Report on the

OPNAV N45
Marine Mammal Monitoring Workshop

R. David Thomas Executive Conference Center
Duke University
Durham, NC
February 19-20, 2009

EXECUTIVE SUMMARY

A Marine Mammal Monitoring Workshop, sponsored by OPNAV N45, was held at the Duke University R. David Thomas Executive Conference Center on 19-20 February 2009. The goals for this workshop were to:

- Review on-going efforts and identify existing monitoring capabilities
- Define requirements for improvement of monitoring capabilities
- Identify research and development needed to meet monitoring goals

Enclosures (1) and (2) provide the workshop agenda and list of attendees respectively.

In keeping with the stated goals, the workshop examined methodologies for monitoring animal exposure as well as assessing animal behavioral response to mid-frequency active sonar (MFAS). Capabilities and needs were discussed within the context of being able to adequately address specific "focused studies" questions. These studies are required by references (a) – (c) to be addressed within the Navy's monitoring plans. The workshop culminated with the development of summary tables that present both existing capabilities and technology goals that the research community feels are achievable within a three to five year timeframe with supporting research and development. These tables are included at the conclusion of the main body of this report.

Outcomes and information resulting from this workshop will be used to inform the development of the Integrated Comprehensive Monitoring Program. It will also be used to provide input to the Adaptive Management Review to be held in the fourth quarter of calendar year 2009.

References:

(a) Federal Register Vol. 74, No. 7, Taking and Importing Marine Mammals; U.S. Navy Training in the Hawaii Range Complex; Final Rule dated 12 Jan 2009.

(b) Federal Register Vol. 74, No. 12, Taking and Importing Marine Mammals; U.S. Navy Training in the Southern California Range Complex; Final Rule dated 21 January 2009.

(c) Federal Register Vol. 74, No. 16, Taking and Importing Marine Mammals; U.S. Navy's Atlantic Fleet Active Sonar Training (AFAST); Final Rule dated 27 January 2009.

OPNAV N45 Marine Mammal Monitoring Workshop

A Marine Mammal Monitoring Workshop, sponsored by OPNAV N456, was held at the Duke University R. David Thomas Executive Conference Center on 19-20 February 2009. The goals for this workshop were to:

- Review on-going efforts and identify existing monitoring capabilities
- Define requirements for improvement of monitoring capabilities
- Identify research and development needed to meet monitoring goals

Specifically, the conference focus was on describing research and development (R&D) requirements for marine mammal monitoring to meet regulatory requirements. This is distinctly separate from the goals of the Navy's R&D program to advance the science.

To address the workshop goals, the first portion of the workshop consisted of a series of individual presentations that provided a broad overview of on-going efforts and perspectives from the regulators, research scientists and Fleet representatives. Electronic copies of the individual presentations are available from OPNAV N45. The individual presentations were then followed by a series of facilitated discussions to examine potential areas of improvement for the monitoring capabilities. These discussions focused on describing what might be achieved in the next 3-5 years given an appropriate level of R&D investment.

The workshop was facilitated by Dr. Andy Read (Duke University), Dr. John Hildebrand (University of California San Diego), and Dr. Jay Barlow (National Oceanic and Atmospheric Administration / Southwest Fisheries Science Center). It provided a healthy exchange of ideas between the various groups in attendance: Navy representatives, National Marine Fisheries Service Office of Protected Resources (NMFS OPR) regulators, NMFS scientists, and academic scientists. Enclosures (1) and (2) provide the workshop agenda and list of attendees respectively.

The subsequent sections provide a summary of the recurring themes from the discussions followed by a set of tables summarizing the findings of the facilitated discussions. A more extensive record of the workshop discussions is available from OPNAV N45.

MONITORING ANIMAL EXPOSURE

Monitoring is required to comply with the terms and conditions of Incidental Take Permits. Monitoring requirements under the recently issued Final Rules for the various Navy Range Complexes span five years. This presents a real opportunity to put monitoring measures in place to significantly increase our knowledge base of the biologics on Navy training ranges. NMFS OPR representatives expressed their preference for developing techniques that would lead to "an increase in the probability of detecting marine mammals," so that proper mitigation measures are applied.

There was a challenge made to the assumption that there needed to be consistency in monitoring approaches between regions. Operational areas between the Pacific and Atlantic are very different. Some attendees opined that it is more important to maintain consistency in approach over time for a particular region as opposed to consistency across regions. The motivation for similar studies across regions comes from a regulatory perspective. The regulators are interested in being able to make general statements about the effects of Navy generated sound on marine mammals. If the data is not collected in a similar manner across regions, it may not be possible to develop these general

statements. The regulators are also interested in understanding how "contextual" the behavioral responses might be.

In monitoring, it is important to choose the best tools and methods based on the given circumstances and monitoring goals. Priorities should be based on risk – i.e., focus monitoring efforts on those animals with small population sizes, or high uncertainty (trend information lacking). Ideally, the monitoring effort will adopt a layered approach that integrates a suite of methods. For example, passive acoustics might be used to direct visual observers on where to look. Given that visual surveys are distance-limited, tags and photo-ID are needed to monitor over larger temporal and spatial scales. Currently this integration is being done in an "arm-waving" way. It is critical that a more rigorous integrated approach be developed.

An integrated approach is also important to monitoring seasonal fluctuations. Winter weather conditions in many areas make it difficult for monitoring. Researchers cannot be confident of conducting regular monitoring visual surveys during winter. Passive acoustic monitoring during the winter is typically more effective than visual surveys. This leads to suggestions for installing passive acoustic monitoring on the ranges, or the use of autonomous vehicles for monitoring.

Visual surveys

Visual surveys are readily used in detecting small cetaceans. The use of visual surveys is also critical for measuring Temporary and Permanent Threshold Shift (TTS and PTS). The zones are so close to the vessel that the only way to measure this is from observers on the vessel itself. The likelihood of measuring TTS/PTS using any other approach is low, unless tags are used that measure acoustic energy received over time.

There are several drawbacks to visual surveys. Visual observations are distance-limited, and as such, are also very limited as a mitigation measure. In addition, "sightability" varies greatly by species, so not all animals will be seen. NMFS is very interested in coming up with other techniques that provide real-time information as to the range of the animal from the ship.

There is also great interest in defining the "detection function," which is an estimate of the probability that watchstanders will actually detect the true number of animals that are "in the box." The Navy uses a variety of models to predict the number of takes. From the regulator's point of view, they want to know if these models reflect reality. There is a strong desire to take advantage of the many, many hours of watchstander observations to help validate the models. However, to do so, they need to estimate the validity of these observations. Determining the detection function is the subject of one of the focused studies to be conducted.

Photo-ID

Photo-ID provides an extremely valuable dataset that is particularly valuable for long-term monitoring. It is also an effective monitoring approach when there is a low resident population. However, from researcher's perspective, this tends to be a throw-in at the end of the planning stage due in part to its low-technology nature. In developing monitoring plans, photo-ID needs to be included from the beginning.

Aerial surveys

Aerial surveys in general were characterized as dangerous and not cost-effective. Several deaths have resulted during aerial monitoring. Current range monitoring plans call for aerial surveys immediately before and after a range exercise. The reported purpose is to determine changes in

density and distribution that might have resulted from the response of the animals to sonar or other aspects of the exercise. The workshop participants who were most familiar with the statistical analysis of survey data expressed doubt that such an effort would be capable of detecting a statistically significant change in the density or distribution of observable cetaceans. Generally, weeks or months of survey effort are required to obtain a reliable estimate of density, and changes in density or distribution after an exercise are only likely to persist for a few days. Additionally, there are many logistical and safety of flight challenges in coordinating aerial survey with other helicopters and P-3s during Navy operations. This is further complicated by the range and flying time required to conduct the surveys when operations take place 150 - 500 miles offshore. Also, given the number of cryptic species, ID can be difficult, especially from aerial surveys. It was also pointed out that periodic aerial surveys widely separated in time are not particularly useful, as the observed effects might be due to other variability in the ocean environment. Strong justification for aerial surveys is needed due to the dangers involved. Workshop attendees indicated their strong desire to shift away from aerial surveys and rely more on acoustic monitoring.

That said, it was suggested that it might be a useful exercise to use the aerial surveys planned for 2009 to look at the differences in animal densities between California and Hawaii. The hypothesis is that aerial surveys are much more informative (i.e., a better investment) on the SCORE range where the animal densities are higher than off Hawaii with lower densities.

Passive Acoustic Monitoring (PAM)

Passive Acoustic Monitoring (PAM) has made great strides over the last decade. Researchers have gone beyond simply monitoring. They have developed the capability to detect and in some instances track beaked whales. PAM is now often used to enhance standard visual survey techniques by deploying towed arrays. Scientists have demonstrated the overall effectiveness of this technique in obtaining increased accuracy of abundance estimates.

The use of the PAM on instrumented Navy undersea ranges for determining the relative abundance of marine mammals within the range shows promise but is confronted with several complex issues. One primary issue is generally referred to as acoustic ecology. Currently there is only limited understanding of when animals call (or emit sound), under what circumstance, and for what duration. This is further complicated by a limited classification database. From the acoustic perspective, there is a need to improve the ability to differentiate among species. However, the challenge is to first establish ground truth. One potential approach to this challenge is to integrate data from tags with the acoustics. Variability is also an issue, as researchers have to determine if the recorded acoustics are attributable to a single animal, or several together, or for an entire population. There is also a need to better understand the directionality and beampatterns of the echolocations to understand detection probabilities. The validation of species, local environmental conditions, and general behavior with a recorded marine mammal sound is both demanding and time consuming.

Monitoring through the collection of acoustic data often lead to terabytes of data that requires post-processing and analysis. It is important to include the need for this analysis upfront when planning and funding the monitoring effort. To deal with the volume of PAM data, there is significant ongoing research into developing techniques for semi-automated to automated feature extractions of whistles, tonals, and clicks. Current error rates in classification are on the order of 15-50%. For many applications, these error rates need to be brought down. One approach is to fuse the classifiers and exploit all sounds that the animals produce.

Survey methods for acoustic data collections are still ad hoc and require standardization to obtain meaningful data for comparison across time and regions. Also, given the rapid advance in technologies being used to do acoustic collections, there is concern with cross-calibration across legacy and advanced equipments. This cross-calibration needs to be done over a sufficiently long period of time, so that there is a better chance to understand underlying causes in any observed trend shifts.

Several workshop attendees challenged the notion that it was impractical to outfit Navy ships with marine mammal passive detection systems for real-time monitoring and added data collection. There are a number of limitations with visual monitoring that might be addressed by integrating visual with passive acoustic monitoring. However, passive monitoring does not typically provide a range to the animal, so it has limited application for determining when to apply mitigation measures requiring power down or shutdown of sonar. At best, shipboard acoustic biological detections would simply provide indications to visual observers as to the general direction to look for the animals. Additionally, the Navy representatives pointed out that this equipment served no warfighting purpose, would pose ship configuration issues, and would require additional manpower with different skillsets from those available to operate the current on-board systems.

Tagging

Tagging has proven to be a very effective research tool that provides insights into how animals use their habitats. Tags have been used to examine seasonal distribution of the animals. Research is now focused on putting the seasonal distribution in context of the oceanography. Tags will provide data as to where the animals are, but not what they are doing. However, this location data can be used to examine where they are spending time looking for food, as well as any ocean features that might be present in those locations. The surface tracks from the tags can then be associated with the 3D behavior in dive patterns. Tags incorporating GPS provide more accurate locations at greater frequency, and are preferred. When combined with the data from salinity depth tags, researchers can then look at the associated physical oceanography for the respective habitats. This helps to separate out population effects from environmental effects such as climate-induced variability such as El Niño and sea surface temperatures.

How many tags does it require to accurately infer patterns for the total population? This is still an open-ended question. Looking to future research, researchers want to be able to record receive level at the animal. It is also important to get a large enough sample size to reduce uncertainty.

Focused studies

The requirements for focused studies are spelled out by the Final Rules for the three ranges (SOCAL, AFAST, and HRC). A recommendation was made that these studies be done in a serial manner, with peer reviews of the results after each study before commencing the next. This will ensure that by the third time the comparison study is made, there is confidence that it is being done well.

Adaptive Management

Based on the workshop discussions that reviewed available tools and techniques, it was suggested that there are alternative approaches that might better address the specific Navy-NMFS agreed upon study questions than those put in place by the current monitoring plans. For example, if we were to take the money being spent now on aerial surveys and instead invest it in advancing acoustic and tagging techniques, we could move ahead more quickly. However, this is not an option for 2009, as

the monitoring plans are already defined by the Final Rules for this year. Adaptive Management will be used to examine options to update the plans for 2010 and beyond.

ANIMAL ABUNDANCE AND DISTRIBUTION

The monitoring plans currently in place at the training ranges (AFAST, HRC, and SOCAL) will use a series of focused studies to examine the behavioral responses of marine mammals exposed to MFAS and any associated geographic redistribution as a result of that exposure. Before undertaking these studies, it is important to assess the initial conditions for animal abundance and distribution. It is also critical to have baseline data on the normal responses and time budgets associated with how animals use time and space, as well as the level of adaptability that is inherent to the species. However, it was acknowledged that in some cases we are starting with next to no information. Data is very sparse.

A series of different approaches is needed to derive the best information available on marine mammal distribution and density. This is particularly true for some ranges where the animal density is low, which in turn makes it more difficult to determine incremental changes in marine mammal density caused specifically by human activities with any statistical confidence.

Densities are generally seasonal averages obtained for a relatively large spatial area. From these densities, models are used to estimate the number of animals that might be exposed in the small areas and short times that corresponds to the Navy's operation. However, given the mismatch in temporal and spatial scales coupled with normal daily fluctuations, these model predictions are often poor. There is a need to improve density estimates to better match spatial, temporal, and habitat scales of Navy operations. This can only be done with a long-duration monitoring effort.

In monitoring the abundance of marine mammals, it is important to consider the various factors that might influence the relative density in a specific area. Are the animals resident or migratory? If they move out of the monitoring area, is that biologically significant? Low animal density may be due to low population size. If this is the case, then the monitoring goals should be to understand risk to the existing populations. This is different than low-density situations in high productivity areas where animals are being displaced. Photo-ID is an effective monitoring approach when there is a low resident population. It generally takes a combination of methods (photo-ID along with genetic sampling and tagging evidence) to assess the resident population.

It is also important to consider the objective of the monitoring study when selecting location. For example, lower densities of beaked whales at AUTEC can make it easier to sort things out in comparison to dealing with the higher densities at SCORE - at least in terms of individual responses. In other cases, research into animal behavior would be more effective in high-density areas. Higher densities are also important for assessing trends in density. However, monitoring will be primarily conducted in areas where the Navy operates, which may not provide the optimal location for the intended study. Navy operations are designed to take place in locations with lower marine mammal densities to the maximum extent practicable to limit potential effects on marine resources.

There are two types of behavioral responses that are of primary interest to the regulators. First, they are looking for any general responses that link the behavioral response to harassment. They would also like to have insight into behavioral responses in specific habitats, such as reproductive and

feeding areas, in order to determine if additional mitigation is needed in these more biologically unique areas.

There are many factors to take into account in assessing behavioral responses. First, it is important to monitor for any changes in the environment, and then separate the effects. For example, there is considerable environmental variability in Onslow Bay due in large part to the meandering presence of the Gulf Stream. It is important to understand this variability and its effects on the distribution / redistribution of marine mammals. Unmanned vehicles (aerial and submersibles) are one means of obtaining this information, particularly during periods when visual surveys are not feasible.

Some workshop participants thought it was premature to discount the ability to scale up from individual behaviors to population-level effects. There was not unanimous agreement on this point. The ability to measure populations is very limited. There is value in looking at individual behaviors in order to bound the problem.

The workshop participants also pointed out limitations they will face in conducting the focused studies. The researchers can only make observations where they have sensors. When the mammals move off the range, they are left to wonder, "What happens then?" One way to address this is to increase the number of animals with tags to support additional tracking. Other participants pointed to the need to take in account longer trends using photo-ID. Previous research indicated that the resight rate of individual animals drops off precipitously over time. To better assess animal movement and distribution, there is a need to monitor farther out in time and space to improve our models of density, habitat, and trends.

MODELING

The Navy uses models to predict the number of takes. From the regulator's point of view, they want to know if these models reflect reality. It appears that the Navy model overestimates the numbers affected. NMFS would like a better understanding of how many animals are actually in the area during an exercise.

The real world situation is more complex than simple models provide. Models tend to overestimate abundance. Also, animal densities in selected areas might be associated with certain oceanographic features rather than uniformly spread across the region. Habitat information and seasonal fluctuations need to be incorporated to improve model predictions. There is a need for complementary monitoring methods, such as tagging, to obtain the required habitat and seasonal fluctuation data. Additionally, simple-minded exposures are not sufficient to determine behavioral response. It is too simplistic to assume that density levels determine exposure, and then population levels determine impact. There are more variables involved. However, it is accepted that understanding these two factors provides the critical floor for more complex modeling.

ONR is funding development of the Population Consequences of Acoustic Disturbance (PCAD) model. This model incorporates two approaches – looking at both individual animal and population trends. Baseline data is needed for the PCAD effort. Currently, there is significant variation in available baseline data for species of particular interest. For example, there is a significant knowledge base for blue fin whales off California, because someone took the extended time and effort to do the studies. Then there are several populations in decline where there is no significant knowledge base and other populations in decline where we are making steady progress in understanding. Long-term data sets that include population levels, calving rates, and densities,

among other parameters need to be included in the modeling. Individual animal behaviors are important to capture. Obtaining the needed data is far more dependent on maintaining a long-time horizon and sustained effort rather than high technology solutions.

NMFS OPR has not adopted the PCAD approach, as they are not focused on the population at the outset. They start with the individual animals, as it is individuals that are exposed. What does the sound exposure mean for the individual? After considering the potential effect to individual animals, then effects to the population and species are considered. The regulators did confirm they want consistency over time to be able to examine trends and agreed that this is more important than consistency across geographical regions.

The regulators also cautioned the group not to confuse monitoring efforts with research into effects analysis. They have two separate areas of focus: exposure and impacts. Monitoring looks at exposures through a nested set of observations. It starts with focused monitoring studies on instrumented ranges, followed by opportunities to look at exposures on a larger scale off the instrumented ranges by monitoring various exercises and operations. With the observations typically made during monitoring, one can begin to assess individual responses and impacts. However, observations of individual responses do not provide enough information to extract "negligible impacts."

Population trends spanning twenty years help to establish the baseline regarding any potential impacts from active sonar operations. These trends are used in forming the biological opinions. However, they are not sufficient to say we are "out of danger" for endangered species. In the absence of more specific data, the trend does help defend the case – but only as a diagnostic.

SUMMARY TABLES FROM FACILITATED DISCUSSIONS:

CURRENT CAPABILITIES FOR MONITORING the exposure of animals to mid-frequency active sonar:

High levels (PTS/TTS) can be detected only from source vessel.
Need calibration of watchstander detection function
Low levels (behavioral) can occur at a substantial distance (beyond watchstanders vision)
1. Model based approach a. Predict locations of animals (from suite of methods) b. Model movement/ diving behavior of animals c. Know source locations d. Calculate sound propagation to animal location 2. Direct measurement at animals a. 3rd party observing b. satellite tag for position c. acoustic tag for recording of received level. d. Use passive acoustics / instrumented ranges e. Integrate suite of methods

GOALS FOR MONITORING CAPABILITIES that could be achievable in 3-5 years with associated R&D:

High levels (PTS/TTS) can be detected only from source vessel.
1) Need to detect submerged animals • active /passive sonar • JMMES, a multispectral air sensor *[Joint Multi-Mission Electro-Optical System (JMMES) is an aircraft sensor designed to enable passive, nonintrusive detection of submerged and concealed targets – but from the Navy rep's perspective, this was not a practical approach, as it had a restrictively narrow field of view and was cost prohibitive]* 2) Improved detection of surface animals, particularly at times of reduced visibility • radar • infrared
Low levels (behavioral) can occur at a substantial distance (beyond watchstanders vision)
1) Model based approach • How to update model predictions? Last-minute data useful? • Passive acoustic abundance estimate, location from range phones • Animals acoustic ecology • Diving behavior of animals 2) Direct Measurement at animals • Satellite tag for position • Longer lasting tags (attachment, and battery issues) • Need tags that can measure received level • GPS capability in small tag (substantial location improvement over ARGOS) • OARS (ocean acoustic waveguide, a type of active sonar)

CURRENT APPROACHES FOR ASSESSING BEHAVIORAL RESPONSE in response to exposure of mid-frequency active sonar:

Fine-scale
Passive Acoustic Monitoring (particularly on instrumented ranges) Photo-ID Tags (D-Tags and Satellite Tags) Opportunistic focal animal studies Access to ranges during exercises
Longer Term
Monitoring abundance and demographic parameters Surveys – taking into account effects of environmental variations Photo identification Sampling to support Passive Acoustic Monitoring ((S)PAM)
Other considerations
Requires research using controlled exposure to MFAS and possible scaled stimuli, and further research on acoustic ecology. Requires creation and management of central data archives Consider different acoustic metric for disparate (explosive acoustic) stimuli

GOALS FOR ASSESSING BEHAVIORAL RESPONSE that could be achievable in 3-5 years with associated R&D:

Identify individual animals from passive acoustics
Short-term – distinguishing individual animals (easier) Long-term identity (harder)
Passive acoustic monitoring
Detection, Classification, Localization & Density Improve algorithms Establish standards for data and performance metrics DECAF and… (e.g. vertical arrays) Uncertainty in environment, behavior, etc. Array design (e.g. sensor placement & dispersion) Upgrades to & availability of analytical tools Stock identification Alternative platforms
Improve Tag Technology
Longer-term tag deployments Improvements in data telemetry (e.g. acoustic modems & OTN) Tags that transmit acoustics, behavior & physiology (acoustic ecology) GPS Improved analysis of telemetry data sets
Integration & fusion of disparate data types
Biopsy sampling for stress hormones
Alternative survey platforms (UAV, USV & UUV)
Other considerations
Development of portable sound sources Determine the most efficient combination of monitoring approaches

NEXT STEPS:

Outcomes and information resulting from this workshop will be used to inform the development of the Integrated Comprehensive Monitoring Program. It will also be used to provide input to the Adaptive Management Review to be held in the fourth quarter of calendar year 2009.

Marine Mammal Monitoring Workshop

February 19-20, 2009
Duke University, Durham NC

Agenda

Goals for Meeting

- Review on-going efforts and identify existing monitoring capabilities
- Define requirements for improvement of monitoring capabilities
- Identify research and development needed to meet monitoring goals

Specific Questions for Consideration

Q1. At what levels are marine mammals exposed to active sonar and explosions?
Q2. What are their behavioral responses to exposure?
Q3. Are current mitigation measures effective?

Thursday, February 19

8:00 – 8:15	Welcome, Introductions, Review Meeting Agenda
8:15 – 8:30	Review of Navy Needs and Meeting Objectives Frank Stone (CNO N45)
8:30 – 9:00	Monitoring Regulatory Requirements Overview Jolie Harrison/Craig Johnson (NOAA – OPR)
9:00-10:45	Overview of Current Monitoring Activities
	9:00 Debbie Palka (NEFSC)
	9:15 Andy Read (Duke)
	9:30 Dave Moretti (NUWC)
	9:45 Peter Tyack (WHOI)
	10:00 Jay Barlow (SWFSC)
	10:15 John Hildebrand (SIO)
	10:30 John Calambokidis (Cascadia)
	10:45 Robin Baird (Cascadia)
11:00-11:15	Break
11:15-12:00	Discussion of Current Approaches – Andy Read
12:00-1:00	LUNCH
1:00 – 2:30	Advances in Monitoring Approaches
	1:00 Len Thomas (St Andrews)
	1:15 Dan Costa (UCSC)
	1:30 Dave Mellinger (OSU)
	1:45 Marie Roch (SDSU)
	2:00 Ching-Sang Chiu (NPGS)
	2:15 Doug Nowacek (Duke)
	2:30 Dave Johnston (Duke)

Agenda continued

2:45 – 3:00 Break
3:00 – 4:00 Discussion of Advances in Monitoring – John Hildebrand
4:00 - 4:30 Naval Mitigation Measures
4:00 Chip Johnson (CPF) – Pacific
4:15 Jene Nissen (USFF) – Atlantic
4:30 – 5:15 Discussion of Mitigation – Jay Barlow
5:15 – 5:30 Wrap-up Day 1 – Frank Stone

Friday, February 20
8:00 – 8:15 Opening Remarks, Summary of Day One
Frank Stone (N45)

8:15 – 8:30 Review of Current Monitoring Discussion – Andy Read
8:30 – 8:45 Review of Monitoring Advances Discussion – John Hildebrand
8:45 – 9:00 Review of Mitigation Discussion – Jay Barlow

9:00 - 12:00 Discussion of Workshop Questions in Subgroups
Current Monitoring Group – Andy Read
Monitoring Advances Group – John Hildebrand

12:00 - 1:15 LUNCH

1:15-2:45 Discuss Components of Workshop Report including
Monitoring Plan

2:45 - 3:00 Summarize Meeting Outcome and Next Steps – Frank Stone

3:00 Adjourn

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Attendees:

Baird	Robin	Cascadia Research
Barlow	Jay	NOAA-Southwest Fisheries Science Center
Bell	Joel	Naval Facilities Engineering Command Atlantic
Brake, USN	CAPT Robin	Office of the Deputy Assistant Secretary of Defense for the Environment (ODASN – Environment)
Calambokidis	John	Cascadia Research
Chiu	Chingsang	Naval Postgraduate School
Costa	Dan	Long Marine Lab
Eckman	Jim	Office of Naval Research (ONR)
Fetherston	Tom	Naval Undersea Warfare Center (NUWC)
Frankel	Adam	Marine Acoustics Inc (MAI)
Garrison	Lance	NOAA-Southeast Fisheries Science Center
Gentry	Roger	Joint Industry Program (JIP)
Good	Caroline	Duke University Marine Lab
Hall	John	Strategic Environmental Research and Development Program/ Environmental Security Technology Certification Program (SERDP/ESTCP)
Halpin	Pat	Duke University Nicholas School of the Environment
Harrison	Jolie	NMFS Office of Protected Resources
Hazen	Lucie	Duke University Marine Lab
Hildebrand	John	University of California San Diego, Scripps Institution of Oceanography
Johnson	Craig	NMFS Office of Protected Resources SSMC3
Johnson	Chip	United States Pacific Fleet - PACFLT Environmental
Johnston	Dave	Duke University Marine Lab
Joseph	John	Naval Postgraduate School
Kumar	Anu	Naval Facilities Engineering Command Atlantic
Mazzuca	Lori	Naval Facilities Engineering Command Pacific
McLellan	William	UNC Wilmington Biology & Marine Biology Department
Mellinger	David	Oregon State University (OSU)
Moretti	David	Naval Undersea Warfare Center (NUWC)
Nissen	Jene	United States Fleet Forces (USFF) - Environmental
Nowacek	Doug	Duke University Nicholas School of the Environment
Palka	Debi	Northeast Fisheries Science Center
Read	Andy	Duke University Marine Lab
Rivers	Julie	Commander, Pacific Fleet (CPF) N01CE1JR
Roch	Marie	San Diego State University Computer Science Department
Soldevilla	Melissa	Duke University Marine Lab
Smith	Amy	Science Applications International Corporation (SAIC)
Stone	V. Frank	OPNAV N456, Operational Environmental Readiness and Planning Branch
Thomas	Len	Centre for Research into Ecological and Environmental Modeling (CREEM), University of St Andrews, Scotland
Van Parijs	Sofie	Northeast Fisheries Science Center
Weise	Michael	Office of Naval Research (ONR)
Williams	Lynne	Duke University Marine Lab