25.7903	51.5807	828	0.9805	0	0.0000	9,061	10.7294
	Alternative 2							8,811	0.0000
Bottom Placed Instruments		2.0000	4.0000	4	0.0004	0	0.0000	6	0.0006
Total				**832**	**0.9808**	**0**	**0.0000**	**17880**	**10.7305**

[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
AMNS/EMNS Neutralizer	50	0	1,285
Aerial Drones	505	0	145
Unmanned Surface Vehicle	25	0	50
Unmanned Underwater Vehicle	2475	0	1,650
Unmanned Aerial System	1195	30	15,435
Surface Target (Recovered)	4630	390	14,530
Subsurface Target (Stationary): Recovered	15	0	150
Subsurface Target (Recovered)	305	0	95
Air Target	0	0	25
Heavyweight Non-Explosive Torpedo	1530	0	505
Buoy (Non-Explosive): Recovered	120	0	0
Total	**10,930**	**420**	**34,515**

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	0	0.0000	0	0.0000	10	0.0029
Mine Shape (Recovered)	Alternative 1	25.7903	51.5807	4140	4.9023	0	0.0000	44,805	53.0549
	Alternative 2							44,055	52.1668
Bottom Placed Instruments		2.0000	4.0000	20	0.0018	0	0.0000	30	0.0028
Total				**4160**	**4.9041**	**0**	**0.0000**	**88,900**	**105.2274**

[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	1	0.0026	1	0.0026
Bombs (Non-Explosive)	8.1203	112.9048	56	0.1451	114	0.2955
Projectiles						
Small-Caliber (Non-Explosive)	0.0301	0.1216	44,100	0.1231	90,800	0.2535
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	1.1437	302,461	1.5547
Kinetic Energy Round	0.5048	1.0097	16,087	0.3729	424	0.0098
Large-Caliber (Explosive)	1.0097	4.0386	3,996	0.3705	4,056	0.3760
Rocket (Non-Explosive): Flechette	0.7987	1.5974	3	0.0001	141	0.0052
Large-Caliber (Non-Explosive)	1.0097	4.0386	21,704	2.0123	21,854	2.0262
Missiles (Explosive)	37.6691	74.7228	396	0.6793	455	0.7805
Missiles (Non-Explosive)	31.0011	62.0023	292	0.4156	389	0.5537
Rockets (Explosive)	0.7987	1.5974	3	0.0001	203	0.0074
Rockets (Non-Explosive)	0.7987	1.5974	9	0.0003	421	0.0154
Countermeasures						
Acoustic Countermeasures	0.3311	1.2432	2,491	0.0711	2,491	0.0711
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
Anti-Torpedo Torpedo	4.524	9.0847	279	0.0582	279	0.0582
Flares	1.2196	4.8782	2,490	0.2789	4,260	0.4771
Targets						
Aerial Drones - Expendable	294.6082	589.2164	0	0.0000	92	1.2444

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)
Air Targets	39.0407	78.0814	130	0.2330	182	0.3262
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	12	0.0105	12	0.0105
Anchor - Expendable	6.2495	12.5001	710	0.2037	2,631	0.7550
Compression Pads/Pistons	0.0043	0.0086	2,490	0.0005	4,260	0.0008
Endcaps	0.0021	0.0043	9,960	0.0010	17,840	0.0018
Flare O-Ring	0.0043	0.0086	2,490	0.0005	4,260	0.0008
Bathythermograph - Expended	0.2771	0.5554	1,209	0.0154	1,241	0.0158
Heavyweight Torpedo (Explosive)	39.6155	79.2299	18	0.0327	18	0.0327
Heavyweight Torpedo Accessories	0.1615	3.2367	241	0.0179	241	0.0179
Lightweight Torpedo Accessories	1.1011	2.0215	1,544	0.0717	1,700	0.0789
Sabot	1.2196	4.8782	16,088	1.8017	424	0.0475
Sonobuoy (Explosive)	1.2207	2.4413	0	0.0000	72	0.0040
Surface-Launched Lightweight Torpedo (Explosive)	10.0782	20.1576	22	0.0102	22	0.0102
Parachutes (Medium)	9.0417	18.0834	472	0.1959	594	0.2466
Total			**370,875**	**10.49**	**507,088**	**22.25**

[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						
Mine (Explosive)	25.7903	51.5807	0	0.0000	90	0.1066
Other						
ANMS/EMNS Neutralizer (Explosive)	1.6286	3.2572	192	0.0144	434	0.0325
Fiber Optic Can	0.0011	0.0022	1,920	0.0001	4,206	0.0002
Sonobuoys (Non-Explosive)	1.2207	2.4413	14,630	0.8199	20,317	1.1387
Buoy (Explosive)	0.97521	3.8987	1,281	0.1147	1,942	0.1738
Small Decelerator/Parachute	2.8438	5.6876	14,630	1.9102	40,778	5.3244
Total			**32,653**	**2.8593**	**67,767**	**6.7761**
Alternative 2						
Targets						
Mine (Explosive)	25.7903	51.5807	0	0.0000	96	0.1137
Other						
ANMS/EMNS Neutralizer (Explosive)	1.6286	3.2572	192	0.0144	464	0.0347
Fiber Optic Can	0.0011	0.0022	1,920	0.0001	4,302	0.0002
Sonobuoys (Non-Explosive)	1.2207	2.4413	14,940	0.8373	20,767	1.1639
Buoy (Explosive)	0.97521	3.8987	1,301	0.1164	1,972	0.1765
Small Decelerator/Parachute	2.8438	5.6876	14,940	1.9507	41,678	5.4419
Total			**33,293**	**2.9189**	**69,279**	**6.9309**

[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	5	0.0130	5	0.0130
Bombs (Non-Explosive)	8.1203	112.9048	280	0.7257	570	1.4774
Projectiles						
Kinetic Energy Round	0.5048	1.0097	80,438	1.8645	2,118	0.0491
Large-Caliber (Explosive)	1.0097	4.0386	19,980	1.8524	20,280	1.8802
Large-Caliber (Non-Explosive)	1.0097	4.0386	108,520	10.0613	109,270	10.1308
Sabot	1.2196	2.4413	80,438	4.5081	2,118	0.1187
Small-Caliber (Non-Explosive)	0.0301	0.1216	220,500	0.6155	454,000	1.2674
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						
Aerial Drones	294.6082	589.2164	0	0.0000	460	6.2222
Air Target - Expended (Non-Drone)	39.0407	78.0894	648	1.1617	908	1.6278
Mine Shapes - Expended	25.7903	51.5807	6,920	8.1942	52,246	61.8661
Sub-Surface Targets (Mobile) - Expended	1.2206	2.4413	1,475	0.0827	1,550	0.0869
Surface Target (Stationary): Expended	96.8752	193.7504	280	1.2454	25	0.1112
Surface Targets - Expended	5.7522	11.5034	2,878	0.7600	5,568	1.4704

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	12,455	0.3552	12,455	0.3552
Air-Launched Lightweight Torpedo (Explosive)	19.1199	39.2399	60	0.0540	60	0.0540
Surface-Launched Lightweight Torpedo (Explosive)	10.0782	20.1576	110	0.0509	110	0.0509
Anti-Torpedo Torpedo	4.524	9.0847	1,395	0.2909	1,395	0.2909
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	90	0.1637	90	0.1637
Heavyweight Torpedo Accessories	0.1615	3.2367	1,205	0.0895	1,205	0.0895
Sonobuoy (Explosive)	1.2207	2.4413	0	0.0000	360	0.0202

[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 (Non-Explosive)	0.056	0.2239	1,112,575	5.7187	1,476,305	7.5883
Medium-Caliber (Explosive)	0.056	0.2239	76,825	0.3949	124,705	0.6410
Missile (Non-Explosive)	31.0011	62.0023	1,460	2.0781	1,921	2.7343
Missiles (Explosive): Non-Fiber Optic Guided	37.6691	74.7228	1,978	3.3931	2,249	3.8579
Rockets (Explosive)	0.7987	1.5974	15	0.0006	815	0.0299
Rockets (Non-Explosive)	0.7987	1.5974	45	0.0017	2,020	0.0741
Rockets (Non-Explosive): Flechette	0.7987	1.5974	15	0.0006	674	0.0247
Other						
Anchor (Expendable)	6.2495	12.5001	3,250	0.9326	12,852	3.6880
ANMS/EMNS Neutralizer (Explosive)	1.6286	3.2572	960	0.0718	2,009	0.1502
Bathythermograph - Expended	0.2771	0.5554	6,030	0.0769	6,145	0.0784
Buoy (Explosive)	0.9752	3.8987	6,300	0.5639	8,984	0.8041
Fiber Optic Can	0.0011	0.0022	9,600	0.0005	20,388	0.0010
Lightweight Torpedo Accessories	1.1011	2.0215	7,690	0.3569	8,284	0.3844
Mine (Explosive)	25.7903	51.5807	0	0.0000	290	0.3434
Parachute Medium	9.0417	18.0834	2,330	0.9673	2,754	1.1433
Small Decelerator/Parachute	2.8438	5.6876	70,995	9.2698	96,127	12.5512
Sonobuoys (Non-Explosive)	1.2207	2.4413	70,995	3.9789	95,767	5.3672
Total			**1,371,063**	**27.8059**	**1,862,289**	**39.4615**

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

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)

Alternative 2						
Projectiles						
Medium Caliber (Non- Explosive)	0.056	0.2239	1,112,575	5.7187	1,512,305	7.7733
Medium-Caliber (Explosive)	0.056	0.2239	76,825	0.3949	136,705	0.7027
Missile (Non-Explosive)	31.0011	62.0023	1,460	2.0781	1,945	2.7685
Missiles (Explosive): Non-Fiber Optic Guided	31.0011	62.0023	1,978	2.8154	2,273	3.2353
Rocket (Explosive)	0.7987	1.5974	15	0.0006	1,015	0.0372
Rocket (Non-Explosive)	0.7987	1.5974	45	0.0017	2,104	0.0772
Rocket (Non-Explosive): Flechette	0.7987	1.5974	15	0.0006	702	0.0257
Other						
Anchor (Expendable)	6.2495	12.5001	3,550	1.0187	13,152	3.7741
ANMS/EMNS Neutralizer (Explosive)	1.6286	3.2572	960	0.0718	2,318	0.1733
Bathythermograph - Expended	0.2771	0.5554	6,045	0.0771	6,205	0.0791
Buoy (Explosive)	0.9752	3.8987	6,505	0.5822	9,860	0.8825
Fiber Optic Can	0.0011	0.0022	9,600	0.0005	21,506	0.0011
Lightweight Torpedo Accessories	1.1011	2.0215	7,720	0.3583	8,500	0.3945
Mine (Explosive)	25.7903	51.5807	0	0.0000	480	0.5684
Parachute Medium	9.0417	18.0834	2,360	0.9797	2,970	1.2330
Small Decelerator/Parachute	2.8438	5.6876	74,700	9.7535	104,195	13.6047
Sonobuoys (Non-Explosive)	1.2207	2.4413	74,700	4.1865	103,835	5.8194
Total			**1,379,053**	**28.0382**	**1,930,070**	**41.1499**

Note: 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	HSTT Transit Lane	Southern California Range Complex
		Number	Number	Number
Other				
Air-Launched Lightweight Torpedo (Non-Explosive)		224	0	285
AMNS/EMNS Neutralizer (Non-Explosive)	Alternative 1	768	0	1,670
	Alternative 2			1,688
Heavyweight Torpedo (Non-explosive)		423	0	423
Surface-Launched Lightweight Torpedo (Non-Explosive)		235	0	252
Aerial Drone		2	0	19
Unmanned Aerial System		21	0	1,467
Unmanned Surface Vehicle		2	0	6
Unmanned Underwater Vehicle		160	0	205
Targets				
Air Targets		520	0	1,738
Sub-Surface Targets (Stationary)		2,580	2400	2,540
Sub-Surface Targets		44	0	2,457
Surface Targets		1,441	0	3,674
Total		**6,420**	**2,400**	**16,424**

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-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		HSTT Transit Lane		Southern California Range Complex	
			Number	Impact (Acre)	Number	Impact (Acre)	Number	Impact (Acre)
Mine Shape (Recovered)	25.7903	51.5807	776	0.9189	0	0.0000	1,121	1.3274
Anchor (Recovered)	6.2495	12.5001	10	0.0029	0	0.0000	0	0.0000
Total			**786**	**0.9218**	**0**	**0**	**1121**	**1.3274**

[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	HSTT Transit Lane	Southern California Range Complex
		Number	Number	Number
Other				
Air-Launched Lightweight Torpedo (Non-Explosive)	Alternative 1	1105	0	1,317
	Alternative 2	1120		1,425
AMNS/EMNS Neutralizer (Non-Explosive)	Alternative 1	3840	0	8,186
	Alternative 2			8,436
Heavyweight Torpedo (Non-explosive)		2115	0	2,115
Surface-Launched Lightweight Torpedo (Non-Explosive)		1175	0	1,260
Aerial Drone		10	0	95
Unmanned Aerial System		105	0	7,335
Unmanned Surface Vehicle		10	0	30
Unmanned Underwater Vehicle		1600	0	1,025
Targets				
Air Targets		2,598	0	8,688
Sub-Surface Targets (Stationary)		12,700	12000	12,700
Sub-Surface Targets	Alternative 1	164	0	11,770
	Alternative 2			12,226
Surface Targets	Alternative 1	7,063	0	18,145
	Alternative 2			18,229
Total		**33,605**	**12,000**	**112,982**

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

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		HSTT Transit Lane		Southern California Range Complex	
				Number	Impact (Acre)	Number	Impact (Acre)	Number	Impact (Acre)
Mine Shape (Recovered)	Alternative 1	25.7903	51.5807	3880	4.5944	0	0.0000	4,789	5.6708
	Alternative 2	25.7903	51.5807	3880	4.5944	0	0.0000	5,605	6.6370
Anchor (Recovered)		6.2495	12.5001	50	0.0143	0	0.0000	0	0.0000

[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.1.3 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	192	0.9489	2,053	0.046210211	0	0.0000000	1,607	0.0590537
Total	***NA***	***NA***	***0.948885***		***0.046210***		***0.0000000***		***0.0590537***
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***	***17.436949***		***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	192	0.9489	2,053	0.046210211	0	0.0000000	1,607	0.0590537
Total	***NA***	***NA***	***0.948885***		***0.046210***		***0.0000000***		***0.0590537***
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	464	2.1437		0.019057		0.0130609		0.0773870
Total	***NA***	***NA***	***18.612379***		***0.165458***		***0.1133994***		***0.6719015***

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	960	4.7444	2,053	0.231049927	0	0.0000000	1,607	0.2952672
Total	***NA***	***NA***	***4.744400***		***0.231050***		***0.0000000***		***0.2952672***
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	2009	9.9277		0.088254		0.0604864		0.3583871
Total	***NA***	***NA***	***59.371800***		***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	960	4.7444	2,053	0.231049927	0	0.0000000	1,607	0.2952672
Total	***NA***	***NA***	***4.744400***		***0.231050***		***0.0000000***		***0.2952672***
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	2318	11.4538		0.101821		0.0697844		0.4134789
Total	***NA***	***NA***	***94.773600***		***0.842509***		***0.5774258***		***3.4212997***

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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