Scientific Advisory Group for Navy Marine Species Monitoring

Workshop Report and Recommendations

1. INTRODUCTION

1.1 Background and Statement of Task (Provided by the Navy)

An October 2010 Navy Monitoring meeting in Arlington, VA initiated a process to critically evaluate current Navy monitoring plans and begin development of revisions to existing region-specific monitoring plans and associated updates to the Integrated Comprehensive Monitoring Program (ICMP). Discussions at that meeting as well as through the Navy/NMFS adaptive management process established a way ahead for continued refinement of the Navy's monitoring program. This process included establishing a Scientific Advisory Group (SAG) composed of technical experts to provide objective scientific guidance for Navy consideration.

The Integrated Comprehensive Monitoring Program provides the overarching framework for coordination of the United States Navy marine species monitoring. It is intended for use as a planning tool to focus Navy monitoring priorities pursuant to ESA and MMPA requirements and as an adaptive management tool to analyze and refine monitoring and mitigation techniques over time. It has been developed in direct response to Navy Range permitting requirements established in the various MMPA Final Rules, ESA consultations, Biological Opinions, and applicable regulations. As a framework document, the ICMP applies by regulation to those activities on ranges and operating areas for which the Navy sought and received incidental take authorizations under the Marine mammal Protection Act. The ICMP does not include or specify the actual monitoring field work or projects, nor does it commit to fund specific monitoring-related activities. Range-specific monitoring plans have been developed through the environmental compliance process in coordination with NMFS that establish specific monitoring activities for each range complex. Collectively these individual monitoring plans are intended to address the ICMP top-level goals.

The following excerpt from the 2010 Update of the Navy ICMP states the current top-level goals as developed through coordination with National marine Fisheries Service:

> "*Monitoring measures prescribed in range/project-specific monitoring plans and Navy-funded research relating to the effects of Navy training and testing activities on protected marine species should be designed to accomplish one or more of the following top-level goals:*
>
> - *An increase in our understanding of the likely occurrence of marine mammals and/or ESA-listed marine species in the vicinity of the action (i.e., presence, abundance, distribution, and/or density of species);*

- *An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammals and/or ESA-listed species to any of the potential stressor(s) associated with the action (e.g., tonal and impulsive sound), through better understanding of one or more of the following: 1) the action and the environment in which it occurs (e.g., sound source characterization, propagation, and ambient noise levels); 2) the affected species (e.g., life history or dive patterns); 3) the likely co-occurrence of marine mammals and/or ESA-listed marine species with the action (in whole or part) associated with specific adverse effects, and/or; 4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and/or ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving or feeding areas);*

- *An increase in our understanding of how individual marine mammals or ESA-listed marine species respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level);*

- *An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g., through effects on annual rates of recruitment or survival);*

- *An increase in our understanding of the effectiveness of mitigation and monitoring measures;*

- *A better understanding and record of the manner in which the authorized entity complies with the Incidental Take Authorization and Incidental Take Statement;*

- *An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals; and*

- *A reduction in the adverse impact of activities to the least practicable level, as defined in the MMPA.*

Several of the top-level goals listed above focus on understanding the short-term effects to individual animals from naval anthropogenic sound. For the purposes of the ICMP, short-term is defined as the period during which the behavioral response is empirically determined or presumed to be directly attributable to exposure to naval anthropogenic sound."

Navy established the SAG in early 2011 with the initial task of evaluating current navy monitoring approaches under the ICMP and existing Letters of Authorization and developing objective scientific recommendations that will serve as the basis for a Strategic Plan for Navy monitoring. The Strategic Plan will be integrated as a primary component of the ICMP and provide a comprehensive 3-5 year "vision" for navy monitoring across geographic regions - serving as guidance for determining how to most efficiently and effectively invest the U.S. Fleet marine species monitoring budget to address ICMP top-level goals and satisfy Marine Mammal Protection Act (MMPA) Letter of Authorization (LOA) regulatory requirements for Fleet testing and training activities. At this stage of the process SAG recommendations are not expected to include detailed study designs or formal work proposals but should serve as guidance for developing the Strategic Plan and help direct selection of appropriate monitoring efforts based on an objective organizational framework and region-specific considerations.

This document serves as the SAG's evaluation of the current Navy monitoring approach, previous guidance, and recommendations for restructuring future investments to most effectively address ICMP top-level goals while maintaining compliance with existing MMPA Letters of Authorization.

1.2 Scientific Advisory Group Members and Workshop Participants

The Scientific Advisory Group was convened for an initial workshop in San Diego, CA March 1-2, 2011. The SAG was composed of the following scientists with significant expertise in marine species monitoring, acoustics, ecology, and modeling. The composition of the Scientific Advisory Group is expected to be fluid over time, based on specific tasking and needs.

Scientific Advisory Group members:

- Andrew Read, Duke University (coordinator)
- Robin Baird, Cascadia Research Collective
- John Calambokidis, Cascadia Research Collective
- Christopher Clark, Cornell University
- Karin Forney, National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center (SWFSC)
- John Hildebrand, Scripps Institution of Oceanography, University of California San Diego
- Brandon Southall, Southall Environmental Associates and University of California, Santa Cruz
- Peter Tyack, Woods Hole Oceanographic Institution
- Bernd Würsig, Texas A&M University, Galveston

Additional attendees at the workshop included representatives from Navy as well as HDR-EOC - the Navy's primary contractor responsible for coordinating and executing marine species monitoring projects. Navy and HDR-EOC representatives provided meeting notes but were not directly involved in developing SAG recommendations. Navy staff's primary purpose was to provide guidance on the

objectives of the workshop, desired output, and background on Navy operations, legal requirements, and current monitoring initiatives. HDR-EOC staff were responsible for documenting the workshop proceedings and providing meeting minutes and notes to the SAG for development of their final report and recommendations.

Navy representatives:

- Joel Bell, Naval Facilities Engineering Command Atlantic (NAVFAC LANT)
- Sean Hanser, Naval Facilities Engineering Command Pacific (NAVFAC PAC)
- Frank Stone, Chief of Naval Operations, Environmental Readiness Division (CNO-N45)
- Amy Smith, Science Applications International Corporation – support to CNO-N45

HDR-EOC Navy marine species monitoring contract support:

- Dan Engelhaupt – Deputy Program Manager
- Kristen Ampela – Deputy Program manager for Analysis and Research Design
- Greg Fulling – Deputy Program manager for Field Operations

1.3 Objectives and Process

The primary objective of the workshop was to develop a framework for evaluating all Navy range complexes under the ICMP and to formulate objective, expert scientific recommendations for addressing top-level goals of the ICMP.

The Navy specifically provided the following objectives to the SAG:

- Evaluate current approaches to addressing Navy Integrated Comprehensive Monitoring Program top-level goals.
- Consider previous input provided by NMFS
- Develop recommendations to effectively and efficiently address ICMP top-level goals through specific regional objectives.
- Focus efforts and resources on those geographic areas where potential effects to marine mammals and other threatened or endangered marine species are most likely to occur due to **concentrated or repetitive activities** and where progress in addressing ICMP goals is most realistic.
- Specify direct links between recommendations and ICMP goals

The SAG accepted these objectives as the starting point for our discussion. The March 2011 workshop served as the primary working session, with the format of a structured brainstorming session. After a brief introduction of the goals and objectives by Navy representatives, the SAG proceeded to evaluate the ICMP top-level goals and established a conceptual framework and process for developing

recommendations. The remainder of the two-day workshop was spent working through each individual range complex, generating notes and tables, and generating information to serve as supporting references for final recommendations.

Following the workshop, Navy and HDR staff compiled and organized working products, notes, and minutes and delivered a package of materials to SAG members for their use in developing recommendations and drafting this report. Dr. Andy Read served as the SAG coordinator and report editor. The final report represents the SAG's opinion and recommendations and was not subject to third-party review or comment by the Navy.

2. FUNDAMENTAL CONSIDERATIONS AND CONCEPTUAL FRAMEWORK

Before proposing specific recommendations, we examine the Navy's current approach to monitoring and the previous circumstances and guidance that bring us to this point. From there we will be better positioned to create a more coherent and effective monitoring program for the Navy.

2.1 Original Objectives and Current Approach of the Navy Monitoring Program

The existing Navy monitoring program is composed of a collection of "range-specific" monitoring plans, each developed individually as part of the MMPA/ESA process as environmental compliance documentation was completed. The ICMP is intended to co-ordinate monitoring efforts across all regions and to allocate the most appropriate level and type of effort for each range.

Originally, five study questions were developed between NMFS and the Navy as guidance for developing monitoring plans and all existing range-specific monitoring plans attempt to address each of these study questions. However, the state of knowledge for the various range complexes is not equal and many factors, including level of existing information, amount of training activity, accessibility, and available logistic resources, all contribute to the ability to perform particular monitoring activities.

The original study questions were as follows:

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, temporary threshold shift (TTS), or permanent threshold shift (PTS))? If so, at what levels are they exposed?
2. If marine mammals (and sea turtles) are exposed to MFAS, 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 received levels?
4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives?

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

NMFS further proposed that in order to address these questions monitoring programs should be designed to identify and quantify instances of the following events:

- marine mammals, sea turtles and protected species of fishes (as applicable) that co-occur in space and time with sound fields generated by active sonar systems associated with naval exercises;
- marine mammals, sea turtles and protected species of fishes (as applicable) that are exposed at various harassment criteria received levels during active sonar transmissions (measured or estimated);
- behavioral responses of marine mammals, sea turtles and protected species of fishes (as applicable) that are exposed to sound fields generated by active sonar systems associated with naval exercise;
- injury or death of marine mammals, sea turtles and protected species of fishes (as applicable) that are exposed to sound fields generated by active sonar systems associated with naval exercises.

The general consensus at the October 2010 Navy Monitoring meeting was that: the five study questions were not equally or practically applicable across all range complexes; the questions are too broad to support development of meaningful monitoring efforts; and that more specific objectives might be established for each range complex.

2.2 Conceptual Framework and Progression of Knowledge

We believe that it makes sense to approach the Navy monitoring program from the perspective of considering the long-term health of populations, which is the intent of the Marine Mammal Protection Act (MMPA) and the primary goal for monitoring under MMPA Letters of Authorization. To move towards this ultimate objective we need to develop a framework of knowledge, from basic information on the occurrence of species within each region, to more specific concepts of exposure, response, and consequences. These concepts are in direct concordance with the original monitoring study questions, NMFS' propositions and the current set of ICMP top-level goals, while at the same time being broadly applicable across the various range complexes.

The creation of an integrated monitoring program with the capacity for adaptive management should allow the Navy to select which monitoring activities to conduct in each range complex. We used the conceptual framework of **occurrence, exposure, response, and consequences** to assess monitoring opportunities, understanding that the overall approach should address all goals, but not necessarily in all locations. For instance, it would not be particularly useful to invest resources in studying response or

consequences in an area where basic occurrence information is lacking. In such cases, however, even a nominal amount of monitoring effort may provide a high return because all information obtained will be novel.

These concepts represent a framework of information required, building from the most basic to the most complex and defined as follows:

Occurrence represents the most basic information on the presence and diversity of species that occur in a Navy range or area of proposed training activity. Such basic information is informed by patterns of habitat use, population structure, density and abundance, along with elements of behavioral ecology, including whether the area is used for feeding, mating, or as a migratory corridor.

Exposure represents information on Navy training activities including where, when and how often sources are being used, the types and properties of the sounds generated, and how sound propagates through the area to allow determination of received levels and other metrics of interest. When this information is integrated with the *Occurrence* information above and information on diving behavior, it is possible to estimate the number of individuals from each population that are exposed to specific sound levels.

Response incorporates how animals react to the exposure on different time scales, including immediate short-term behavioral responses of individuals or groups and medium-term responses such as movements over larger spatial scales, changes in behavioral/social interactions and changes in habitat use. Baseline information on behavior will be required to assess responses. If animals respond in a way that reduces exposure (such as moving away from the source), this information can be used to refine the exposure estimates.

Consequence represents the long-term impacts of exposure and responses, including cumulative effects taken in the context of the species occurrence and use of an area. Evaluation of long-term consequences requires a full understanding of habitat use of the region (such as how important the habitat is within the larger geographic context of the population's range) to understand the demographic effects of individual responses at the population level. Consequences include the long-term impacts of modifications to distribution, behavior, social groupings, or foraging success and how these changes affect fitness through reproduction, growth or survival.

The monitoring plan will require validation of the effectiveness of mitigation measures employed by the Navy to reduce impacts on marine mammals. The information on occurrence, exposure, response, and consequence described above will help inform what types of mitigation measures are most important and provide a better means of evaluating their efficacy.

2.3 Available Methods

The SAG considered the methods available to address the hierarchy of information needs identified in 2.2 above. **Table 1** contains an abbreviated summary of the methods that could be used to address these information needs. This is by no means an exhaustive list, but represents the most common approaches available at the present time.

3 RECOMMENDATIONS FOR PROGRAM STRUCTURE AND MANAGEMENT

We identified a number of general recommendations that apply broadly across the Navy's monitoring program. It is important to address these early in the process to develop an efficient program.

3.1 Transparency, Collaboration, and Data Accessibility

The SAG emphasized that implementation of monitoring plans must be conducted in a transparent manner. The program should facilitate collaboration among researchers in each region, with the intent to develop a coherent and synergistic regional monitoring and research effort. The plan of action (including timelines) for each geographic region should be available to all parties.

Navy monitoring projects need to produce timely results with consistent methodologies. Results should be published in a timely manner by the original data collectors. We recommend that each contract stipulate that data be made available within a specified timeframe and that a data management plan should be a project deliverable. We make the following specific recommendations:

- Data generated from the monitoring program should be contributed to a publicly available database, such as OBIS-SEAMAP. Data and metadata should meet widely accepted standards. The data generated by these monitoring programs should be readily available to researchers, members of the public and students of all levels.

- Scientists conducting monitoring work (and the SAG) should be kept informed of modifications to the overall monitoring program, so they understand how their work contributes to Navy requirements. A website containing comprehensive and current information about monitoring efforts would meet this goal.

- We stress the importance of ensuring that scientists have appropriate access to sensitive data, and that critical classified and non-classified data are made available in a timely manner to ensure open and unfettered investigation into the effects of Navy-generated sound.

3.2 Programmatic Recommendations

Specific Programmatic recommendations were also identified by the SAG in four key areas: (1) Overall monitoring objectives and scope; (2) Operational methodology; (3) Data analysis and integration; and (4) Procedural logistics.

3.2.1. Overall monitoring objectives and scope

- The overall monitoring program should establish metrics for meeting goals and/or reporting requirements. Both the Navy and NOAA should strive to move away from a "box-checking" mentality. Accordingly, monitoring studies should be designed and conducted according to scientific objectives, rather than on merely cataloging effort expended. Methods should be selected based upon an open and critical evaluation of what best meets each scientific objective. This change in culture would create a climate in which quality of project design, data collection, and analysis are given weight over effort-based metrics that do not necessarily produce useful results.

- The monitoring plan up until now has focused primarily on sightings of *groups* of animals, but it is important to combine this with data from *individuals* and on *population structure*. Photo-identification of individuals can provide useful data for mark-recapture estimates of abundance and for assessing population identity by examining the associations and ranging patterns of individuals[1]. Data on genetics and long duration movements (from satellite tags) are critical for defining population structure and habitat use.

3.2.2. Operational methodology

- The SAG emphasized that we still lack basic biological and/or behavioral data on many of the protected species being monitored in this program. Specific data are needed in terms of diving and vocal behavior of a number of species, and there is a need to document and validate species-specific and context-specific acoustic repertoires.

- Acoustic exposure metrics should involve more than simply received level, but other salient features such as the relative spatial distribution of operations and exposed animals, behavioral state of animals observed, and the presence of other anthropogenic activities, if applicable.

- The SAG agreed that there is a need to be explicit about the time scale of monitoring studies in relation to training exercises. Short-term (response) effects should be distinguished from medium-term effects, which are, in turn, distinct from long-term consequences. Short-term, detailed behavioral response studies, comparative analysis of longer-term tracking of individual movement and synoptic passive acoustic monitoring on broad time scales should be integrated.

- Opportunities exist for analyzing responses to active sonar during Navy training exercises, but a strategic approach is needed to determine the right monitoring approach for specific types of operations; an integrated approach using different tools for differing conditions is required. Monitoring methods must have a reasonably high likelihood of providing scientifically meaningful and statistically powerful results. This integrated approach may involve the

[1] The most well-known example of the value of such information is the determination of sympatric populations of fish-eating and mammal-eating killer whales in the Pacific Northwest (the so-called "resident", "transient" and "offshore" populations), but there are many other examples (*e.g.*, melon-headed whales, false killer whales, and Blainville's beaked whales, among others, in the HRC).

deployment of satellite tags prior to large-scale training operations to obtain insight into movement patterns before, during, and after sonar training activities. Information on such operations should ideally be made available for analysis in a declassified manner that retains relevant information to assess sound exposure. However reconstruction of complex training exercises with detailed information on ship tracks and outputs may be cost-prohibitive and/or complicated by security issues. Detailed measurements of exposure and response using acoustic tags and other sensors should focus on unit level training operations where a limited number of sound sources will be active. The SAG recommends that monitoring efforts around realistic exercises should be undertaken only when biologists are involved in the experimental design and execution and when a statistically significant outcome could result. This kind of monitoring should not be conducted without guaranteed access to all data required to estimate exposure.

3.2.3. Data analysis and integration

- Data analysis and synthesis must be a clear and explicit priority. A plan for data analysis should be included early in the life of each project and resources must be provided to supporting such analysis. We understand that there are limited resources available to conduct monitoring activities, but failing to properly plan and execute the analysis leads to a backlog of data and a lack of information from which to draw inferences and conclusions. Furthermore, the SAG notes that a large volume of data has already been collected but remains unanalyzed because sufficient resources have not been available to support data analysis. A complete assessment of these existing data sets should be conducted to ensure that those that are relevant are utilized to the full extent practicable.

- The monitoring program should establish and apply widely accepted data and metadata standards (see NSF and NIH for numerous examples) for all data types, and ensure that these data are contributed to managed public databases. The program should also apply quality control standards and make an investment in developing these databases in standardized archives to support transparency, collaboration, and the maximum benefit from data collection efforts.

- The SAG recommends incorporating existing data from SONAR effects studies into a meta-analysis, especially as datasets become sufficiently mature to support such an analysis. This would allow an assessment of the effectiveness of differing methodologies across various time scales. Future monitoring studies could also be compiled into a similar analysis, to judge the effectiveness of monitoring efforts in hindsight.

3.2.4. Procedural logistics

- An annual science review meeting should be conducted to review information, assess progress, and enhance understanding and cooperation among scientists.

- An interdisciplinary working group should address a plan of action specifically dealing with passive acoustic data (moored and mobile sensors) collection, results, management and how to best focus on responses to sonar activities. This plan of action would include, for example, conceptual experimental design for the deployment of sensors (e.g., HARPs, MARUs), standardized formats for data storage, data processing parameters, etc.

- The overall program should collaborate and partner with NOAA whenever possible to achieve large scale population monitoring, and to fill in existing data gaps in each region. The SAG recommends that the Navy participate with NOAA in a supporting role to conduct large-scale, multi-modal (visual and acoustic) line transect and passive acoustic surveys, as resources allow, to help address existing data gaps.

3.3 Monitoring Other Activities

Discussion at the workshop focused almost exclusively on mid-frequency ASW training, but the SAG noted that it is important to monitor the effects of all types of training exercises, including low-frequency active sonar (LFAS) and explosives. Without such a comprehensive perspective, it will not be possible to provide a full analysis of the effects of Navy-generated sound on marine species and their populations. The SAG emphasized that different approaches may be needed to monitor the effects of various types of exercises.

4 RANGE-SPECIFIC RECOMMENDATIONS

We developed a series of range-specific recommendations within the framework of **occurrence, exposure, response, consequences and mitigation** (see Section 2.2 above). These recommendations were generated after an evaluation of existing information and considering a variety of regionally specific factors. It is important to ensure that basic information on species *occurrence* (including consideration of distribution, density and ecology) be obtained either before or at least simultaneously to consideration of questions of *exposure*, *response*, and *consequences*. The SAG emphasized that, due to the existence of past ASW training exercises, it is not possible to determine pre-exposure conditions in any of the areas considered. In regions where basic information on occurrence is lacking or deficient, monitoring efforts should emphasize studies of presence, diversity, distribution, population structure and density, given practical considerations such as logistic support, accessibility and field conditions. More sophisticated questions of exposure, response, and consequences should be focused in areas where such work is practicable, but some approaches will not be possible or desirable in all areas until considerable information is available on basic occurrence. We note the great opportunity provided by instrumented ranges, particularly those where synoptic field approaches are logistically feasible. Furthermore, we caution against trying to do everything in each range and spreading limited resources too thinly.

We evaluated each range complex in terms of *occurrence* (presence, diversity, distribution, population structure and density). **Table 2** provides a "quick-look" comparison of Navy range complexes based on

this occurrence information and other range-complex characteristics. **Table 3** presents a prioritization of monitoring methods for each range complex. Both **Tables 2 & 3** serve as supporting references throughout the following section.

Aerial Surveys

The SAG spent considerable time discussing aerial surveys as a monitoring method and make the following comments specific to this method. There is a significant safety risk associated with aerial surveys and, in many cases, return on investment can be low. The use of aerial (or vessel) surveys for monitoring before/after an event has relatively little value, especially if sighting conditions are not optimal. The group agreed that aerial survey monitoring should only be used if the following criteria are met: (1) the aerial survey is critical to the mission and (2) the data cannot be collected by any safer and more cost-effective means. The SAG recommends limited use of aerial surveys and only in specific locations and contexts as noted in the specific recommendations section. Otherwise we feel it is best to rely on other methods. The same safety caution applies for behavioral data gathering from aircraft, which usually consists of flying "circles" around individuals or groups for information on orientation, reorientation, surfacing/dive/respiration, *etc*. The merits of this circling technique should be evaluated separately from line transect or other aerial surveys.

4.1 Mariana Islands Range Complex (MIRC)

The Mariana Islands Range Complex is located in the western Pacific, encompassing a large (500,000 nm^2) region where little effort has been conducted on the study of marine mammals. Because so little is known about species occurrence in this area, the priority for this region should be on establishing occurrence. Passive acoustic monitoring is highly recommended for use in this region, in combination with recordings from small boats to obtain species-specific vocalizations. Other appropriate methods to collect occurrence data in this region include small boat surveys, biopsy sampling, satellite tagging and photo-identification (photo-ID). Photo-ID mark-recapture studies represent the best opportunity for evaluating the abundance of small populations, as opposed to standard line-transect methods. Photo-ID is also a useful mechanism for fostering and enabling local research capabilities. There will be a high return for monitoring in the Mariana Islands, because even basic information will greatly expand what is known for this region. In addition, the medium-to-high level of naval activity in the region also increases its importance for monitoring effort.

4.2 Gulf of Alaska (GOA)

The Gulf of Alaska naval training area encompasses a portion of the continental shelf and deep water offshore from Alaska (42,000 nm^2). We recommend low to moderate monitoring investment in this area due to the low level of Navy training activities. Monitoring efforts should focus on the occurrence for species of critical interest, such as the highly endangered North Pacific right whale. Additional species of concern include: Steller sea lions; gray whales; beaked whales; porpoises; and killer whales, including the endangered AT1 group. Due to the low level of Navy activity, and the relatively difficult working conditions, the GOA is not an appropriate area to conduct exposure/response studies, even though

relatively naïve animals may be present. Fixed passive acoustic monitoring is recommended to better characterize marine mammal occurrence. Some photo-ID and small vessel work may be practical in coastal regions where there is an intersection with Navy activities.

4.3 Northwest Training Range (NWTR)

The Northwest Training Range Complex is located off the coast of Washington and Oregon, and in the Puget Sound region. The area includes both inland waterways, as well as continental shelf and offshore deepwater (120,000 nm^2). Occurrence, density, seasonality, and population structure are relatively well known for most species in this area with the exception of beaked whales. Species of concern include: Steller sea lions; gray whales; beaked whales; southern resident killer whales; harbor porpoises; and leatherback turtles. Personnel and logistic support are available for small boat operations in this region. Due to the low intensity of Navy training activities, however, we recommend a low to moderate level of investment in monitoring. This is an area where animals are *relatively* naïve to MFAS and thus could serve as a comparison with areas with more regular exposure to MFAS such as SOCAL. The SAG recommends the use of fixed passive acoustic monitoring in this range and short-term tags provide an opportunity to obtain vocalization rates. Non-systematic small vessel surveys and photo ID/mark recapture studies and satellite tagging are also recommended. Long-term photo-ID catalogs are available for humpback, fin, gray, and killer whales in this region. This area provides unique opportunities for work with endangered Southern Resident Killer Whales. There are also opportunities for visual surveys using larger vessels, even in winter, taking advantage of weather windows.

4.4 Southern California Range Complex (SOCAL)

The Southern California Range Complex (SOCAL) covers an area (120,000 nm^2) off the coast of southern California and northern Baja California. Although the range complex includes substantial deep waters off the continental shelf, most training activities and a high level of sonar usage takes place in moderate water depths adjacent to San Clemente Island, on the continental borderlands. The range area includes the California current system, a zone of high productivity, resulting in both high density and high diversity of marine mammal species. These include several endangered species (blue, fin, humpback, sei, and sperm whales) as well as species of concern for impact from sonar (Cuvier's beaked whales). The SOCAL region has been the focus of substantial research effort, by government, university and independent research organizations, and a fixed hydrophone array off San Clemente Island allows for efficient localization and tracking of animals. Weather conditions are favorable for field studies in this region much of the year. The SAG recommends a broad suite of monitoring for this area including passive acoustic monitoring, and non-systematic surveys incorporating biopsy, tagging and photo-identification studies. Despite the relatively good knowledge of marine mammal occurrence in this region, data gaps still persist, such as the population structure of beaked whales. The combination of a relatively high level of sonar activity, high animal density, excellent logistic support and favorable weather offer the opportunity to conduct exposure/response studies.

4.5 Hawaii Range Complex (HRC)

The Hawai'i Range Complex is large (235,000 nm^2), encompassing both island-associated and deepwater habitats. Most Navy training activities, however, take place in a relatively small area around Kaua'i and Ni'ihau, with some activities elsewhere, in particular in offshore areas west of the island of Hawaii. Navy sonar activity levels in the HRC are high. The HRC region has been the focus of substantial research efforts, by government, university and independent research organizations. Considerable information is available on both resident populations of odontocetes and on migratory humpback whales in the HRC, although data gaps exist, particularly around Kaua'i and Ni'ihau, in offshore areas, and for some cryptic species for which there are known to be resident populations (*e.g.* dwarf sperm whales). Biological productivity is low, resulting in low densities, but the relatively high diversity and presence of resident island-associated populations influences the choice of monitoring methods. Species of concern include Cuvier's beaked whales, Blainville's beaked whales, melon-headed whales, dwarf sperm whales, and false killer whales. Weather conditions limit monitoring efforts in offshore and windward areas, and seasonal storms and trade winds may limit monitoring in some deep-water leeward areas during the winter. The SAG recommends a broad suite of monitoring for this area including passive acoustic monitoring, and non-systematic surveys incorporating biopsy, tagging and photo-identification studies. A fixed hydrophone array off Kaua'i allows for acoustic monitoring and provide potential synergy with boat-based monitoring efforts.

4.6 Atlantic Fleet Active Sonar Training (AFAST)

The Atlantic Fleet Active Sonar Training (AFAST) region encompasses a vast region including most of the US Atlantic coast, as well as the northern Gulf of Mexico. Within AFAST, a set of 12 operational areas (OPAREAs) have been defined. There is extensive overlap of intensive Navy training events and relatively high species diversity in the VACAPES OPAREA off Cape Hatteras. Odontocete species present here include: short-finned pilot whales; sperm whales; several species of beaked whales; Risso's, common, spotted and bottlenose dolphins; and *Kogia*. In addition, humpback and other baleen whales are present seasonally, including the highly endangered North Atlantic right whale. Loggerhead sea turtles are common seasonally. An ongoing monitoring program, combining aerial and vessel surveys and passive acoustic monitoring, has focused on documenting the occurrence of marine mammals and sea turtles off Hatteras, NC, Onslow Bay, NC and the future USWTR site off Jacksonville, FL. The combination of aerial line transect surveys, photo-ID and passive acoustic monitoring has proven particularly useful in this area. There are several important monitoring opportunities, including: exposure-response studies; the use of satellite tags to characterize medium-term response to exposure; and D-Tags to monitor acute response to exposure. In addition, there is a unique opportunity for monitoring before and after concentration of sonar activities occurs in the proposed USWTR location off Jacksonville. It is recommended that the spatial coverage for monitoring within AFAST be expanded to sample the full range of marine mammal habitats that are exposed to Naval activities.

5 CONCLUSIONS

In closing we emphasize two points. First, it is critical for the Navy to progress from range-by-range monitoring to an integrated monitoring plan. Not all methods are appropriate at all range areas, and with limited resources, it is important to focus on those areas and methods that will yield results. The

metrics for success of the monitoring plan should be the ability to answer important questions related to the impact of naval training activities on marine life. Metrics of effort alone will not result in significant advances in understanding. Second, in many areas where the Navy currently trains, our understanding of the occurrence of marine species is rudimentary. Thus, monitoring efforts in such areas should address fundamental gaps in our knowledge of distribution, density abundance, habitat use and population structure. We emphasize the importance of monitoring exposure, response and consequences in areas where our understanding of patterns of occurrence is better established and in which requisite logistical and operational capacity exists.

Table 1 - Methods Available to Address the Conceptual Framework

ICMP Goals	Method
Occurrence	
Presence	Sighting surveys; passive acoustics; biopsies, stranding records; by-catch.
Density	Line transects or point sampling with visual and/or acoustic detection methods; photo-ID or genetic capture/recapture
Population Structure	Genetics; photo-ID; satellite tags
Trend	Visual line transect or mark-recapture surveys; long term passive acoustic monitoring from fixed stations
Exposure	
Acoustic Exposure	Sound source characterization; environmental data critical for propagation modeling; ambient noise levels
Behavioral Response	DTAGs; passive acoustics; satellite tags
Co-occurrence with Navy Activities	Information on Navy training activities; habitat modeling; satellite tags. We do not include direct observation because of logistical problems with biological observations during exercises.
Behavioral Context of Exposure	Focal behavioral sampling; photo-ID; satellite tags
Response	
Individual Response	Information on Navy training activities; strandings; controlled exposure experiments; satellite tagging before during and after naval activities
Population Effects	Genetics; photo-ID; long-term study of identified individuals; methods to relate cumulative exposure and short-term responses to long-term effects.

Table 2 - Range Complex Quick-Look Comparison

	HRC	SOCAL	AFAST	NWTR	GOA	MIRC
Level of Navy sonar activity	*High*	*High*	*High*	*Low*	*Low*	*Med/High*[1]
Diversity of marine mammals	*High*	*High*	*High*	*Medium*	*Med*	*Med/High*
Density of marine mammals	*Low/Med*	*High*	*Med*[2]	*Med*	*Med*	*Low/Med*
Need for information on basic occurrence	*Med*	*Low*	*Low/Med*	*Low/Med*	*Med*	*High*
Logistics support availability	*Med/High*	*High*	*Med/High*	*Med*	*Low*	*Low*
Existence of favorable conditions[3]	*Med*	*High*	*Med*	*Med*	*Low*	*Low*
Ability to address exposure/response	*High*[4]	*High*[4]	*Med*[5]	*Low*	*Low*	*Low*
Best ability to address consequences	*Med*	*Med*	*Med/High*[6]	*Low*	*Low*	*Low*
Presence of species of concern	*High*	*High*	*High*	*Med*	*Med*	*?*
Suggested level of monitoring investment[7]	*Med/High*	*High*	*High*	*Low/Med*	*Low/Med*	*Med*

1 – Sonar activity in MIRC is anticipated to increase

2 – Diversity and density are high at specific locations within the AFAST area but low in others

3 – Weather conditions are typically seasonally dependent with the exception of SOCAL

4 – Instrumented ranges provide a unique and powerful monitoring opportunity

5 – Future USWTR instrumented range; temporary bottom-mounted acoustic arrays simulate small-scale instrumented ranges

6 – USWTR offers a unique opportunity to examine consequences before/after concentration of ASW activity

7 – Monitoring investment is relative among regions based on available resources. Specific objectives vary among regions based on evaluation of existing information and expected ability to address ICMP monitoring goals.

TABLE 3 - Relative Prioritization of Monitoring Methods

Method	HRC	SOCAL	AFAST	NWTR	GOA	MIRC
Fixed acoustic monitoring	*High*	*High*	*High*	*Med*	*Med*	*High*
Aerial – line transect[1]	*Low (turtles only)*	-	*Med*	*Low (turtles only)*	-	-
Aerial – behavioral response[1]	-	*Med*	-	-	-	-
Large vessel – systematic line transect & towed array[2]	*With NOAA*	*With NOAA*	*With NOAA*	*With NOAA*	*With NOAA*	*With NOAA*
Medium vessel – systematic line transect, small vessel support & towed array	*Med*	-	*Med*	-	-	*Med*
Non-systematic survey, biopsy, tagging & photo-ID	*High*	*High*	*High*	*Med*	*Low*	*Med*
Shore-based observations	-	-	-	-	-	*Low (?)*
Biopsy sampling & genetic analysis	*High*	*High*	*High*	*Low*	*Low*	*Med*
Analysis of photo- ID data	*High*	*High*	*High*	*Low*	*Low*	*Med*
Development of local expertise	-	-	-	-	-	*High*
Satellite tags – population structure and movements	*High*	*Med*	*Low*	*Med*	*Low*	*Med*
Satellite tags – response	*High*	*High*	*Med*	-	-	-
D-tags – exposure/response	*High*	*High*	*Med*	-	-	-
Behavioral response studies	*Med*	*High*	*Med*	-	-	-

1 –. See section on concerns regarding aerial safety

2 – We recommend the Navy participate in a supporting role when available resources allow, especially to address specific data gaps.