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Prepared by

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Northwest Training Range Complex Monitoring Plan

DRAFT

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This Monitoring Plan is submitted to NMFS in support of the

Taking and Importing Marine Mammals; U.S. Navy Training in the Northwest Training Range Complex; Proposed Rule

AND

Biological Opinion on the U.S. Navy's training in the Northwest Training Range Complex

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EXECUTIVE SUMMARY

The Northwest Training Range Complex (NWTRC) Monitoring Plan proposes monitoring goals for marine mammals and sea turtles that are unique with regard to their breadth as well as their focus on potential impacts of mid-frequency active sonar (MFAS) and underwater explosions on marine mammals and sea turtles.

To accomplish these goals, the Navy will use similar methods of implementation and data analysis which have demonstrated success in comparable monitoring programs studying the effects of anthropogenic sound on marine animals. To this end, the Navy in consultation with the National Marine Fisheries Service (NMFS) designed a series of focused "study questions" to gather data in various combination within the Navy's range complexes to address:

Question 1. Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

Question 2. If marine mammals and sea turtles are exposed to MFAS in NWTRC, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

Question 3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?

Question 4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

Question 5. Is the Navy's suite of mitigation measures for MFAS and explosives [e.g., Protective Measures Assessment Protocol (PMAP)], major exercise measures agreed to by the Navy through permitting] effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

Given the larger scope of training events within other Navy range complexes as compared to NWTRC, not every one of these original five study questions will be address within NWTRC (**Tables ES-1** and **ES-2**). Rather, data collected from NWTRC monitoring will be used to supplement a consolidate range complex marine mammal monitoring report incorporating data from the Atlantic Fleet Active Sonar Training Range (AFAST), Hawaii Range Complex (HRC), NWTRC, and Southern California (SOCAL) Range Complex.

Monitoring methods proposed for the NWTRC include a combination of research elements designed to support both Range Complex specific monitoring, and contribute information to a larger Navy-wide program. These research elements include visual surveys from vessel or airplanes, passive acoustic monitoring (PAM), marine mammal observers (MMO), and marine mammal tagging. The techniques selected for the NWTRC will be primarily focuses on providing additional data for study questions 2, 3, and 4.

In addition to the U.S. Pacific Fleet funded initiative, the Chief of Naval Operations (CNO) Environmental Readiness Division and the Office of Naval Research (ONR) have developed a coordinated Science & Technology and Research & Development program focused on marine mammals and sound. Total investment in this program from 2004-2008 was $100M. FY09 funding was $22 million. Continued funding at levels greater than $14 million is foreseen in subsequent years (>2010).

Table ES-1. Summary of proposed monitoring studies and level of effort in support of the NWTRC Monitoring Plan.

STUDY 2 (geographic redistribution)									
	FY10	ADAPTIVE MANAGEMENT REASSESSMENT (AMR)	FY11	AMR	FY12	AMR	FY13	AMR	FY14
Passive Acoustics Monitoring (PAM)	Deploy a minimum of two passive acoustic monitoring devices; conduct data analysis as available		To be determined (TBD) pending AMR review		TBD pending AMR review		TBD pending AMR review		TBD pending AMR review
Marine Mammal Tagging	Conduct opportunistic marine mammal or sea turtle tagging		To be determined (TBD) pending AMR review		TBD pending AMR review		TBD pending AMR review		TBD pending AMR review
STUDY 3, 4 (exposures and behavioral responses)									
Passive Acoustics Monitoring (PAM)	Conduct data analysis from buoys deployed for Study 2	MANAGEMENT REASSESSME	To be determined (TBD) pending AMR review	AMR		AMR		AMR	
Marine Mammal Tagging	Conduct opportunistic marine mammal or sea turtle tagging		To be determined (TBD) pending AMR review		To be determined (TBD) pending AMR review		To be determined (TBD) pending AMR review		To be determined (TBD) pending AMR review
FY Commitment:	**Navy FY10 commitment:** - Deploy a minimum of two (2) passive acoustic monitoring devices - Attempt to deploy opportunistically deploy marine mammal or sea turtle tags Other organization FY10 commitment:		**Navy FY11 commitment:** To be determined (TBD) pending AMR review Other organization FY11 commitment:		**Navy FY12 commitment:** To be determined (TBD) pending AMR review Other organization FY12 commitment:		**Navy FY13 commitment:** To be determined (TBD) pending AMR review Other organization FY13 commitment:		**Navy FY14 commitment:** To be determined (TBD) pending AMR review Other organization FY14 commitment:

Table ES-2. Breakdown of monitoring elements by NMFS research objectives.

Monitoring element	NMFS research objectives				
	Q1 MFAS exposure assessment	**Q2** Geographical redistribution	**Q3** MFAS behavioral response	**Q4** Explosive exposure assessment	**Q5** Mitigation effectiveness
Aerial Survey	√		√	√	√
Marine Mammal Observers (MMO)	√		√	√	√
Vessel Survey	√		√	√	
Tagging- Satellite Tags	√	√	√		C
Tagging- Acoustic Tags	√		√		C
Passive Acoustics Monitoring (PAM)	C	√	C	C	C
Other Technology / Technique	TBD	TBD	TBD	TBD	TBD

√ = primary Plan support

C = contributory support

TBD = to be determined in future iterations of the Plan

Q1 = Question 1 MFAS exposure assessment: Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

Q2 = Question 2 Geographical redistribution: If marine mammals and sea turtles are exposed to MFAS in NWTRC, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

Q3 = Question 3 MFAS behavioral response: If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?

Q4 = Question 4 Explosive exposure assessment: What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

Q5 = Question 5 Mitigation effectiveness: Is the Navy's suite of mitigation measures for MFAS and explosives (e.g., PMAP, major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

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LIST OF ACRONYMNS

AFAST	Atlantic Fleet Active Sonar Training Range
AMR	Adaptive Management Review
ARP	acoustic recording package
ATOC	Acoustic Thermometry of Ocean Climate
CNES	Centre National d'Etudes Spatiales
CNO	Chief of Naval Operations
DoD	Department of Defense
DEIS	Draft Environmental Impact Statement
DOEIS	Draft Overseas Environmental Impact Statement
DoN	Department of the Navy
DTAG	digital acoustic recording tag
ESA	Endangered Species Act
FY	fiscal year
HARP	high-frequency acoustic recording package
HFAS	high-frequency active sonar
HQ	headquarters
HRC	Hawaii Range Complex
ICMP	Integrated Comprehensive Monitoring Program
ITA	Incidental Take Authorization
LOA	Letter of Authorization
MFAS	mid-frequency active sonar
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NWTRC	Northwest Training Range Complex
ONR	Office of Naval Research
PAM	passive acoustic monitoring
PMAP	Protective Measures Assessment Protocol
POES	Polar-orbiting Operational Environmental Satellites
PTS	permanent threshold shift
R&D	research and development
SOCAL	Southern California
SOP	standard operating procedure
SPORTS	Sonar Positional Reporting System
SPOT	Smart Position or Temperature Transmitting Tag
SURTASS	Surveillance Towed Array Sensor System
TOPP	tagging of pelagic predators
TTS	temporary threshold shift

INTRODUCTION

The U.S. Navy has developed this Northwest Training Range Complex (NWTRC) (**Figure 1**) Monitoring Plan to provide marine mammal and sea turtle monitoring as required under the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973.

In order to issue an Incidental Take Authorization (ITA) for an activity, Section 101(a) (5) (a) of the MMPA states that National Marine Fisheries Service (NOAA/NMFS) must set forth "*requirements pertaining to the monitoring and reporting of such taking*". The MMPA implementing regulations at 50 CFR Section 216.104 (a) (13) note that requests for Letters of Authorization (LOAs) must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present (NOAA/NMFS, 2005).

While the Endangered Species Act (ESA) does not have specific monitoring requirements, recent Biological Opinions issued by National Marine Fisheries Service (NMFS) have included terms and conditions requiring the Navy to develop a monitoring program.

Additional Navy funded research and development (R&D) studies and ancillary research collaborations with academia and other institutions will be integrated as possible to enhance the available data, and will be used in part to address objectives of a larger Navy-wide initiative discussed in this Plan. Lastly, as an adaptive management strategy, the NWTRC Monitoring Plan will integrate elements from Navy-wide marine mammal research into the regional monitoring and data analysis proposed in this Plan when new technologies and techniques become available.

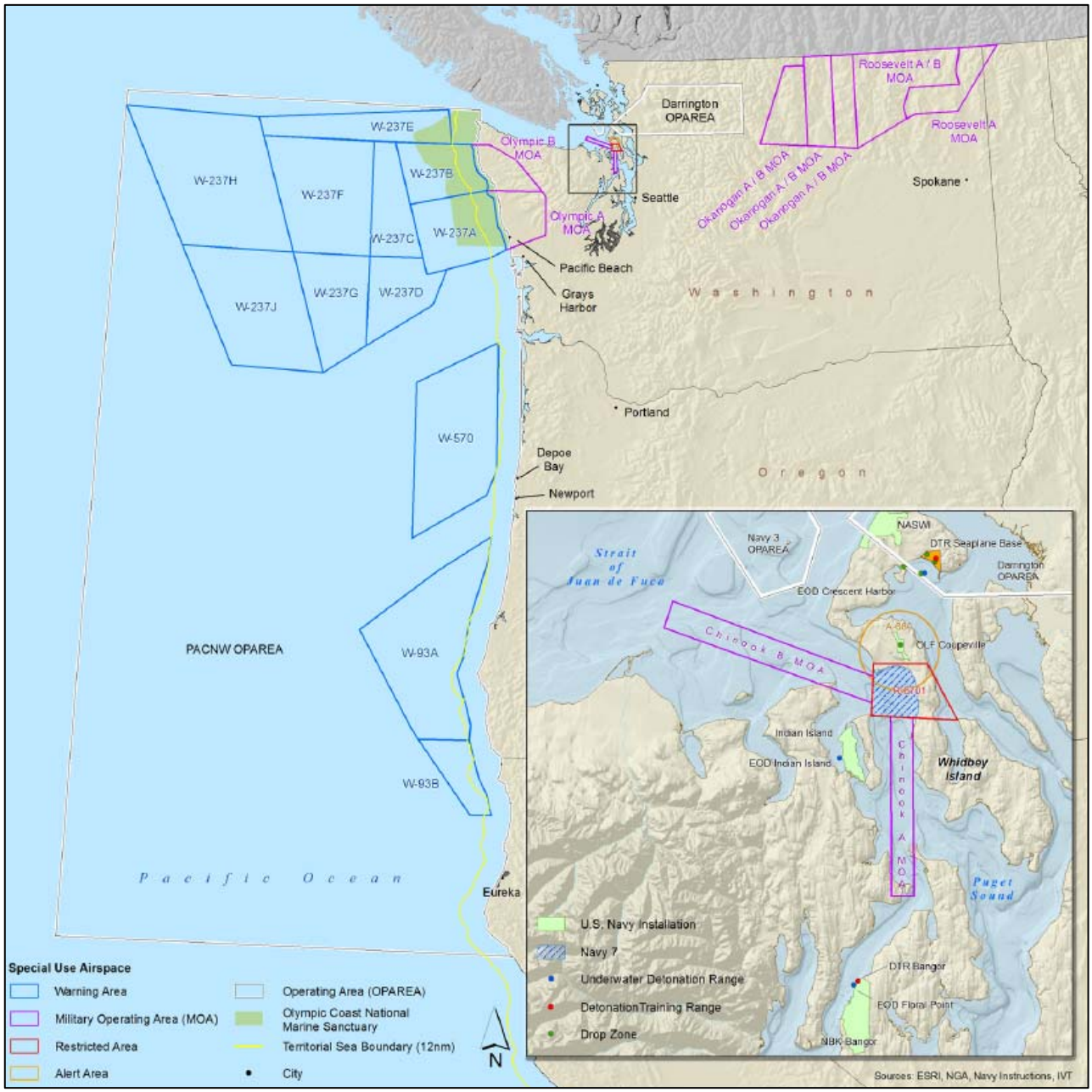

Figure 1. Northwest Training Range Complex.

(From DoN, 2008)

NAVY-WIDE INTEGRATED COMPREHENSIVE MONITORING PROGRAM (ICMP)

The Integrated Comprehensive Monitoring Program (ICMP) is Navy-wide and will provide an overarching structure and coordination that compiles data from all Navy range specific monitoring plans (**Figure 2**).

In addition to the NWTRC monitoring plan, a number of other Navy range complex monitoring plans are being developed for protected marine species, primarily marine mammals and sea turtles, as part of the environmental planning and regulatory compliance process associated with a variety of training actions in those regions. Goals of these monitoring plans are to assess the impacts of training activities on marine species and effectiveness of the Navy's current mitigation practices. Ranges with the largest amount of operations will be prioritized for monitoring based on availability of both funding and scientific resources. These include the Atlantic Fleet Active Sonar Training Range (AFAST), Hawaii Range Complex (HRC), and Southern California (SOCAL) Range Complex.

The NWTRC plan is one component of the ICMP and the studies outlined here will also be implemented in various combinations within other range complexes (**Figure 2**). The overall objective of the ICMP is to assimilate relevant data collected across Navy range complexes in order to answer questions pertaining to the impact of mid-frequency active sonar (MFAS) and underwater explosive detonation on marine mammals and sea turtles.

The primary objectives of the ICMP are to:

- Monitor and assess the effects or lack of effects of Navy activities on marine species (marine mammals, sea turtles);
- Ensure that data collected at multiple locations is collected in a manner that allows comparison between and among different geographical locations;
- Assess the efficacy and practicality of monitoring and mitigation techniques;
- Add to the overall knowledgebase of marine species, and the effects or lack of effects of Navy activities on marine species.

Operational components of the ICMP are still in development and will be finalized after by October 2009. These include defining organizational responsibilities including flow diagrams of Navy funding, program coordination, and oversight responsibilities; identifying optimum monitoring strategies; identifying region specific monitoring that has applicability for all Navy ranges; seeking collaboration with non-Navy government and academic scientists in monitoring review via an "expert team" concept; and defining appropriate level of statistical analysis and data set management leveraged across multiple Range Complex Monitoring Plans. Working toward an approach that allows data to be compared across Range Complex and identifying the appropriate level of statistical power required to address basic monitoring plan research objects, along with selecting the best analysis strategy, is a critical short term task of the ICMP.

Given the relatively new direction and design of the Navy-wide ICMP, specific details of the ICMP will be promulgated as they are finalized in a separate report from the current range complex monitoring plans. During the Adaptive Management Reassessment of the NWTRC Monitoring Plan (discussed later in this report), Plan monitoring elements may be adjusted based on direction of the ICMP and with concurrence of NMFS.

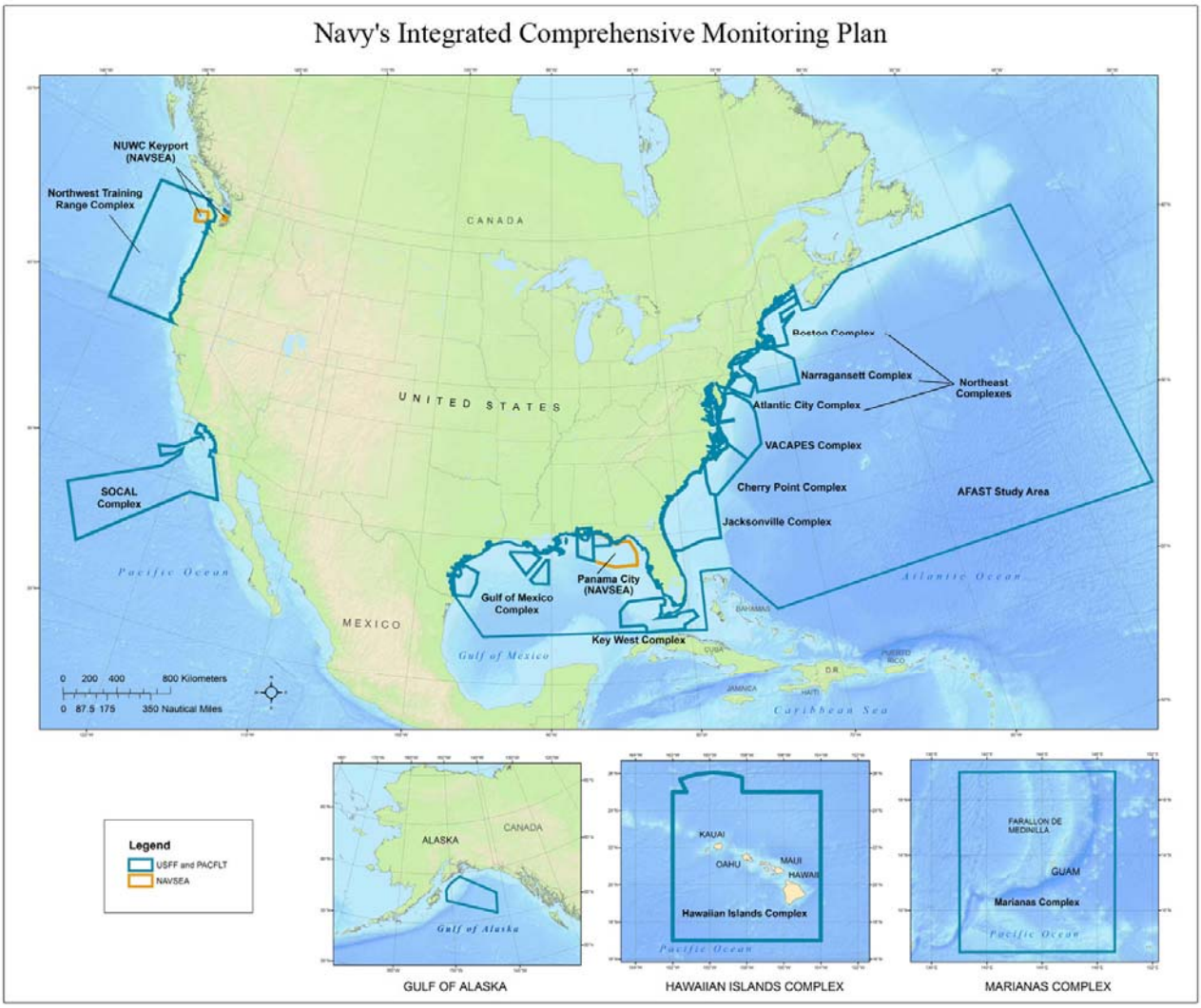

Figure 2. Integrated Comprehensive Monitoring Plan – Navy-wide Map of Ranges where data collection is expected to occur.

Details to be determined as compliance documents are finalized

NWTRC MONITORING PLAN

Monitoring Plan Objectives

To accomplish these monitoring goals, the Navy will use similar methods of implementation and data analysis which have demonstrated success in comparable monitoring programs studying the effects of anthropogenic sound on marine animals. To this end, the Navy in consultation with the National Marine Fisheries Service (NMFS) designed a series of focused "study questions" to gather data in various combination within the Navy's range complexes to address:

1. Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?
2. If marine mammals and sea turtles are exposed to MFAS in NWTRC, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?
3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?
4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?
5. Is the Navy's suite of mitigation measures for MFAS and explosives [e.g., Protective Measures Assessment Protocol (PMAP)], major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

Given the larger scope of training events within other Navy range complexes as compared to NWTRC, not every one of these original five study questions will be address within NWTRC (**Tables ES-1** and **ES-2**). Rather, data collected from NWTRC monitoring will be used to supplement a consolidate range complex marine mammal monitoring report incorporating data from the Atlantic Fleet Active Sonar Training Range (AFAST), Hawaii Range Complex (HRC), NWTRC, and Southern California (SOCAL) Range Complex.

To this end, monitoring techniques for the NWTRC will be focused to address:

2. If marine mammals and sea turtles are exposed to MFAS in NWTRC, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?
3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?
4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

Marine Species Under Consideration

There are 41 potential marine mammal species or separate stocks with possible or confirmed occurrence in the marine waters off Southern California and within the NWTRC. There are 34 cetacean species (whales, dolphins, and porpoises), six pinnipeds (sea lions, fur seals and true seals) and one sea otter species. **Appendix A Table A-1** has marine mammal species with possible occurrence within the NWTRC.

There are several sources of information on Pacific Northwest marine mammals and sea turtles, including the NMFS Stock Assessment Reports for marine mammals, and the Navy's Northwest Training Range Complex Draft Environmental Impact Statement (DEIS)\Draft Overseas Environmental Impact Statement (DOEIS) (DoN, 2008).

The NMFS U.S. Pacific Stock Assessment Reports are prepared annually and available at:

http://www.nmfs.noaa.gov/pr/sars/

The NWTRC DEIS\DOEIS also contains a summary of the scientific literature on animal distribution and likely occurrence within the Pacific Northwest marine waters (DoN, 2008).

This NWTRC Monitoring Plan has been designed to attempt gathering data on all species of marine mammals and sea turtles observed in the NWTRC study area. However, the Navy will prioritize monitoring efforts for species based on regulatory requirement due to ESA-listing, and on beaked whale species where MFAS use and strandings have been linked in certain circumstances. Of note, all of the beaked whale strandings and association with MFAS have been in specific geographic locations of the Atlantic Ocean (Bahamas, Canary Islands) and Mediterranean Sea (Greece). There have been no beaked whale atypical mass strandings associated with MFAS use on U.S. Navy Range Complexes within the Atlantic or Pacific. A detailed discussion on marine mammal stranding is contained in the NWTRC DEIS\DOEIS (DoN, 2008).

Therefore, based on the requirements listed above, species for study within the NWTRC Monitoring Plan that regularly occur within NWTRC will be prioritized for research as follows:

- **Beaked whale species** (Cuvier's beaked whale, Baird's beaked whale, other Mesoplodon species)
- **ESA-listed species** (blue whale, fin whale, humpback whale, sei whale, sperm whale, Southern Resident killer whale, and Stellar sea lion)
- **Killer whale** (Eastern North Pacific Offshore stock,)
- **Harbor porpoise**

The Plan recognizes that deep diving and cryptic species of marine mammals such as beaked whales, and sperm whales, may have low probability of visual detection (Barlow and Gisiner, 2006). Therefore, methods may be utilized to address this issue (e.g., passive acoustic monitoring, animal tagging).

OVERVIEW OF MONITORING PLAN RESEARCH ELEMENTS

Each monitoring technique has advantages and disadvantages that vary temporally and spatially, as well as support one particular study objective better than another (**Table ES-2**). The Navy intends to use a combination of techniques so that detection and observation of marine animals is maximized, and meaningful information can be derived to answer the research objectives described previously.

Monitoring methods initially proposed for the NWTRC starting in February of 2010 include a combination of the following research elements designed to support both Range Complex specific monitoring, and contribute information to the ICMP. These research elements include:

- Passive Acoustic Monitoring (PAM)
- Marine mammal tagging (opportunistically as available)

Passive Acoustic Monitoring (PAM)

There are both benefits and limitations to passive acoustic monitoring as discussed in Mellinger and Barlow (2003) and Mellinger et al. (2007). PAM allows detection of marine mammals that may not be seen during a visual survey, and monitoring of vocalization/echolocation rates before, during, and after Navy training events. When interpreting data collected from PAM, it should be noted that species specific results must be viewed with caution because not all animals within a given population may be vocalizing, or may only vocalize only under certain conditions (Mellinger et al., 2007; Oleson et al., 2007a, 2007b; ONR, 2007; Oleson et al., 2008).

Deployable acoustic recording packages (ARP) may offer the first immediately available tools (see Newcomb et al., 2002; Hildebrand, 2005; Hildebrand, 2007; Wiggins and Hildebrand, 2007; Lammers et al., 2008, Oleson et al. 2008). Other acoustic monitoring buoy types will also be considered for deployment as well (Lammers et al., 2005). The entire suite of PAM tools, both bottom-mounted ARPs, stationary surface sonobuoys, towed passive acoustic arrays, and other technology if available, will be investigated for applicability and affordability within the NWTRC Monitoring Plan.

At this preliminary stage, no particular technique is immediately preferred, but rather a flexible multi-tool approach is initially envisioned. As the Plan progresses within the first year and experience gained within NWTRC, either through direct measurement of results, review of technical PAM specifications, and from guidance of subject matter experts within the field, future NWTRC monitoring may include a smaller sub-set of PAM devices.

PAM in the NWTRC will be used to detect, locate, and potentially track vocalizing marine mammals, as well as provide seasonal estimates of presence/absence. The exact number of buoys needed to adequately characterize an area is under review. Buoys will be set on a duty cycle that maximizes battery power, data storage space, and provides adequate sampling. If Navy funding is available and additional buoys deemed necessary after consultation with NMFS and regional scientists, then potentially additional buoys may be considered. Another PAM buoy under consideration are pop-up buoys (or similar buoys) to be used to monitor specific areas for periods of time before, during, and after training events in conjunction with other monitoring efforts when possible. The buoys will be distributed in an array to facilitate data collection on geographical movements; however, the exact placement of the buoys each year will be determined using operational guidance to maximize the likelihood of capturing data during training events. These buoys will be left in place for a long enough duration that data are collected both during and outside of training events. All passive acoustic recording packages will be set on a duty cycle to provide appropriate sampling coverage and maximize battery power and data storage space. Buoys will be retrieved as required for maintenance and downloading of data. Autonomous acoustic recording buoys will provide long term, daily information on the presence and absence of marine mammals and their movements through an area (Mellinger and Barlow, 2003; Oswald et al., 2003; Melliger et al., 2007, Oleson et al., 2008). Acoustic data will be collected according to standard and accepted passive acoustic monitoring protocols (NMFS 2008 Passive Acoustic guidelines).

Previous Navy-funded Pacific Northwest PAM

As discussed in more detail in **Appendix B**, the Navy has funded the deployment of previous PAM in the Pacific Northwest from 2004-2009 (Oleson et al. 2008). Example data analysis as contained in Oleson et al. (2008) is shown in **Figures 3-5**.

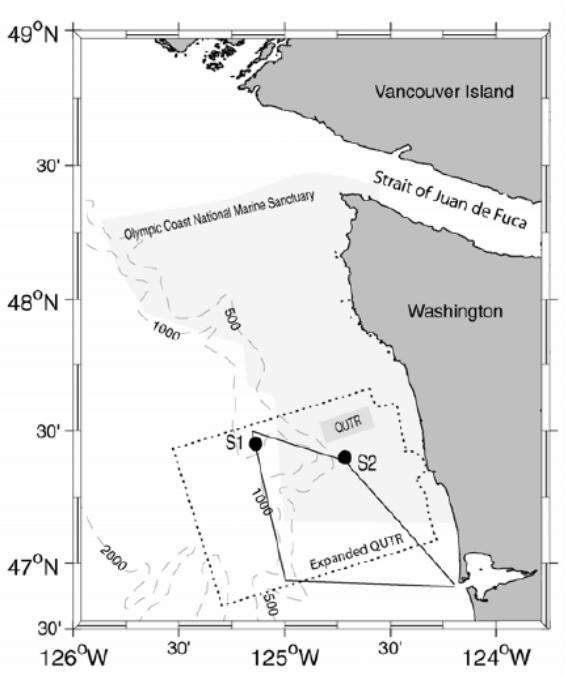

Figure 3. Locations of two High-frequency Acoustic Recording Packages, S1 and S2, and the primary track for monthly visual surveys (solid line) from Westport Harbor, WA from 2004 to 2007.

(from Oleson et al. 2008)

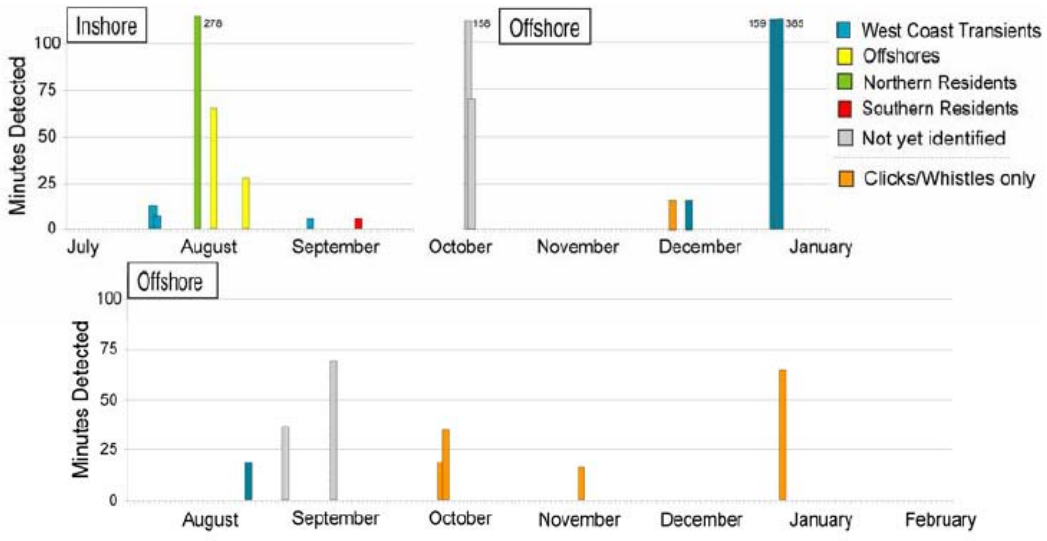

Figure 4. Killer whale occurrence PAM by eco-type from July 2004 to February 2006.

All four populations of killer whale known to occur in this region have been recorded to date, including Northern and Southern Residents. The upper panels include recordings from S1 and S2 extending from July 2004 to January 2005 (from Oleson et al. 2008). The lower panel represents recordings solely from S1 and extends from July 2005 to February 2006.

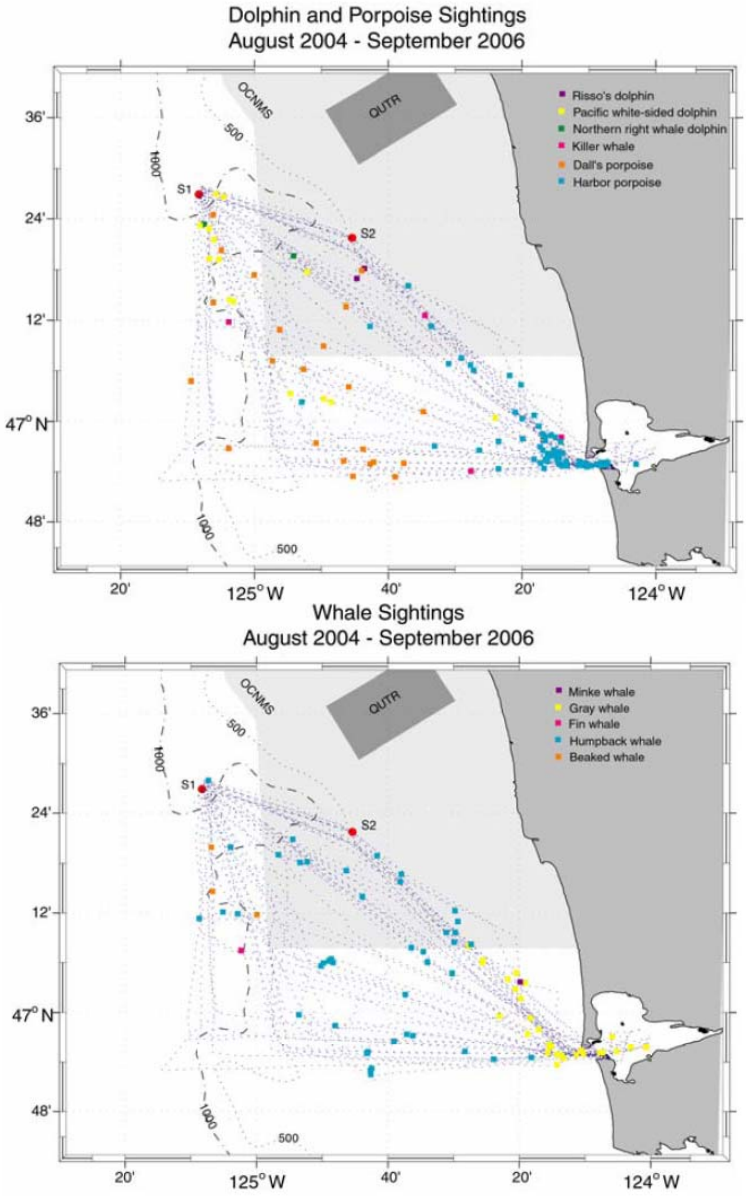

Figure 5. Dolphin and porpoise (top panel) and large whale (bottom) sightings during visual surveys since August 2004.

Dall's and harbor porpoise are common in all months, the remaining delphinids have been seen on very few surveys, and primarily during the summer. Humpback whales are the most common large whale, though Gray whales are also common in winter and spring. Beaked whales have been seen on three occasions along the shelf edge (from Oleson et al., 2008).

Marine Mammal Tagging

Technological advancements in recent years now provide opportunity for data collection by deploying tags on individual marine mammals (Mate et al., 1999; Baird et al., 2006; Tyack, 2007; Baird, et al., 2008; Calambokidis et al., 2008). Individuals can be tracked using VHF radio or satellite tags. These types of tags, as well as acoustic recording tags that provide more discreet information about pitch, roll, vertical and horizontal movement, can provide significant new information about animal movement and habitat use. This tool is especially useful when deployed on medium-sized, difficult-to-observe and deep-diving target species such as beaked whales (Zimmer et al., 2005; Tyack, 2007, Johnson et al., 2008). To date, some tag attachments are lasting in excess of 60 days (Baird, pers. comm. 2008). A variety of long and short term tags will be used to obtain a broad-scale data set. Effort will also be given to coordinate with ongoing marine mammal tagging efforts in the NWTRC study area for baleen whale species [i.e., Tagging of Pacific Predators (TOPP) available at: http://www.topp.org]. Tagging of Pacific Predators began in 2000 as one of 17 projects of the Census of Marine Life, a 10-year, 80-nation endeavor to assess and explain the diversity and abundance of life in the oceans. NOAA's Pacific Fisheries Ecosystems Lab, Stanford's Hopkins Marine Lab, and University of California, Santa Cruz's Long Marine Laboratory manage the program. The Navy's ONR already provides funding for marine mammal tag development and improvement.

In addition to baleen whale tagging already being conducted in Central and Southern California, the Navy will directly fund academic researchers in a program to tag whale species of interest recommended by researchers within NWTRC. This program is in an initial planning phase and will be integrated as the NWTRC monitoring plan matures. As was the case for PAM, a toolkit of applicable tag types will be reviewed. Examples of tags include retrievable Digital Acoustic Recording Tag (DTAG) which is a short-term tag (hours-to-days) that can record short term animal movement (diving profiles, swimming speed, depth), exposure to underwater sound, and potential behavioral reactions; or one of a series of satellite position tags that can provide medium to longer term indication of animal movement over time. Another tag successfully used in NWTRC by academic and Navy researchers has been satellite Argos tags. The Argos program is administered under a joint agreement between NOAA and the French space agency, Centre National d'Etudes Spatiales (CNES). The system consists of in-situ data collection platforms equipped with sensors and transmitters and the Argos instrument aboard the NOAA Polar-orbiting Operational Environmental Satellites (POES) (http://noaasis.noaa.gov/ARGOS/). Argos tags can be attached by a dorsal fin dart and can remain attached for over 30 days (Schorr et al., 2007). Another example of a long term tags, discussed on the TOPP web site, is the Smart Position or Temperature Transmitting Tag (SPOT) which has a potential lifespan of two years. Species will be tagged opportunistically; however the focus will be on cryptic and deep diving species such as beaked, or sperm whales that have the lowest rates of detectability in visual surveys (Barlow and Gisiner, 2006). Other tag types will be considered as more information becomes available.

Results from tagging will be examined annually to assess the effectiveness of this technique.

OTHER POTENTIAL MONITORING ELEMENTS FOR FUTURE CONSIDERATION

There may be a number of potential additional marine mammal monitoring techniques, or variations of those already described, that could be attempted under this Plan. Future modifications to the NWTRC Monitoring Plan may include integration of additional marine mammal monitoring techniques and research as either new technology or new information becomes available. The previously discussed list of elements is based on initial identification of the research questions promulgated by NMFS and subsequent dialog on best immediate techniques to attempt at the outset of this Plan (>Feb 2010) based on past non-integrated monitoring, and regional availability.

As part of future dialog to begin in the summer of 2009 with Northwest Pacific NMFS marine mammal scientists, academic scientists, and other subject matter experts with extensive field monitoring experience, the Navy will continually solicit input and recommendations to this Plan. An annual formal review with NMFS is being proposed at the end of each year's monitoring to capture lessons learned, and seek concurrence as to the best mix of monitoring techniques to employ in the next year's sampling based on scientific merit, applicability to the direct research questions posed in this Plan, and logistic and economic feasibility (**Table ES-1**). As additional recommendations are made from the Navy's ICMP as it develops, these too will be integrated into future NWTRC monitoring.

MONITORING PLAN STUDY DESCRIPTIONS

The implementation of various NWTRC specific studies and proposed hour goal for conducting these monitoring studies are shown in **Table ES-1**. The hours shown are actual study hours or other metrics of accomplishment.

Specific areas within NWTRC have been deemed focus areas based on either past marine mammal surveys within that area, or lack of marine mammal survey information. **Figure 4** shows the preliminary areas of monitoring interest within the NWTRC and represent areas accessible enough for the various research elements discussed in this Plan. These nominated research areas, however, do not preclude monitoring in other areas of the NWTRC, but are intended to designation sub-regions within NWTRC that will have initial prioritization. The designation of the most appropriate monitoring sub-areas will be reviewed at the end of each monitoring year as part of an adaptive management approach based on results for that year's monitoring.

As described later in this Plan, at the end of each monitoring and reporting year, a review of monitoring results, expectations, and fit in answering the Plan's overall objectives will be conducted, termed an Adaptive Management Review (AMR).

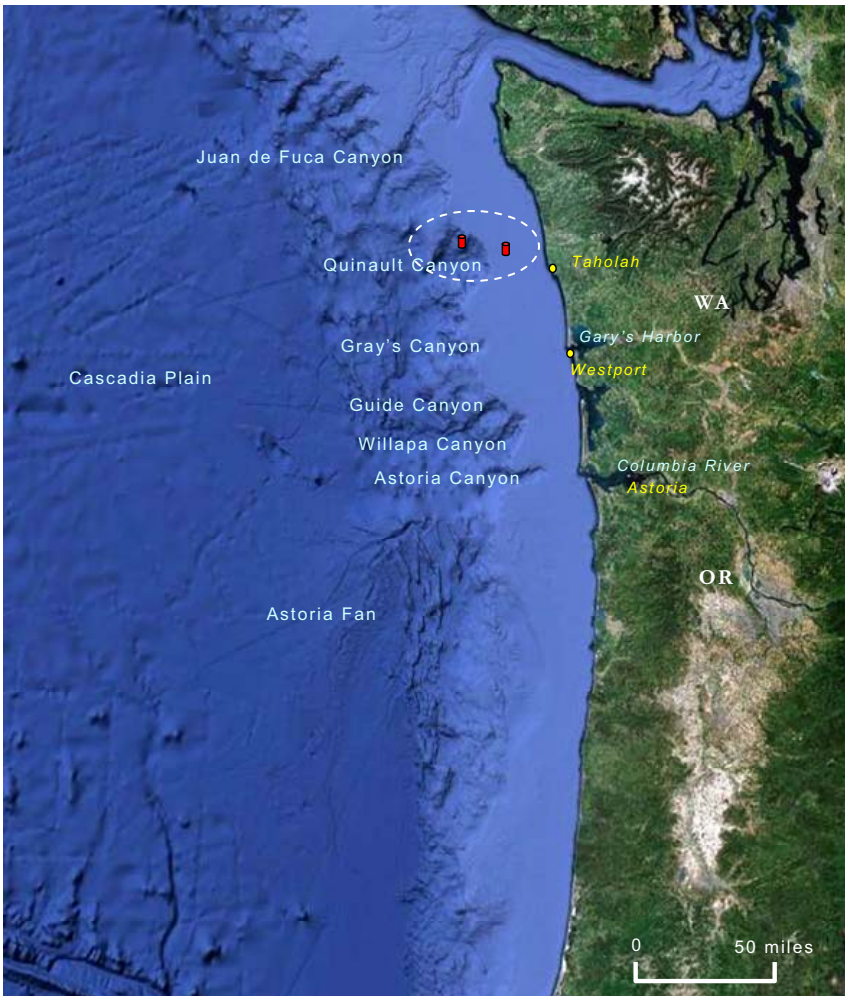

Figure 6. Proposed region within the Pacific Northwest proposed as initial focus area for the NWTRC Monitoring Plan.

Red cylinders are approximate locations of previous Navy funded PAM devices. Area(s) actually monitored depends on individual survey design. Monitoring could occur in any particular combination of areas.

STUDY 2: IF MARINE MAMMALS AND SEA TURTLES ARE EXPOSED TO MFAS IN THE NWTRC, DO THEY REDISTRIBUTE GEOGRAPHICALLY AS A RESULT OF CONTINUED EXPOSURE? IF SO, HOW LONG DOES THE REDISTRIBUTION LAST?

Methods- In order to address this question, there is a need to detect marine mammals and sea turtles not only at the surface, but to the extent possible in the water column. To this effect, a combination of PAM, and tagging is proposed for Study 2.

PAM- Temporary PAM buoys can be used to track the presence and absence of vocalizing marine mammals over both short (hours-days) and long time scales (weeks-months). The exact number of buoys above two needed to adequately characterize an area is under review and will be promulgated as a separate study plan. Depending on PAM location in relation to training events, data from monitoring buoys might be used to assess potential sound exposure levels based on receive levels recorded by the buoys. The extent of actual exposure is an extrapolation of potential exposure between the source and the buoy, but is not an exact measure of the actual sound level to which an individual marine mammal was actually exposed.

Marine mammal tagging (Beaked whale, killer whale, sperm whale, or surrogate species animal tagging)- Attempts to tag suitable animals will be conducted prior to a given Navy event, allowing animals the opportunity to distribute naturally prior to any potential immediate exposure to training activities. Tags shall be applied in a geographical area within NWTRC that is likely to be transited by Navy vessels during the training event. The goal of the tagging effort is to examine spatial distribution of animals before, during and after a training event; as well as potential long-term habitat associations and distributions independent of Navy training events. It should be cautioned that finding, approaching, and tagging these rather cryptic species is a very difficult process, and successful tag attachment can not be guaranteed.

STUDY 3: IF MARINE MAMMALS AND SEA TURTLES ARE EXPOSED TO MFAS, WHAT ARE THEIR BEHAVIORAL RESPONSES TO VARIOUS LEVELS?

Methods- Documenting known at-sea behavioral reactions of marine mammal to military sonar and explosives is complicated by lack of information and direct observations of cause-and-effects. Any particular reaction is likely to be conditional on the species in question, and a host of other factors such as feeding status, breeding status, time of day, overall health, and other issues. In order to address this question, there is a need to assess whether marine mammals and sea turtles are not only at the surface, but in the water column where they could be potentially exposed to sonar. If animals are not present, then there would be no exposure and no possibility of behavioral reaction, or lack of reaction. Within the NWTRC, therefore, a combination of PAM and tagging will be used for Study 3.

Passive Acoustic Monitoring- Opportunistic data collected as part of PAM in the NWTRC (described in Study 2) may offer insights to animal vocalization rates, potential dive pattern, and possible movement in relation to Navy training events. This field is relatively new in terms of defining behavioral context of vocalization and is dependent of knowing marine mammal vocalization patterns when no Navy operations are present.

STUDY 4: WHAT ARE THE BEHAVIORAL RESPONSES OF MARINE MAMMALS AND SEA TURTLES THAT ARE EXPOSED TO EXPLOSIVES?

Methods- Documenting known at-sea behavioral reactions of marine mammal to underwater explosion that occur on relatively short time scales is complicated by lack of information and direct observations of cause-and-effects. Any particular reaction is likely to be conditional on the species in question, and a host of other factors such as feeding status, breeding status, time of day, overall health, and other issues. In order to address this question, there is a need to assess whether marine mammals and sea turtles are not only at the surface, but in the water column where they could be potentially exposed to underwater explosions. If animals are not present, then there would be no exposure and no possibility of behavioral reaction, or lack of reaction. Therefore, for this study, use of PAM will be attempted.

Passive Acoustic Monitoring- Opportunistic data collected as part of PAM in the NWTRC (described in Study 2) may offer insights to animal vocalization rates, potential dive pattern, and possible movement in relation to Navy training events. This field is relatively new in terms of defining behavioral context of vocalization and is dependent of knowing marine mammal vocalization patterns when no Navy operations are present.

IMPLEMENTATION – ANALYSIS – REPORTING

Worldwide, a suite of visual and acoustic monitoring techniques has been used to assess the effects of anthropogenic sound on marine mammals (Barlow and Gisiner, 2006). The NWTRC Monitoring Plan proposes monitoring goals that are unique with regard to their breadth as well as their focus on potential impacts of MFAS and underwater explosions on marine mammals and sea turtles. To accomplish these goals, the Navy will use similar methods of implementation and data analysis which have demonstrated success in comparable monitoring programs studying the effects of anthropogenic sound on marine animals.

NWTRC Monitoring Plan Implementation and Analysis

Contracted third party data collection will be collected by qualified, professional marine mammal and sea turtle biologists that are experts in their field. Researchers will provide annual reports to the Navy, however, this is expected to be an ongoing process with data collected, analyzed and interpreted over many years. It is not likely that firm conclusions can be drawn on most questions within a single year of monitoring effort due to the difficulty in achieving sufficient sample sizes for statistical analysis. The Navy will provide annual reports to NMFS headquarters (HQ) in fulfillment of the MMPA LOA requirements. The report will provide information on the amount and spatial/temporal distribution of monitoring effort as well as summaries of data collected and any preliminary results that may be available from analysis.

While the monitoring described in this plan represent the best estimate of availability, there may be instances within any given year where exercise schedules shift, survey crew availability becomes limited, or extreme weather precludes effective sampling. In case of monitoring delay based on these conditions, monitoring effort will be re-scheduled at the next available opportunity. In the event that a particular target exercise is not available within the remainder of a particular year, monitoring may have to be made up in a following year.

Table ES-1 provides detail about how the NWTRC Monitoring Plan will be implemented from 2010 to 2014. After the issuance of the LOA, implementation of this monitoring plan will commence in 2010 at which time monitoring will begin gradually and then ramp up in 2011. Many of the study hours may overlap when implemented, allowing for data to be collected for more than one study simultaneously.

The Navy will be investing significant funding and personnel towards this monitoring program and intends to conduct the research in a scientifically sound and robust manner. The Navy is committed to conducting research until the original program objectives have been answered to the satisfaction of both NMFS and Navy. Therefore, it is in the best interest of the Navy to choose studies wisely in each range complex that are the most likely to collect large data sets, and will enable the Navy and NMFS to answer required questions. Some field methods may be applied throughout Navy ranges, while other methodologies may be specially selected for one or two ranges that are most likely to produce the best quality data.

For the NWTRC Monitoring Plan, therefore, it is premature to dictate before data collection begins what sample size will be required from each species in each study. This is particularly true given that research will be conducted on a diversity of species. The NWTRC Plan, as written, covers research on the effects from MFAS and explosives on a diversity of mysticete and odonotocete species found in the NWTRC. This range of species will make each study unique in the sense of knowing when enough data have been collected. As a result, it may be prudent to initially focus some of the studies on prioritized species that are likely to provide more data collection opportunities and use those as representative species.

Using the Acoustic Thermometry of Ocean Climate (ATOC) and SURTASS Low-Frequency Active Sonar monitoring programs as a guideline for success (**Appendix A**), one thing becomes clear - the key to the success of the plan's execution and analysis is using scientific professionals that are the top of their field (Aburto et al., 1997; Au et al., 1997; Frankel and Clark, 1998 and 2000; NRC, 2000, 2003, 2005; Croll et al., 2001; ONR, 2001; Costa et al., 2003; Fristrup et al., 2003; Clark and Altman, 2006; Mobley, 2001, 2006). It's the Navy's intention that the NWTRC Monitoring Plan be implemented by a team of qualified, professional marine mammal and sea turtle biologists that are experts in their field. This team of experts will include statistical analysts to analyze data and make recommendations as to when they are beginning to see a pattern in the data and/or when the study designs need to be slightly altered for more robust data collection. This adaptive management process will provide a critical feedback loop to allow for adapting to

new methods and evolving methodology. The process will be transparent to the public in the sense of yearly reporting to NMFS under the MMPA permit as well as encouraging the scientific team to publish results as they become available.

Although it is not typically considered valid to combine data sets from various platforms, (e.g., shipboard and aerial surveys) this will need to occur in order to provide the best possible data coverage. Issues related to data compatibility will be confronted, given that the use of scientifically acceptable combinations of methods will be critical to accomplishing goals and objectives. Data collection methods will also be standardized to allow for comparison from ranges in different geographic locations. For example, as with the research programs described in **Appendix A**, it is suggested that data collected for the range complex plans will be assessed using a software program that can be custom designed (e.g., Noldus products, Cornell's Aardvark) to provide the framework for standardization of data collection and analysis between the different geographical regions. A data management system will be developed to assure standardized, quality data are collected towards meeting of the goals.

New technology and techniques will be incorporated as part of the Navy's adaptive management strategy. Adaptive measures and feedback from the experts will allow flexibility within a given year and/or within years so as to best achieve monitoring plan goals and take into consideration shifting demands, inclement weather and other unforeseen events. For example, flexibility is built in to monitor an alternate but equal training exercise within the year and/or in a following year in the instance an operational schedule changes, is delayed or cancelled. This flexibility ensures monitoring will occur under the best of circumstances and conditions.

In addition to the studies conducted under the NWTRC Monitoring Plan, the Navy intends to collaborate with other researchers in the Washington, Oregon, and California that are conducting complimentary research on this topic. Those studies will not replace the Navy's obligation under the NMFS LOA requirements, but will augment the resources provided to the Plan's specific questions.

ICMP and Relationship To NWTRC Monitoring Program

The ICMP is currently in development by the Navy. The program does not duplicate the NWTRC Monitoring Plan, instead it's intended to provide the overarching coordination that will support compilation of data from range-specific monitoring plans (e.g., NWTRC plan) as well as Navy funded R&D studies. The ICMP will coordinate the monitoring programs progress towards meeting its goals and develop a data management plan. A program review board is also being considered to provide additional guidance. The ICMP will be evaluated annually to provide a matrix for progress and goals for the following year, and will make recommendations on adaptive management for refinement and analysis of the monitoring methods.

Due to the complexity of the ICMP and large number of U.S. Navy Range Complexes and training events, the Navy is considering the dedication of a Program Manager to oversee the ICMP. Specific qualifications, roles and responsibilities are yet to be determined but may include the oversight and coordination of all range-complex monitoring plans.

Analysis And Reporting

The Navy is currently working on the overarching structure and coordination (ICMP) that will, over time, compile data from both range-specific monitoring plans (e.g., NWTRC monitoring plan) as well as Navy funded research and development (R&D) studies. The analysis protocols are still in development phase at this time. However, data collection methods will be standardized to allow for comparison from ranges in different geographic locations. The sampling scheme for the program will be developed so that the results are scientifically defensible. For example, since all data will be collected using a behavioral program like Noldus, data collection will be standardized between the different geographical regions. A data management system will be developed to assure standardized, quality data are collected towards meeting of the goals. The data management plan shall provide standard marine species sighting forms for Navy lookouts and biologists to use to standardize data collection. Annual reports summarizing effort, analysis and results will be compiled and submitted to NMFS. These reports will allow the Navy and NMFS to assess and adaptively manage the Navy's monitoring effort to more effectively answer the questions outlined above.

Data collection will begin after February 2010, when the NWTRC LOA is issued and the monitoring plan finalized (See **Table ES-1** for year by year implementation schedule). Data collected from the NWTRC monitoring plan will be added to a Navy wide analysis of monitoring from other permitted Navy range complexes via the ICMP. All available data will be included in Navy's annual report and individual exercise reports for the NWTRC as detailed in the requirements specified in the NMFS MMPA LOA. The Navy's reports will provide information on the amount and spatial/temporal distribution of monitoring effort as well as summaries of data collected and any preliminary results that may be available from analysis. This also includes an evaluation of the effectiveness of any given element within the NWTRC monitoring program. All subsequent analysis shall be completed in time for Navy's five year report to NMFS.

All data will be considered Navy and NMFS proprietary at least throughout the five year period of the LOA. Annual Reports, associated data, and any conclusions based on data from this Monitoring Plan cannot be published or used by non-Navy or non-NMFS individuals or organizations without the written consent of both the Director of NOAA and the Secretary of the Navy or their designee.

ADAPTIVE MANAGEMENT

Background

NMFS acknowledges that the NWTRC Monitoring Plan plan will enhance the understanding of how MFAS/HFAS or underwater detonations (as well as other environmental conditions) may, or may not, be associated with marine mammal injury or strandings. Additionally, NMFS also points out that information gained from the investigations associated with this Plan may be used in the adaptive management of mitigation or monitoring measures in subsequent LOAs, if appropriate.

Adaptive management is an iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. Within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself. Adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable ecosystems (Williams el at., 2007). Adaptive management helps science managers maintain FLEXIBILTY in their decisions, knowing that uncertainties exist and provides managers the latitude to change direction; will improve UNDERSTANDING of ecological systems to achieve management objectives; and is about taking ACTION to improve progress towards desired outcomes (Williams et al., 2008). Further discussion of adaptive management in the natural resource community is available from the U.S. Department of Interior's Adaptive Management Guidelines: http://www.doi.gov/initiatives/AdaptiveManagement/index.html

The Navy's adative management of the NWTRC Monitoring Plan involves close coordination with NMFS to align marine mammal monitoring with the Plan's overall objectives as stated within earlier sections of the Plan. To recap, the objectives of the Navy's NWTRC Monitoring Plan are to determine:

1. Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

2. If marine mammals and sea turtles are exposed to MFAS in NWTRC, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?

4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

5. Is the Navy's suite of mitigation measures for MFAS and explosives (e.g., PMAP, major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

Adaptive Management Implementation

There are periodic exercise and annual reporting requirements contained in NMFS MMPA authorization associated with the NWTRC EIS\OEIS. Following the Navy's Annual Report to NMFS, the Navy will request specific written discussion from NMFS of NMFS's assessment of the Plan's past year results. The goal of this consultation and collaboration would be to determine if these research elements and associated results continue to meet the overall objectives of the Plan specific to the NWTRC. For instance, if one particilar research element does not provide direct or indirect support to one of the objectives listed above, then resources for future instances of that element could be re-directed to other research elements that do provide more support.

The actual Adaptive Management Reassessment (AMR) will be a multipart review. Initial accomplishments will be tabulated by Navy subject matter experts familiar with marine mammal monitoring. If available, collaberation with regional Southern California NMFS scientists, academic scientists, and other non-Navy subject matter experts will be informally sought. As of this time, there is no formal mechanism in which to compensate a non-Navy "expert team", but this is one goal for the ICMP to designated, structure, and potentially fund. The Navy will then consult with the NMFS Office of Protected Resources in discussion of lessons learned and recommended way forward for the next year's sampling effort.

Until at least one or two years worth of monitoring data are collected and analyzed both within the NWTRC and in context of the ICMP, it is premature to guess which, if any of the proposed elements contained in this Plan will provide the most scientifically valid information to address the objectives. Most likely it will be a combination of elements that will provide the best data in addressing MFAS and explosive effects or lack of effects on the marine mammals within the NWTRC. The original intent of this Monitoring Plan is to integrated into both the text discussions on research elements, and Table ES-1 allocation of effort, what is anticipated as being the best allocation of resources to address the Plan's objectives.

Proper application of the adaptive management concept will allow future adjustments to be made to the NWTRC Monitoring Plan that will enhance overall scientific conclusions, lead to better statistical approaches, integrate new technologices in marine mammal monitoring and detection, and provide a stronger foundation upon which to base mitigation and policy decisions. In addition, as part of the annual review, a more complete cost-benefit analysis can be presented based on actual monitoring cost by research element within NWTRC.

LITERATURE CITED

Au, W.W. L., P.E. Nachtigall, and J.L. Pawloski. 1997. Acoustic effects of the ATOC signal (75 Hz, 195 dB) on dolphins and whales. Journal of the Acoustical Society of America 101: 2973-2977.

Baird, R.W., G.S. Schorr, D.L. Webster, D.J. McSweeney, and S.D. Mahaffy. 2006. Studies of beaked whale diving behavior and odontocete stock structure in Hawai'i in March/April 2006. Report prepared under contract No. AB133F-06-CN-0053 to Cascadia Research from the Southwest Fisheries Science Center, NMFS, La Jolla, CA.

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(3):630-642.

Barlow, J. and R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management. 7:239-249.

Barlow, J. and K. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509–526.

Calambokidis, J., G.S. Schorr, G.H. Steiger, J. Francis, M. Bakhtiari, G. Marshall, E.M. Oleson, D. Gendron, and K. Robertson. 2008. Insights into the Underwater Diving, Feeding, and Calling Behavior of Blue Whales from a Suction-Cup- Attached Video-Imaging Tag (CRITTERCAM). Marine Technology Society Journal 41(4):19-29.

Clark C.W. and N.S. Altman 2006. Acoustic Detections of blue whale (*Balaenoptera musculus*) and fin whale (*Balaenoptera physalus*) sounds during a SURTASS LFA exercise. IEEE Journal of Oceanic Engineering, 311(1): pp 120-128.

Costa, D.P., D.E. Crocker, J. Gedamke, P.M. Webb, D.S. Houser, S.B. Blackwell, D. Waples, S.A. Hayes, and B.J. Le Boeuf. 2003. The effect of a low-frequency sound source (acoustic thermometry of the ocean climate) on the diving behavior of juvenile northern elephant seals, *Mirounga angustirostirs*. Journal of the Acoustical Society of America 113(2):1155-1165.

Cox T.M., T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Ranford, L. Crum, A. D'amico, G. D'spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. Macleod, P. Miller, S. Moore, D.C. Mountain., D. Palka:, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Meads, L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management. 7:177–187.

Croll, D.A., C.W. Clark, J. Calambokidis, W.T. Ellison and B.R. Tershy. 2001. Effect Of Anthropogenic Low-Frequency Noise On The foraging ecology of Balaenoptera whales. Animal Conservation 4: 13-27.

Deeck, V.B. 2006. Studying marine mammal cognition in the wild: a review of four decades of playback experiments. Aquatic Mammals 32(4):461-482.

DoN. 2008.Northwest Training Range Complex: Draft Environmental Impact Statement\Draft Overseas Environmental Impact Statement- December 2009. Department of the Navy.

Frankel, A.S. and C.W. Clark. 1998. Results of low-frequency playback of M-sequence noise to humpback whales, *Megaptera novaeangliae*, in Hawaii. Canadian Journal of Zoology 76:521-535.

Frankel, A.S. and C.W. Clark. 2000. Behavioral responses of humpback whales (*Megaptera novaeangliae*) to full-scale ATOC signals. Journal of the Acoustic Society of America 108(4):1930-1937.

Hildebrand, J. 2005. Marine Mammal acoustic monitoring and habitat investigation, Southern California Channel Island region- Final Report for ONR # N00014-01-D-0043 D12- July 2005. Prepared by: Marine Physical Laboratory, Scripps Institute of Oceanography. Prepared for: Office of Naval Research, Washington, D.C. 166 pp.

Hildebrand, J. 2007. Marine Mammal Acoustic Monitoring and Habitat Investigation, Southern California Offshore Region- Technical Report July 2006 - June 2007. Prepared by: Marine Physical Laboratory, Scripps Institute of Oceanography. Prepared: for Chief of Naval Operations, N45, Washington D.C. and Naval Post-Graduate School, Monterey, CA. NPS-OC-08-002. 42 pp.

Johnson, M., L.S. Hickmott, N. A. Soto, and P.T. Madsen. 2008. Echolocation behaviour adapted to prey in foraging Blainville's beaked whale (*Mesoplodon densirostris*). Proceedings of Royal Society London 275(1631):133-139.

Lammers, M.O., R.E. Brainard, W.W.L. Au, T.A. Mooney, and K. Wong. 2007. An ecological acoustic recorder (EAR) for long-term monitoring of biological and anthropogenic sounds on coral reefs and in nearby waters. Journal of the Acoustical Society of America. 123:1720-1728.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific blue whales during the feeding season off Southern California and their southern fall migration. Marine Mammal Science 15(4):1246-1257.

Mellinger, D.K. and J. Barlow. 2003. Future directions for acoustic marine mammal surveys: stock assessment and habitat use. NOAA OAR Special Report, NOAA/PMEL Contribution 2557. 37 pp.

Mellinger, D.K., K.M. Stafford, S.E. Moore, R.P. Dziak, and H. Matsumoto. 2007. An Overview of fixed passive acoustic observation methods for cetaceans. Oceanography 20(4):36-45.

Mobley, J.R., S.S. Spitz, and R. Grotefendt. 2001. Abundance of humpback whales in Hawaiian waters: Results of 1993-2000 aerial surveys. Report prepared for the Hawaii Department of Land and Natural Resources and the Hawaiian Islands Humpback Whale National Marine Sanctuary, NOAA, U.S. Department of Commerce. 26 pp.

Newcomb, J., R. Fisher, R. Field, G. Rayborn, S. Kuczaj, G. Ioup, J. Ioup, and A. Turgut. 2002. Measurements of Ambient Noise and Sperm Whale Vocalizations in the Northern Gulf of Mexico Using Near Bottom Hydrophones. IEEE Journal Of Oceanic Engineering:1365-1371.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2):81-115.

NRC. 2000. Marine mammals and low-frequency sound: Progress since 1994. National Research Council, National Academy Press, Washington, D.C.

NRC. 2003. Ocean noise and marine mammals. National Research Council, National Academies Press, Washington, D.C.

NRC. 2005. Marine Mammal Populations and Ocean Noise-Determining When Noise Causes Biologically Significant Effects. National Research Council, National Academies Press, Washington, D.C.

Oleson, E.M., J. Calambokidis, J. Barlow, J.A. Hildebrand. 2007a. Blue whale visual and acoustic encounter rates in the Southern California Bight. Marine Mammal Science 23(3): 574–597.

Oleson, E.M., J. Calambokidis, W.C. Burgess, M.A. McDonald, C.A. LeDuc, J.A. Hildebrand. 2007b. Behavioral context of call production by eastern North Pacific blue whales. Marine Ecology Progress Series 330: 269–284.

Oleson, E.M., J.A. Hildebrand, J. Calambokidis, G. Schorr, and E. Falcone. 2008. 2006 Progress Report on Acoustic and Visual Monitoring for Cetaceans along the Outer Washington Coast. Prepared for U.S. Navy. Naval Postgraduate School, Monterey, CA. NPS-OC-07-003. 30 pp.

ONR. 2001. Final environmental impact statement for the North Pacific Acoustic Laboratory, Volumes I and II. Office of Naval Research, Washington, DC.

ONR. 2007. 3rd International Workshop on the Detection and Classification of Marine Mammals Using Passive Acoustics 24 - 26 July 2007. Boston, MA. Office of Naval Research. 28 pp.

NMFS. 2008. Oregon, California and Washington Line-Transect Expedition (ORCAWALE)- NOAA marine mammal survey expedition scheduled to take place from 28 July – 01 Dec of 2008. http://swfsc.noaa.gov/textblock.aspx?Division=PRD&ParentMenuId=562&id=12718

Oswald, J.N., J. Barlow, and T.F. Norris. 2003. Acoustic identification of nine delphinid species in the eastern tropical Pacific Ocean. Marine Mammal Science. 19:20-37.

Schorr, G.S., R.W. Baird, D.L. Webster, D.J. McSweeney, M.B. Hanson, R.D. Andrews and J. Barlow. 2007. Spatial distribution of Blainville's beaked whales, Cuvier's beaked whales, and short-finned pilot whales in Hawai'i using dorsal fin-attached satellite and VHF tags: Implications for management and conservation. Presented at the 17th Biennial Conference on the Biology of Marine Mammals, Cape Town, South Africa, 2007 (unpublished).

Southall, B. L. 2008. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 411-521.

Tiemann, C.O., S.W. Martin, and J.R. Mobley, Jr. 2006. Aerial and Acoustic Marine Mammal Detection and Localization on Navy Ranges. IEEE Journal Of Oceanic Engineering 31(1):107-119.

Tyack, P. 2007. Acoustic Response and Detection of Marine Mammals Using an Advanced Digital Acoustic Recording Tag. Prepared by: Woods Hole Oceanographic Institute, Woods Hole, MA. Prepared for: Strategic Environmental Research and Development Program (SERDP), Washington, D.C. Final Technical Report March 2007. SERDP SI-1188. DACA72-01-C-0011.

Wiggins, S.M. and J.A. Hildebrand. 2007. High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. IEEE Symposium on Underwater Technology, Workshop on Scientific Use of Submarine Cables and Related Technologies. Pp. 551-557.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2007. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Zimmer, W.M.X., M.P. Johnson, P.T. Madsen, and P.L Tyack. 2005. Echolocation clicks of free-ranging Cuvier's beaked whales (*Ziphius cavirostris*). Journal of the Acoustic Society of America 117(6): 3919-3927.

APPENDIX A- COMMON MARINE MAMMAL SPECIES IN NWTRC

Table A-1. Summary of Marine Mammal Species in the Pacific Northwest.

Common Name	Stock	ESA/ MMPA Status	Population Trend	Occurrence	Designated Critical Habitat in NWTRC	Primary occurrence Warm Season May-Oct	Primary occurrence Cold Season Nov-Apr
ESA Listed							
Blue whale	Eastern North Pacific	E,D,S	May be increasing	Rare, all year	None	Yes	No
Fin whale	CA, OR, WA	E,D,S	May be increasing	Rare, all year	None	Yes	No
Humpback whale	Eastern North Pacific	E,D,S	Increasing	Rare, warm season	None	Yes	No
Killer whale	Eastern North Pacific-Southern Resident	E,D	Increasing	Infrequent	Puget Sound and vicinity	Yes	Yes
North Pacific right whale	Eastern North Pacific	E,D,S	Unknown	Very rare, warm season	None	Possible	No
Sei whale	Eastern North Pacific	E,D,S	May be increasing	Very rare, all season	None	Yes	No
Sperm whale	CA, OR, WA	E,D,S	Unknown	Uncommon, but expected	None	Yes	Yes
Stellar sea lion	Eastern North Pacific	T,D	Increasing	Uncommon	Rookeries in OR and CA	Yes	Yes
Sea otter	Washington	T, D	Increasing	Common, all year	None	Yes	Yes
Sea otter	California	T,D	Increasing	Common, all year	None	Yes	Yes

Common Name	Stock	ESA/ MMPA Status	Population Trend	Occurrence	Designated Critical Habitat in NWTRC	Primary occurrence Warm Season May-Oct	Primary occurrence Cold Season Nov-Apr
Non-ESA Listed							
Baird's beaked whale	CA, OR, WA	-	Unknown	Very rare, warm season	-	Yes	Yes
Bottlenose dolphin	CA, OR, WA Offshore	-	Stable	Very rare, extralimital	-	Yes	Yes
California sea lion	U.S.	-	Increasing	Common	-	Yes	Yes
Cuvier's beaked whale	CA, OR, WA	-	Unknown	Uncommon, but expected	-	Yes	Unknown
Dall's porpoise	CA, OR, WA	-	Unknown	Abundant	-	No	Yes
Dwarf sperm whale	CA, OR, WA	-	Unknown	Uncommon, warm season	-	Yes	Unknown
Gray whale	Eastern North Pacific	-	Increasing	Common, warm season	-	Yes	No
Harbor porpoise	WA inland waters	-	Stable	Common	-	Yes	Yes
Harbor porpoise	OR, WA Coast	-	Stable	Common	-	Yes	Yes
Harbor porpoise	Northern CA, Southern OR	-	Stable	Common	-	Yes	Yes
Harbor seal	Washington Inland waters	-	Increasing, approaching stable	Abundant year round	-	Yes	Yes
Harbor seal	OR and WA Coast	-	Increasing, approaching stable	Abundant year round	-	Yes	Yes
Hubb's beaked whale	CA, OR, WA	-	Unknown	Rage	-	Unknown	Unknown

Common Name	Stock	ESA/ MMPA Status	Population Trend	Occurrence	Designated Critical Habitat in NWTRC	Primary occurrence Warm Season May-Oct	Primary occurrence Cold Season Nov-Apr
Killer whale	Eastern North Pacific Offshore	-	Unknown	Uncommon, all year	-	Yes	Unknown
Killer whale	West Coast transient	-	Unknown	Uncommon, all year	-	Yes	Unknown
Minke whale	CA, OR, WA	-	No trends	Rare, all year	-	No	Yes
Northern elephant seal	CA Breeding	-	Increasing	Uncommon	-	Yes	Yes
Northern fur seal	San Miguel Island		Increasing	Common cold, uncommon warm	-	No	Yes
Northern right whale dolphin	CA, OR, WA	-	No trend	Common	-	Yes	Yes
Pacific white-sided dolphin	CA, OR, WA	-	No trend	Common, warm season	-	Yes	Yes
Risso's dolphin	CA, OR, WA	-	No trend	Uncommon	-	Yes	Yes
Short-beaked common dolphin	CA, OR, WA	-	No trend	Uncommon, warm season off CA	-	Yes	No
Short-finned pilot whale	CA, OR, WA	-	Unknown	Rare	-	Unknown	Unknown
Stejneger's beaked whale	CA, OR, WA	-	Unknown	Rare	-	Unknown	Unknown
Striped dolphin	CA, OR, WA	-	No trend	Very rare, off N. CA	-	Possible	No

ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; E= Endangered; D= Depleted; S= strategic stock under MMPS; T= Threatened
CA= California; OR= Oregon; WA= Washington

APPENDIX B- ADDITIONAL NAVY MARINE MAMMAL RESEARCH IN THE PACIFIC NORTHWEST

In August 2008, a new Navy oversight committee for Navy funded marine mammal research was formed by the Assistant Secretary of the Navy (Installations and Environment) and CNO N4. This oversight committee is call the Sonar and Living Marine Resources Research Oversight Group (SLMRROG). The goal of the SLMRROG is to identify Navy funded marine species research requirements, ensure research meets science and environmental reporting needs, solicit input from the greater marine mammal science community, and establish a consensus on prioritized research requirements. An existing CNO N45 and ONR coordinated Science & Technology and Research & Development program focused on marine mammals and sound for the past twenty years will fall under the SLMRROG umbrella.

Total investment in this program by CNO N45 and ONR Navy-wide has totaled $100M from 2004-2008, and $22M for FY09. Continued funding at levels greater than $14 million is foreseen in subsequent years. The CNO N45 and ONR coordinated Science & Technology and Research & Development (S&T R&D) program currently is focused in the following areas through the end of FY09:

- Comprises four interrelated areas: determining marine mammal demographics; establishing accepted criteria and thresholds to measure the effects of naval activities; developing effective protective methods to lessen those effects; and further understanding the effects of man-made sound fields on marine life.
- Provides better biological data and tools to enable the Fleet to train prior to deployments at a minimal risk to marine mammals.
- Seeks to make monitoring and mitigation as compatible as possible with Fleet sensors, data displays and personnel training.

The NWTRC DEIS/DOEIS summarized some of the general science on past studies of anthropogenic (i.e., human generated) noise on marine mammals (DoN, 2008). Other related references also include Cox et al., 2006; Deeck, 2006; Nowacek et al., 2007; and Southall et al., 2008). In light of continued discoveries and identification of knowledge gaps from scientific references cite above, continuing adjustments and prioritization to the R&D S&T program will be achieved via consensus with the SLMRROG in order to advance the knowledge of marine mammal science. It should be noted, the N45 and ONR marine mammal S&T R&D program is a separately funded and administered program from the proposed NWTRC Monitoring Plan to be funded by U.S. Pacific Fleet. Both programs (S&T R&D and Range Complex monitoring) can be complementary in many instances and data from one can be leveraged and used within the other. In support of this complementary nature, several significant projects funded by the Navy S&T R&D program are funded through FY11 and currently ongoing within NWTRC. The NWTRC Monitoring Plan will integrate elements and data from these region specific studies into this Plan as appropriate. Included as an example of this effort, following this summary is a progress report summarizing visual and PAM from Navy funded research in the offshore waters of Washington State (Oleson et al., 2008).

Literature Cited

Cox T.M., T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Ranford, L. Crum, A. D'amico, G. D'spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. Macleod, P. Miller, S. Moore, D.C. Mountain., D. Palka:, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Meads, L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management. 7:177–187.

Deeck, V.B. 2006. Studying marine mammal cognition in the wild: a review of four decades of playback experiments. Aquatic Mammals 32(4):461-482.

DoN. 2008.Northwest Training Range Complex: Draft Environmental Impact Statement\Draft Overseas Environmental Impact Statement- December 2009. Department of the Navy.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2):81-115.

Oleson, E.M., J.A. Hildebrand, J. Calambokidis, G. Schorr, and E. Falcone. 2008. 2006 Progress Report on Acoustic and Visual Monitoring for Cetaceans along the Outer Washington Coast. Prepared for U.S. Navy. Naval Postgraduate School, Monterey, CA. NPS-OC-07-003. 30 pp.

Southall, B. L. 2008. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 411-521.