MARINE MAMMAL COMMISSION

17 June 2015

Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3226

Dear Ms. Harrison:

The Marine Mammal Commission (the Commission), in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the National Marine Fisheries Service's (NMFS) 3 June 2015 notice (80 Fed. Reg. 31738) and the revised letter of authorization (LOA) application[1] submitted by the U.S. Department of the Navy seeking issuance of regulations under section 101(a)(5)(A) of the Marine Mammal Protection Act (the MMPA). The regulations would authorize the taking of marine mammals incidental to training and research, development, test, and evaluation (testing) activities to be conducted from 2015 to 2020 within the Northwest Training and Testing study area (NWTT). The Commission previously commented on NMFS's advance notice of proposed rulemaking and the Navy's Draft Environmental Impact Statement/Overseas Environmental Impact Statement (DEIS) regarding the proposed activities[2] on 20 February 2014. In addition, the Navy is requesting that NMFS authorize modifications to watchstander[3] reporting requirements, unrelated to implementation of mitigation measures, for regulations associated with the Hawaii-Southern California Training and Testing study area (HSTT), Atlantic Fleet Training and Testing study area (AFTT), Mariana Islands Training and Testing study area, and Gulf of Alaska study area (GOA).

Background

The Navy proposes to conduct training and testing activities in the waters off northern California, Oregon, Washington, and British Columbia (including the Strait of Juan de Fuca and Puget Sound) and in Western Behm Canal in southeastern Alaska. The activities would involve the use of low-, mid-, high- and very high-frequency sonar, weapons systems, explosive and non-explosive practice munitions and ordnance, high-explosive underwater detonations, expended materials, electromagnetic devices, high-energy lasers, vessels, underwater vehicles, and aircraft.

[1] Which was revised last in April 2015.
[2] The Commission understands that the Navy will not be conducting activities involving time-delay firing devices, which recently were removed from its DEIS (via its supplemental DEIS) and revised LOA application. Therefore, the Commission did not include the associated rationale and recommendation as it had in its 20 February 2014 letter.
[3] i.e., lookouts.

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Uncertainty in density estimates

Uncertainty in general—The Navy estimated marine mammal densities for NWTT based on (1) models that use direct survey sighting data and distance sampling theory, (2) models that use known or inferred habitat associations to predict densities (e.g., relative environmental suitability (RES) models), typically in areas where survey data are limited or non-existent, or (3) extrapolation from neighboring regional density estimates or population/stock assessments based on expert opinion (Department of the Navy 2015). The Navy acknowledged that estimates from both RES models and extrapolated densities include a high degree of uncertainty (Department of the Navy 2015), but it does not appear that the Navy included measures of uncertainty (e.g., standard deviation, coefficient of variation (CV), etc.) in those estimates.

For NWTT, the Navy indicated that extrapolated density estimates from the Southwest Fisheries Science Center (SWFSC) data were considered more representative of expected densities than those generated from RES models.[4] The Navy stated that, in the absence of any other density data for various species that occur in the U.S. Northwest Offshore or the Canada Offshore stratum[5], density data from the SWFSC's Oregon/Washington stratum were used (Department of the Navy 2015). Those data originated from areas south of the two offshore strata. For other species, such as Dall's porpoise, data from the SWFSC's Northern California stratum were applied to the Oregon/Washington and the U.S. Offshore strata. The SWFSC's data were collected in summer and fall but were used to estimate winter and spring densities for species expected to occur in winter and/or spring. In addition, some density estimates were based on (1) a single sighting, for which the Navy noted the confidence in the value was low and/or (2) f(0) and g(0) values derived from other surveys in the North Pacific[6] (Department of the Navy 2009). Further, for Dall's porpoise and minke whale densities for the inland waters of Washington, the Navy used density data from harbor porpoise surveys that then were prorated (i.e., scaled) based on harbor porpoise sightings relative to Dall's porpoise and minke whale sightings (ManTech-SRS Technologies 2007). Man-Tech SRS Technologies (2007) emphasized that those estimates were subject to high levels of uncertainty and variability since the prorating method required several assumptions that could not be evaluated fully.

The Commission understands that density data are not available for all areas where or times when activities may occur and that even when such data are available the densities could be underestimated. However, the Commission continues to believe that action proponents, including the Navy, should use the best available density estimate plus some measure of uncertainty (e.g., mean plus two standard deviations, mean plus the coefficient of variation, the upper limit of the confidence interval) in those instances. The Navy did indicate that uncertainty characterized in the original density data references was catalogued and retained for potential later use. Thus, those values should be readily available for analysis. Therefore, the Commission recommends that NMFS require the Navy to (1) account for uncertainty in extrapolated density estimates for all species by

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[4] The Commission is unsure how the Navy could determine that the extrapolated densities better represent the expected densities than densities from RES models in the absence of density data in those areas.
[5] For NWTT, the Navy delineated three different density areas (i.e., offshore, inland waters, and Western Behm Canal in Alaska), which were differentiated further into various strata within those areas.
[6] For example, Waite (2003), which apparently served as the basis for various cetacean densities for Western Behm Canal, did not provide survey-specific f(0) and g(0) values. Therefore, those values originated from other surveys that occurred in the North Pacific.

using the upper limit of the 95% confidence interval or the arithmetic mean plus two standard deviations and (2) then re-estimate the numbers of takes accordingly.

Pinniped densities—To estimate pinniped densities, the Navy primarily used sightings or abundance data divided by an area. In the offshore area, the Navy used the following areas:

- for harbor seals, the area was based on Calambokidis et al. (2004) reporting that seals occur within 40 km of the coastline;
- for Steller sea lions, the area was based on the entire geographic range of the eastern stock;
- for elephant seals, the area was based on the female foraging range (based on a figure in LeBoeuf et al. (2000)); and
- for California sea lions and northern fur seals[7], the areas were based on "geographic area of occurrence."

The Commission is unsure if that last area is represented by the total area of the NWTT offshore area, the actual area in which the animals occur or forage off the Pacific Northwest coast, or the entire range of the stock. To estimate the densities in Western Behm Canal for Steller sea lions, northern elephant seals, and northern fur seals, the Navy used the area of the Gulf of Alaska Large Marine Ecosystem[8] (Department of the Navy 2009[9]). For harbor seals in Western Behm Canal, the Navy used the area associated with haul-out sites within 35 km of the Navy's study area. Except for harbor seals, for which the Commission believes that the areas used to estimate densities in both the offshore and Western Behm Canal areas are appropriate, more representative data exist regarding areas of use for each of the other species.

For Steller sea lions, Department of the Navy (2009) cited satellite telemetry data for dispersion and haul-out behavior of pups and dependent juveniles with females in Southeast Alaska from Raum-Suryan et al. (2004) and Call et al. (2007). However, it does not appear that the Navy used those data to define the area in which Steller sea lions occur. In addition, NMML has unpublished satellite telemetry data[10] that could be used to determine the areas of Steller sea lion occurrence for both the offshore and Western Behm Canal areas. For elephant seals, Robinson et al. (2012) provided satellite telemetry data on dispersion and movements of female northern elephant seals similar to that of LeBoeuf et al. (2000). From a total of 297 deployments, the researchers collected data on 209 elephant seal tracks of which 195 originated from Año Nuevo Island (see Figure 6 in Robinson et al. (2012)). Those newer elephant seal data should be combined with the LeBoeuf et al. (2000) data to revise the Navy's area approximation for offshore densities. For California sea lions, Weise et al. (2006) determined that adult male California sea lions remained fairly close to shore but do venture farther out to sea when anomalous oceanic conditions occur,

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[7] In its DEIS and its original LOA application, the Navy assumed that the model-estimated takes for the California stock of northern fur seals were a reasonable approximation and conservative estimation for Guadalupe fur seals. The Navy has since prorated that assumption for its EIS and revised LOA application.
[8] www.lme.noaa.gov
[9] The Department of the Navy's (2009) density estimation methods were referenced by Department of the Navy (2010b).
[10] The Commission understands it is difficult to determine densities when the best available data are not published. Accordingly, the Commission recommended in its 3 April 2014 letter regarding the 2013 stock assessment reports that NMFS, including NMML, make every effort to ensure that data collected on at-sea distribution and movements of pinnipeds are made available in a timely manner and to a broad audience.

such as were observed in 2005. Although California sea lions were tracked only to southern Oregon by Weise et al. (2006), the Commission believes that unpublished data likely exist from sea lions tagged at San Miguel by NMML. Those unpublished data may better inform the range of California sea lions within the offshore area. Lastly, movements of northern fur seals have been investigated using satellite telemetry from adult females (Ream et al. 2005, Melin et al. 2012, Pelland et al. 2014, Sterling et al. 2014), adult males (Sterling et al. 2014), and pups (Lea et al. 2009). Those data, in addition to unpublished data from NMML, could be used to better define the areas in which fur seals occur in both the offshore and Western Behm Canal areas. Specifically, data regarding movements and dispersion of tagged fur seals in the two areas could be scaled to the population and be used for a better approximation of density in those areas. Accordingly, the Commission recommends that NMFS require the Navy to (1) incorporate data from Raum-Suryan et al. (2004) and Call et al. (2007) and consult with scientists at NMML[11] regarding unpublished data to revise the areas used in estimating Steller sea lion densities in the offshore and Western Behm Canal areas, (2) incorporate data from Robinson et al. (2012) into the areas used in estimating northern elephant seal densities in the offshore and Western Behm Canal areas, (3) incorporate data from Weise et al. (2006) and consult with scientists at NMML regarding unpublished data to revise the areas used in estimating California sea lion densities in the offshore area, and (4) incorporate data from Ream et al. (2005), Lea et al. (2009), Melin et al. (2012), Pelland et al. (2014), and Sterling et al. (2014) and consult with scientists at NMML to revise its northern fur seal density estimates by using movement and dispersion data from tagged fur seals specific to the study area and scaled to the population.

In general, the Navy used abundance estimates from stock assessment reports to estimate pinniped densities. Some of those estimates may be outdated or not considered best available science. The abundance estimates that the Navy used in both the offshore and Western Behm Canal areas have increased for Steller sea lions and northern fur seals (see Allen and Angliss (2014) and Carretta et al. (2014)) since reported in Department of the Navy (2009, 2015)—the latter also would affect the Guadalupe fur seal take estimates for the offshore area. Although not explicitly stated in the Navy's revised LOA application, NMFS indicated in the *Federal Register* notice that the takes of Guadalupe fur seals, that originally were equal to northern fur seal takes, were prorated based on the Navy apparently assuming that Guadalupe fur seals would occur 50 nmi or less from shore. The Commission does not doubt that Guadalupe fur seals would likely occur in numbers less than northern fur seals in the offshore area but notes that Guadalupe fur seals do occur in waters beyond 50 nmi from shore based on Gallo-Reynoso et al. (2012). Thus, the Commission questions the basis of the 50-nmi demarcation. For harbor seals, the Navy indicated that updated abundance estimates would be available in 2010 or 2011 (Department of the Navy 2010b), but those have not been provided. It is unclear if the Navy tried to obtain those data and they are still unavailable or if the Navy has not updated the harbor seal density data since the Department of the Navy (2010b) document. In either case, it is likely that more current data for harbor seals have become available in the last four years. Therefore, the Commission recommends that NMFS require the Navy to (1) revise its abundance estimates to include data from Allen and Angliss (2014) and Carretta et al. (2014) to determine Steller sea lion and northern fur seal densities in both the offshore and Western Behm Canal areas, (2) update the Guadalupe fur seal take estimates based on the revised northern fur seal density estimates and provide better justification for the reduction in Guadalupe fur seal takes for the offshore area, and (3) revise its abundance estimates to include updated data for harbor seals in the Western Behm Canal area, if available.

[11] The Commission can provide contact information for the appropriate scientists at NMML.

To better estimate the densities of harbor seals in NWTT, the Navy applied correction factors to various abundance estimates in all three areas. A single "regional combined" haul-out correction factor of 1.53 from Huber et al. (2001) was applied to the abundance estimate for both offshore and inland Washington areas[12] except Hood Canal. However, Huber et al. (2001) not only determined separate haul-out correction factors for the offshore and inland waters (i.e., 1.50 and 1.57, respectively) but also for the same areas that correspond to the four inland areas[13] designated by the Navy (except Hood Canal). The Navy did update its Hood Canal-specific correction factor from 1.53 to 5.0 based on London et al. (2012)[14], but the Commission believes the Navy should update the other areas as well. Because these data are based on best available science, these correction factors should have been used to adjust the density estimates for each of the respective areas. Therefore, the Commission recommends that NMFS require the Navy to use harbor seal haul-out correction factors of 1.50 for the offshore area, 1.85 for the Strait of Juan de Fuca and San Juan Islands, 1.51 for Eastern Bays, and 1.36 for Puget Sound rather than a pooled correction factor of 1.53—the proportion of seals at sea for each of those areas also should be adjusted accordingly and then incorporated with the relevant abundance estimates to derive the appropriate density estimates.

For Western Behm Canal, the Navy used a correction factor of 0.198 based on Allen and Angliss (2010)[15] to adjust the harbor seal abundance estimate. The Commission believes the Navy misinterpreted that information. Simpkins et al. (2003) determined a pooled haul-out correction factor of 1.198[16], which would account for seals at sea and not counted during a survey[17]. The proportion of seals hauled out would be 0.835 with 0.165 at sea (Simpkins et al. 2003). The abundance estimate, which was based on hauled-out seals, should have been multiplied by the haul-out correction factor to determine the overall abundance. Then the overall abundance should have been reduced by the proportion at sea, which is the same method used by the Navy for its offshore density estimate.

In addition, Withrow and Loughlin (1995) determined a haul-out correction factor of 1.74 for the same general area and at the same time of year as Simpkins et al. (2003)[18]. It is unclear why the correction factors differ so much, but the Commission believes that the Navy should use the mean of the two haul-out correction factors for Grand Island (1.49)[19] to determine the overall abundance estimate for Western Behm Canal. The Navy then should reduce that overall abundance estimate by 0.33 (0.67 would be the proportion of seals hauled out[20]) to determine the number of

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12 Including Strait of Juan de Fuca, San Juan Islands, Eastern Bays, and Puget Sound based on Jeffries et al. (2003) and incorporated into Department of the Navy (2015).
13 Protection Island is within the Strait of Juan de Fuca and San Juan Islands, Boundary Bay is within the Eastern Bays, Gertrude Island is within Puget Sound, and Hood Canal corresponds to Hood Canal.
14 That specific haul-out correction factor coincides with the time of day the abundance estimates would have been obtained based on Jeffries et al. (2003).
15 However, the haul-out correction factor originated in Simpkins et al. (2003).
16 From Grand Island and Nanvak Bay based on individual correction factors of 1.23 and 1.17, respectively.
17 The correction factor to adjust an abundance estimate to account for seals in the water is the reciprocal of the proportion of tagged animals hauled out. That correction factor is not the same as the proportion of seals in the water.
18 Both projects occurred in the Grand Island area of southeast Alaska in summer 1994.
19 Which is based on the average of 1.23 and 1.74. The Commission inadvertently used 1.47 rather than 1.49 in its 20 February 2014 letter.
20 The reciprocal of the mean haul-out correction factor of 1.49 is 0.67, which is the proportion of seals hauled out. Therefore, 0.33 would be the proportion of seals in the water.

animals at sea. Therefore, rather than applying a single, inaccurate correction factor of 0.198, the Commission recommends that NMFS require the Navy to use a haul-out correction factor of 1.49 to determine the overall abundance of harbor seals for the Western Behm Canal area and apply a correction of 0.33 to determine the proportion of the overall abundance at sea, which then is used to derive the density estimate.

Lack of transparency in density estimations—The Commission had a difficult time determining how some of the densities were calculated, which stemmed from the need to review multiple sources of information and an overall lack of transparency. For example, the Navy indicated in its density database technical report (Department of the Navy 2015) that the densities of Cuvier's and Baird's beaked whales for Western Behm Canal were taken from Department of the Navy (2010b). But that source indicated that the densities were calculated in Department of the Navy (2009) and were based on Waite (2003). In addition, various documents (e.g., Department of the Navy 2009, 2010b, 2015) use different delineations for seasons—some use the conventional four seasons, while others use warm and cold seasons. Further, Waite (2003) data were collected in summer (June and July) but the Department of the Navy (2015) included densities for all four seasons. The Navy should have explained[21] the method by which the densities were calculated for each area (for NWTT that would include each of the three density areas) and each season in Department of the Navy (2015). Therefore, the Commission recommends that NMFS require the Navy to provide the method(s) by which species-specific densities were calculated for each area and each season and cite the primary literature from which those data originated.

Criteria and thresholds

The Navy proposed to estimate the numbers of takes resulting from its activities by adjusting received sound levels at different frequencies based on the hearing sensitivity of various groups of marine mammals at those frequencies. The adjustments were based on "weighting" functions derived by Southall et al. (2007) and Finneran and Jenkins (2012; Type I and Type II weighting functions, respectively). Type I weighting functions (see Figure 1 in Southall et al. 2007) are flat over a wide range of frequencies and then decline at the extremes of the animal's hearing range. Type II weighting functions (Finneran and Jenkins 2012) are used only for cetaceans and combine the precautionary Type I curves developed by Southall et al. (2007) with equal loudness weighting functions derived from empirical studies of bottlenose dolphins (Finneran and Schlundt 2011).

The Commission considers the theory behind those weighting functions to be reasonable. Essentially, Type II weighting functions lead to an increase in sensitivity at certain frequencies effectively lowering the sound exposure level (SEL) thresholds by 16–20 dB compared to the Type I weighting functions (see Figures 2 and 6 of Finneran and Jenkins (2012)). For sonar-related activities, Finneran and Jenkins (2012) reduced the TTS thresholds for acoustic sources for low- and mid-frequency by 17 dB[22]. Because data are lacking for TTS thresholds for high-frequency cetaceans exposed to acoustic (i.e., tonal) sources, Finneran and Jenkins (2012) added a 6-dB correction factor to the TTS threshold derived from exposure to non-explosive impulsive sources (i.e., from airguns). Finneran and Jenkins (2012) ascribed the 6-dB difference to the method outlined in Southall et al.

[21] As it had in the Gulf of Alaska Navy Marine Species Density Database technical report.
[22] Assuming they rounded up from 16.5 dB.

(2007). However, as the Commission previously has noted, Southall et al. (2007) did not use a 6-dB correction factor to extrapolate from impulsive to acoustic thresholds[23], but rather to estimate PTS thresholds from TTS thresholds based on peak pressure levels.

The Commission assumes that Finneran and Jenkins (2012) incorrectly provided Southall et al. (2007) as the justification for the 6-dB correction factor[24] that likely originated from the same beluga whale that participated in the Schlundt et al. (2000) and Finneran et al. (2002) experiments. If that is the case and the explosive threshold of 164.3 dB re 1 μPa^2-sec (based on Lucke et al. (2009) and used in Finneran and Jenkins (2012)) is increased by 6 dB, the resulting unadjusted TTS threshold would be 170.3 dB re 1 μPa^2-sec for acoustic sources. That threshold then should have been adjusted by 19.4 dB to yield a TTS threshold[25] of 151 rather than 152 dB re 1 μPa^2-sec. Similar adjustments should have been made to the explosive threshold as well, which also served as the basis for the PTS and behavioral thresholds. The Commission recommends that NMFS require the Navy to (1) update Finneran and Jenkins (2012) to include the appropriate justification for its use of the 6-dB extrapolation factor between explosive and acoustic sources, (2) use 151 rather than 152 dB re 1 μPa^2-sec as the TTS threshold for high-frequency cetaceans exposed to acoustic sources, (3) use 145 rather than 146 dB re 1 μPa^2-sec as the TTS threshold for high-frequency cetaceans for explosive sources, and (4)(a) based on these changes to the TTS thresholds, adjust the PTS thresholds for high-frequency cetaceans by increasing the amended TTS threshold by 20 dB for acoustic sources and 15 dB for explosive sources and (b) adjust the behavioral thresholds by decreasing the amended TTS thresholds by 5 dB for explosive sources.

Probability of strike

The Navy used a qualitative assessment to determine the number of whales that could be struck by a vessel based on historical data. The Navy also estimated the probabilities of expended munitions and non-explosive materials (e.g., sonobouys) striking a marine mammal based on simple probability calculations (Appendix I of its DEIS). In doing so, the Navy compared the aggregated footprint of some specific marine mammal species with the footprint of all objects that might strike them. Both of those were based only on densities of marine mammals in the action area and expected amount of materials to be expended within a year in those areas. By combining marine mammal densities and those activities over space and time into a single calculation, the Navy provided a crude estimate of strike probabilities for the average condition, which may have been an underestimate given the shortcomings of the density data (as previously discussed). Neither marine mammals nor Navy activities are distributed homogeneously in space or time. To provide a more reliable estimate of possible takes from munitions and materials, the Navy should incorporate spatial and temporal considerations in its calculations to estimate takes. For example, the Navy's model for determining takes of marine mammals from sound-producing activities can account for the movement of sound sources, munitions, and marine mammals. Using that model to estimate the probability of strike, the Navy could change the data collected by the animat dosimeters from a

[23] Southall et al. (2007) indicated that the TTS threshold for non-pulse (acoustic) sources was 12 dB greater than for pulse (explosive) sources based on SELs (195 dB re 1 μPa^2-sec based on mean data from Schlundt et al. (2000) vs 183 dB re 1 μPa^2-sec based on a single beluga data point from Finneran et al. (2002) and a 3-dB Type I weighting adjustment, respectively).
[24] Which also was used for pinnipeds.
[25] Which served as the basis for the PTS threshold.

received sound level to a close approach distance, which would result in more realistic strike probabilities.

For the HSTT Final Environmental Impact Statement/Overseas Environmental Impact Statement (FEIS), the Navy indicated that it considered using a dynamic simulation model to estimate strike probabilities but determined that use of historical data was more appropriate for the analysis. The Navy believed that those data account for real-world variables over many years, and any model would be expected to be less accurate than the use of actual data. The Commission disagrees with that conclusion. First of all, the activities under the Preferred Alternative would increase over baseline (i.e., the No Action Alternative). As an example, the number of training activities involving vessel movement in inland waters would increase by more than 770 percent over the No Action Alternative[26] (4 vs. 310 activities) and using the historical rate of ship strikes based on lesser numbers of vessels would underestimate the possibility of ship strikes under the Preferred Alternative. Further, the Commission supports the use of actual data relevant to the activities proposed under the alternatives. However, those data should be used to seed the dynamic simulation models rather than in the qualitative assessment of vessel strike or current crude calculations of strike probabilities for expended munitions and materials. For these reasons, the Navy should provide a more accurate assessment based on the best available information for marine mammals and the locations and scheduled times of its activities. Therefore, the Commission again recommends that NMFS require the Navy to use spatially and temporally dynamic simulation models rather than qualitative assessments and simple probability calculations to estimate strike probabilities for specific activities (i.e., movements of vessels, torpedoes, unmanned underwater vehicles and expended munitions, ordnance, and other devices).

Mitigation and monitoring measures

Ranges to impact criteria—Many of the proposed activities involve mitigation measures that currently are being implemented in accordance with previous environmental planning documents, regulations, or consultations. Most of the current mitigation zones for activities involving acoustic (e.g., mid- and high-frequency active sonar) or explosive sources (e.g., underwater detonations, explosive sonobuoys, surface detonations) were designed originally to reduce the potential for onset of TTS. For its LOA application, the Navy revised its acoustic propagation models by updating hearing criteria and thresholds and marine mammal density and depth data. Based on the updated information, the models now predict that for certain activities the ranges to onset of TTS are much larger than those estimated previously. Due to the ineffectiveness and unacceptable operational impacts associated with mitigating those large areas, the Navy is unable to mitigate for onset of TTS for every activity. For that reason, it proposes to base its mitigation zones for each activity on avoiding or reducing PTS out to the predicted maximum range.

Table 11-1 in the revised LOA application lists the Navy's predicted distances or ranges over which PTS and TTS might occur and the recommended mitigation zones. Rather than include all sources, the table categorizes sound sources by a representative source type within a source bin (e.g., Bin MF1: SQS-53 antisubmarine warfare hull-mounted sonar) and provides average and maximum distances from the sound source at which PTS could be expected to occur and the average range at

[26] A similar example for the number of testing activities in offshore waters to increase by nearly 400 percent over the No Action Alternative (37 vs. 138 activities) was provided in the Commission's 20 February 2014 letter.

which TTS could be expected to occur. Chapter 6 of the revised LOA application also includes tables listing various ranges. However, the tables in Chapter 6 include (1) only a subset of the proposed activities, some of which are not relevant to NWTT, (2) the average rather than maximum ranges, and (3) nominal values for deep water offshore areas, not specific to NWTT (see Table 6-13). In addition, the revised LOA application does not provide the ranges to PTS for acoustic sources for more than 1 ping (Table 6-8), as it does for TTS (i.e., 1, 5, and 10 pings; Table 6-9). Instead, the Navy assumed that marine mammals could not maintain a speed of 10 knots parallel the ship and receive adequate energy over successive pings to result in PTS. Further, the Navy indicated in Table 6-8 that the ranges to PTS for acoustic sources were "within representative ocean acoustic environments" and in Table 6-9 that the ranges to TTS for acoustic sources were "over a representative range of ocean environments", which the Commission assumes as not necessarily within NWTT (similar to Table 6-13).

The Navy stated that modeling for inland waters provides an overestimate of the range to effects because it cannot adequately account for the complex interactions of the sound energy into very shallow water and associated shorelines, the loss into dampening structures (i.e., such as adjacent pilings, jetties, or seawalls), or occasions when a ship or submarine is moored bow-in so that the sound is transmitted toward the nearby shoreline. Therefore, the Navy noted that the ranges in Table 11-1 would be even more protective for activities in the inland waters. The Commission agrees that in many cases the Navy's range estimates are more protective in inland waters, but that is not true in all cases. Situations occur in which sound can propagate greater distances in shallower water. Data specific to NWTT are essential, especially for inland waters[27] and Western Behm Canal where waters are shallower and bottom characteristics would be important for determining sound propagation. Further, the Navy did not propose, and NMFS does not intend to require the Navy, to power down when pinnipeds are within various radii of the acoustic source, as is the case for cetaceans. Rather, the Navy proposed to shut down when pinnipeds are at 90 m or less. The Commission believes that shutting down for pinnipeds likely would occur most often in either inland waters or in Western Behm Canal, which may not be represented by the ranges in Tables 6-8, -9, and -13. Absent specific information for the three NWTT areas, the LOA application process is not fully transparent and the Commission and public cannot comment on the appropriateness of the proposed mitigation zones. To address those shortcomings, <u>the Commission recommends</u> that NMFS require the Navy to provide the predicted average and maximum ranges for all impact criteria (i.e., behavioral response, TTS, PTS, onset slight lung injury, onset slight gastrointestinal injury, and onset mortality), for all activities (i.e., based on the activity category and representative source bins and including ranges for more than 1 ping), and for all functional hearing groups of marine mammals specific to the three NWTT areas (i.e., offshore, inland waters, and Western Behm Canal).

<u>Passive and active acoustic monitoring</u>—The Navy indicated in its revised LOA application that use of lookouts (i.e., observers) contributes to helping minimize potential impacts on marine mammal species from training and testing activities. Further, the Navy indicated in its DEIS that the use of lookouts would increase the likelihood of detecting marine mammals at the surface, but it also noted that it is unlikely that using lookouts will be able to help avoid impacts on all species entirely due to the inherent difficulties of visually detecting marine mammals. The Commission agrees and has made numerous recommendations to the Navy in previous letters related to the effectiveness of

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[27] Empirical sound propagation measurements have been obtained by Washington Department of Transportation and the Navy at Naval Base Kitsap, which could inform modeling for inland waters.

visual observation. For a number of years, the Navy has been working with collaborators at the University of St. Andrews to study observer effectiveness. The Navy has noted in the DEIS, that while data were collected as part of a proof-of-concept phase, those data are not fairly comparable as protocols were being changed and assessed, nor are those data statistically significant. The Commission understands those points but believes the basic information the studies provide is useful. In one instance, the marine mammal observers (MMOs) sighted at least three marine mammals at distances of less than 914 m (i.e., within the mitigation zone for mid-frequency active sonar for cetaceans), which were not sighted by Navy lookouts (Department of the Navy 2012). Further, MMOs have reported marine mammal sightings not observed by Navy lookouts to the Officer of the Deck, presumably to implement mitigation measures (Department of the Navy 2010a). Neither details regarding those reports nor raw sightings data were provided to confirm this. The Commission believes that the study will be very informative once completed and that a precautionary approach based on preliminary data should be taken in the interim.

The Commission believes that the Navy should supplement its visual monitoring efforts with other measures rather than simply reducing the size of the zones it plans to monitor. The Navy did propose to supplement visual monitoring with passive acoustic monitoring during activities that generate impulsive sounds (primarily explosives) but not during the use of low-, mid-, and high-frequency active sonar. The Navy also uses visual, passive acoustic, and active acoustic monitoring during Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar activities to augment its mitigation efforts over large areas. Therefore, it is not clear why the Navy did not propose to use those same monitoring methods as part of its mitigation measures for the other activities described in its revised LOA application. To ensure effective mitigation and monitoring, the Commission recommends that NMFS require the Navy to use passive and active acoustic monitoring, whenever practicable, to supplement visual monitoring during the implementation of its mitigation measures for all activities that could cause PTS, injury, or mortality beyond those explosive activities for which passive acoustic monitoring already was proposed.

Clearance time for deep-diving species—The Navy has proposed to cease acoustic activities (i.e., active sonar transmissions, Bin MF1) when a marine mammal is detected within the mitigation zone, which raises the issue of when those activities should resume. According to the revised LOA application, those acoustic activities would resume when (1) the animal has been observed exiting the mitigation zone, (2) the animal has been thought to have exited the mitigation zone based on its course and speed, (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes, (4) the ship has transited more than 1.8 km beyond the location of the last sighting, or (5) the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave (and there are no other marine mammal sightings within the mitigation zone). The Commission questions some of those requirements when the position of the marine mammal is unknown. The key consideration is the position of the marine mammal relative to the sound source, which is best estimated as a function of the marine mammal's position when first sighted and the speed and heading of both the vessel and the marine mammal. If the vessel and marine mammal are not moving in the same direction, then the marine mammal may leave the mitigation zone relatively quickly. However, if they are moving in the same direction, then the marine mammal may remain within the mitigation zone for a prolonged period. Unless the marine mammal is resighted leaving or already outside the mitigation zone, the Navy should not resume its activity until it has had a reasonable chance of verifying that it can do so without impacting the marine mammal to a greater degree. The delay should take into account that (1) a marine mammal may remain underwater where it is not visible, (2) it may change its heading and speed in response to a vessel or sound source, and (3) visual observation alone may not be sufficient to determine a marine mammal's position relative to a vessel or sound source after the initial sighting, unless the marine mammal surfaces again and is observed.

The dive time of a sighted marine mammal is a central consideration whenever mitigation measures depend on visual observation. For some medium-sized and large cetaceans, the proposed 30-minute clearance time may be inadequate, sometimes markedly so. Beaked and sperm whales, in particular, can remain submerged for periods far exceeding 30 minutes. Blainville's and Cuvier's beaked whales have been known to dive to considerable depths (> 1,400 m) and remain submerged for more than 80 minutes (Baird et al. 2008). The grand mean dive duration for those species of beaked whales during foraging dives has been estimated at approximately 60 minutes (51.3 and 64.5 minutes for Blainville's and Cuvier's beaked whales, respectively; Baird pers. comm.). Recent data on Cuvier's beaked whales revealed a maximum dive duration of more than 137 minutes and dive depths of more than 2,990 m with a mean dive duration of 67.4 minutes (Schorr et al. 2014). Sperm whales also dive to great depths and can remain submerged for at least 55 minutes (Drouot et al. 2004), with a grand mean dive time of approximately 45 minutes (Watwood et al. 2006). In addition, if those species continue foraging in the same area as a stationary acoustic source, which only has a clearance time of 10 minutes based on the fuel capacity of the aircraft, then beaked whales and sperm whales could be exposed to sound levels sufficient to cause Level A harassment. More importantly, for some explosive activities (including missile and bombing exercises and torpedo testing), the clearance time also is only 10 minutes—a timeframe which is far from sufficient for those types of activities to re-commence.

Furthermore, lookouts may not detect marine mammals each time they return to the surface, especially cryptic species such as beaked whales, which are difficult to detect even under ideal conditions. Barlow (1999) found that "[a]ccounting for both submerged animals and animals that are otherwise missed by the observers in excellent survey conditions, only 23 percent of Cuvier's beaked whales and 45 percent of *Mesoplodon* beaked whales are estimated to be seen on ship surveys if they are located directly on the survey trackline." Therefore, after a shutdown, <u>the Commission recommends</u> that NMFS require the Navy to use a second clearance time category of 60 minutes for beaked whales and sperm whales if the animal has not been observed exiting the mitigation zone.

Request for Level A harassment and mortality takes

The Navy proposed an additional post-model analysis of acoustic and explosive effects to include (1) animal avoidance of repeated sound exposures, (2) sensitive species avoidance of areas of activity before a sound source or explosive is used, and (3) effective implementation of mitigation measures. That analysis effectively reduced the model-estimated numbers of Level A harassment (i.e., PTS and injury) and mortality takes.

The Navy assumed that marine mammals likely would avoid repeated high-level exposures to a sound source that could result in injuries (i.e., PTS). It therefore adjusted its estimated numbers of takes to account for marine mammals swimming away from a sonar or other active source and away from multiple explosions to avoid repeated high-level sound exposures. The Navy also assumed that harbor porpoises and beaked whales would avoid certain training and testing activity areas because of high levels of vessel or aircraft traffic before those activities. For those types of activities, the Navy appears to have reduced the model-estimated takes from Level A harassment (i.e., PTS) to Level B harassment (i.e., TTS) during use of sonar and other active acoustic sources and from mortality to Level A harassment (i.e., injury) during use of explosive sources. The Commission recognizes that, depending on conditions, marine mammals may avoid areas of excessive sound or activity. That being said, the Commission knows of no scientifically established basis for predicting the extent to which marine mammals will abandon their habitat based on the presence of vessels or aircraft, which would be essential for adjusting the estimated numbers of takes.

As an example, the Navy indicated that beaked whales that were model-estimated to be within range of the mortality threshold were assumed to avoid the activity for missile exercises (air-to-surface; see Table 3.4-21 in the DEIS). But in Chapter 5 of the DEIS, the Navy indicated that missile exercises involve the aircraft firing munitions at a target location typically up to 27 km away (and infrequently at ranges up to 138 km away). When an aircraft is conducting the exercise, it can travel close to the intended impact area so that the area can be visually observed. However, the Navy indicated that there is a chance that animals could enter the impact area after the visual observations have been completed and the activity has commenced. The Commission understands that to mean the aircraft clears the zone around the target and then travels to its firing location to commence the activity. Therefore, the Commission is unsure why the Navy would reduce any mortality take estimates based on mitigation measures that are followed by a time lag before the activities actually commence, which could allow for the animals to re-enter the mitigation zone around the target.

The Navy also indicated that its post-model analysis considered the potential for highly effective mitigation to reduce the likelihood or risk of PTS from exposure to sonar and other active acoustic sources and injuries (presumably including PTS) and mortality from exposure to explosive sources. Clearly, the purpose of mitigation measures is to reduce the number and severity of takes. However, the effectiveness of the Navy's mitigation measures has not been demonstrated and remains uncertain. This is an issue that the Commission has raised many times in the past, and the Navy has recognized the need to assess the effectiveness of its mitigation measures in its Integrated Comprehensive Monitoring Program, DEIS, and revised LOA application. That application stated that although the use of lookouts is expected to increase the overall likelihood that certain marine species would be detected at the water's surface, lookouts would not always be entirely effective at avoiding impacts on all species.

According to data in the monitoring reports mentioned previously (Department of the Navy 2010a, 2012), the effectiveness of the lookouts has yet to be determined. However, the Navy proposed to adjust its take estimates based on both mitigation effectiveness scores and g(0)—the probability that an animal on a vessel's or aircraft's track line will be detected. According to its proposed approach, for each species the Navy would multiply a mitigation effectiveness score and a g(0) to estimate the percentage of the subject species that would be observed by lookouts and for which mitigation would be implemented, thus reducing the estimated numbers of marine mammal takes for Level A harassment and mortality (explosive sources only). The Commission understands the Navy would reduce the estimated numbers of Level A harassment (i.e., PTS and injury) and mortality takes for that species to Level B (i.e., TTS) takes.

To implement that approach, the Navy assigned mitigation effectiveness scores of—

1 mitigation is considered fully effective if the entire mitigation zone can be observed visually on a continuous basis based on the surveillance platform(s), number of lookouts, and size of the range to effects zone;

0.5 mitigation is considered mostly effective if (1) over half of the mitigation zone can be observed visually on a continuous basis or (2) there is one or more of the scenarios within the activity for which the mitigation zone cannot be observed visually on a continuous basis (but the range to effects zone can be observed visually for the majority of the scenarios); or

N/A mitigation is not considered as an adjustment factor if (1) less than half of the mitigation zone can be observed visually on a continuous basis or (2) the mitigation zone cannot be observed visually on a continuous basis during most of the scenarios within the activity due to the type of surveillance platform(s), number of lookouts, and size of the mitigation zone.

The difficulty with this approach is in determining the appropriate adjustment factors. Again, the information needed to judge effectiveness has not been made available. The Navy also has not provided the criteria (i.e., the numbers and types of surveillance platforms, numbers of lookouts, and sizes of the respective zones) needed to elicit the three mitigation effectiveness scores. Moreover, measures of effort (i.e., numbers and types of surveillance platforms, numbers of lookouts, and sizes of mitigation zones) are not necessarily measures of, or even linked to, effectiveness. The Navy also has not demonstrated the effectiveness of the visual monitoring measures, as discussed previously. The Navy further reinforced that fact in its DEIS when stating the Navy believes that it is improper to use the proof-of-concept data to draw any conclusions on the effectiveness of Navy lookouts.

The information that the Navy provided in Chapter 11 of its revised LOA application and Chapter 5 of its DEIS regarding the effectiveness of various mitigation measures does not necessarily comport with its determination of mitigation effectiveness scores. For example, the Navy indicated that the mitigation zone for torpedo testing exercises is 1.9 km in both its revised LOA application and DEIS. However, the Navy stated in its DEIS that it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 1.9 km near the perimeter of the mitigation zone. The Commission is unclear how the Navy would implement a shut down or delay for odontocetes that are not in a large group or for pinnipeds in general. Nevertheless, the Navy assigned a mitigation effectiveness score of 1, apparently assuming that the mitigation would be fully effective. (Table 6-12). Those effectiveness scores again are measures of effort rather than of true effectiveness.

In addition, the Navy appears to be inconsistent in its use of the terms "range to effects zone" and "mitigation zone," which are not the same (see Table 11-1 of the revised LOA application). More importantly, some of the mitigation zones may be smaller than the estimated range to effects zones. For example, the Navy proposed a mitigation zone of 183 m after a 10 dB reduction in power for its most powerful active acoustic sources (e.g., Bin MF1) and assumed that marine mammals would leave the area near the sound source after the first few pings. However, the Navy did not present data on the range to onset PTS for more than 1 ping and only provided data for "representative ocean acoustic environments", which may or may not be representative of inland waters and Western Behm Canal. It also is unclear how the Navy evaluated sources that have a typical duty cycle of several pings per minute (i.e., dipping sonar), as the range to onset PTS for those sources appear to be based on 1 ping as well (compare Tables 6-9 and 11-1). Without the relevant information, mitigation based on those zones cannot be evaluated fully or deemed effective and assigning mitigation effectiveness scores is inappropriate.

The Navy used numerous references to estimate species-specific g(0) values (Table 6-6)—the Commission notes that g(0) values for various species have been updated in Barlow (2015). Those sources were based on both vessel- and aircraft-based scientific surveys of marine mammals. It also indicated that various factors are involved in estimating g(0), including sightability and detectability of the animal (e.g., behavior and appearance, group size, blow characteristics), viewing conditions (e.g., sea state, wind speed, wind direction, wave height, and glare), the observer's ability to detect animals (e.g., experience, fatigue, and concentration), and platform characteristics (e.g., pitch, roll, speed, and height above water). In its revised LOA application, the Navy noted that due to the various detection probabilities, levels of experience, and dependence on sighting conditions, lookouts would not always be effective at avoiding impacts on all species. Yet it based its g(0) estimates on data from experienced researchers conducting scientific surveys, not on data from Navy lookouts whose effectiveness as observers has yet to be determined. The Commission recommended earlier in this letter that the Navy supplement its mitigation and monitoring measures because the observer effectiveness study has yet to be completed or reviewed. It therefore would be inappropriate for the Navy to reduce the numbers of takes based on the proposed post-analysis approach because, as the Navy has described its approach, it does not address the issue of observer effectiveness in the Navy's development of mitigation effectiveness scores or g(0) values. Further, the Navy believes that it also would be improper to use the proof-of-concept data to draw any conclusions on the effectiveness of Navy lookouts. Accordingly, applicable data do not exist at the current time to fulfill the Navy's post-analysis objective. Based on these concerns, the Commission recommends that NMFS require the Navy to request the total numbers of model-estimated Level A harassment (PTS and slight lung and gastrointestinal tract injuries) and mortality takes rather than reducing the estimated numbers of Level A harassment and mortality takes based on the Navy's proposed post-model analysis and base the negligible impact determination analyses on those adjusted takes.

Possible errors in the take tables

The Commission observed some possible errors in the take tables provided in the Navy's revised LOA application, DEIS, and NWTT technical report that includes the raw modeled data (NWTT-TR; Department of the Navy 2014). For example, in the NWTT-TR, the model-estimated takes for TTS exceed those for behavior for both *Kogia* spp. (52.67 and 13.83, respectively) and Dall's porpoises (2429.77 and 758.91, respectively) exposed to non-impulsive sources (acoustic sources) during training events under Alternative 1[28] (Table 14 in Department of the Navy 2014), but not for harbor porpoises (768.59 and 5920.38, respectively). The Commission is unsure how the takes would be so much greater for the TTS threshold when it is higher than the behavioral threshold.

[28] Alternative 1 in the DEIS and NWTT-TR is the Preferred Alternative, as discussed in the LOA application.

One possible explanation is that the Navy used the behavioral response functions (BRF_1 and BRF_2)[29] from Finneran and Jenkins (2012) without updating them with the new weighted TTS thresholds. BRF_1 and BRF_2 were based on the assumption that 50 percent of the exposed animals would exhibit a behavioral response at 165 dB re 1 μPa (based on a basement parameter of 120 dB re 1 μPa and *K* parameter of 45 dB re 1 μPa, see Finneran and Jenkins (2012) for details on the BRF parameters). Because the weighted TTS threshold can be as low as 152[30] dB re 1 μPa^2-sec for high-frequency cetaceans, it is illogical that the behavioral threshold that equates to a 50 percent response would be higher than the TTS threshold. Thus, the current BRFs appear to underestimate the numbers of behavioral takes. BRF_1 and BRF_2 should have been adjusted with more representative values for *K* (and, in turn, the *A* parameter that informs the shape of the curve) and the behavioral takes recalculated accordingly.

In addition, there is a fundamental problem in converting between cumulative SEL thresholds for TTS and sound pressure level thresholds for behavior. The Commission believes that the Navy likely assumed the pings emitted from the sound sources were 1 sec in length, thus the sound pressure level and sound exposure level were equivalent. The assumption of a 1-sec ping may be appropriate for some sound sources but likely is not appropriate for all. For these reasons, the Commission recommends that NMFS require the Navy to (1) adjust BRF_1 for low-frequency cetaceans and BRF_2 for mid- and high-frequency cetaceans (except harbor porpoises and beaked whales), phocids, and otariids with appropriate *K* and *A* parameters based on the basement parameter and the weighted TTS thresholds and (2) recalculate its behavioral take estimates for all marine mammals exposed to acoustic sources based on those revised BRFs.

The Navy also appears to be rounding all take numbers from the NWTT-TR down in its revised LOA application and DEIS rather than rounding to the nearest whole number, which the Commission believes was the Navy's policy[31] for species listed under the Marine Mammal Protection Act (MMPA) in its environmental compliance documents for its TAP Program. When determining the population within a modeling area in its NWTT-TR, the Navy indicated the total true population is (1) rounded to 1 if the total true population is equal to or greater than 0.05 but less than 1.0 and (2) rounded to the nearest whole number if the total true population is equal to or greater than 1.0. For example, the model-estimated non-TTS (behavioral) takes for Alaska resident killer whales exposed to non-impulsive sources during testing events under Alternative 1 in the NWTT-TR was 2.91 (Table 15 in Department of the Navy 2014) but was rounded down to 2 in the revised LOA application (Table 5.5[32]) and DEIS (Table 3.4-18). Accordingly, the Commission recommends that NMFS require the Navy to round its takes based on model-estimated takes to the nearest whole number or zero in all of its take tables.

[29] BRF_1 is used for low-frequency cetaceans; while BRF_2 is used for all mid- and high-frequency cetaceans (and pinnipeds) except beaked whales and harbor porpoises.
[30] Which the Commission believes should be 151 dB re 1 μPa^2-sec.
[31] And NMFS's policy for other incidental take authorizations.
[32] The Commission understands that Table 5-5 includes takes for exposure to both non-impulsive and impulsive sources, but the model-estimated takes for non-TTS (behavior) and TTS for impulsive sources were both 0.

The Commission hopes you find its letter helpful. Please contact me if you have questions concerning the Commission's recommendations or rationale.

Sincerely,

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References

Allen, B.M., and R.P. Angliss. 2010. Alaska marine mammal stock assessments, 2009. NOAA Technical Memorandum NMFS-AFSC-206. National Marine Mammal Laboratory, Seattle, Washington. 276 pages.

Allen, B.M., and R.P. Angliss. 2014. Draft Alaska marine mammal stock assessments, 2014. NOAA Technical Memorandum NMFS-AFSC-xxx. National Marine Mammal Laboratory, Seattle, Washington. 275 pages.

Baird, R.W., D.L. Webster, G.S. Schorr, D.J. McSweeney, and J. Barlow. 2008. Diel variation in beaked whale diving behavior. Marine Mammal Science 24:630-642.

Barlow, J. 1999. Trackline detection probability for long-diving whales. Pages 209–221 *in* G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson (eds.), Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam, The Netherlands.

Barlow, J. 2015. Inferring trackline detection probabilities, g(0), for cetaceans from apparent densities in different survey conditions. Marine Mammal Science (early view):21 pages. doi: 10.1111/mms.12205.

Calambokidis, J., G.H. Steiger, D.K. Ellifrit, B.L. Troutman, and C.E. Bowlby. 2004. Distribution and abundance of humpback whales (*Megaptera novaeangliae*) and other marine mammals off the northern Washington coast. Fishery Bulletin 102:563–580.

Call, K.A., B.S. Fadely, A. Grieg, and M.J. Rehberg. 2007. At-sea and on-shore cycles of juvenile Steller sea lions (*Eumetopias jubatus*) derived from satellite dive recorders: a comparison between declining and increasing populations. Deep-Sea Research II 54: 298–300.

Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, T. Orr, H. Huber, M.S. Lowry, J. Barlow, J. E. Moore, D. Lynch., L. Carswell, R.L. Brownell, and D.K. Matilla. 2014. U.S. Pacific draft marine mammal stock assessments: 2014. NOAA Technical Memorandum NMFS-SWFSC-xxx. National Oceanic and Atmospheric Administration, La Jolla, California. 81 pages.

Department of Navy. 2009. Appendix E: Marine mammal density report. *in* Gulf of Alaska Navy training activities Draft Environmental Impact Statement/Overseas Environmental Impact Statement. Department of the Navy, U.S. Pacific Fleet. 46 pages.

Department of the Navy. 2010a. Appendix C–Cruise report, marine species monitoring and lookout effectiveness study: Submarine Commanders Course, February 2010, Hawaii Range Complex. *in* Marine mammal monitoring for the U.S. Navy's Hawaii Range Complex and Southern California Range Complex Annual Report 2010. Department of the Navy, U.S. Pacific Fleet. 31 pages.

Department of the Navy. 2010b. Marine Mammal Occurrence/Density Report for the Southeast Alaska Acoustic Measurement Facility (SEAFAC). Naval Facilities Engineering Command, Northwest and Naval Sea Systems Command. 23 pages.

Department of the Navy. 2012. Cruise report, marine species monitoring and lookout effectiveness study: Koa Kai, November 2011, Hawaii Range Complex. *in* Marine species monitoring for the U.S. Navy's Hawaii Range Complex 2012 Annual Report. Department of the Navy, U.S. Pacific Fleet, Honolulu, Hawaii. 12 pages.

Department of the Navy. 2014. Determination of acoustic effects on marine mammals and sea turtles for the Northwest Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement pre-final 8 January 2014. Naval Undersea Warfare Center Division, Newport, Newport, Rhode Island. 89 pages.

Department of the Navy. 2015. Pacific Navy Marine Species Density Database: Revised Final Northwest Training and Testing Technical Report. Naval Facilities Engineering Command Pacific, Pearl Harbor, Hawaii. 488 pages.

Department of the Navy. 2015. Land-water interface and service pier extension activities at Naval Base Kitsap Bangor: Draft environmental impact statement. Naval Facilities Engineering Command Northwest, Silverdale, Washington.

Drouot V., A. Gannier, and J.C. Goold. 2004. Diving and feeding behaviour of sperm whale (*Physeter macrocephalus*) in the northwestern Mediterranean Sea. Aquatic Mammals 30:419–426.

Finneran, J.J., and A.K. Jenkins. 2012. Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis. SPAWAR Marine Mammal Program, San Diego, California, 64 pages.

Finneran, J. J., C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds (MTTS) in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America 111(6): 2929–2940.

Finneran, J.J., and C.E. Schlundt. 2011. Subjective loudness level measurements and equal loudness contours in a bottlenose dolphin (*Tursiops truncatus*). Journal of the Acoustical Society of America 130(5):3124–3136.

Gallo-Reynoso, J.P., A.L. Figueroa, and B.J. Le Boeuf. 2008. Foraging behavior of lactating Guadalupe fur seal females. Pages 595–614 *in* C. Lorenzo, E. Espinoza and J. Ortega (eds.), Avances en el Estudio de los Mamíferos de México, Publicaciones Especiales, Vol. II. Asociación Mexicana de Mastozoología, A. C., México.

Huber, H.R., S.J. Jeffries, R.F. Brown, R.L. DeLong, and G. VanBlaricom. 2001. Correcting aerial survey counts of harbor seals (*Phoca vitulina richardsi*) in Washington and Oregon. Marine Mammal Science 17(2):276–293.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. 2003. Trends and status of harbor seals in Washington State: 1978-1999. The Journal of Wildlife Management 67: 208–219.

Kastak, D., B.L., Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: effects of noise level and duration. Journal of the Acoustical Society of America 118:3154–3163.

Lea, M-A., D. Johnson, R. Ream, J. Sterling, S. Melin, and T. Gelatt. 2009. Extreme weather events influence dispersal of naive northern fur seals. Biology Letters 5:252–257.

LeBoeuf, B.J., D.E. Crocker, D.P. Costa, S.B. Blackwell, P.M. Webb, and D.S. Houser. 2000. Foraging ecology of northern elephant seals. Ecological Monographs 70:353–382.

London, J.M., J.M. Ver Hoef, S.J. Jeffries, M.M. Lance, and P.L. Boveng. 2012. Haul-out behavior of harbor seals (*Phoca vitulina*) in Hood Canal, Washington. PLoS ONE 7(6):e38180. doi:10.1371/journal.pone.0038180.

Lucke, K., U. Siebert, P.A. Lepper, and M-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. Journal of the Acoustical Society of America 125:4060-4070.

ManTech-SRS Technologies. 2007. Marine mammal and sea turtle density estimates for the Pacific Northwest Study Area. Prepared for the U.S. Department of the Navy. 38 pages.

Melin, S.R., J.T. Sterling, R.R. Ream, R. Towell, T.K. Zeppelin, A.J. Orr, B. Dickerson, N. Pelland, and C. Kuhn. 2012. A tale of two stocks: Studies of northern fur seals breeding at the northern and southern extent of the range. Alaska Fisheries Science Center Quarterly Report, Seattle, Washington. 6 pages.

Pelland, N.A., J.T Sterling, M-A. Lea, N.A. Bond, R.R. Ream, C.M. Lee, and C.C. Eriksen. 2014. Fortuitous encounters between seagliders and adult female northern fur seals (*Callorhinus ursinus*) off the Washington (USA) coast: Upper ocean variability and links to top predator behavior. PLoS One 9(8):e101268. doi: 10.1371/journal.pone.0101268.

Raum-Suryan, K.L., M.J. Rehberg, G.W. Pendleton, K.W. Pitcher, and T.S. Gelatt. 2004. Development of dispersal, movement patterns, and haul-out use by pup and juvenile Steller sea lions (*Eumetopias jubatus*) in Alaska. Marine Mammal Science 20(4):823–850.

Ream, R.R., J.T. Sterling, and T.R. Loughlin. 2005. Oceanographic features related to northern fur seal migratory movements. Deep-Sea Research II 52:823–843.

Robinson, P.W., D.P. Costa, D.E. Crocker, J.P. Gallo-Reynoso, C.D. Champagne, M.A. Fowler, C. Goetsch, K.T. Goetz, J. Hassrick, L.A. Hückstädt, C.E. Kuhn, J.L. Maresh, S.M. Maxell, B.I. McDonald, S.H. Peterson, S.E. Simmons, N.M. Teutschel, S. Villegas-Amtmann, and K. Yoda. 2012. Foraging behavior and success of a mesopelagic predator in the northeast Pacific Ocean: Insights from a data-rich species, the northern elephant seal. PLoS ONE 7(5): e36728. doi:10.1371/journal.pone.0036728.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds (MTTS) of bottlenose dolphins and white whales after exposure to intense tones. Journal of the Acoustical Society of America 107:3496–3508.

Schorr, G.S., E.A. Falcone, D.J. Moretti, and R.D. Andrews RD. 2014. First long-term behavioral records from Cuvier's beaked whales (*Ziphius cavirostris*) reveal record-breaking dives. PLoS ONE 9(3):e92633. doi:10.1371/journal.pone.0092633.

Simpkins, M.A., D.E. Withrow, J.C. Cesarone, and P.L. Boveng. 2003. Stability in the proportion of harbor seals hauled out under locally ideal conditions. Marine Mammal Science 19(4):791–805.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendation. Aquatic Mammals 33(4):411–521.

Sterling, J.T., A.M. Springer, S.J. Iverson, S.P. Johnson, N.A. Pelland, D.S. Johnson, M-A. Lea, and N.A. Bond. 2014. The sun, moon, wind, and biological imperative-shaping contrasting wintertime migration and foraging strategies of adult male and female northern fur seals (*Callorhinus ursinus*). PLoS ONE 9(4):e93068. doi:10.1371/journal.pone.0093068.

Waite, J. 2003. Cetacean Assessment and Ecology Program: Cetacean survey. Alaska Fisheries Science Center's quarterly research reports-July to September 2003. http://www.afsc.noaa.gov/Quarterly/jas2003/divrptsNMML2.htm.

Watwood S.L., P.J.O. Miller, M. Johnson, P.T. Madsen, and P.L. Tyack. 2006. Deep-diving foraging behavior of sperm whales (*Physeter macrocephalus*). Journal of Animal Ecology 75:814–825.

Weise, M.J., D.P. Costa, and R.M. Kudela. 2006. Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005 compared to those of 2004. Geophysical Research Letters 3:L22S10. doi:10.1029/2006GL027113.

Withrow, D.E., and T.R. Loughlin. 1995. Haulout behavior and method to estimate the proportion of harbor seals missed during mot census surveys in Alaska. Annual report to Office of Protected Resources, National Marine Fisheries Service, Silver Spring, Maryland. 38 pages.