# APPENDIX C

(INCLUDED AS APPENDIX C WITHIN:
FINAL 2013 COMPREHENSIVE EXERCISE AND MARINE SPECIES
MONITORING REPORT FOR THE U.S. NAVY'S HAWAII RANGE COMPLEX)

# HRC DATA ANALYSIS PLANNING MEETING, 10–11 SEPTEMBER 2012

## FINAL MEETING REPORT

April 2013

# EXECUTIVE SUMMARY

A working group of experts (i.e., biologists, acousticians, and other researchers with extensive experience working in the Hawaii Range Complex [HRC]) was convened in San Diego, California, for an HRC Data Analysis Planning Meeting on 10 and 11 September 2012. The purpose of the meeting was to assess how existing HRC monitoring data can be used to support the United States (U.S.) Pacific Fleet's regulatory requirements to determine the: 1) presence/absence, abundance, and density of marine mammals and sea turtles in the HRC; and 2) behavioral responses of marine mammals and sea turtles to U.S. Navy training exercises, including mid-frequency active sonar and underwater detonations. In accordance with the scope of work for this task order, the group suggested revising the existing HRC monitoring questions to be framed in the context of the 2010 Scientific Advisory Group's (SAG) recommendations regarding assessment of noise impacts (DoN 2011). The working group assessed the current status of various HRC monitoring data collection methodologies, and reviewed their relative strengths and challenges vis-a-vis the U.S. Navy's regulatory requirements and the SAG goals. Finally, the working group suggested specific data analyses of existing datasets that could be undertaken to address some of these revised questions. The group also made general recommendations on where to concentrate future HRC monitoring and data collection efforts. As an overall conclusion, the group recommended that a targeted, yet integrated scientific approach involving multiple and combined methods be used to monitor marine mammals and sea turtle living marine resources, in which simultaneous, synoptic data acquisition on both animals and realistic training events occur.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AEP | Auditory Evoked Potential |
| AIS | Automatic Identification System |
| B/D/A | Before/During/After |
| BURP | Biological Underwater Recording Package |
| DTAG | Digital Acoustic Recording Tag |
| DoN | Department of the Navy |
| EAR | Ecological Acoustic Recorder |
| HRC | Hawaii Range Complex |
| HRC WG | HRC Working Group |
| ICMP | Integrated Comprehensive Monitoring Program |
| MFAS | mid-frequency active sonar |
| NMFS | National Marine Fisheries Service |
| PAM | Passive Acoustic Monitoring |
| PIFSC/SIO | Pacific Islands Fisheries Science Center/Scripps Institution of Oceanography |
| PMRF | Pacific Missile Range Facility |
| PTS | permanent threshold shift |
| RL | Received level |
| ROCCA | Real-time Odontocete Call Classification Algorithm |
| SAG | Scientific Advisory Group |
| SPORTS | SONAR Positional Reporting System |
| SVP | Sound Velocity Profile |
| TTS | temporary threshold shift |
| U.S. | United States |

# INTRODUCTION

The United States (U.S.) Pacific Fleet has conducted marine species monitoring in the Hawaii Range Complex (HRC) since 2006. In some cases, monitoring efforts overlapped in time and space with U.S. Navy training events. However, adequate information (available in an unclassified setting) about training events concurrent with monitoring effort/data has been limited. From 10-11 September 2012, a working group (i.e., biologists, acousticians, and other researchers with extensive experience working in the HRC) was convened for a Data Analysis Planning Meeting in San Diego, California, to review existing HRC monitoring data relative to U.S. Navy monitoring requirements and goals outlined in various management documents (e.g., Department of the Navy [DoN] 2010, DoN 2011). The primary goal was to evaluate the usefulness of these data to address questions regarding the following aspects of marine mammal and sea turtles species in the HRC: (1) presence/absence, abundance, and density, and (2) behavioral responses to U.S. Navy training events, including mid-frequency active sonar (MFAS) testing and underwater detonations. The group reviewed available visual, acoustic, and tagging data, both as individual datasets and as a whole, in order to: (1) suggest effective analysis approaches for existing HRC monitoring data, and (2) identify possible synergistic approaches to the analysis of multiple datasets to improve the effectiveness and utility of future datasets.

Meeting attendees were as follows:

Robin Baird (Cascadia Research Collective)
Thomas A. Jefferson (Clymene Enterprises)
Marc Lammers (University of Hawaii, Oceanwide Sciences Institute)
Steve Martin (Space and Naval Warfare Systems Center, Pacific)
Joseph Mobley, Jr. (University of Hawaii; HDR, Inc.)
Paul Nachtigall (University of Hawaii)
Tom Norris (Bio-Waves, Inc.)
Julie Oswald (Bio-Waves, Inc.)
Mari Smultea (Smultea Environmental Sciences, LLC)
Brandon Southall (Southall Environmental Associates, Inc.)

Whitlow Au (University of Hawaii) and Chris Clark (Cornell University) could not attend the meeting and were not part of the core working group. However, they reviewed the meeting's work products and provided input during the meeting's follow-up process.

# METHODS

Participants were asked to: (1) assess the feasibility of answering the five original monitoring questions presented in the HRC Monitoring Plan (DoN 2008) using the existing data sets, (2) identify two to five additional Fleet monitoring relevant questions (guided by the Integrated Comprehensive Monitoring Plan [ICMP] and Scientific Advisory Group [SAG] report, described below) which are answerable within a designated time frame and budget using the existing data sets, 3) provide a cost estimate and timeline menu for each of the questions, and 4) work with the Navy to develop an estimated 3-10 page plan to answer the final selected questions (selected by the Navy from a and b) using the existing data. In completing these specified tasks, participants first assessed the original monitoring questions in the context of a recommended conceptual framework developed by the SAG convened in 2011. The working group then integrated these original questions directly into a revised set of monitoring questions and objectives based on the

SAG framework. Available datasets and analytical requirements were also assessed using this framework, and the group estimated relative costs and timelines for respective analytic approaches. Finally, the working group developed recommendations according to a prioritized approach, with high-priority monitoring questions answerable in the short term taking precedence over lower-priority questions that may take years, or even decades to answer.

Data analyses proposed by the group, based on the assessments that form the basis of this report, were in addition to those already required under the scope of work for the comprehensive HRC data analysis task order (Contract Task Order KB19, Contract # N62470-10-D-3011) currently underway. Discussions and conclusions of the working group are the foundations of this report, which reflect the collective contributions of all members' input and review.

The working group reviewed existing monitoring datasets and reports prior to the meeting. Documents were made available on a collaborative project Microsoft SharePoint website set up by HDR to provide access to relevant documents. Meeting minutes and other post-meeting documents were housed on this website. Presentations made on the first meeting day summarized four categories of monitoring platforms and associated existing datasets: vessel-based monitoring, aerial-based monitoring, acoustic monitoring, and animal tagging. Presentation content was made available to the group after the meeting for reference.

The HRC working group then reviewed the following original five HRC Monitoring Plan study questions:

1. Are marine mammals (and sea turtles) exposed to MFAS, especially at levels associated with adverse effects (i.e., based on National Marine Fisheries Service's [NMFS'] criteria for behavioral harassment, temporary threshold shift [TTS], or permanent threshold shift [PTS])? If so, at what levels are they exposed?
2. If MM/ST 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 U.S. Navy's suite of mitigation measures for MFAS (e.g., measures agreed to by the U.S. Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals?

In March 2011, a Scientific Advisory Group (SAG) was convened by the U.S. Navy to evaluate current and future U.S. Navy monitoring plans and update the Integrated Comprehensive Monitoring Program (ICMP, DoN 2011). In the process, the SAG recommended recasting these five questions within a new conceptual framework for the following reasons: (1) to develop more focused and answerable questions related to both acute and longer-term effects of disturbance of marine mammals from U.S. Navy training, (2) to guide monitoring efforts and data collection activities, and (3) to assess monitoring opportunities specific to each U.S. Navy training range complex. The suggested framework involved four broad categories of study questions: (1) animal occurrence, (2) exposure to Navy-generated underwater noise, (3) responses to underwater noise, and (4) long-term consequences to animal populations. The HRC working group's approach was consistent with that of the SAG. The four categories of **occurrence, exposure, response,** and **consequences** were then further refined to address specific HRC meeting objectives (e.g., to address "presence/absence, abundance, and density" of marine species in the HRC, as well as their behavioral responses to U.S. Navy training events). The newly developed categories were:

1. **Baseline biological information**
2. **Exposure** to underwater noise
3. **Effects and responses** of marine species to underwater noise
4. Long-term **consequences** of underwater noise on marine species populations.

"Occurrence" was changed to "baseline biological information" to capture baseline behavioral data as well as baseline abundance and distribution data. "Effects" was changed to "effects and responses" in order to include all potential effects of noise exposure, for example masking and physiological effects, that may not necessarily manifest as behavioral (or observable) animal responses. A series of hypotheses related to these four categories was then developed. This gave rise to a series of 12 proposed HRC study questions (three per category). The proposed questions are presented in the context of their relationship with the original HRC Monitoring Plan study questions in **Table 1**.

In addition to revisiting the study questions relevant to HRC monitoring, the group assessed current monitoring techniques. This was based on the amount and types of data currently available for the HRC, and strengths and weaknesses of each approach. An abbreviated version of these assessments is presented in **Table 2,** and in complete form in **Appendix A**. This information is intended to provide the Navy with a decision-making tool for assessing current and guiding future monitoring efforts in HRC.

The revised monitoring questions developed by the HRC Working Group were also reviewed according to four criteria. *Criterion (1): the current status of our knowledge in the HRC relative to the revised questions*. This was essentially a data gap analysis to help determine if, and how, existing datasets may be used to address the revised monitoring questions. Results are found in **Appendix B**. *Criterion (2): existing datasets available for analysis in order to address each question*. This was a requirement of the scope of work, in which the WG was asked to review all existing datasets (monitoring and otherwise) and identify those which can be used to answer the revised questions. Results are found in **Appendix A**. *Criterion (3): prioritize revised questions based on overall importance and short-term answerability, and recommend specific analyses that can reasonably be accomplished in the reporting timeframe of the current task order (June 2013).* This assessment was intended as a practical and immediate decision-making tool for the Navy, and was shaped by the findings from criteria (1) and (2). Results are found in **Tables 3** and **4**. *Criterion (4): list of broader recommendations for future monitoring methods and analyses.* This information was included to assist the Navy in long-term planning of monitoring efforts. Results are found in **Appendix B**. Finally, the group was asked to provide a qualitative assessment (low-to-high) of the extent to which the proposed questions can be addressed using existing monitoring techniques (assuming access to existing data). The group then rated each question assuming *additional* monitoring effort in the future. The purpose of this exercise was to evaluate various monitoring techniques and to identify their relative usefulness in answering the proposed study questions. There was insufficient time at the in-person meeting to accomplish this. Thus, participants were asked to respond to an online survey (using the SurveyMonkey® online application) subsequent to the meeting. In this survey, they were asked to rate each question accordingly. This approach provided an opportunity for all participants to provide their assessments in a systematic way, and for responses to be summarized in an impartial manner. Respondents had the option to include comments in addition to answering each question. All answers and comments are presented in **Appendix C**. It should be noted that while the group was tasked with assessing datasets and proposed analyses for "marine species," the expertise of the HRC WG was in marine mammalogy, and there was no in-depth discussion of sea turtles or other marine species.

**Table 1. Original and revised HRC monitoring questions.**

| Original 5 Monitoring Question(s) Addressed 1/ | Revised Monitoring Questions | | |
|---|---|---|---|
| | **Baseline Biological Questions** | | |
| (2) (3) (4) | (1) How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups? | (2) How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups? | (3) What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC? |
| | **Exposure Questions** | | |
| (1) | (1) How well are U.S. Navy noise-generating activities known and available outside of the classified realm? | (2) How well do sound propagation models predict received levels? | (3) How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups? |
| | **Effects and Response Questions** | | |
| (2) (3) (4) (5) | (1) Do we know what exposure levels to MFAS or underwater explosion exposures cause temporary threshold shift (TTS), permanent threshold shift (PTS), injury, or mortality to MM/ST? | (2) What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions? | (3) When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last? |
| | **Consequences Questions** | | |
| N/A | (1) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST? | (2) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST? | (3) Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST? |

Note: [1] See Methods, pg. 2 for the numbered list of original questions.

Key: HRC = Hawaii Range Complex; MFAS = Mid-Frequency Active Sonar; MM/ST = Marine Mammals/Sea Turtles; PTS = permanent threshold shift; TTS = temporary threshold shift

**Table 2. HRC Monitoring Platform Assessment: Strengths & Challenges.**

| Method/ Data Type | Strengths | Challenges |
|---|---|---|
| **Vessel-based Surveys** | 1) Versatile platform may allow: line-transect data, focal follows, tagging, photo-identification, biopsy, and PAM.<br>2) If data integrated, useful for occurrence, distribution, behavior correlation with U.S. Navy activities.<br>3) Anecdotal observations (e.g., bow-riding dolphins during MFAS).<br>4) Focal follows conducted within view of U.S. Navy activities. | 1) Sighting sample sizes small for abundance/density.<br>2) Detailed sonar and U.S. Navy training info needed to correlate behavior/occurrence.<br>3) Data integration needed from other sampling platforms.<br>4) Medium to-large vessels costly, inflexible relative to poor sea states. |
| **Aerial Surveys** | 1) Quick synoptic view of distribution & abundance (when transects used).<br>2) With ship-follows can detect MM at high exposure.<br>3) Optical penetration below surface (<BF4), overhead group social behavior perspective.<br>4) Establishes presence and proximity of MM during training. | 1) Limited to surface and near-surface behaviors of animals.<br>2) Limited to good sea-state conditions for most species.<br>3) Difficulty identifying many odontocetes to species (possible with good photos).<br>4) Safety risks associated with offshore aerial surveys. |
| **Photo-ID and Biopsy** | 1) Biopsy sample genetics allow for assessment of population identity and sex of individuals.<br>2) Photo-identification data—allows assessment of population identification and site fidelity important for understanding sound exposure history. | 1) Limited sample sizes for some rare and/or cryptic species (e.g., beaked whales off Kauai).<br>2) Limited to data collection during favorable weather. |
| **Animal Tagging/Tracking** | 1) Satellite tags provide only unbiased source of animal location information and large sample sizes of locations for rarely seen species.<br>2) Data can be long-term tracks of movement. | 1) Difficult to tag some species due to behavior, small sample sizes of some species due to low encounter rates.<br>2) Long-term tags limited to position and basic dive data (no high-resolution movement or acoustics). |

| Method/ Data Type | Strengths | Challenges |
|---|---|---|
| **Passive Acoustic Monitoring (PAM)**<br><br>*(Includes cabled hydrophones and arrays, towed hydrophones arrays, autonomous recorders, sonobuoys and dipping hydrophones, does not include acoustic data-logger tags)* | 1) Combined visual/acoustic line-transect surveys useful for species identification, density estimates, and behavioral response measurements.<br>2) Fixed PAM installations (e.g. seafloor hydrophones) and autonomous recorders effective for long-time series of ambient noise and animal occurrence data.<br>3) Fixed PAM installations and autonomous recorders effective for coverage of large areas/long time periods with little effort.<br>4) Verification of modeled sound propagation; determination of source levels and exposure levels.<br>5) Localization and tracking of animals – may allow behavioral response studies.<br>6) Detection of MFAS and UNDET activities independent of U.S. Navy reporting.<br>7) Long-term monitoring may address population level information. | 1) For some systems, the effective frequency band of operation may be limited.<br>2) Towed hydrophone array surveys may be noise-limited.<br>3) Fixed PAM lacks visual species, group size/composition and social context verification.<br>4) Large amounts of data are generated; automated methods may be required for efficient processing.<br>5) Recorders usually duty-cycled, creating monitoring gaps.<br>6) Spatial coverage for autonomous recorders may be limited (due to limited availability or high cost of recorders and/or deployment and retrieval).<br>7) Sonobuoys are limited in duration to < 8 hr (short-term monitoring) |

Key: BF = Beaufort (Sea State); hr = hour(s); PAM = passive acoustic monitoring; MM = marine mammal(s); UNDET = underwater detonation

**Table 3. Identification of high-priority monitoring questions that may be answered in the short-term.**

***(Note: for the purposes of this report "short-term" means analyses/assessments that are possible within the next 6 months; "long-term" means analyses possible with additional data over 3-10 year time horizon. Also, there is a level of relevance/priority implied in the order of relevant data types/methods. High-priority questions that can be answered in the short term are shaded in dark gray.)***

| Baseline Biological Questions | | |
|---|---|---|
| *1) How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups?* | *2) How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups?* | *3) What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC?* |
| **Current ability to address**:<br>Moderately well for certain species (e.g., humpback whales, coastal delphinids), but poor for most pelagic species (e.g., beaked whales).<br><br>**Relevant data types/methods**:<br>PAM<br>Tagging/tracking<br>Photo ID/Biopsy<br>Aerial Surveys<br>Vessel Surveys<br><br>**Assessed relative priority:**<br>***SHORT-TERM HIGH***<br>Rationale: most fundamental questions about exposure and potential impact depend on spatial overlap with Navy training events; efforts utilizing existing data here have high potential short-term benefit<br>**LONG-TERM HIGH** | **Current ability to address**:<br>Very poor to non-existent given almost complete absence of long-term, broad spatial scale data on species-specific distribution<br><br>**Relevant data types/methods**:<br>PAM<br>Tagging/tracking<br>Photo ID/Biopsy<br>Vessel Surveys<br>Aerial Surveys<br><br>**Assessed relative priority:**<br>**LONG-TERM HIGH** | **Current ability to address**:<br>Moderately well for certain (not all) aspects for certain species (e.g., humpback whales, certain delphinids), but very poor for most pelagic species (e.g., beaked whales)<br><br>**Relevant data types/methods**:<br>PAM<br>Tagging/tracking<br>Laboratory Assessments<br>Photo ID/Biopsy<br>Vessel Surveys<br>Aerial Surveys<br><br>**Assessed relative priority:**<br>**SHORT-TERM MODERATE**<br>**&**<br>**LONG-TERM HIGH** |

| Exposure Questions | | |
|---|---|---|
| *1) How well are U.S. Navy noise-generating activities known and available outside of the classified realm?* | *2) How well do sound propagation models predict received levels?* | *3) How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups?* |
| **Current ability to address**:<br>Very limited in most cases outside classified realm | **Current ability to address**:<br>One of the more advanced and mature aspects of impact assessment; subsequent efforts should focus on field verification of modeled levels | **Current ability to address**:<br>Limited for almost all species because integrated assessments have been largely lacking. For specific species there is moderate-good potential for progress |
| **Relevant data types/methods**:<br>Internal Navy processes – outside scope of monitoring program but directly relevant | **Relevant data types/methods**:<br>PAM<br>Animal tagging/tracking | **Relevant data types/methods**:<br>PAM<br>Navy active source data<br>Tagging/tracking<br>Aerial Surveys<br>Vessel Surveys |
| **Assessed relative priority:**<br>***SHORT-TERM HIGH***<br>BUT this is an internal Navy required action and does not directly require HRC range monitoring assets | **Assessed relative priority:**<br>**SHORT-TERM MODERATE**<br>**&**<br>**LONG-TERM MODERATE** | **Assessed relative priority:**<br>***SHORT-TERM HIGH***<br>Rationale: While this is presently quite limited, for specific species there is moderate-good potential for progress by integrating distribution patterns with patterns of sound transmission<br><br>**LONG-TERM HIGH** |

| Effects and Response Questions | | |
|---|---|---|
| *1) Do we know what exposure levels to MFAS or underwater explosion exposures cause TTS, PTS, injury, or mortality to MM/ST?* | *2) What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions?* | *3) When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last?* |
| **Current ability to address**:<br>Limited information on TTS levels for several cetacean species (most notably bottlenose dolphins), with extrapolation to PTS, injury. Aerial/vessel surveys can identify animals in close proximity to active sources and provide anecdotal information<br><br>**Relevant data types/methods**:<br>Laboratory measurements<br>Anecdotal information (e.g., Silver Strand)<br>Aerial & Vessel Surveys<br><br>**Assessed relative priority:**<br>**SHORT-TERM MODERATE**<br>&<br>**LONG-TERM MODERATE** | **Current ability to address**:<br>Limited for many species but some existing data available in conjunction with actual training events (of varying degrees of quality)<br><br>**Relevant data types/methods**:<br>PAM<br>Navy active source data<br>Tagging/tracking<br>Aerial Surveys<br>Vessel Surveys<br>MMOs on Navy Vessels<br><br>**Assessed relative priority:**<br>***SHORT-TERM HIGH***<br>Rationale: While this is presently quite limited, for certain species there is moderate-good potential for progress by integrating behavioral data from PAM recordings, tags, and aerial/vessel surveys with information about MFAS and underwater detonations; there are limitations of some of these methods to identify subtle or statistically significant changes. Long-term objectives may include controlled exposure experiments<br><br>**LONG-TERM HIGH** | **Current ability to address**:<br>Limited for many species but some existing data available in conjunction with actual training events (of varying degrees of quality) – more challenging to address than short-term responses over smaller spatial scales<br><br>**Relevant data types/methods**:<br>PAM<br>Navy active source data<br>Tagging/tracking<br>Aerial Surveys<br>Vessel Surveys<br><br>**Assessed relative priority:**<br>**LONG-TERM HIGH** |

| Consequences Questions | | |
|---|---|---|
| *1) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST?* | *2) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST?* | *3) Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST?* |
| **Current ability to address**:<br>Very limited ability to address this important question with currently available data<br><br>**Relevant data types/methods**:<br>PAM<br>Navy active source data<br>Tagging/tracking<br>Aerial Surveys<br>Vessel Surveys<br><br>**Assessed relative priority:**<br>**LONG-TERM HIGH** | **Current ability to address**:<br>Extremely limited ability to address this important question with currently available data<br><br>**Relevant data types/methods**:<br>PAM<br>Navy active source data<br>Tagging/tracking<br>Aerial Surveys<br>Vessel Surveys<br><br>**Assessed relative priority:**<br>**LONG-TERM HIGH** | **Current ability to address**:<br>No ability to address this important question with currently available data<br><br>**Relevant data types/methods**:<br>PAM<br>Navy active source data<br>Tagging/tracking<br>Aerial Surveys<br>Vessel Surveys<br><br>**Assessed relative priority:**<br>**LONG-TERM MODERATE**<br>**(this is clearly a key question but progress on consequence questions 1 and 2 is required before realistically establishing this as high priority even in long-term planning)** |

Key: B/D/A = Before, During and After; BURP = Biological Underwater Recording Package; DTAG = Digital Acoustic Recording Tag; EAR = Ecological Acoustic Recorder; HRC = Hawaii Range Complex; MFAS = mid-frequency active sonar; MM = marine mammal(s); MMO = marine mammal observer; ONR = Office of Naval Research; PAM = passive acoustic monitoring; PIFSC/SIO = Pacific Islands Fisheries Science Center/Scripps Institution of Oceanography; PMRF = Pacific Missile Range Facility; RL = received level; ROCCA = Real-time Odontocete Call Classification Algorithm; SPORTS = SONAR Positional Reporting System; SVP = Sound Velocity Profile; TTS = temporary threshold shift

**Table 4. Suggested integrated analytical measures to address short-term, high-priority monitoring questions, and sampling strategies for longer-term objectives.**

***(Note: for the purposes of this report "short-term" means analyses/assessments that are possible within the next 6 months; "long-term" means analyses possible with additional data over 3-10 year time horizon. Also, there is a level of relevance/priority implied in the order of relevant data types/methods. High-priority questions that can be answered in the short term are shaded in dark gray.)***

| **Baseline Biological Questions** | | |
|---|---|---|
| *1) How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups?* | *2) How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups?* | *3) What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC?* |
| *Specific analyses identified for high-priority, short-term objectives*:<br>1) Assess distribution and habitat use patterns by validating acoustic species identification using PAM datasets with associated species-specific presence/behavioral data (vessel, aerial, tag), potentially including datasets from:<br>- PMRF PAM systems<br>-Analyze PMRF/PM data for differential use of habitat within and among species at PMRF<br>- EAR datasets (e.g., Niihau and Kaula Rock)<br>- ONR-funded deployments off Oahu and Kauai.<br>2) Integrated analysis of longitudinal aerial survey data to provide detailed assessment of selected species<br>3) Geospatial habitat modeling using existing oceanographic data for high priority species (e.g., beaked whales)<br>*Suggested approaches to address long-term objectives*:<br>Longer-term integrated monitoring approaches should prioritize synoptic sampling methods (PAM, visual, targeted tagging). Particular areas of need include density estimates for all species and distribution/density information for pelagic species. | *Suggested approach to address moderate priority and long-term objectives*:<br>Sustained and methodologically consistent PAM, aerial and vessel survey, satellite tagging, and photo-ID sampling. Addressing this question adequately will not be possible for all HI marine mammals, but a dedicated effort to sample several different species representing different groups (e.g., baleen whales, coastal delphinids, pelagic species) should be taken using an integration of sampling approaches most appropriate to each representative species. | *Suggested approach to address moderate priority and long-term objectives*:<br>Tag data (including both satellite and acoustic tags but with a high priority on obtaining some depth/3D movement and acoustic data) still needed for most species. These data should be integrated with visual survey and PAM approaches (e.g., visually validated acoustic recordings and behavior/vocalization rates from tags or observations).<br>Basic hearing data (with particular emphasis on use of auditory evoked potentials with rapid response to stranded animals) for currently untested species will remain a need in the moderate and long-term (priority: any mysticete, melon-headed whale). |

| Exposure Questions | | |
|---|---|---|
| *1) How well are U.S. Navy noise-generating activities known and available outside of the classified realm?* | *2) How well do sound propagation models predict received levels?* | *3) How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups?* |
| *Suggested approach to address both short-term high priorities and long-term objectives*:<br><br>This is an internal Navy issue, which obviously must be resolved with security considerations, rather than something specific to the HRC monitoring effort. However, a systematic method for accurately obtaining and providing necessary information on spatiotemporal use of U.S. Navy MFAS and underwater detonation activities is clearly and critically needed to fully interpret the environmental and monitoring data. This process should result from a dialogue between the U.S. Navy and scientists working on these issues to find a systematic, agreed-upon approach and timeline. Navy-funded PAM deployments could be used to test accuracy of SPORTS databases in terms of actual MFAS usage. | *Suggested approach to address moderate priority and long-term objectives*:<br><br>This is arguably the most well-known or established aspect of the identified monitoring questions, given that the position of sound sources and animals can be determined or reasonably estimated. There are some moderate priority needs in terms of model validation using real-animal positions; sustained efforts to collect *in-situ* SVP data and validation of propagation models from remote-deployed and animal-borne acoustic sensors would provide such assessment. | *Specific analyses identified for high-priority, short-term objectives*:<br><br>1) Use marine mammal acoustic behavior before, during, and after selected periods with known MFAS transmissions using PMRF PAM data to identify exposure RLs<br>2) Analyze satellite-tagged animal movement data in relation to PMRF PAM data, Navy vessel MMO, aerial survey data, and known MFAS use patterns.<br>3) Compile an aggregate account of marine mammal sightings made from various observer platforms (e.g., aerial surveys, Navy-vessel observers) in known proximity to MFAS sources and estimate RLs<br><br>*Suggested approaches to address long-term objectives*:<br>This is perhaps the greatest area of opportunity for HRC monitoring to address a difficult and important question. Synoptic, integrated sampling using PMRF PAM, vessel-based MMOs (including systematic behavioral sampling from Navy destroyer MMOs) and aerial-survey focal follows should be conducted before, during, after selected MFAS activity. Additional tagging effort (to include position, movement, and ideally acoustic tags) prior to training events or controlled exposures should be included. |

| Effects and Response Questions | | |
|---|---|---|
| *1) Do we know what exposure levels to MFAS or underwater explosion exposures cause TTS, PTS, injury, or mortality to MM/ST?* | *2) What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions?* | *3) When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last?* |
| *Suggested approach to address moderate priority and long-term objectives*:<br><br>These questions can only be addressed empirically in controlled, captive settings, although anecdotal or observational data from realistic field scenarios may provide some additional support. Further studies are needed on TTS-onset and frequency-responses in selected species to address threshold impact criteria and refine frequency-weighting functions. Advance planning to be prepared for HRC investigations of marine mammal stranding events to use as opportunities to gain information for injury/mortality. | *Specific analyses identified for high-priority, short-term objectives*:<br><br>1) Use PMRF PAM sensors to compare marine mammal acoustic behavior before, during, and after selected periods with known MFAS transmissions using estimated exposure RLs.<br>2) Analyze and integrate tagging data with available PMRF PAM data, U.S. Navy vessel MMO, and aerial survey data for selected situations with known MFAS transmissions.<br><br>*Suggested approaches to address long-term objectives*:<br>Case study examples or inventory of observations of animals by vessel-based MMOs and aerial-survey focal follows around U.S. Navy training events. Simultaneous and coordinated use of multiple data acquisition capabilities (i.e., visual surveys, PAM, tagging) around realistic, selected U.S. Navy sound-producing activities; could include controlled and integrated measurements using acoustic tagging. | *Suggested approach to address moderate priority and long-term objectives*:<br><br>Subsequent monitoring efforts (e.g., Feb 2013) should integrate synoptic, multi-modal data collection methods (i.e., PAM, visual, tagging) with pre-planning coordination (amongst scientific teams and with U.S. Navy). Targeted PAM and tagging deployments before training activities in areas just off the range could provide indication of movement to areas off the range. Given the time and spatial scales required to adequately address these questions, a targeted, focused approach using a wide suite of sensors to monitor selected training activities and species is likely more fruitful than using one selected method (e.g., aerial surveys) to monitor large areas for all species. |

| Consequences Questions | | |
|---|---|---|
| *1) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST?* | *2) Do U.S Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST?* | *3) Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST?* |
| *Suggested approach to address long-term objectives*:<br><br>Each of these consequences questions will require sustained effort and realistic expectations about what can reasonably be achieved, even over the long-term. Addressing cumulative effects on the individual level will require repeated photo-ID, biopsy samples, and ideally data on reproductive patterns. Protocols should be in place to ensure AEP and physiological measurements in the rare case in which a known animal live-strands. | *Suggested approach to address long-term objectives*:<br><br>This is another challenging question that will require sustained and consistent measurements using various data-collection methods in targeted sites to support time-series analyses of local populations. Photo-identification with mark-recapture analyses to assess trends in abundance for populations with high and low levels of exposure. As in other questions, a targeted approach focusing on several key species is preferred over a diffuse one for many species. | *Suggested approach to address long-term objectives*:<br><br>This is the most challenging of the monitoring questions posed to address. Longer-term effort will require biological and environmental data integration, geospatial analytical tools for both animal and noise distribution (e.g., NOAA Cetacean & Sound Mapping Working Group) and longitudinal trends. |

Key: AEP = Auditory Evoked Potential; AIS = Automatic Identification System; HRC = Hawaii Range Complex; MM/ST = Marine Mammals/Sea Turtles; MMO = Marine Mammal Observer(s); NOAA = National Oceanic and Atmospheric Administration; PAM = Passive Acoustic Monitoring; PMRF = Pacific Missile Range Facility; SVP = Sound Velocity Profile; TTS = Temporary Threshold Shift

## RESULTS

A summary of the group's assessments are found in **Tables 2–4**. Detailed responses and the results of the online poll are found in **Appendices A-C**. Appendices reflect a working-level, "raw" information produced by the group. This information is distilled and encapsulated in simpler form in the tables found in the main body of this report.

## DISCUSSION

An important outcome of the HRC Data Analysis Planning Meeting was an objective assessment of the strengths and weaknesses of different data types to address specific questions related to baseline behavior, exposure, response, and consequences. The meeting participants identified these as they relate specifically to HRC monitoring goals. The working group agreed that there are critical needs for integration of effort across different monitoring methods. This includes synoptic measurement using integrated monitoring methods. Complementary data collection methods and data integration across datasets will enhance the information products generated by the U.S. Navy's HRC Monitoring Program. Equally important is the need to have detailed information about U.S. Navy training exercises in time and space in order to relate potential responses (or not) to training activities (e.g., MFAS and underwater detonations).Three questions and related proposed analyses were identified by the HRC WG as high-priority and answerable in the short-term, i.e., by June 2013 (**Table 5**).

**Table 5. High-priority HRC monitoring questions answerable in the short term.**

| Revised Monitoring Question | Question Category |
|---|---|
| How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups? | Baseline Biology |
| How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups? | Exposure |
| What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions? | Effects and response |

The group did not identify any questions related to long-term consequences (of underwater noise on marine species populations) as being "short-term high-priority". This assessment should not be interpreted as a dismissal of this type of question, since potential long-term, population-level noise effects on marine species is a critical issue deserving further attention. However, in the context of the HRC WG meeting and report, this category of questions is not answerable in the short-term, and therefore this type of analysis is not an appropriate focus for U.S. Navy HRC monitoring resources at this time.

Proposed analyses (to be accomplished by June 2013) combine a variety of existing datasets, including passive acoustic monitoring, animal telemetry, photo ID and biopsy, Navy active source data, and aerial and vessel surveys. For example, the group recommends using PMRF and EAR datasets in conjunction with tagging, geospatial habitat modeling and visual survey data to improve our understanding distribution and density of marine species in HRC. By taking an integrated approach to answer the three prioritized monitoring questions (**Table 5**), the WG recommends using a combination of methods to monitor marine mammals and sea turtles, in which simultaneous, synoptic data acquisition on both animals and realistic training events occur.

Overall, the HRC WG assigned a high degree of importance to timely and centralized accrual and maintenance of long-term datasets in the HRC and other training range complexes. This is the only way to improve our understanding of potential long-term and chronic noise effects on marine mammals and sea turtles.

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# APPENDIX C-A

# Assessment of HRC Monitoring and Sampling Effort to Date

## Table A1-1. Assessment of HRC Effort to Date: Vessel-based Visual Surveys.

| Relative Effort | Key publications and documents | General Summary/ Overview | Datasets | Strengths | Challenges | Relative cost/year |
|---|---|---|---|---|---|---|
| - Less effort (hr, km) than U.S. Navy-funded aerial & PAM<br>- Effort small compared to NMFS surveys, but largest vessel effort off NW Kauai, some coordinated w/ Barking Sands hydrophones & aerials. | - Norris et al. 2005.<br>- Rankin et al. 2007.<br>- Smultea et al. 2007, 2008.<br>- Smultea 2008.<br>- Uyeyama & Hanser 2010a,b.<br>- Farak et al. 2011a,b.<br>- HDR 2011.<br>- Richie & Fujimoto 2011.<br>- Richie et al. 2011.<br>- Uyeyama et al. 2011, 2012.<br>- Uyeyama & Richie 2011.<br>- Baird et al. 2012a.<br>- HDR 2012.<br>- Watwood et al. 2012a,b.<br>- Norris 2010, 2011, 2012 (ONR yearly reports). | - 20 U.S. Navy monitoring surveys since 2005 (725 hr of effort)<br>- 7 line-transect/focal follows:<br>• 479 hr<br>• 5,883 km<br>• 11 species, 387 groups, 1,369 individuals<br>- 4 Lookout effectiveness studies<br>- 4 UNDET monitoring surveys<br>- Some coordinated w/ other platforms (aerial, PAM, tag). | - Currently being centralized and uploaded to EIMS and OBIS SEAMAP by HDR<br>- Collected by Cetos, CRC, HDR, MMRC, MMRP, Navy. | 1) Versatile platform allows: line transect data (density estimates if sufficient sample size), focal follows, tagging, photo-ID, biopsy, PAM<br>2) If data integrated, useful for occurrence, distribution, behavior correlation with U.S. Navy activities<br>3) Can collate anecdotal reactions from all surveys (e.g., bow-riding dolphins during MFAS)<br>4) Focal follows conducted within view of U.S. Navy MTEs. | 1) Sighting sample sizes small for abundance/densit y<br>2) U.S. Navy sound transmission times needed to correlate behavior/ occurrence<br>3) Integration of data from other sampling platforms needed<br>4) Medium to large vessels relatively expensive & slow & inflexible relative to poor sea states. | $$ |

Key: $ = order of hundreds of thousands; CRC = Cascadia Research Collective; EIMS = Environmental Information Management System; MMRC = Marine Mammal Research and Conservation Program; MMRP = Marine Mammal Research Program; MTE = Major Training Exercise; OBIS SEAMAP = Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations; ONR = Office of Naval Research; PAM = passive acoustic monitoring; photo-ID = photo identification; UNDET = underwater detonation

## Table A1-2. Assessment of HRC Effort to Date: Aerial Surveys.

| Relative Effort | Key Publications and Documents | General Summary/ Overview | Datasets | Strengths | Challenges | Relative Cost/Year |
|---|---|---|---|---|---|---|
| Aerial surveys for all MM species:<br>- Mobley state-wide surveys (1993-2003)<br>- NPAL (Kauai/Niihau only: 2001-2006)<br>- PMRF (ONR-funded: 2002-2006) (density estimates derivable since transects used; pending funding)<br>- U.S. Navy Fleet-funded surveys (2008 to 2012)<br>- SCC exercises (6) (focal follows with U.S. Navy ships, 2008-2012)<br>- USWEX (2)<br>- RIMPAC (1). | - Mobley 2005 (JASA).<br>- Mobley 2004 (ONR report).<br>- Mobley et al. (1999).<br>- Forney et al. (2000) (SWFSC report for odontocetes).<br>- Thorne et al. (2012) for spinner habitat, includes aerial data<br>U.S. Navy-funded:<br>- RIMPAC: Mobley (2008a).<br>- USWEX: Mobley (2008b).<br>- SCC: Smultea et al. (2009).<br>- Mobley & Milette (2010).<br>- Mobley (2011).<br>- Mobley & Pacini (2012). | - All aerial surveys include distribution data for all MM species<br>- Abundance estimates available for humpback whales (1993-2003) in Mobley (2004)<br>- Abundance estimates available for odontocetes (1993-1998) in Forney et al. (2000)<br>- Densities available for all species from all statewide surveys (1993-2003) in unpublished results (Oswald & Mobley)<br>- Aerial surveys represent largest concentrated visual effort on PMRF Range. | - 1993-2003 state-wide survey results (Mobley)<br>- 2001-2006 NPAL surveys (Mobley)<br>- PMRF 2002-2006 (Mobley)<br>- SCC focal-follow videos & data (2008-2012). | 1) Quick synoptic view of distribution & abundance (when transects used)<br>2) When conducted with ship-follows—good for detecting MMs at potentially high levels of exposure & all MMs within 5 km of ship<br>3) Optical penetration below surface (if BSS < 4)<br>4) Established presence of MMs on PMRF Range during MTEs. | 1) Limited to surface and near-surface behaviors of animals<br>2) Limited to good sea-state conditions for most species<br>3) Difficulty identifying many odontocetes to species (i.e., better with photos)<br>4) Human safety risks associated with aerial surveys. | **$$$** |

Key: $ = order of hundreds of thousands; MM = marine mammal(s); MTE = Major Training Exercise; USWEX = Undersea Warfare Exercise; PMRF = Pacific Missile Range Facility; RIMPAC = Rim of the Pacific

**Table A1-3. Assessment of HRC Effort to Date: Photo-ID and Biopsy.**

| Relative Effort | Key Publications and Documents | General Summary/ Overview | Datasets | Strengths | Challenges | Relative Cost/Year |
|---|---|---|---|---|---|---|
| - Photo-ID catalogs for 10 species of odontocetes throughout MHI with up to 1,600 individuals, some catalogs from mid-1980s-2012<br>- 316 biopsy samples from 8 odontocete species available off Kauai/Niihau since 2003 (1,294 from 12 species throughout MHI). | - Albertson et al. 2011.<br>- Aschettino et al. 2011.<br>- Baird et al. 2006, 2008a, 2008b, 2009, 2011, 2012a, 2012b, 2012c.<br>- Courbis et al. 2012.<br>- Mahaffy et al. 2012.<br>- Martin et al. 2011.<br>- McSweeney et al. 2007, 2009.<br>- Chivers et al. 2007, 2010. | - Photo-ID and biopsy samples collected through U.S. Navy and non-U.S. Navy sponsored projects off Kauai since 2003 and throughout MHI since 2000, plus contributions of photos by variety of sources<br>- Photos can be used to estimate abundance and survival (and thus, assess trends), examine movements and population structure, as well as determine social structure, assess reproductive rates. | - All genetic samples (at NMFS-SWFSC—subsamples of most at CRC)<br>- Long-term photo-ID catalogs of 10 species (CRC). | 1) Genetic analyses of biopsy samples allow for assessment of population identity, as well as sex of individuals<br>2) Photo-ID data allows for assessment of population identity and site fidelity important for understanding history of prior exposure. | 1) Limited sample sizes for some rare and/or cryptic species (e.g., beaked whales) off Kauai<br>2) Limited to data collection during favorable weather (i.e., BSS, visibility) periods. | $$ |

Key: $ = order of hundreds of thousands; BSS = Beaufort Sea State; CRC = Cascadia Research Collective; MHI = Main Hawaiian Islands; NMFS = National Marine Fisheries Services; Photo-ID = photo-identification; SWFSC = Southwest Fisheries Science Center

**Table A1-4. Assessment of HRC Effort to Date: Animal Tagging/Tracking.**

| Relative Effort | Key publications and documents | General Summary/ Overview | Datasets | Strengths | Challenges | Relative cost/year |
|---|---|---|---|---|---|---|
| - Satellite tag data off Kauai and Niihau available for 28 individuals from 5 species<br>- All MHI: 152 individuals of 9 species for periods of 2-228 days. | - Baird et al. 2010, 2011a, 2011b, 2012a, 2012b, 2012c.<br>- Sakai et al. 2011.<br>- Schorr et al. 2009.<br>- Woodworth et al. 2012. | - Multi-species, multi-area satellite tagging efforts supported by U.S. Navy and non-U.S. Navy sources since 2006<br>- Majority of tag deployments off Kauai and Big Island. | Navy/CRC satellite tag location datasets include dive data from 5 tags (4 species) deployed off Kauai and 23 individuals (7 species) deployed throughout MHI, as well as location data from all. | 1) Satellite tags provide the only unbiased source of animal location information and large sample sizes of locations for rarely seen species<br>2) Data can be long-term (up to 220 days) tracks of movements (average ~25 days over all species). | 1) Difficult to tag some species due to behavior, small sample sizes of some species due to low encounter rates<br>2) Long-term tags limited to position and basic dive data (no high-resolution movement or acoustics). | **$$$** |

Key: $ = order of hundreds of thousands; CRC = Cascadia Research Collective; MHI = Main Hawaiian Islands

**Table A1-5. Assessment of HRC Effort to Date: Passive Acoustic Monitoring.**

| Relative Effort | Key publications and documents | General Summary/ Overview | Datasets | Strengths | Challenges | Relative cost/year |
|---|---|---|---|---|---|---|
| - 3 years of visual/acoustic towed array in PMRF - some with sonobuoy deployments<br>- 2 years of EAR monitoring off Kauai and Oahu (2009-2011) & several additional months off Kauai and Niihau<br>- ATOC data (Cornell BRP) from the North Shore<br>- T. Norris has thesis data on effects of vessel noise on humpback whales that has been analyzed, but not published<br>- NMFS-SWFSC HICEAS 2002 survey (visual/acoustic line-transect surveys in Hawaiian EEZ)<br>- 6 year-long systematic data collections of PMRF hydrophones, 2x per month year-long, with weeks of continuous data focused on major training exercises and RDT&E. | - ONR reports from W. Au.<br>- Frankel et al. 1995 for ATOC data.<br>- Oswald et al. 2007.<br>- Lammers et al. 2008.<br>- Mellinger et al. 2007.<br>- Martin et al. 2012.<br>- Barlow and Rankin 2007.<br>- Barlow et al. 2004.<br>- Mellinger et al. 2011 (minke detection).<br>- Martin informal reports to PACFLT on methods for estimating SPL for animals exposed to 53C sonar. | - 3 years visual/acoustic survey data (*R/V Dariabar*); CPF/ONR-sponsored work<br>- 3 years of EAR monitoring at multiple locations (from 2009)<br>- 6 years of acoustic data collections at PMRF of multiple bottom hydrophones (includes classified acoustic and shipboard data collected during 2011 and on SCC training exercises). | - T. Norris, unpublished data (ONR reports)<br>- SWFSC HICEAS and PICEAS visual/acoustic line-transect data.<br>- Five EAR sites around Oahu and Kauai (10 total)<br>- Additional datasets from Kauai and Niihau during RIMPAC and at other times<br>- Additional data during exercises and other research (e.g., Norris ONR minke whale research)<br>- OBIS SEAMAP dataset for minke whale locations with acoustic density estimation. | 1) Combined visual/acoustic line-transect dataset useful for species validation, density estimates, behavioral responses to sound and other naval activities<br>2) Fixed PAM installations collect long-time series of ambient noise and animal occurrence data<br>3) Coverage of relatively large areas with relatively little effort<br>4) Verification of modeled sound propagation; determination of source levels and exposure levels<br>5) Localization and tracking of animals – with classified transmission information may allow behavioral response studies<br>6) Detection of MFAS and UNDET activities independent of U.S. Navy reporting<br>7) Long-term monitoring could also address population-level information. | 1) Effective frequency band of operation may be limited<br>2) Towed hydrophone array surveys may be ship-noise and speed-limited<br>3) Fixed PAM data lacks visual species verification<br>4) Large amounts of data are generated; automated methods required for processing<br>5) Recorders usually duty cycled, creating monitoring gaps. | **$$$$** |

Key: $ = order of $1M; ATOC = Acoustic Thermometry of Ocean Climate; BRP = Bioacoustics Research Program; EAR = Ecological Acoustic Recorder; HICEAS = Hawaiian Islands Cetacean and Ecosystem Assessment Survey; MFAS = mid-frequency active sonar; NAVFAC PAC = Naval Facilities Command Pacific; NMFS = National Marine Fisheries Service; OBIS = Ocean Biogeographic Information System; ONR = Office of Naval Research; PACFLT = Pacific Fleet; PAM = passive acoustic monitoring; PICEAS = Palmyra Cetacean and Ecosystem Assessment Survey; PMRF = Pacific Missile Range Facility; RIMPAC = Rim of the Pacific; NMFS = National Marine Fisheries; RDT&E = Research Development Test and Evaluation; SCC = Submarine Commander's Course; SWFSC = Southwest Fisheries Science Center; UNDET = underwater detonation

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# APPENDIX C-B

# Assessment of Revised Monitoring Questions by Current Status of Knowledge, Existing Navy Datasets to Answer Each, and Specific Proposed Analyses to be Accomplished by June 2013

### Table B-1. Current status of Knowledge.

| Baseline Biological Questions | | |
|---|---|---|
| *1) How well is baseline occurrence (e.g., distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups?* | *2) How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups?* | *3) What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC?* |
| For most insular toothed whale populations, there is moderate understanding of baseline occurrence; for pelagic odontocetes and for cryptic/rare species in the western MHI, this understanding is poor.<br>For baleen whales (all seasonally present), this is well-known for humpback whales and less well-known for all other species. | Poorly understood—some time-series data exist. | Relatively well-known for some species (humpback whale, spinner dolphin, Cuvier's and Blainville's beaked whales, monk seals). Less well-known for some others (see below) and very poorly-understood for others. |
| **Exposure Questions** | | |
| *1) How well are U.S. Navy noise-generating activities known and available outside of the classified realm?* | *2) How well do sound propagation models predict received levels?* | *3) How does our ability to address questions of sound exposure (integrating propagation models and animal occurrence) vary with species/species groups?* |
| This is one of the most limiting aspects in assessing and understanding the potential environmental effects of U.S. Navy sound-producing activities. Some efforts have been made to declassify MFAS transmissions (e.g., RIMPAC 2008) or are available within the classified realm (e.g., PMRF). However, information about transmissions with which to estimate sound exposures on animals is not generally and systematically/reliably available. | Current models are relatively mature for most sound sources. In the HRC, the presence of strong surface-ducting conditions complicate sound propagation models. Propagation modeling for impulsive sounds (e.g., from underwater detonations) in shallow water are of more limited efficacy. | This is limited largely by available information about the location and transmission patterns of U.S. Navy-sound producing activities. It is also restricted to some extent, particularly for oceanic species, by limited information about occurrence (e.g., distribution, density, habitat use). |

| Effects and Response Questions | | |
|---|---|---|
| *1) Do we know what exposure levels to MFAS or to underwater explosions cause TTS, PTS, injury, or mortality to MM/ST?* | *2) What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions?* | *3) When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last?* |
| Data exist on TTS for bottlenose dolphin for MFAS and for a few other toothed whale and pinniped species (non-HRC) for other sound types; TTS thresholds for other species are estimated from that (likely inaccurate). Current understanding of frequency-specific hearing/weighting functions, and gain control in hearing is rapidly evolving as a result of new data. PTS thresholds for all species are extrapolated. Injury and mortality thresholds are estimated from very limited information for all species—there is potentially new information here arising from the Silver Strand investigation. | In the HRC, this is largely unknown for almost all species. Some opportunistic data exist from PMRF monitoring. There is an increasing body of information using controlled exposure experiments and observational methods to measure behavioral responses of marine mammals in SOCAL, AUTEC, and Europe. | In the HRC, this is largely unknown for almost all species. Data from AUTEC suggests spatial redistribution on the scale of tens of km and several days for beaked whales and sonar activity; recent (and limited) data from PRMF suggests similar kinds of patterns including observations of animals vocalizing during U.S. Navy training activities. |
| **Consequences Questions** | | |
| *1) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST?* | *2) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST?* | *3) Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST?* |
| It is currently quite difficult to address these issues, in large part due to the absence of true baseline (no U.S. Navy activities) in the HRC. | It is currently quite difficult to address these issues, in large part due to the absence of true baseline (no U.S. Navy activities) in the HRC. There are some seeming peculiarities in the distribution of some species in similar areas with more or less MFAS activity, although this cannot be presently concluded to represent population level effects from sonar. | Virtually nothing conclusive is available with which to currently address this question. |

Key: AUTEC = Atlantic Undersea Test and Evaluation Center; HRC = Hawaii Range Complex; MFAS = mid-frequency active sonar; MHI = Main Hawaiian Islands; MM/ST = marine mammal/sea turtle; PMRF = Pacific Missile Range Facility; PTS = permanent threshold shift; RIMPAC = Rim of the Pacific; SOCAL = southern California; TTS = temporary threshold shift

**Table B-2. Existing data sets owned by (or available to) Navy for analysis in addressing each question.**

| Baseline Biological Questions | | |
|---|---|---|
| *1) How well is baseline occurrence (e.g., distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups?* | *2) How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups?* | *3) What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC?* |
| Mobley state-wide aerial survey data (1993-2003); Kauai (1993-2006); PRMF (2006-2010). PMRF and EAR data (distribution) around Oahu and Kauai. CRC tagging, photo-ID and small-boat survey datasets. Towed array/line-transect (Bio-Waves) with complimentary PMRF data—distribution. A. Rudd/W. Au ongoing towed-EARs behind island barges. PIFSC/SIO HARP data from Kauai. | Mobley state-wide aerial survey data (1993-2003); Kauai (1993-2006); PRMF (2006-2010). PMRF and EAR data (distribution) around Oahu, Kauai. CRC tagging, photo-ID and small-boat survey datasets. | For some other species considerable tagging/photo datasets exist, but are not published yet (short-finned pilot whale, false killer whale, rough-toothed dolphin, melon-headed whale, Cuvier's beaked whale). Vessel-survey focal-follow data including video off Kauai; PAM and recent acoustic tagging data sets with sounds from poorly-known species. Aerial survey and PAM data from ATOC studies around Kauai and Big Island (mostly un-analyzed). E. Oleson Acousonde data from pantropical spotted dolphins. |
| **Exposure Questions** | | |
| *1) How well are U.S. Navy noise-generating activities known and available outside of the classified realm?* | *2) How well do sound propagation models predict received levels?* | *3) How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups?* |
| Largely U.S. Navy-related issue; some civilian Navy-funded PAM and U.S. Navy-vessel MMO data exist that could be utilized. | Efforts underway within other U.S. Navy-funded programs on propagation modeling. | MMO data from U.S. Navy ships relevant here for known position relative to transmissions. Aerial focal follows coordinated with destroyer-based observers. PMRF data on vocalizing animals during sonar activity. Some tagging data potentially applicable, particularly for animals around Kauai. EAR and HARP data potentially applicable for exposure on animals within detection range. |

| Effects and Response Questions | | |
|---|---|---|
| *1) Do we know what exposure levels to MFAS or underwater explosion exposures cause TTS, PTS, injury, or mortality to MM/ST?* | *2) What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions?* | *3) When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last?* |
| Lower-frequency (than MFAS) TTS studies are ongoing/planned for bottlenose dolphin. Information exists on several MFAS and explosion-associated marine mammal strandings (non-HRC). | PMRF PAM data for MM vocalizations and training events exist for exercises after February 2011. Some tagging data and vessel-based MMO data exist for same time periods as vessel transmission logs and/or PMRF PAM data. | CRC satellite tagging data on different species showing spatial habitat use. Some vessel-based MMOs and aerial survey observations of spatial distribution of animals before, during, after training events. EAR deployments in various locations before/during/after MFAS activity in several locations around Oahu, Kauai, NWHI; some HARP data in different HRC locations as well. EAR data from Puuloa Range before/during/after explosives training. PMRF PAM data over larger area than AUTEC possibly useful in assessing spatial redistribution on range. |
| **Consequences Questions** | | |
| *1) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST?* | *2) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST?* | *3) Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST?* |
| Long-term photo-ID data sets are most appropriate here. Biopsy data to look at long-term trends in stress hormones and other physiological measurements. Longer-duration satellite tags could potentially address shorter-term cumulative effects. | 10-year dataset for Hawaii-wide aerial survey data may be amenable to assess long-term trends (preceding ATOC data could potentially serve as baseline comparison in same areas). General population trends in humpback whales and Hawaiian monk seals may be applicable, although relation specifically to MFAS use is uncertain. | All data available for Questions 1 and 2 would be applicable for population trends relative to U.S. Navy activities. For natural variability, climate change, or other environmental factors, there are data from U.S. Navy oceanographic and various NOAA oceanographic/climatological data. For other non-U.S. Navy anthropogenic activities (e.g., shipping noise and seismic surveys), U.S. Coast Guard AIS data would provide near-shore ship presence; VOS data are available for offshore vessels. MMO data on interactions with pelagic longline fisheries are relevant |

Key: AIS = Automatic Identification System; ATOC = Acoustic Thermometry of Ocean Climate; AUTEC = Atlantic Undersea Test and Evaluation Center; CRC = Cascadia Research Collective; EAR = Ecological Acoustic Recorder; HARP = High-frequency Recording Package; HRC = Hawaii Range Complex; MM/ST = marine mammal/sea turtle; MFAS = mid-frequency active sonar; MMO = marine mammal observer(s); NOAA = National Oceanic and Atmospheric Administration; NWHI = Northwest Hawaiian Islands; PAM = passive acoustic monitoring; PIFSC/SIO = Pacific Islands Fisheries Science Center/Scripps Institution of Oceanography; Photo-ID = photo-identification; PMRF = Pacific Missile Range Facility; VOS = Voluntary Observing Ship

## Table B-3. Specific proposed analyses to be accomplished by June 2013.

| Baseline Biological Questions | | |
|---|---|---|
| *1) How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups?* | *2) How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups?* | *3) What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC?* |
| Validate acoustic species identification using multiple data sets that have associated visual observations (Barlow BURP data, Mooney DTAG data, PIFSC/SIO recordings, towed hydrophone array recordings).<br>Preliminary analysis of marine mammal occurrence patterns from PMRF data. S. Martin can identify sections of recordings with whistles, then Bio-Waves can use ROCCA to classify delphinids and blackfish; recommend strategic data subsampling. Could combine with Effects and Response Question 2 analysis.<br>Analysis of select EAR datasets: can include analyses from Niihau and Kaula Island currently funded under HDR task orders, as well as ONR-funded deployments off Oahu and Kauai.<br>Integrate across different data types/sets (e.g., PAM with vessel/aerial/tagging sampling).<br>Combined analysis of all aerial survey data.<br>Spatial habitat modeling approaches. | Not currently applicable—subsequent time series data required. Detailed analysis of selected long-term datasets for a few species (e.g. humpback whales or spinner dolphins) to assess long-term habitat use could be possible. | Complete and publish tagging and photo- identification data analysis for pilot whale, false killer whale, melon-headed whale, and rough toothed dolphin.<br>PMRF data integrated with aerial-survey focal-follow data.<br>Complete and publish pygmy killer whale audiogram analysis and stranded animal hearing analysis.<br>Examine Bio-Waves' towed acoustic data for species other than minke whales (e.g., delphinids and blackfish).<br>Analysis of PMRF hydrophone data for minke whales (and other species) before, during, after MFAS sonar activity. |

| **Exposure Questions** | | |
|---|---|---|
| *1) How well are U.S. Navy noise-generating activities known and available outside of the classified realm?* | *2) How well do sound propagation models predict received levels?* | *3) How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups?* |
| Internal U.S. Navy issue. | Several new efforts ongoing to apply *in-situ* SVPs to existing propagation models.<br>Subsequent development of propagation modeling outside the scope of HRC monitoring effort.<br>S. Martin: use acoustic sea-surface sensor data to validate models. | MMO, vessel-survey, and aerial-survey data (with concurrent PAM if available) could be analyzed to show proximity to U.S. Navy vessels before, during MFAS and detonations.<br>Some PMRF data analyzed to estimate RLs on vocalizing animals; other datasets exist, including EAR data.<br>Analysis of tag data (with high priority for detailed diving behavior) possible but requires information on transmission<br>Continue work being done by S. Martin on PMRF data. |
| **Effects and Response Questions** | | |
| *1) Do we know what exposure levels to MFAS or underwater explosion exposures cause TTS, PTS, injury, or mortality to MM/ST?* | *2) What are the short-term behavioral responses of MM/ST when exposed to MFAS/explosions at different levels/conditions?* | *3) When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last?* |
| All available TTS data on onset/growth have been analyzed; ongoing studies will become available and should be applied in modifying impact threshold levels and weighting functions. W. Au: could use bottlenose dolphin TTS data. Possible additional data from Silver Strand investigation | Analyze and integrate tagging data in relation to PMRF data, U.S. Navy vessel MMO, aerial survey data, and possibly information from SPORTS database. Use EAR data to validate/test the accuracy of SPORTs database in specific locations. Analyze PMRF MM vocal behavioral data before/during/after training events. J. Oswald: use PMRF delphinid acoustic data to address B/D/A question. Examine characteristics of acoustic encounters e.g. vocalization rates B/D/A, occurrence of species B/D/A (use ROCCA to identify delphinids – could be combined with Baseline Biological Questions-Question 1 analysis), presence of mimicry, etc. Compare with a time period with no MFAS/explosions. Limited funding limits how much data can be extracted and examined. | Analysis of visual, acoustic, tag data on animal occurrence B/D/A MFAS transmissions and explosions; datasets will be integrated across platforms when/if possible. Examples include PMRF PAM integrated with visual data off Kauai and EAR data near Kauai and Oahu. M. Lammers: use existing sonar on/off times and animal occurrence information captured in EAR data to address this question. These kinds of analyses are more likely to be conclusive for species for which there is less natural variability in behavior (although also dependent on sample sizes, which are likely to be limiting in Hawaii). |

| **Consequences Questions** | | |
|---|---|---|
| *1) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST?* | *2) Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST?* | *3) Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST?* |
| Limited opportunities at present to address this question. | Potential analysis of longitudinal aerial survey data (likely applicable for relatively few species). Preliminary analysis of longitudinal acoustic data on PMRF. M. Lammers: Collect longitudinal acoustic data at other locations in HRC (e.g., EAR data off Kauai and Oahu). W. Au: Already collecting data off Niihau and Kaula Island. | Limited opportunities at present to address this question.<br>C. Clark: construct noise budget paradigm for HRC, find relative signal of MFAS in the context of other underwater noise sources. |

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# APPENDIX C-C
# Assessment of Current and Future Ability to Answer Proposed Study Questions: Results of Online Survey (via SurveyMonkey®)

Respondents (*n* = 10) were asked to rate the ability to answer each proposed study question using data from various monitoring platforms, assuming 1) current available data, and 2) increased effort and resulting enhanced datasets in the future. Stacked column figures present a breakdown of responses to each question, and respondents' comments to each question are preserved below each figure. Not all respondents provided comments, since doing so was optional. Ratings were on a low-to-high scale, with "low" indicating a low ability to answer the question using the given monitoring technique, and "high" indicating a high ability to answer the question using the given monitoring technique.

Additionally, **Figures C-25** and **C-26** present summaries of all respondents' answers to *all* study questions, assuming current available data and increased future monitoring effort, respectively.

**<u>Question 1a:</u>**

**How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups with the existing HRC data?**

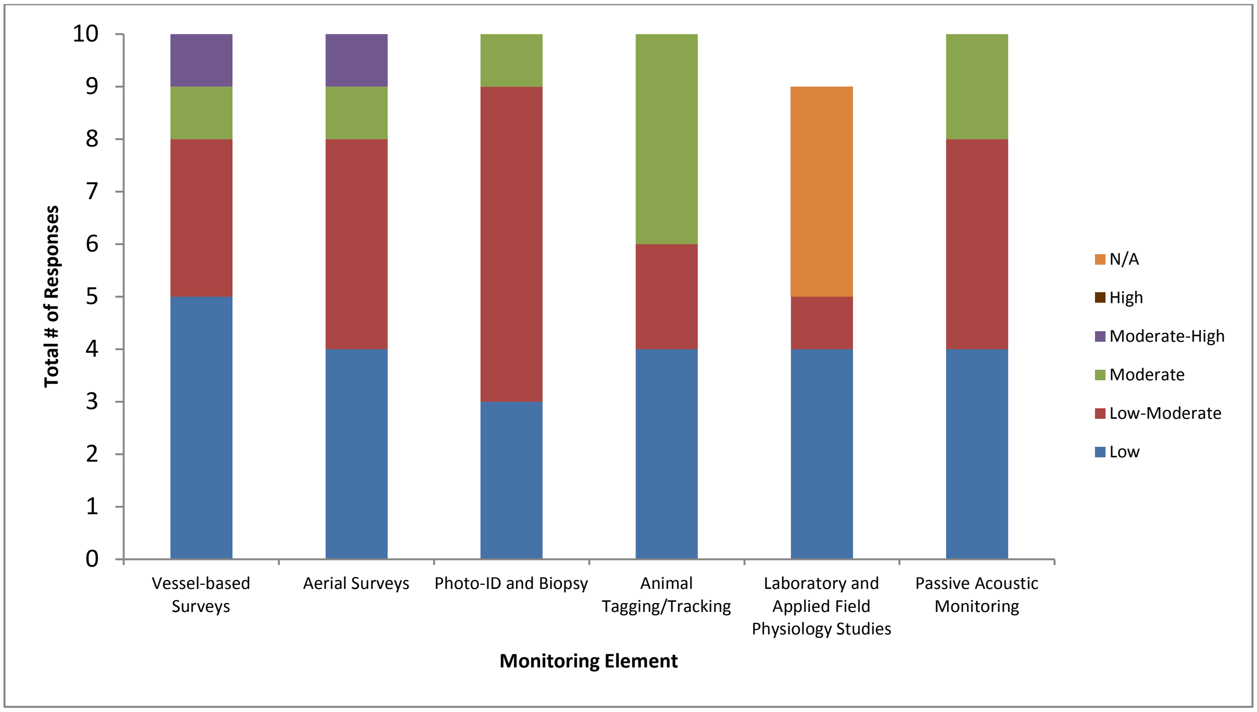


**Figure C-1. Group Responses to Question 1a**

**Table C-1. Comments to Question 1a**

| Individual Comments | Commenter |
|---|---|
| This varies by species. Nearshore species and humpback whales are much better understood than offshore species. | J. Oswald |
| Obviously for some species some methods are better than others. Aerial is good for large whales and small odontocetes in large groups, but not small solitary or dispersed groups. Photo-ID is good for some species (with small population sizes) that are approachable, but limited for the HRC, because offshore areas cannot be sampled easily. Tagging is good for habitat use for species that can be tagged. Acoustics is good for long-term remote monitoring of vocal species (most) but requires adequate spatial/temporal coverage (more sampling needed than has been conducted thus far) and doesn’t necessarily sample all age/sex/classes (for baleen whales) or species that vocalize infrequently. Also, interpretation of results requires understanding the function of vocalizations. | T. Norris |
| The only method that is independent of weather conditions (i.e., information on where the animals go can be obtained in an unbiased way regardless of the weather conditions where it goes) is satellite tagging. Aerial surveys are limited by species identification issues for many odontocetes. Passive acoustic monitoring is limited by species identification issues, as well as limited spatial coverage. | R. Baird |
| Obviously, this is highly variable depending upon species. | B. Southall |

HRC = Hawaii Range Complex; Photo-ID = photo-identification

## Question 1b:

**How well is baseline occurrence (distribution, density, and habitat use) known/defined (short- to medium-term) across species/species groups with substantial increased effort?**

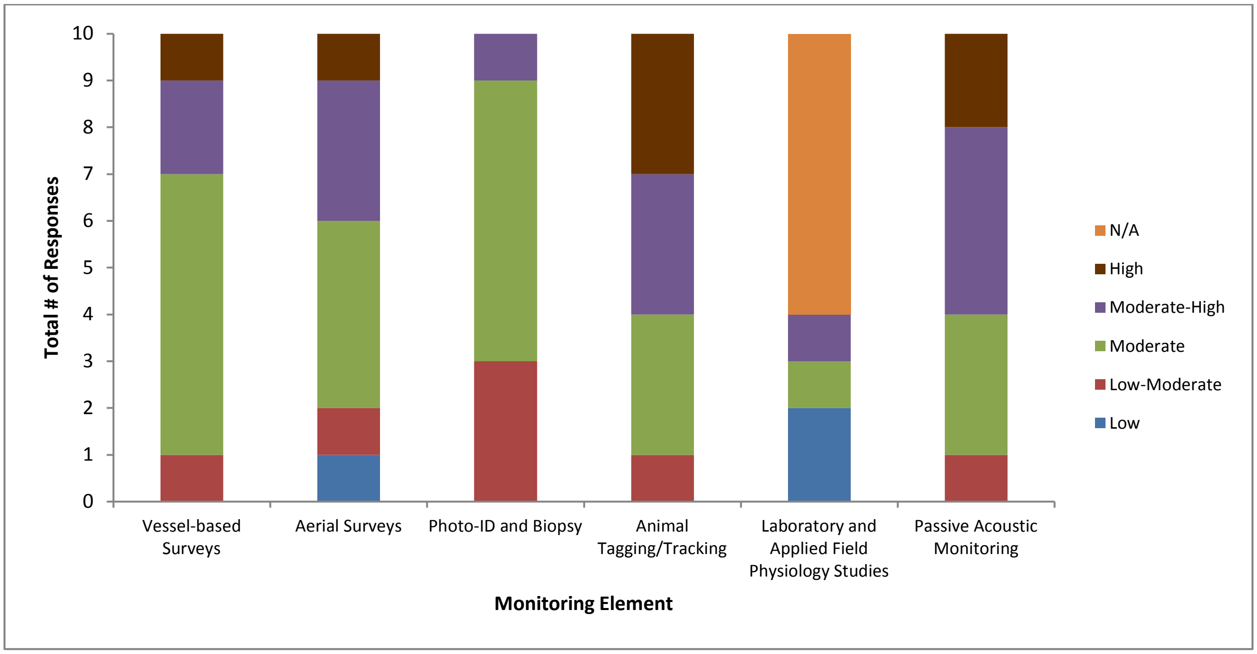


**Figure C-2. Group responses to Question 1b**

**Table C-2. Comments to Question 1b**

| Individual Comments | Commenter |
|---|---|
| Passive acoustic monitoring has good potential for providing baseline data, but the identification of species is a challenge that still needs more work (for many species). | J. Oswald |
| See comment to Question 1a. I think that aerial and vessel surveys combined with PAM would be the best approach as it can provide the most comprehensive information. If these methods are used in a complementary manner, they can increase the effectiveness of both. Validation of acoustic data is needed and will allow for better interpretation of the data (visual and acoustic). Combining both also will allow monitoring from airplanes when surface/visibility conditions are poor (e.g., using sonobuoys). Photo-ID and tagging/tracking offer promise for some species but not all. Tagging can get very expensive so species should be prioritized. Photo-ID can be cost effective when combined with tagging or vessel survey effort. | T. Norris |
| The only method that is independent of weather conditions (i.e., information on where the animals go can be obtained in an unbiased way regardless of the weather conditions where it goes) is satellite tagging. Aerial surveys are limited by species identification issues for many odontocetes. Passive acoustic monitoring is limited by species identification issues as well as limited spatial coverage (e.g., sensors moored in waters <1,000 m deep). | R. Baird |

**PAM = passive acoustic monitoring; photo-ID = photo-identification**

**Question 2a:**

**How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups *with the existing HRC data*?**

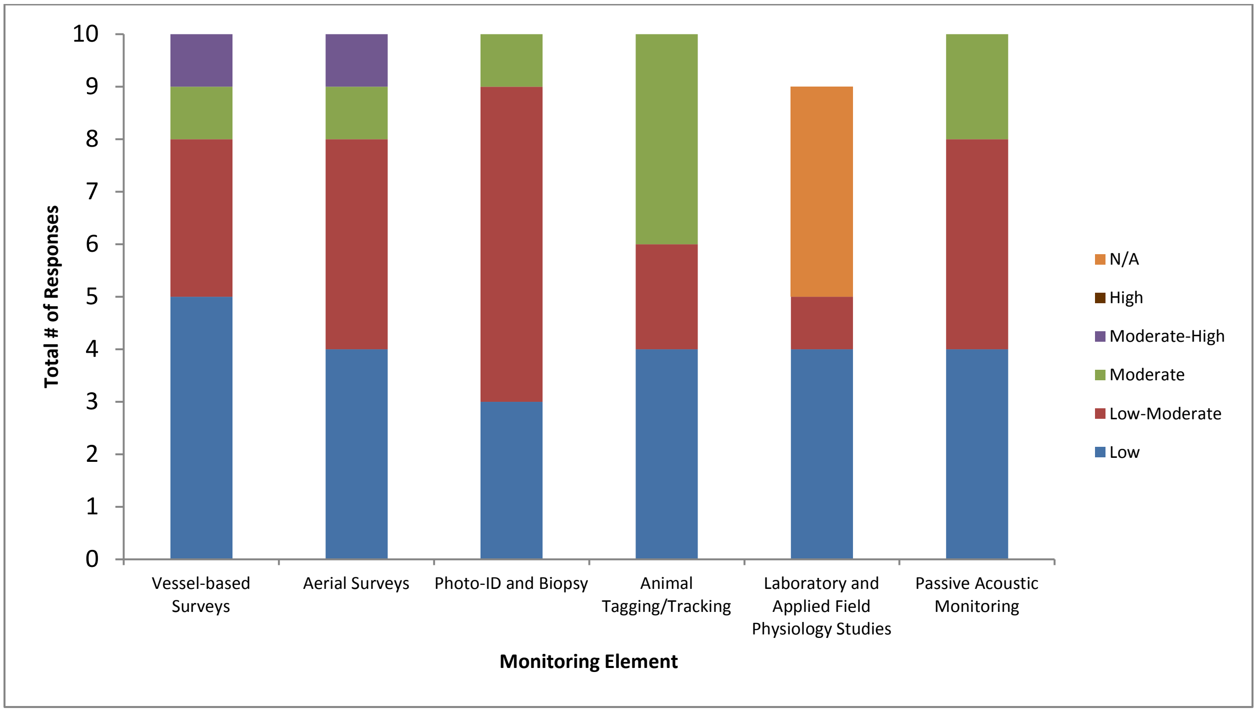


**Figure C-3. Group responses to Question 2a**

**Table C-3. Comments to Question 2a**

| Individual Comments | Commenter |
|---|---|
| Similar to comments to Questions 1a and 1b. Combining/integrating data when possible will provide more value and allow for better interpretation of results. There is a long history of aerial survey data that should be used to look at long-term trends in distribution and abundance. It might be possible to somehow integrate this with acoustic data collected from PMRF and other sources (e.g., ATOC). | T. Norris |

ATOC = Acoustic Thermometry of Ocean Climate; PMRF = Pacific Missile Range Facility

**<u>Question 2b:</u>**

**How well do we understand medium- to long-term habitat use (including the effects of environmental variability) in different species groups *with substantial increased effort*?**

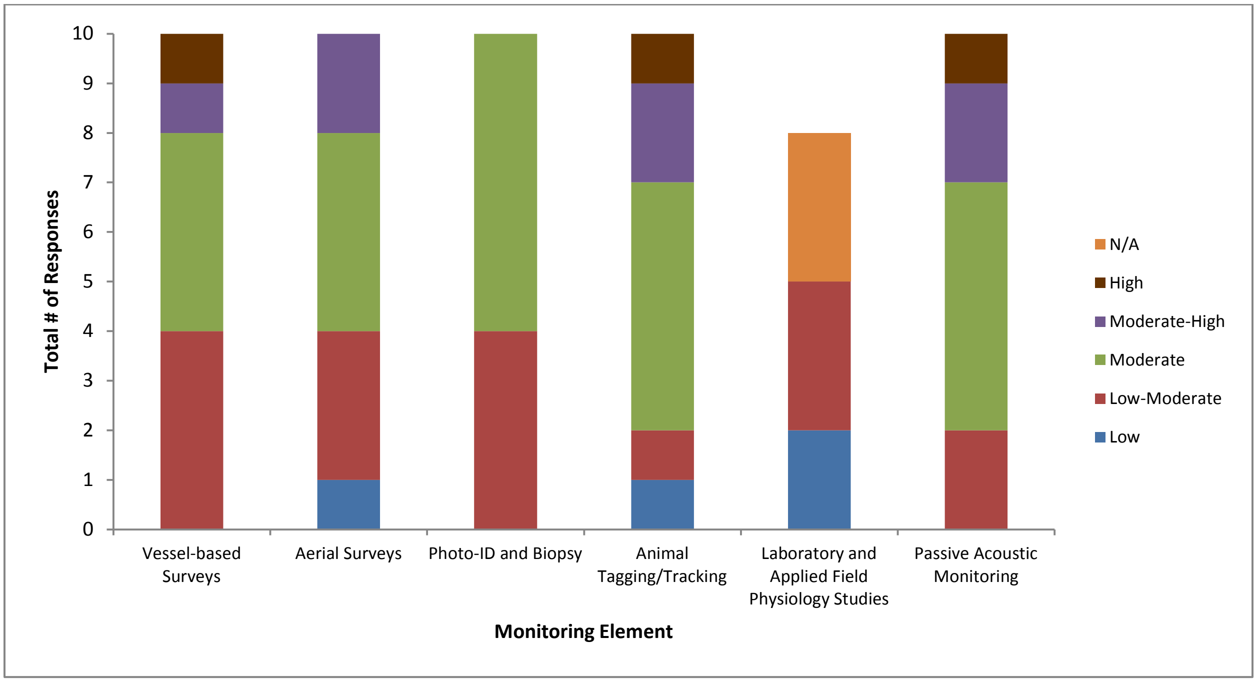


**Figure C-4. Group responses to Question 2b**

**Table C-4. Comments to Question 2b**

| Individual Comments | Commenter |
|---|---|
| I think passive acoustics is the best method for long term monitoring as it is possible to monitor animals 24 hr/day for 365 days a year if units are deployed (and sufficient duty cycle used if necessary). Again complementing acoustics with other methods is most effective and will allow for better interpretation of data. Vessel-based work has the advantage over aerial surveys in that *in-situ* environmental data can be collected, which might be important. Tagging provides a synoptic/large scale view, but is limited in the number of animals that can be tracked and thus can be biased (for some species at least). As stated initially, some methods are better for some species, so a combination of methods will be required. | T. Norris |
| Species identification issues for small odontocetes will limit the value for aerial surveys. Considerable work is needed to ground-truth acoustic identifications for some species before passive acoustics could be used. | R. Baird |

**Question 3a:**

**What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC *with the existing HRC data*?**

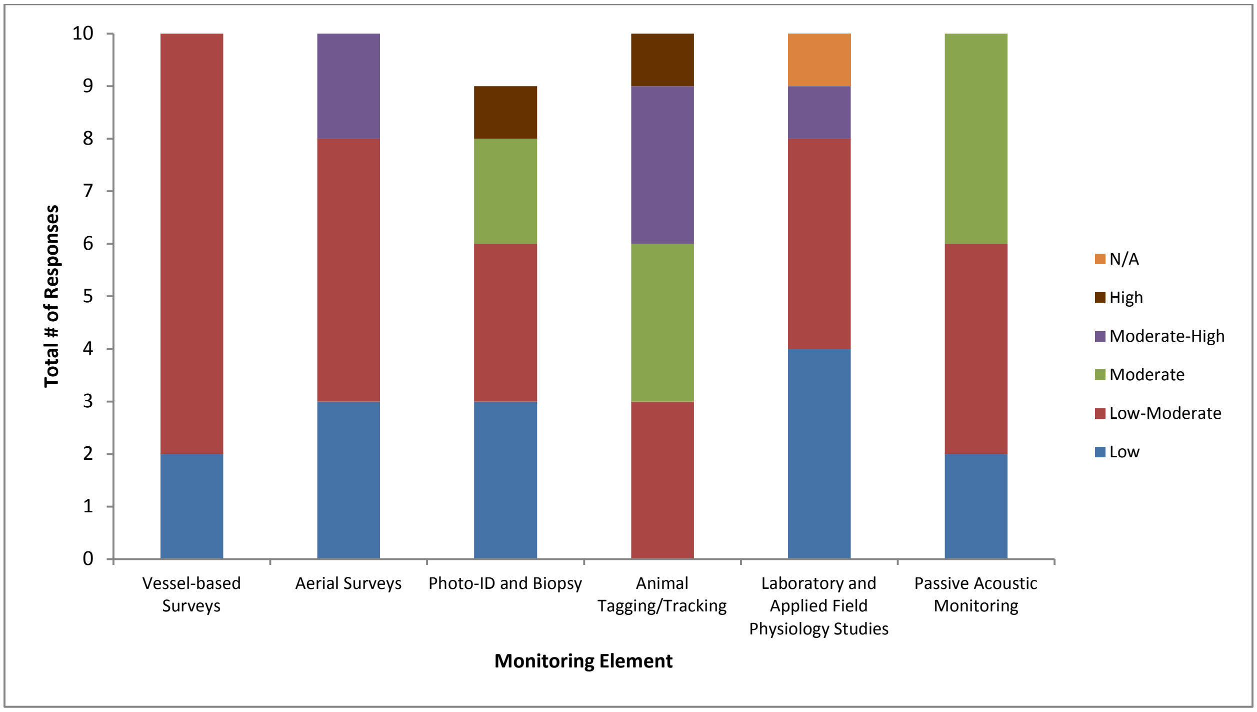


**Figure C-5. Group responses to Question 3a**

**Table C-5. Comments to Question 3a**

| Individual Comments | Commenter |
|---|---|
| Again, this varies by species. We know a lot about some species and very little about others. | J. Oswald |
| Again, complementing approaches will be the most effective. Aerial monitoring is good for some species, but is limited to "surface behaviors" and does not provide any information about the acoustic environment so coupling with sonobuoys or other passive acoustic methods is the most effective approach. Vessel-based visual surveys always run the risk of affecting animals' "normal" behavior and should be avoided. Tagging with acoustic tags provides very important and useful information in this area, so (for species that can be tagged) it is probably one of the most effective. However, sample sizes usually limit this approach. Lab studies are needed to better understand sensory systems, but also require field work to understand what is really happening in the wild. Passive acoustic monitoring is very effective if there is a strong response, but is not as good for subtle responses or for "experiments" in which controls are important. | T. Norris |
| Laboratory and applied field physiology monitoring are relevant to mechanisms and characteristics of sound production, but not to actual sound use in the wild (e.g., calling rates, call types used in different behavioral contexts, etc). | R. Baird |

**Question 3b:**

**What is the baseline behavioral repertoire (e.g., diving, feeding, social interaction, reproduction, sound production, sensory systems) of MM/ST in the HRC *with substantial increased effort*?**

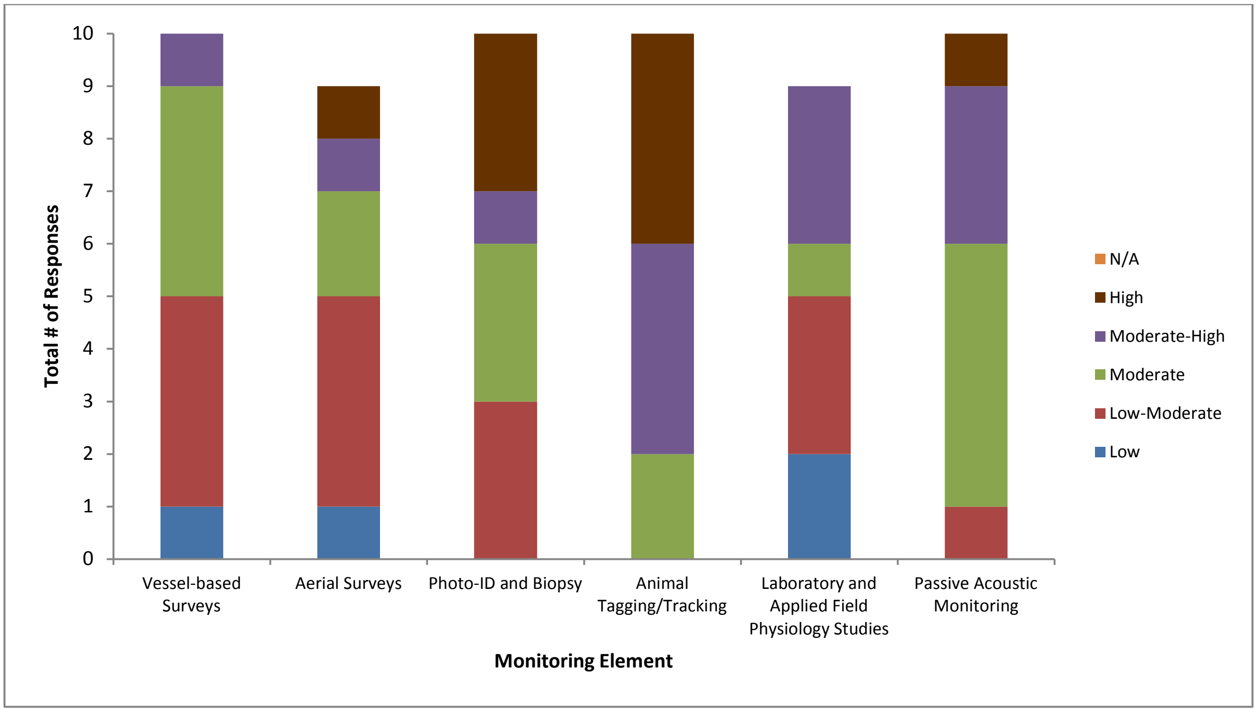


**Figure C-6. Group responses to Question 3b**

**Table C-6. Comments to Question 3b**

| Individual Comments | Commenter |
|---|---|
| Same comments as above. Shore-based work combined with tagging and passive acoustics would be effective for species observable from shore. | T. Norris |
| Shore-station observation is best for describing behaviors (i.e., due to non-reactive nature of the animal[s]). | J. Mobley |

**Question 4a:**

**How well are U.S. Navy noise-generating activities known and available outside of the classified realm *with the existing HRC data*?**

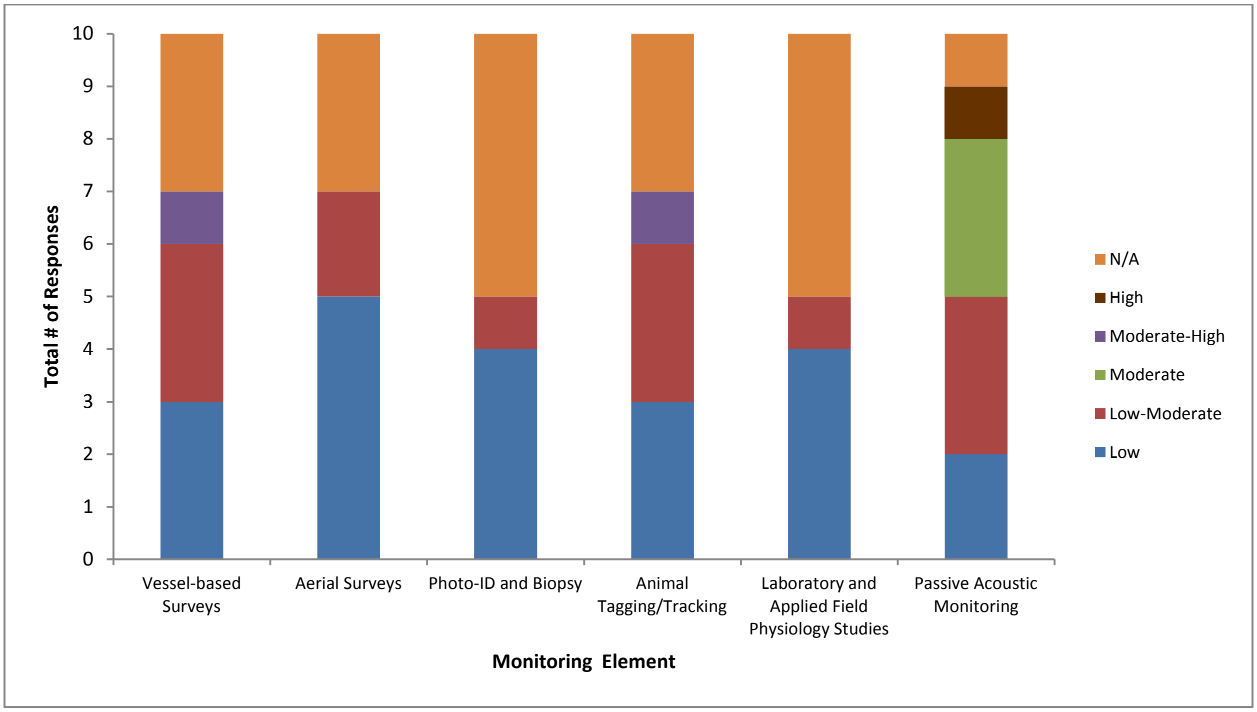


**Figure C-7. Group responses to Question 4a**

**Table C-7. Comments to Question 4a**

| Individual Comments | Commenter |
|---|---|
| Passive acoustic monitoring is undoubtedly the best approach here. I have included aerial and vessel only if they are coupled with passive acoustics (e.g., using a towed array and/or sonobuoys). Tagging is useful if acoustic tags are used and enough are deployed to characterize the environment. One aspect of tagging is that the aspect that we are really concerned with is the acoustic environment (specifically U.S. Navy activity-generated noise) that MMs are exposed to, so this makes these types of tags more important in this respect. | T. Norris |
| Data must come from U.S. Navy. HARP and EAR data could be used to assess noise outside of PMRF range better than U.S. Navy databases. | R. Baird |
| This question is independent of the monitoring teams/datasets. | B. Southall |
| I assume this question refers to the ability to detect MFAS and other sounds. | M. Lammers |

EAR = Ecological Acoustic Recorder; HARP = High-Frequency Acoustic Recording Package; MFAS = mid-frequency active sonar; MM = marine mammal(s)

**Question 4b:**

**How well are U.S. Navy noise-generating activities known and available outside of the classified realm *with substantial increased effort*?**

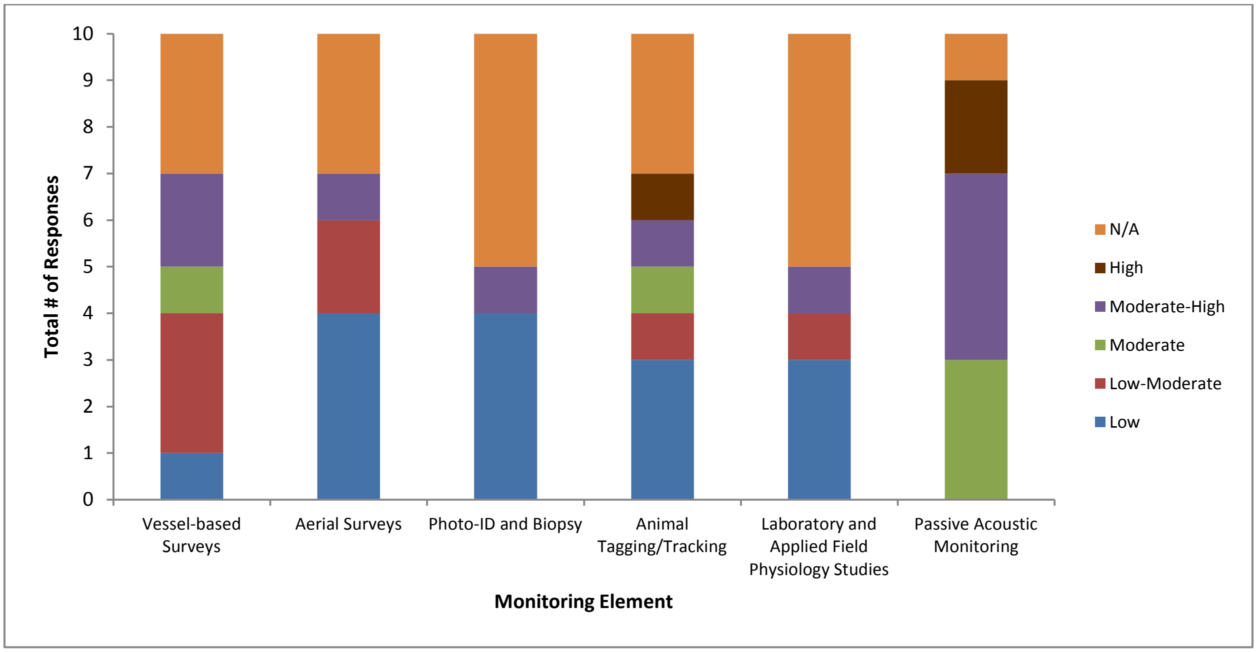


**Figure C-8. Group responses to Question 4b**

**Table C-8. Comments to Question 4b**

| Individual Comments | Commenter |
|---|---|
| Same as response to Question 4a, but passive acoustics far exceed other methods. Acoustic tags are really just another form of passive acoustic monitoring in this respect. More deployments of autonomous recorders outside of U.S. Navy ranges. This could also be supplemented with sonobuoys if aerial or vessel surveys were conducted in these regions. | T. Norris |
| Broader use of HARPs and EARs outside of U.S. Navy ranges could be used to characterize noise. | R. Baird |

EAR = Ecological Acoustic Recorder; HARP = High-Frequency Acoustic Recording Package

**<u>Question 5a:</u>**

**How well do sound propagation models predict received levels *with the existing HRC data*?**

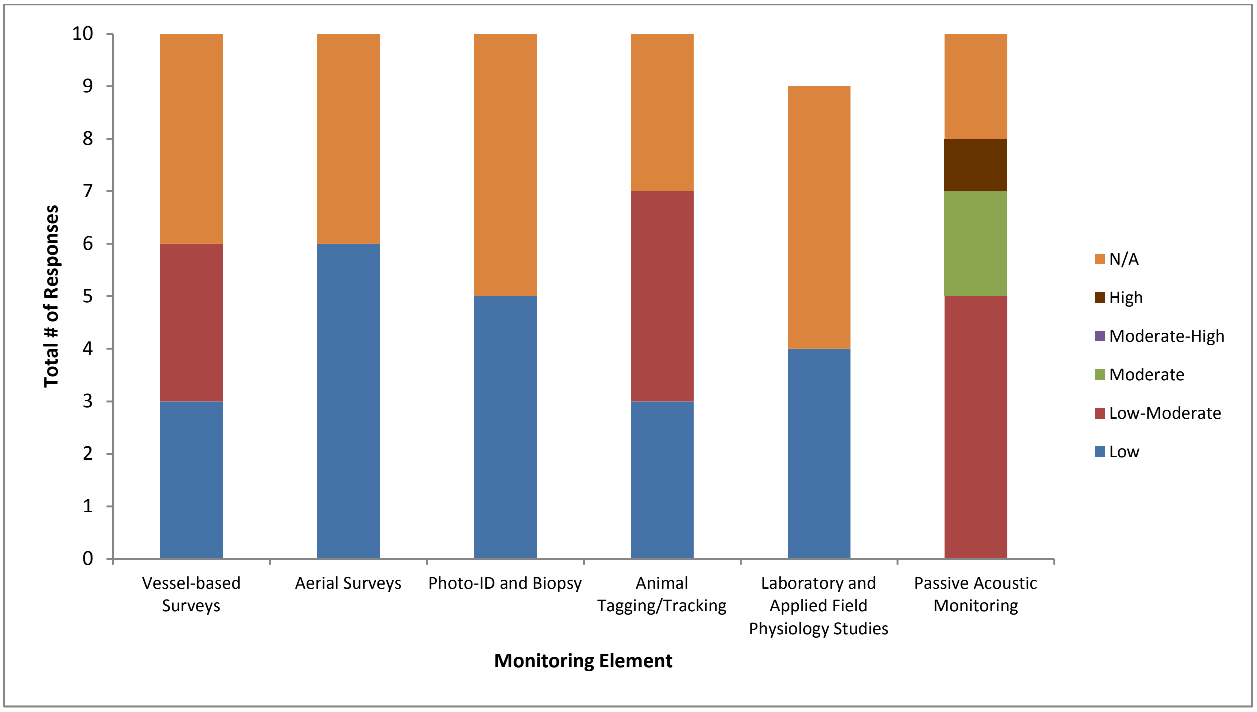


**Figure C-9. Group responses to Question 5a**

**Table C-9. Comments to Question 5a**

| Individual Comments | Commenter |
|---|---|
| I checked 'vessel' here, because they can be coupled with passive acoustic methods (e.g., sonobuoys) and, therefore, should be considered as platforms "to deploy" passive acoustic systems. Fixed PAM is limited to the seafloor, so other passive acoustic methods (e.g., sonobuoys, drifting recorders, or gliders) will be needed to sample the water column vertically. These types of acoustic data will be needed for ground-truthing. Better spatial sampling equals better ground-truthing. | T. Norris |
| This is a question about oceanography and acoustics. Received levels are how loud it is at the point of where an animal is. It is independent of the animal. They cannot predict what an animal hears. That takes a measurement of animal hearing. | P. Nachtigall |
| Without ground-truthing evidence, it is difficult to say. | J. Mobley |

PAM = passive acoustic monitoring

**Question 5b:**

**How well do sound propagation models predict received levels *with substantial increased effort*?**

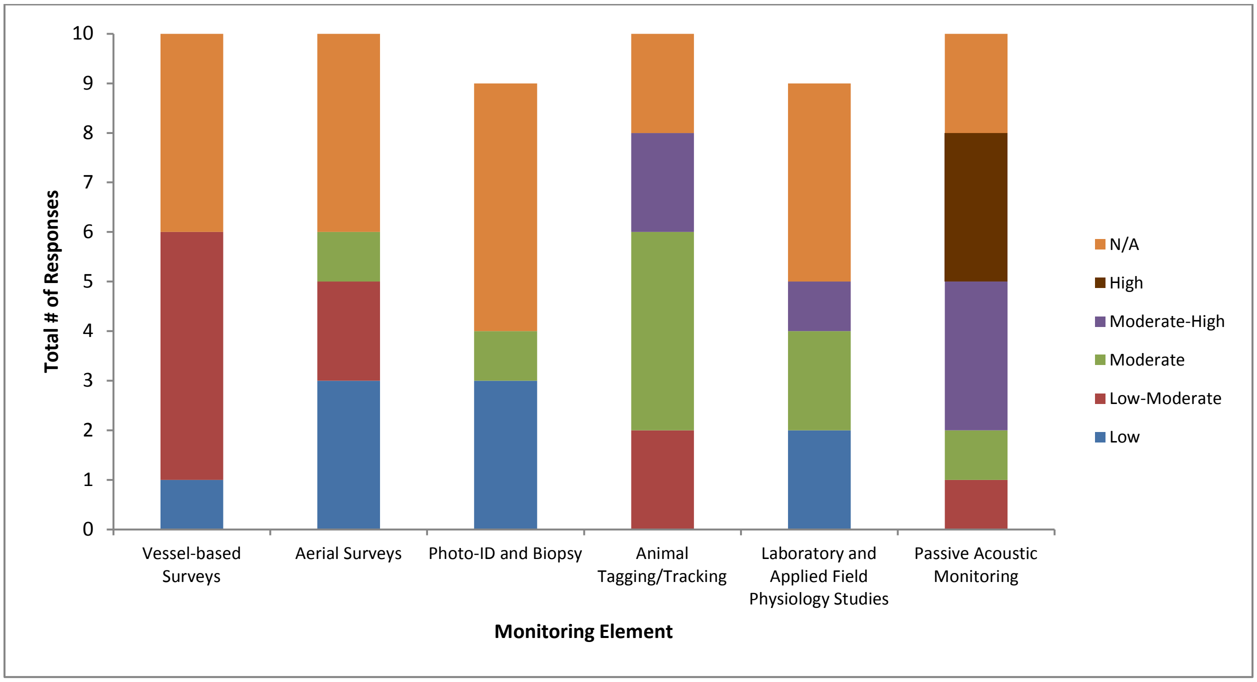


**Figure C-10. Group responses to Question 5b**

**Table C-10. Comments to Question 5b**

| Individual Comments | Commenter |
|---|---|
| Same as comment to Question 5a, with the added possibility of using aerial surveys coupled with sonobuoys. Greater effort for autonomous recorders and sonobuoys should include better spatial sampling (both vertical and horizontal). | T. Norris |
| This is a question about oceanography and acoustics. Received levels are how loud it is at the point of where an animal is. It is independent of the animal. They cannot predict what an animal hears. That takes a measurement of animal hearing. | P. Nachtigall |
| Major opportunities exist for field validation of realistic propagation conditions with existing PAM sensors either in place or remote-deployed as well as animal-borne tags (but requires those with calibrated hydrophones). | B. Southall |
| Acoustic tags on animals could help test the models. Hearing data will help determine whether received levels are significant. Passive acoustic data can be used to validate the models. | M. Lammers |
| Tagging with D-tags or equivalent acoustic tags. | J. Mobley |

PAM = passive acoustic monitoring

**<u>Question 6a:</u>**

**How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups *with the existing HRC data*?**

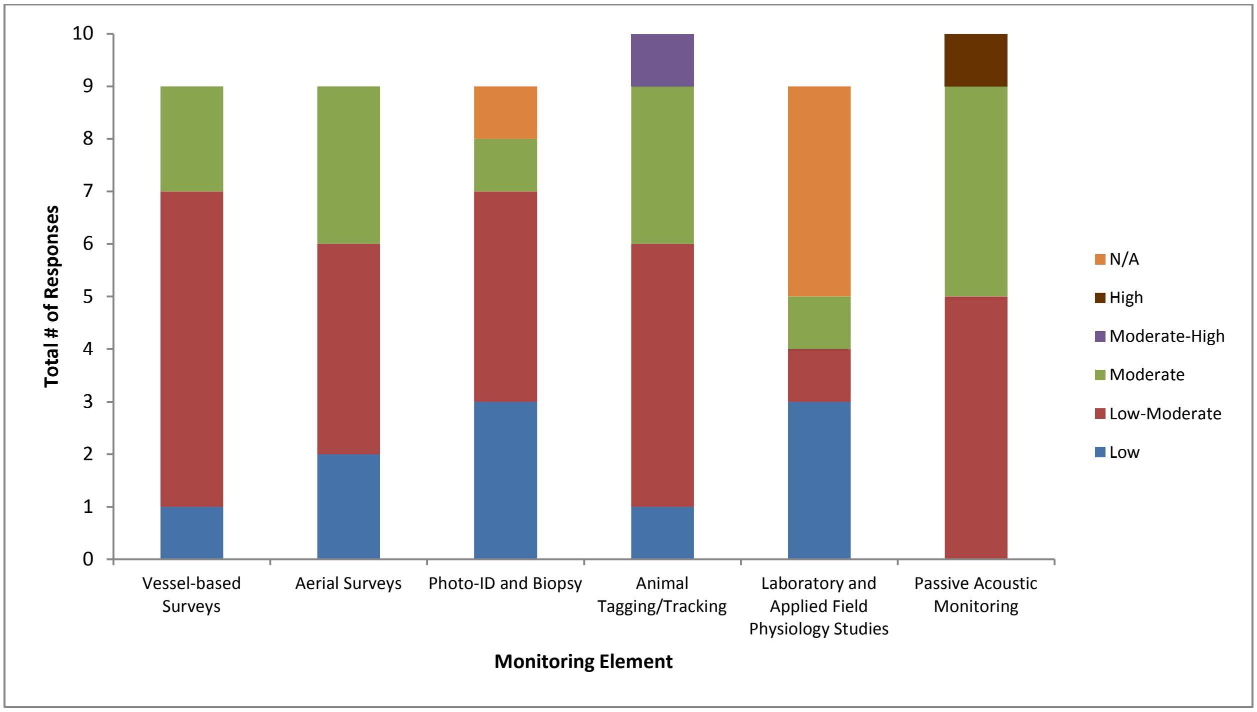


**Figure C-11. Group responses to Question 6a**

**Table C-11. Comments to Question 6a**

| Individual Comments | Commenter |
|---|---|
| It varies greatly. I think passive acoustic methods and data-logger tags are mostly needed to answer this question. Satellite tags are only useful if coupled with real data on U.S. Navy's noise-generating activities. | T. Norris |
| This requires more than a measure of animal occurrence. It requires a measure of the animal's ability to hear along with a measure of what the sound level is. We have basic audiograms on 17 of the 85 species of whales and dolphins. | P. Nachtigall |
| Aerial and vessel-based surveys will always be limited with real-world exposure situations because reactions are likely to occur over the visual horizon, and aerial surveys limited for many species because of difficulty of identifying and frequency of misidentifying individuals from the air. | R. Baird |

## Question 6b:

**How does our ability to address questions of exposure (integrating propagation models and animal occurrence) vary with species/species groups *with substantial increased effort*?**

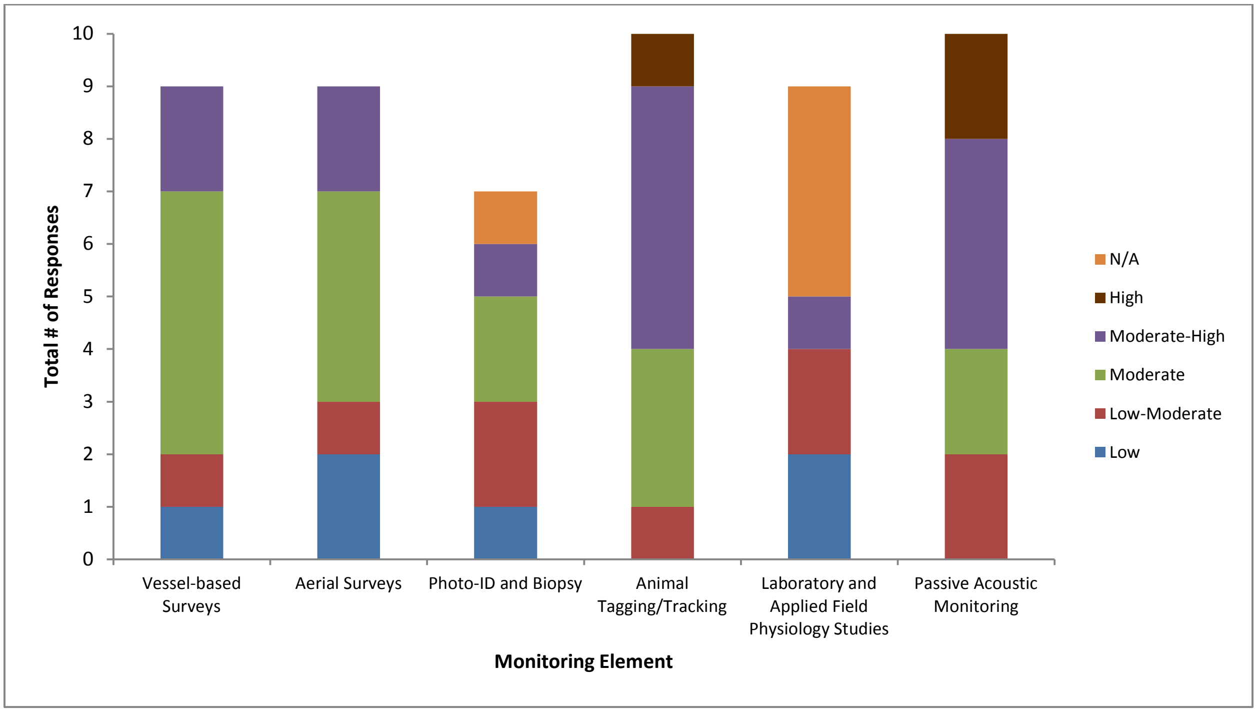


**Figure C-12. Group responses to Question 6b**

**Table C-12. Comments to Question 6b**

| Individual Comments | Commenter |
|---|---|
| Same comment as Question 6a. | T. Norris |
| This requires more than a measure of animal occurrence. It requires a measure of the animal's ability to hear along with a measure of what the sound level is. We have basic audiograms on 17 of the 85 species of whales and dolphins. | P. Nachtigall |
| Aerial and ship-based surveys will always be limited with real-world exposure situations because reactions are likely to occur over the visual horizon. Passive acoustic monitoring alone will not be able to discriminate between animals stopping vocalizing but remaining in an area, and animals stopping vocalizing and leaving an area. | R. Baird |

## Question 7a:

**Do we know what exposure levels to MFAS or underwater detonation cause TTS, PTS, injury, or mortality to MM/ST *with the existing HRC data*?**

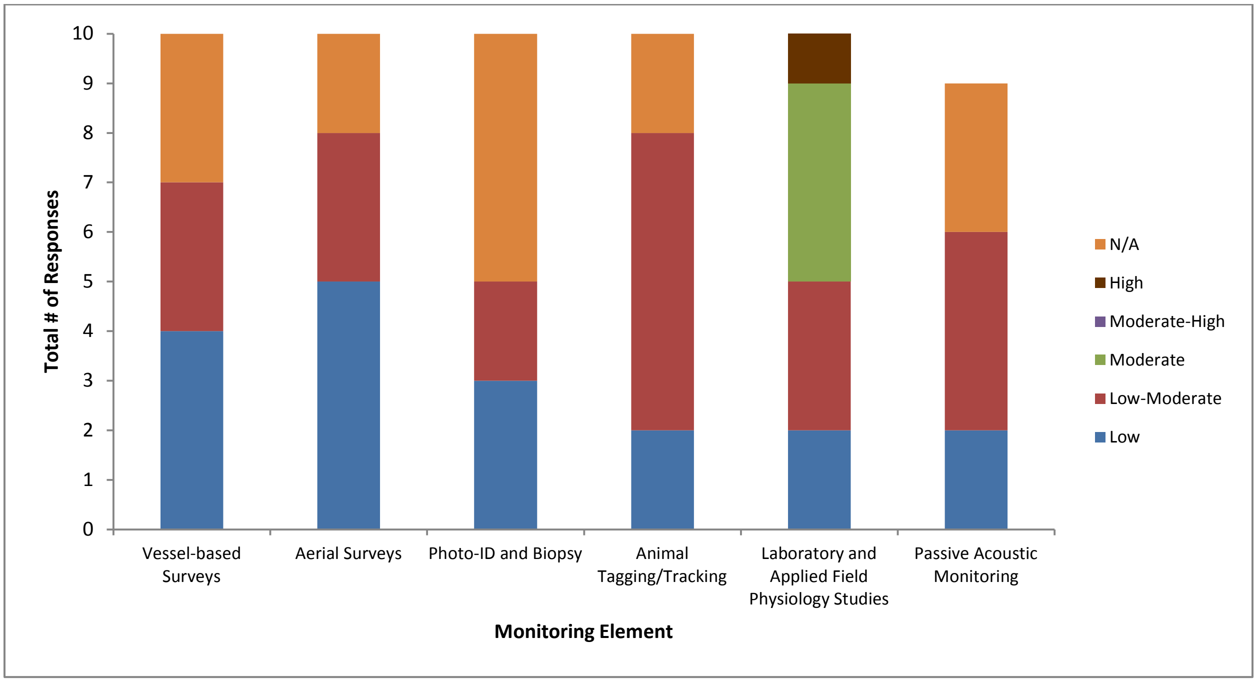


**Figure C-13. Group responses to Question 7a**

**Table C-13. Comments to Question 7a**

| Individual Comments | Commenter |
|---|---|
| I only added tagging and aerial surveys because they might be able to find or detect mortality events. | T. Norris |
| Laboratory and Applied Field Physiology are the only ways to assess TTS and PTS, other methods could potentially assess mortality if dead animals are detected at the surface or on the beach (aerial and vessel-based surveys including small-boat surveys), or if a tagged animal stranded. | R. Baird |
| Lab studies are the crux for this question obviously. However, observations of animals in conditions of high exposure without debilitating injuries evident can still be informative, albeit at a limited level. | B. Southall |

PTS = permanent threshold shift; TTS = temporary threshold shift

**<u>Question 7b:</u>**

**Do we know what exposure levels to MFAS or underwater detonation exposures cause TTS, PTS, injury, or mortality to MM/ST *with substantial increased effort*?**

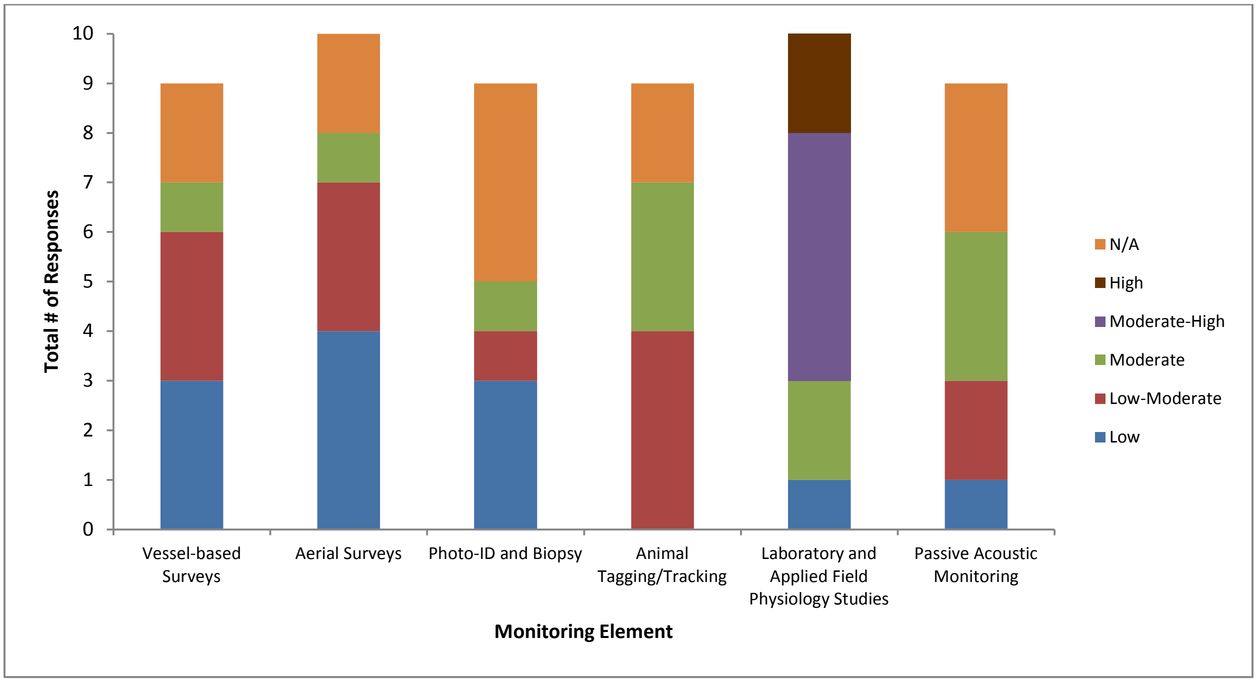


**Figure C-14. Group responses to Question 7b**

**Table C-14. Comments to Question 7b**

| Individual Comments | Commenter |
|---|---|
| See relatively little chance for much progress in this area other than for laboratory efforts, and those are limited to some extent by the species that can be kept and tested in the lab. | B. Southall |

**Question 8a:**

**What are the short-term behavioral responses of MM/ST when exposed to MFAS/underwater detonations at different levels/conditions *with the existing HRC data*?**

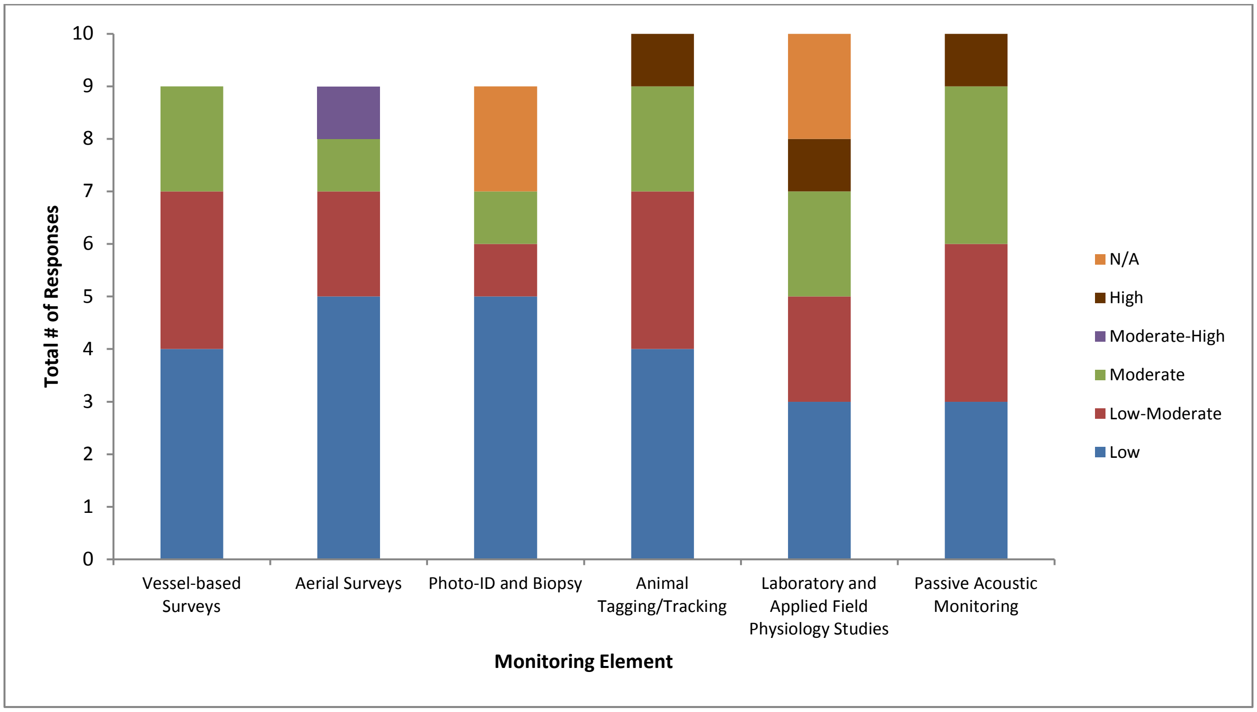


**Figure C-15. Group responses to Question 8a**

**Table C-15. Comments to Question 8a**

| Individual Comments | Commenter |
|---|---|
| Tags and passive acoustics can detect changes in behaviors. Passive acoustics are limited to acoustic behaviors, but for some species (e.g., toothed whales) these may include feeding behaviors, and for others (e.g., baleen whales) this could include courtship/breeding behaviors. | T. Norris |
| Sample sizes (# species, # individuals) are extremely limited for all methods. Reactions for most species likely occur over the visual horizon. | R. Baird |
| All of these have some utility, but in very different ways/applications. | B. Southall |

## Question 8b:

**What are the short-term behavioral responses of MM/ST when exposed to MFAS/underwater detonations at different levels/conditions *with substantial increased effort*?**

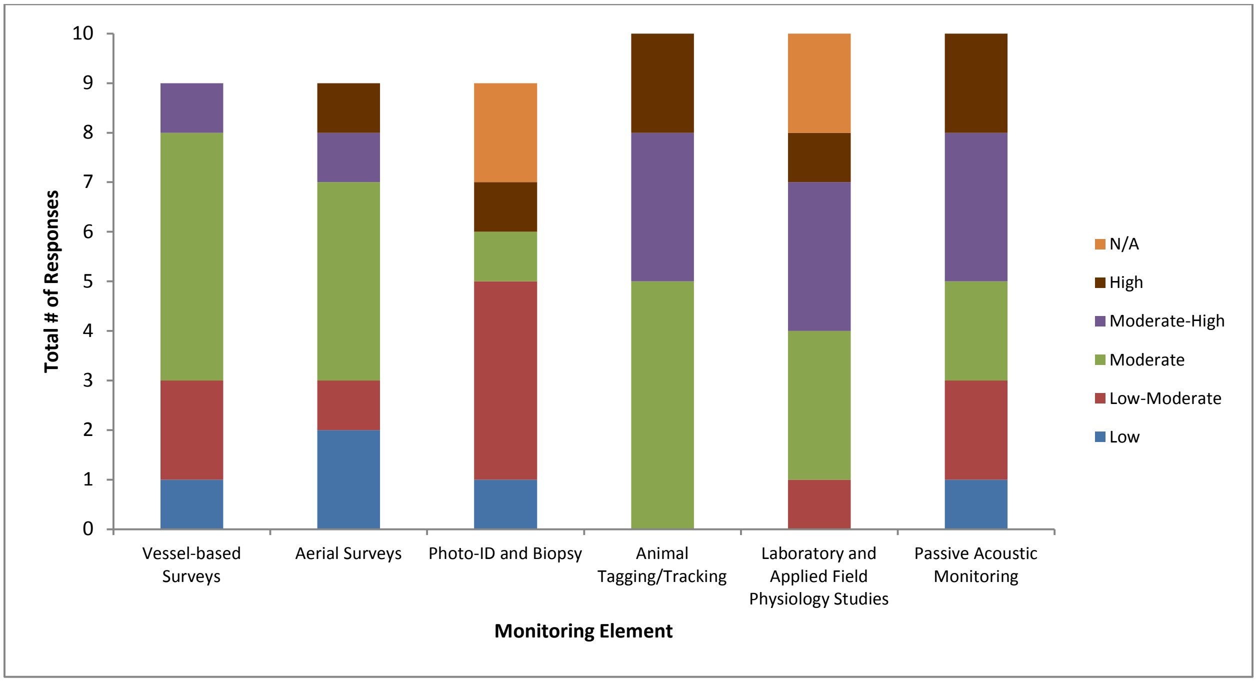


**Figure C-16. Group responses to Question 8b**

**Table C-16. Comments to Question 8b**

| Individual Comments | Commenter |
|---|---|
| Same comment as Question 8a. | T. Norris |
| Best chance for progress here is in tagging studies synched with tag-borne acoustics and ideally PAM from longer-term sensors as well. | B. Southall |

PAM = passive acoustic monitoring

## Question 9a:

**When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last *with the existing HRC data*?**

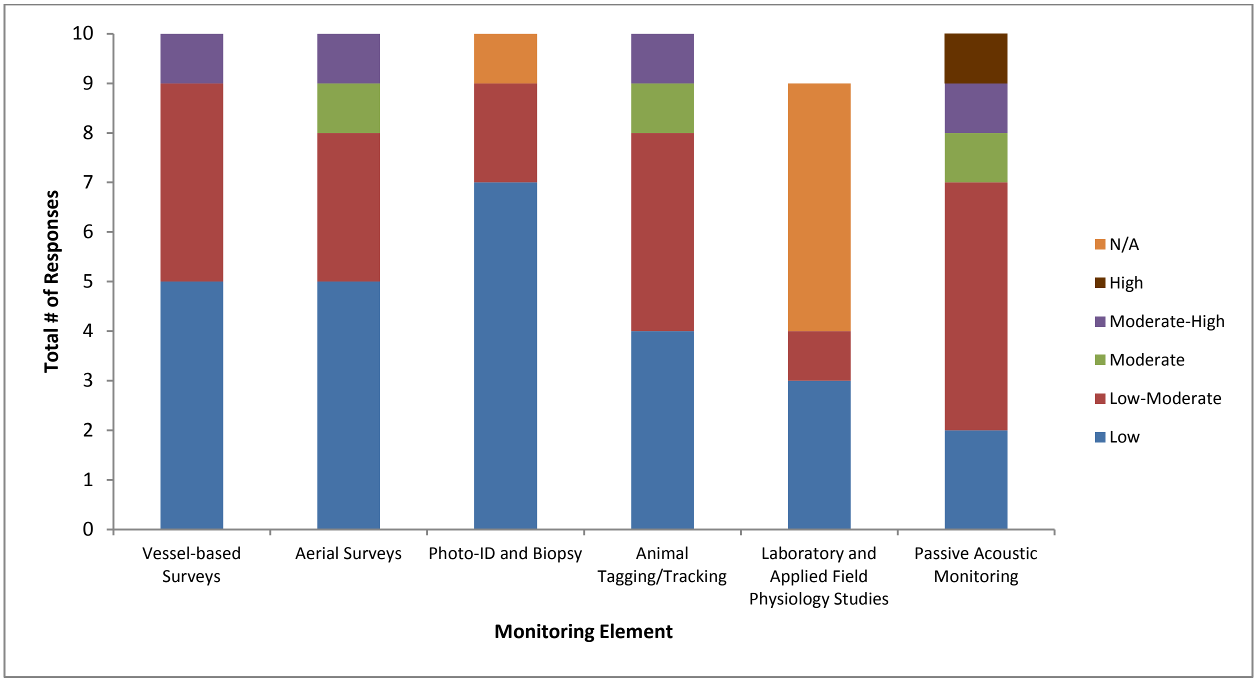


**Figure C-17. Group responses to Question 9a**

**Table C-17. Comments to Question 9a**

| Individual Comments | Commenter |
|---|---|
| Passive acoustics are the best approach. Tagging only if enough animals are tagged. Aerial surveys with substantial increase in effort | T. Norris |
| We are pretty limited in this regard presently with some HRC tagging and PAM data being somewhat applicable. | B. Southall |

HRC = Hawaii Range Complex; PAM = passive acoustic monitoring

**<u>Question 9b:</u>**

**When MM/ST are exposed to MFAS and/or explosions, do they redistribute in space? If so, how long does the redistribution last *with substantial increased effort*?**

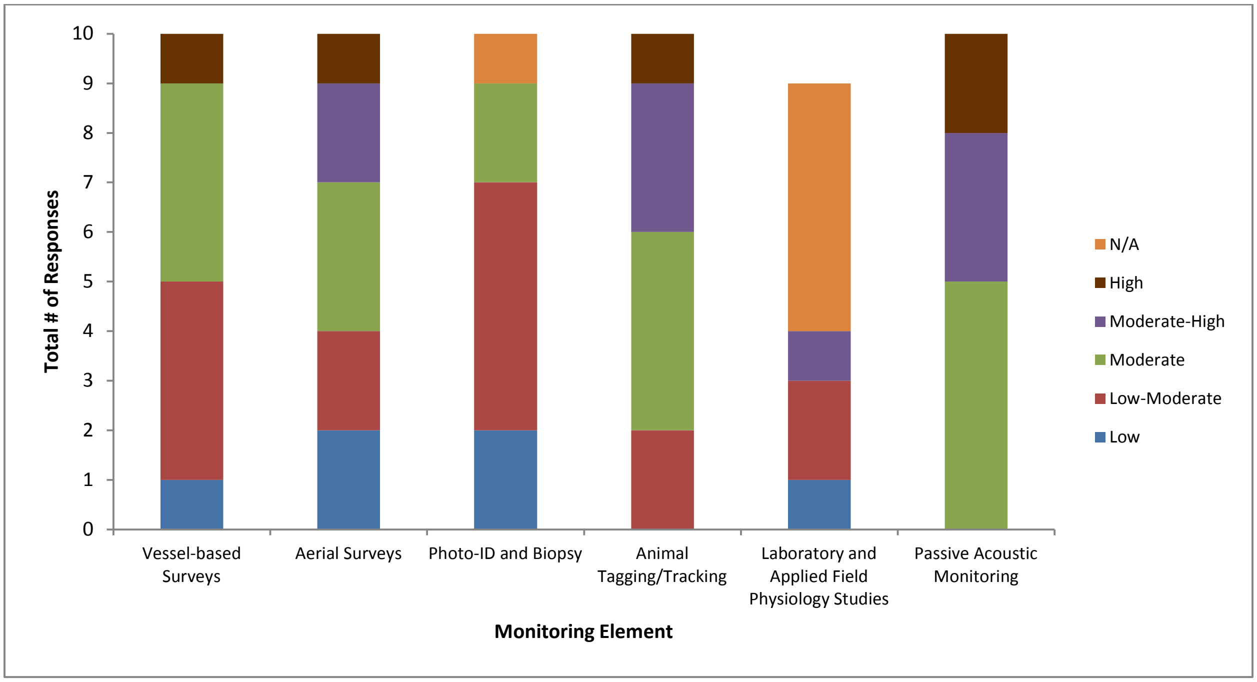


**Figure C-18. Group responses to Question 9b**

**Table C-18. Comments to Question 9b**

| Individual Comments | Commenter |
|---|---|
| Same comment as Question 9a. | T. Norris |
| In order to assess how long redistribution lasts, need to be able to obtain long-term tracks or assess large areas. | R. Baird |
| Again, see the tagging and PAM work giving the best hope given the limitations in time/space sampling of the other types of data sets. | B. Southall |

PAM = passive acoustic monitoring

**<u>Question 10a:</u>**

**Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST *with the existing HRC data*?**

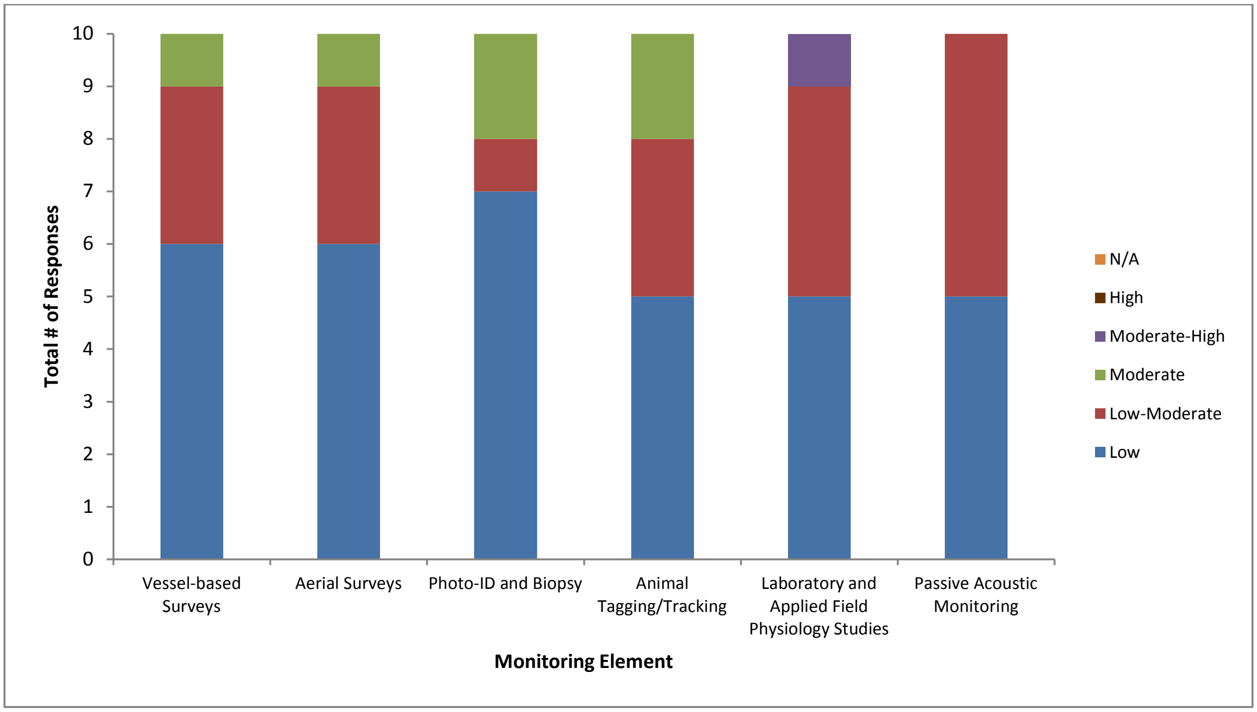


**Figure C-19. Group responses to Question 10a**

**Table C-19. Comments to Question 10a**

| Individual Comments | Commenter |
|---|---|
| This one is a difficult question to answer. I put lab/field studies as moderate/high, because this approach has the best ability to monitor individuals, but there is always a question of relevance of these results to wild animals. Photo-ID and tagging can answer questions if animals are displaced, but only if a direct cause/effect can be demonstrated, which is difficult in most cases. The others have limited abilities to follow individual animals, although big strides are being made in acoustic studies to identify individuals using "pattern recognition" work (similar to voice-pattern recognition). | T. Norris |
| To be blunt, I don't think we are really ready to answer this almost anywhere with some of the AUTEC work being about the closest we might get or some of the whale-watching studies (not HRC, though). | B. Southall |

AUTEC = Atlantic Undersea Test and Evaluation Center; HRC = Hawaii Range Complex; photo-ID = photo-identification

**Question 10b:**

**Do U.S. Navy noise-generating activities have cumulative adverse impacts at the individual level on MM/ST *with substantial increased effort*?**

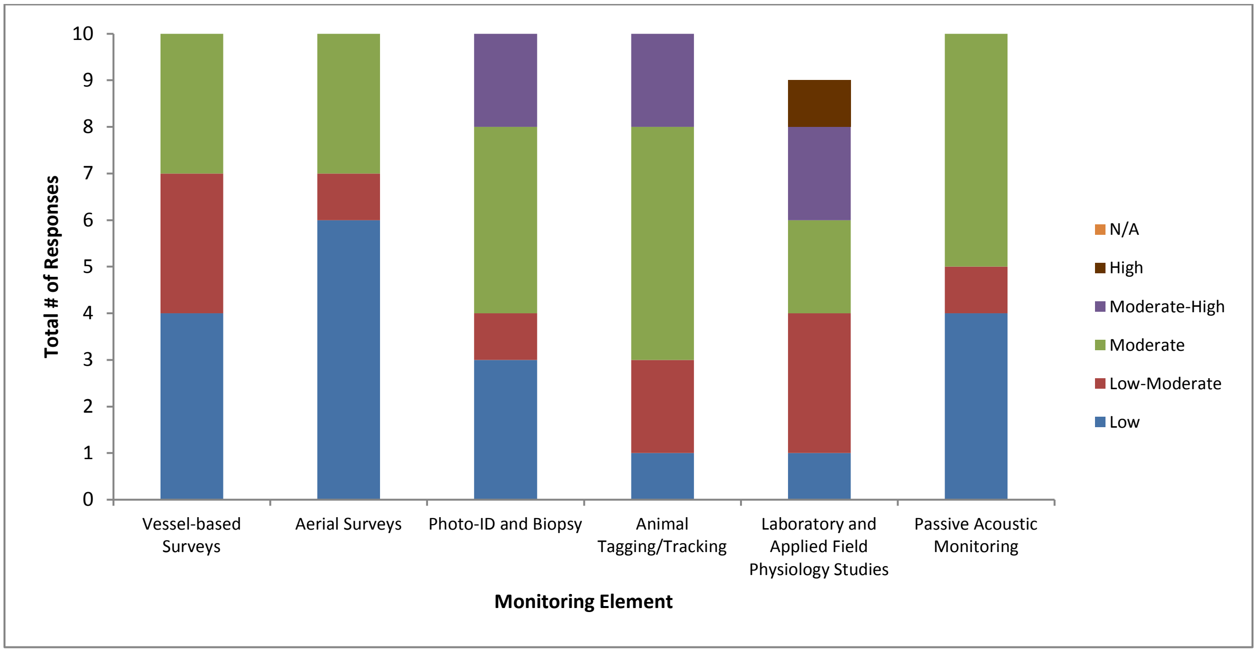


**Figure C-20. Group responses to Question 10b**

**Table C-20. Comments to Question 10b**

| Individual Comments | Commenter |
|---|---|
| Same as comment to Question 10a—more effort might be effective for photo-identification and animal tagging methods, but again, a direct causal link needs to be demonstrated, which is difficult. | T. Norris |

## Question 11a:

**Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST *with the existing HRC data*?**

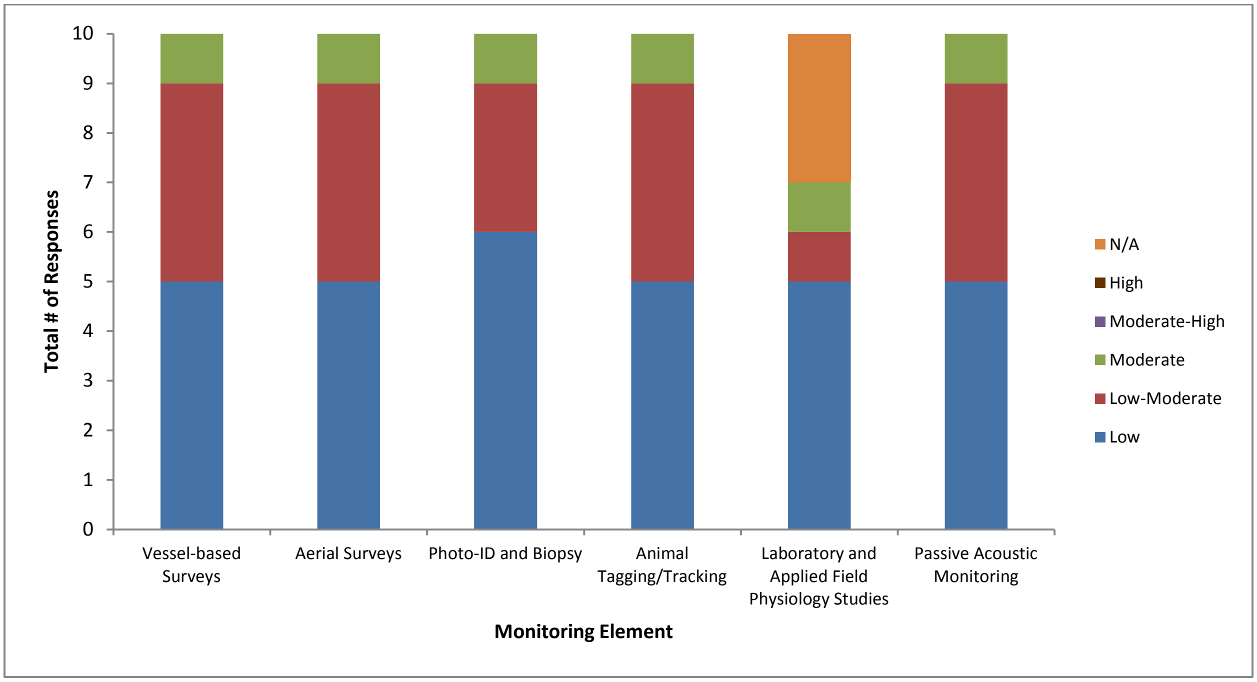


**Figure C-21. Group responses to Question 11a**

**Table C-21. Comments to Question 11a**

| Individual Comments | Commenter |
|---|---|
| To answer this at the population level will require using multiple methods. The ones checked above are the most effective methods to do this, but combining them when possible will provide the best information. | T. Norris |
| Important questions...not enough information to make a reasoned decision. | B. Southall |

**Question 11b:**

**Do U.S. Navy noise-generating activities have cumulative adverse impacts at the population level on MM/ST *with substantial increased effort*?**

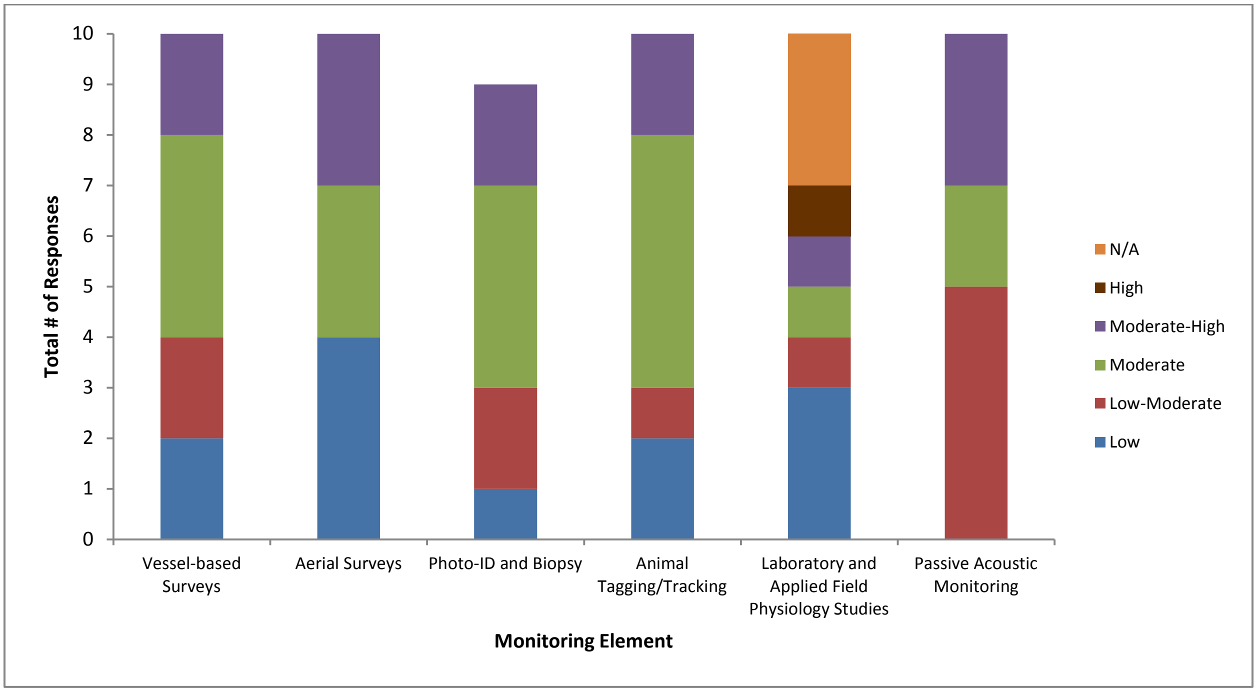


**Figure C-22. Group responses to Question 11b**

**Table C-22. Comments to Question 11b**

| Individual Comments | Commenter |
|---|---|
| It would take quite a long time to collect enough data to address this question. | J. Oswald |
| Same comment as Question 11a. | T. Norris |

**Question 12a:**

**Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST *with the existing HRC data*?**

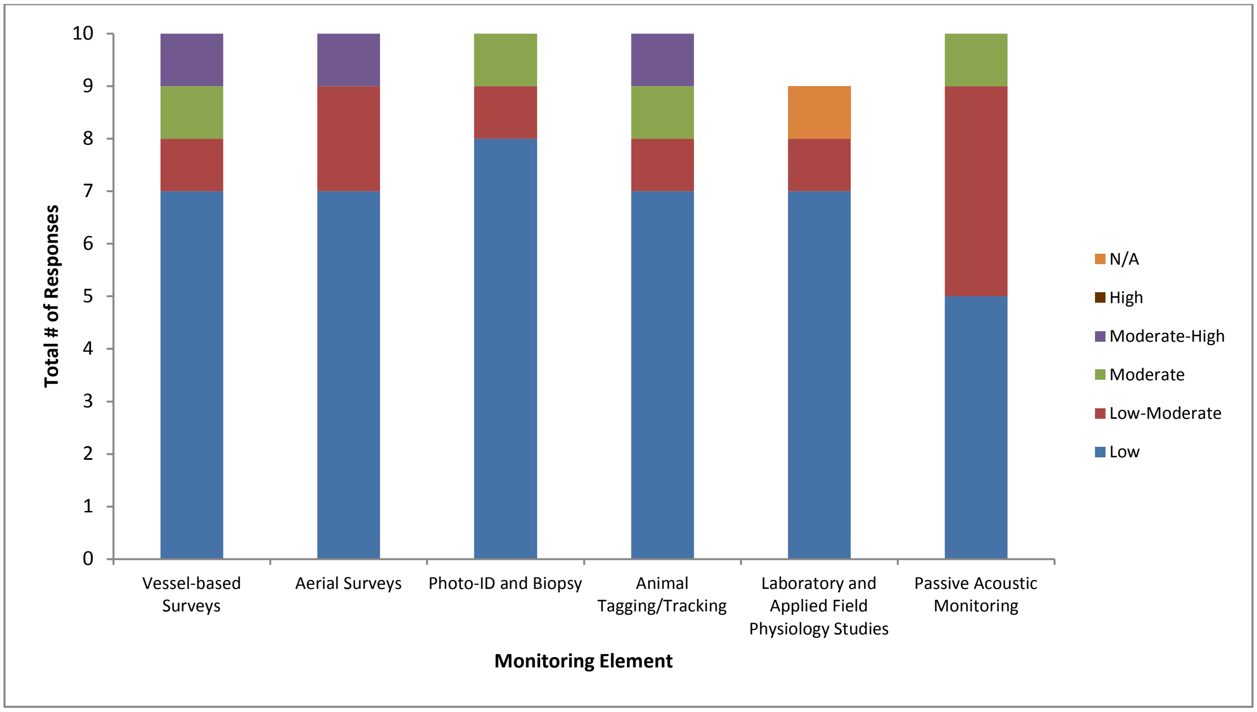


**Figure C-23. Group responses to Question 12a**

**Table C-23. Comments to Question 12a**

| Individual Comments | Commenter |
|---|---|
| Any methods that allow *in-situ* collection of environmental data are desirable over remotely collected data (e.g., satellite data), thus I included vessel surveys in this answer. Again combining methods and data will provide the best results. | T. Norris |
| Same comment as Question 11b, but even harder. | B. Southall |

## Question 12b:

**Do U.S. Navy noise-generating activities interact with other environmental factors (e.g., natural variability, anthropogenic activities) to cause long-term consequences to MM/ST *with substantial increased effort*?**

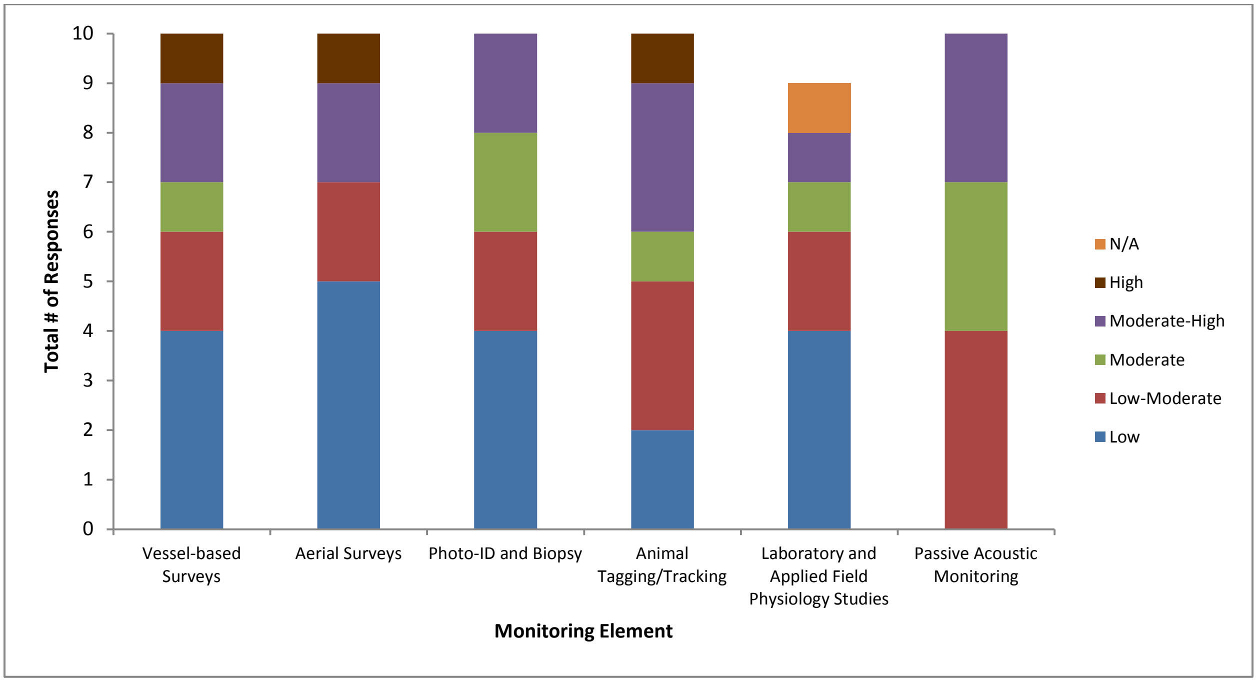


**Figure C-24. Group responses to Question 12b**

**Table C-24. Comments to Question 12b**

| Individual Comments | Commenter |
|---|---|
| Same comment as Question 12a. | T. Norris |

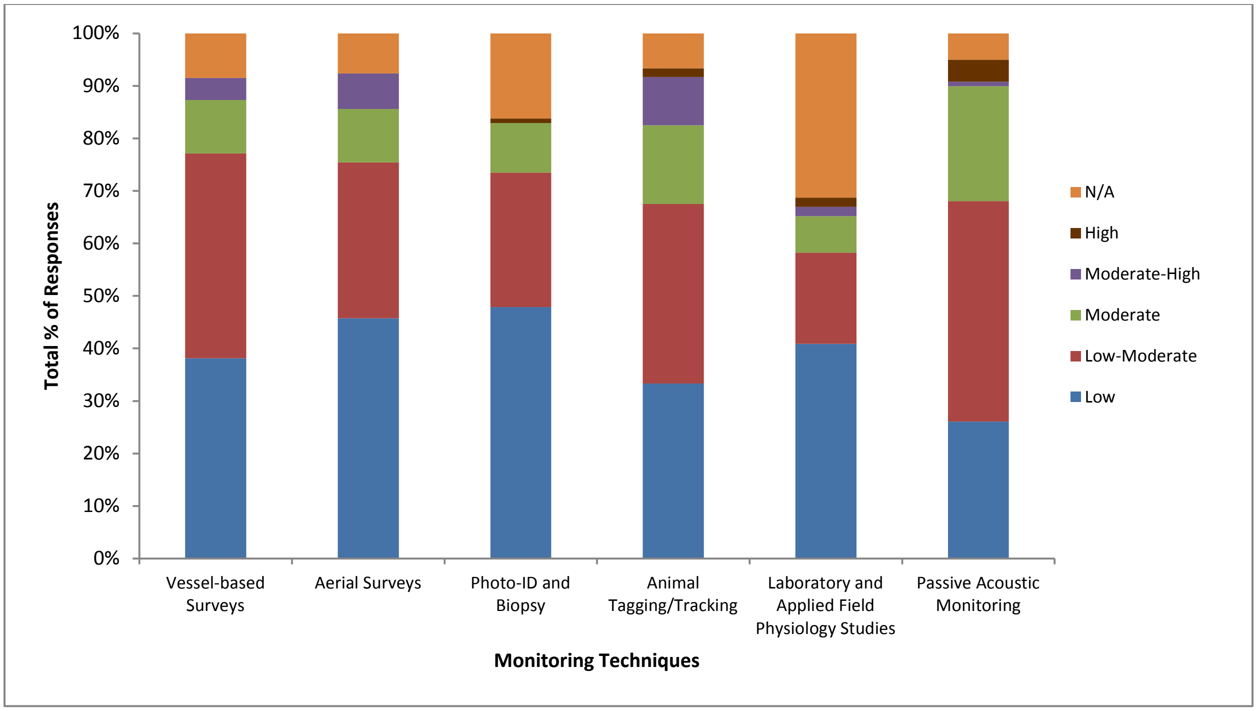


**Figure C-25. All responses to all survey questions, *assuming existing HRC data***

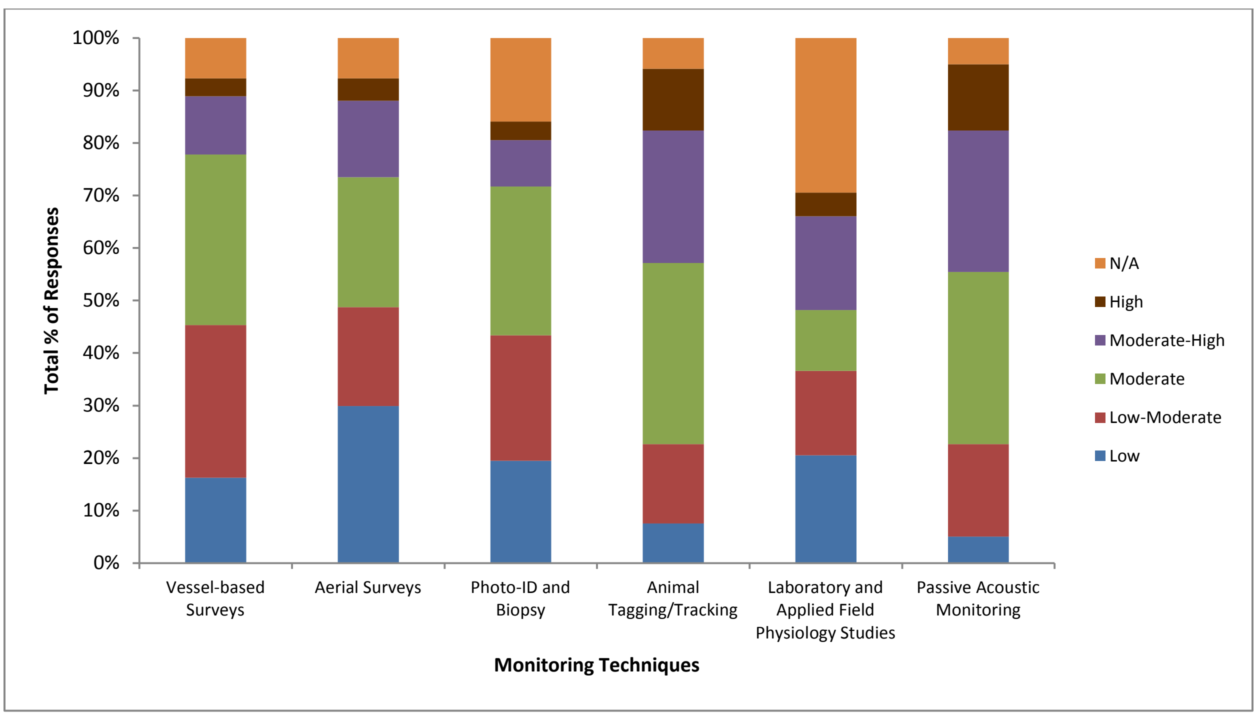


**Figure C-26. All responses to all survey questions, *assuming substantial increased effort***