Prepared for the National Marine Fisheries Service
Office of Protected Resources
Prepared by U.S. Pacific Fleet Environmental Readiness Office

Mariana Islands Range Complex
Marine Species
Monitoring Plan
FY13-2015

This Monitoring Plan is submitted to NMFS in support of the Taking and Importing Marine Mammals; U.S. Navy Training in the Mariana Islands Range Complex

AND

Programmatic Biological Opinion on the U.S. Navy's Training in the Mariana Islands Range Complex

LIST OF ACRONYMNS

AMR	Adaptive Management Review
CFR	Code of Federal Regulations
CNO	Chief of Naval Operations
DoD	Department of Defense
EIS	Environmental Impact Statement
OEIS	Overseas Environmental Impact Statement
DON	Department of the Navy
ESA	Endangered Species Act
FY	fiscal year
GPS	global positioning system
HQ	headquarters
HRC	Hawaii Range Complex
ICMP	Integrated Comprehensive Monitoring Program
ITA	Incidental Take Authorization
LOA	Letter of Authorization
MIRC	Mariana Islands Range Complex
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	Nautical miles
NOAA	National Oceanographic and Atmospheric Administration
ONR	Office of Naval Research
PAM	passive acoustic monitoring
PIFSC	Pacific Islands Fisheries Science Center
R&D	Research and Development
SAG	Science Advisory Group

EXECUTIVE SUMMARY

The U. S. Navy (Navy) has developed this Mariana Islands Range Complex (MIRC) Monitoring Plan to provide marine mammal and sea turtle monitoring as required under the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973. In order to issue an Incidental Take Authorization (ITA) for an activity, Section 101(a)(5)(a) of the MMPA states that National Marine Fisheries Service (NMFS) must set forth "requirements pertaining to the monitoring and reporting of such taking." The MMPA implementing regulations in 50 CFR Section 216.104 (a)(13) note that requests for Letters of Authorization (LOAs) must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or effects to populations of marine mammals that are expected to be present.

Navy marine species monitoring conducted in the MIRC from FY10 to FY12 has utilized a combination of visual line-transect surveys, non-random/non-systematic visual surveys, and passive acoustics. Through the process of adaptive management, input was solicited from an independent scientific advisory group. In order to meet the top level goals established by the Navy and NMFS and through the lessons learned from past monitoring, the Navy is recommending revisions to the monitoring plan for FY13 and FY14. The monitoring plan includes visual survey from either a vessel or shore-based station, maintenance of autonomous passive acoustic monitoring devices in FY13 and FY14 and subsequent analysis, use of a dipping hydrophone during vessel surveys, support for collection of biopsy samples (including preliminary analysis and archiving) per year, support for satellite tagging including purchase of tags and analysis of data per year, mark-recapture abundance estimates, and either line transect diving sea turtle surveys per year or turtle tagging.

1. INTRODUCTION

The Mariana Islands Range Complex (MIRC) is located in the western North Pacific Ocean and encompasses an area of approximately 500,000 nm2. The range complex surrounds the Mariana Island Archipelago which includes the Commonwealth of the Northern Mariana Islands and the Territory of Guam (see Figure 1). Very little is known about the marine mammal and sea turtle species in the MIRC (Ligon et al., 2011).

Because the islands are a geographically isolated archipelago, it is hypothesized that the assemblage of marine mammals and sea turtles would bear some ecological resemblance to the isolated Hawaiian Islands archipelago. The expected similarities between the archipelagos, in terms of the cetacean assemblage, include low density and high diversity, but could also include island-associated odontocetes, overlapping ranges of oceanic, offshore, and island-associated odontocete populations, resident offshore species, and seasonally present baleen whales.

Evidence for low marine mammal density is suggested by low sighting rates from a Navy study (Fulling et al., 2011) and small boat surveys during 2010 and 2011 off Guam and Saipan (HDR, 2011; Hill et al., 2011; Ligon et al., 2011). Evidence for high diversity and similar species assemblages comes from sighting/acoustic records: Twelve species were sighted during the Navy-sponsored, large-vessel Mariana Islands Sea Turtle and Cetacean Survey (MISTCS) (DoN, 2007), and ten species were sighted during the collaborative Pacific Island Fisheries Science Center (PIFSC)/Navy large vessel cruises during 2010 (Oleson and Hill, 2010). Several additional species not detected visually were detected by passive acoustic methods in both studies. Patterns of species' presence and density may be similar to Hawaii.

The above mentioned studies represent nearly the entirety of the scientific corpus on this topic; therefore fundamental issues of occurrence and distribution of species have yet to be fully described, and such knowledge is a prerequisite to deeper conclusions through the monitoring program regarding the potential impacts of Navy training.

Monitoring in the Mariana Islands presents special challenges. Past experience has proved that windward sides of islands and offshore areas are difficult to access in small vessels (HDR, 2011; Hill et al., 2011; Ligon et al., 2011). Winter conditions consistently impair field efforts. For these reasons, sighting opportunities of baleen whales are infrequent. Alternative means of collecting data that complement visual surveys are recommended as ways to achieve data collection goals.

There are four levels that guide implementation of the Adaptive Management Review (section 2.3) process for monitoring in the MIRC:

1) The Navy's Integrated Comprehensive Monitoring Program (ICMP) provides the overarching structure for the monitoring program. The ICMP is a planning tool, developed through coordination with the National Marine Fisheries Service (NMFS), which establishes top-level goals for Navy marine species monitoring pursuant to the Endangered Species and the Marine Mammal Protection Act.

2) The Scientific Advisory Group (SAG) Report is the product of an independent scientific advisory panel which convened to critically evaluate Navy marine species monitoring plans and propose recommendations for the refinement of the monitoring and mitigation program. Establishing the SAG was an outgrowth of the adaptive management process.

The SAG made conceptual and programmatic recommendations which address ICMP goals but are more specific to range complex level monitoring plans.

3) Communication with researchers: The Navy also solicited additional input on local monitoring questions and priorities from researchers at universities, science centers, and private institutions who have worked in MIRC or the Hawaiian Islands. The contributors had expertise across disciplines, species, and techniques and had publications relevant to Navy marine species monitoring in the MIRC or the Hawaiian Islands.

4) Previous surveys: Current scientific and monitoring knowledge gained through previous efforts in the study area.

These four items are described in more detail below.

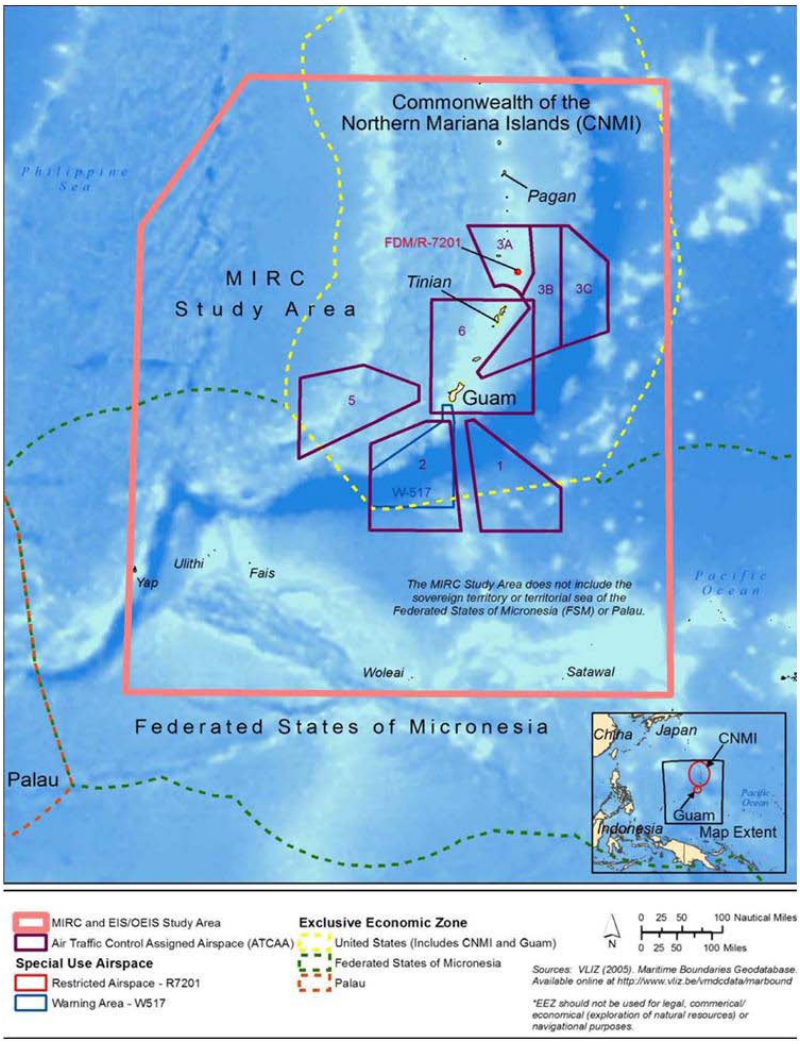

Figure 1. MIRC Study Area

1.1 INTEGRATED COMPREHENSIVE MONITORING PROGRAM (ICMP)

The ICMP provides the overarching framework for coordination of the Navy's monitoring program. It is intended for use as a planning tool to focus Navy monitoring priorities pursuant to Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) requirements. It is also an adaptive management tool to analyze and refine monitoring and mitigation techniques over time. The ICMP was developed in direct response to Navy range permitting requirements established in the various MMPA Final Rules, ESA Consultations, Biological Opinions, and applicable regulations. As a framework document, the ICMP applies by regulation to those activities on ranges and operating areas for which the Navy sought and received incidental take authorizations. The ICMP is an "umbrella" document over specific monitoring plans that have been or are being developed for the Navy's range complexes and operating areas, depicted in Figure 2. Additional ranges or study areas may be added to the ICMP consistent with future Navy range permitting requirements.

The MMPA Final Rules provides that the primary objectives of the ICMP are to:

- Monitor and assess the effects of Navy activities on protected marine species;
- Ensure that data collected at multiple locations is collected in a manner that allows comparison between and among different geographic locations;
- Assess the efficacy and practicality of the monitoring and mitigation techniques;
- Add to the overall knowledge base of protected marine species and the effects of Navy activities on these species.

The ICMP meets these requirements and objectives by:

- Identifying top-level goals for the monitoring program, as well as guidelines for use in prioritizing monitoring projects and related Research & Development;
- Defining standard procedures for the compilation and management of data from range/project-specific monitoring plans;
- Establishing an adaptive management process that includes annual reviews with NMFS;
- Making provisions to review relevant monitoring-related research and, where appropriate, incorporate findings as updates to the range/project-specific monitoring plans and mitigation measures through adaptive management; and
- Providing an unclassified recordkeeping system that will allow interested parties to see how each Range Complex is contributing to ongoing monitoring.

The ICMP is evaluated annually through the adaptive management process (Section 2.3) to assess progress, provide a matrix of goals for the following year, and make recommendations for refinement and analysis of the monitoring and mitigation techniques. This process includes conducting an Adaptive Management Review (AMR) at which Navy and NMFS will jointly consider the prior year goals, monitoring results, and related science advances to determine if modifications are needed to more effectively address monitoring program goals.

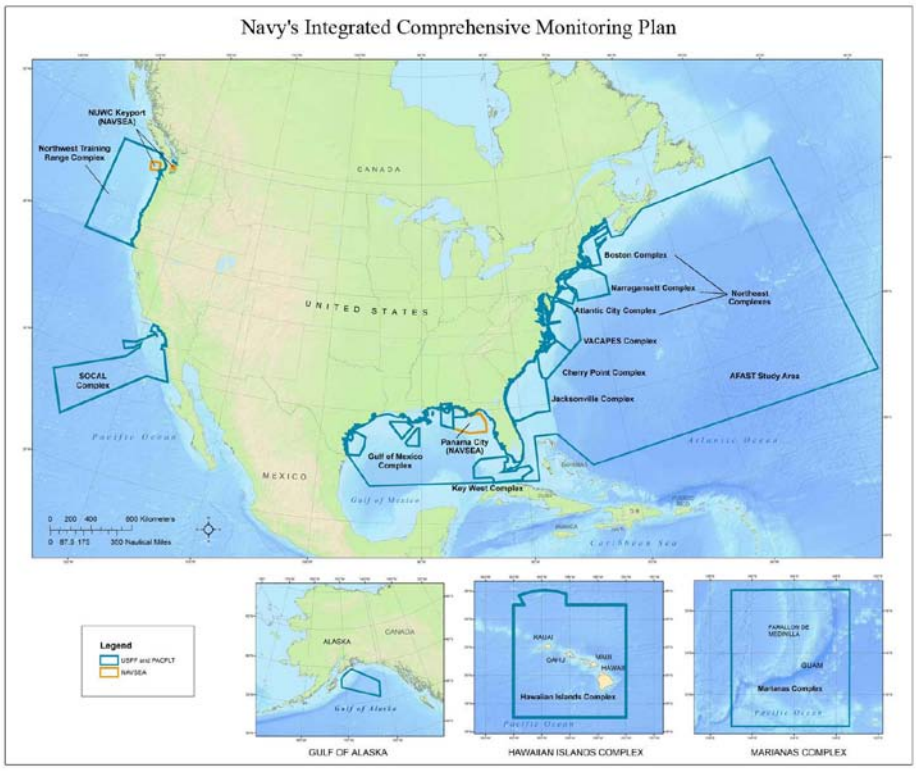

Figure 2. Navy Range Complexes and Study Areas included under the ICMP

1.2 THE SCIENTIFIC ADVISORY GROUP REPORT

The SAG Report laid out range-specific recommendations that follow a framework of knowledge which considers the occurrence of marine mammals, exposure to Navy training, potential response to those activities, and potential consequences of the interactions. The range specific recommendations for MIRC were:

> *"The Mariana Islands Range Complex is located in the western Pacific, encompassing a large (500,000 nm2) region where little effort has been conducted on the study of marine mammals. Because so little is known about species occurrence in this area, the priority for this region should be on establishing occurrence. Passive acoustic monitoring is highly recommended for use in this region, in combination with recordings from small boats to obtain species-specific vocalizations. Other appropriate methods to collect occurrence data in this region include small boat surveys, biopsy sampling, satellite tagging and photo-identification (photo-ID). Photo-ID mark-recapture studies represent the best opportunity for evaluating the abundance of small populations, as opposed to standard line-transect methods. Photo-ID is also a useful mechanism for fostering and enabling local research capabilities. There will be a high return for monitoring in the Mariana Islands, because even basic information will greatly expand what is known for this region. In addition, the medium-to-high level of naval activity in the region also increases its importance for monitoring effort."*

An assessment was also made for the comparing the range complexes. MIRC was rated high in the need for basic occurrence information and medium in the suggested level of monitoring

effort, relative to SOCAL and AFAST (high) and HRC (medium/high). For a summary of programmatic changes recommend by the SAG, please see the Final Scientific Advisory Group for Navy Marine Species Monitoring Workshop Report and Recommendations which can be found online at http://www.nmfs.noaa.gov/pr/pdfs/permits/navy_species_monitoring.pdf.

1.3 RECOMMENDATIONS FROM REGIONAL RESEARCHERS

Researchers with experience working in MIRC and similar environments were asked to submit their recommendations for future marine species monitoring given lessons learned from the previous surveys (listed below in Section 1.4). This input varied from broad conceptual questions to the challenges and logistics of working in the Marianas. To summarize, the unique recommendations which added to the existing recommendations of the SAG report included a focus on collection of visually validated acoustic recordings, investigation into local areas of high density, aerial line-transect surveys conducted in the summer, a Lookout Effectiveness embarkation during a naval exercise in MIRC and surveying during seasons of the best weather.

1.4 PREVIOUS SURVEYS

Prior to 2007 there was little information available on the abundance and density of marine mammals and sea turtles in the MIRC Study Area. Most information on the occurrence of marine mammals came from short surveys (several days) and opportunistic sightings (NMFS Platform of Opportunity, oceanographic cruises or strandings). Eldredge (1991) compiled the first list of published and unpublished records for the greater Micronesia area, reporting 19 marine mammal species. Some of these species accounts were based on unsubstantiated reports and may not reflect true species distribution in the region. Eldredge (2003) refined this list specifically for 13 cetacean species thought to occur around Guam. The following surveys were funded by the U.S. Pacific Fleet (unless noted) in support of marine species monitoring in the MIRC.

2007 Aerial Survey - An aerial monitoring survey was conducted after the Valiant Shield training exercise in July 2007. The survey covered 2,352 km of linear effort, with transect grids distributed randomly throughout an 163,300 km2 area. A total of 8 sightings were recorded during the five-day period including seven cetacean (Bryde's whale, pygmy or dwarf sperm whale, Cuvier's beaked whale, pantropical spotted dolphin, and rough-toothed dolphin) and one unidentified turtle species (Mobley, 2007).

2007 MISTCS - The first comprehensive survey of the area, MISTCS, was conducted from January to April 2007 (DoN, 2007; Fulling et al., 2011;). The visual survey was conducted using the systematic line-transect survey protocol developed by the NMFS Southwest Fisheries Science Center (Barlow, 2006; Barlow and Forney, 2007; Ferguson and Barlow, 2001; 2003). Acoustic detection methods were made using two towed arrays and sonobuoys; these methods supplemented the visual detections. There were 148 sightings of 12 marine mammal species (sperm whale, sei whale, Bryde's whale, false killer whale, short-finned pilot whale, melon-headed whale, pygmy killer whale, pantropical spotted dolphin, striped dolphin, bottlenose dolphin, spinner dolphin, rough-toothed dolphin), and one sightings of a hawksbill turtle. The full report is provided at http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications under the section title 2008 Mariana Island Range Complex, as well as at http://www.nmfs.noaa.gov/pr/pdfs/permits/mirc_mistcs_report.pdf.

Navy / NMFS collaborative survey - January to May 2010, NMFS, PIFSC was partially supported by the U.S. Pacific Fleet to conduct visual surveys from both small boats and a large research vessel

(Oleson and Hill, 2010) (available as "Appendix A" within the 2010 MIRC monitoring report: http://www.nmfs.noaa.gov/pr/pdfs/permits/navy_mirc_monitoring2011.pdf). Sea turtle effort was not part of the protocols. The report consisted of four separate field efforts tasks:

Task 1 (OES 10-01): A large vessel line transect survey was conducted on the high seas between Honolulu and Guam during January and February 2010 for 16 days covering 1,285 nmi of trackline over 146 on-effort hours, and had 25 sightings, 6 species (sperm whale, sei whale, false killer whale, melon-headed whale, striped dolphin, and Mesoplodon spp.), 626 photographs, and 1 biopsy. There was also an acoustic component consisting of: a) a towed array that made over 100 detections, mostly of sperm and minke whales; and b) 37 sonobuoy drops that detected humpback, sperm, minke, fin, and sei whales, and possible delphinid clicks and whistles

Task 2 (OES 10-03): an opportunistic line transect survey was conducted during transit legs of a large vessel oceanography cruise off Micronesia and CNMI during March and April 2010 covering 792 nmi of trackline over 172 on-effort hours, and had 9 sightings of 3 species (Risso's dolphin, short-finned pilot whale, striped dolphin). Photography and biopsy sampling were not part of the study protocol. Conductivity/temperature/depth sampling was also conducted.

Task 3 (OES 10-04): a large vessel line transect survey was conducted on the high seas between Honolulu and Guam including a circuit around Wake Island during April and May2010 covering 1,285 nmi of trackline over 171 on-effort hours, and had 21 sightings, 7 species (sperm whale, sei whale, short-finned pilot whale, melon-headed whale, false killer whale, pantropical spotted dolphin, and spinner dolphin), 1,243 photographs, and 0 successful biopsies. There was also an acoustic component consisting of: a) 150 hours of towed array recordings that detected pilot whales, melon-headed whales, and false killer whales, with 6 detections being matched with concurrent sightings from the visual team; and b) 37 sonobuoy deployments that detected delphinid whistles, sperm whales, minke whales, and sei whales.

Task 4: small boat cetacean surveys were conducted off Guam, Tinian, and Saipan during February and March 2010, and is summarized separately below (Ligon et al., 2011)

Small Boat Cetacean Surveys - February to March 2010 - From February 9 to March 3, 2010, small small-boat nonrandom opportunistic surveys were conducted off the islands of Guam, Tinian, and Saipan (Ligon et al., 2011). The surveys covered 700 nmi of trackline over 98 on-effort hours. The Guam portion of the effort yielded 11 sightings with 3 species (sperm whale, spinner dolphin, pantropical spotted dolphin), 2,769 photographs, and 8 biopsy samples. The Tinian-Saipan portion yielded 7 sightings of 2 species (sperm whale, spinner dolphin), and 4 biopsies. Sea turtle effort was not part of the study protocol.

MISTCS acoustic analysis - In 2011, additional analyses of the MISTCS acoustic array data were conducted (Norris et al., 2012). The results included improved estimates of the density and distribution of minke and sperm whales in MIRC. An attempt was made to compare a small sample of humpback whale song from MIRC to Hawaiian humpback whale song. The results were inconclusive. Odontocete whistles were classified into acoustic groups. Finally, sei whale vocalizations were described and qualitatively compared with sei whale vocalizations from other locations in the Pacific.

Small Boat cetacean surveys - February to March 2011 – From February 17 to March 3, 2011, was a small-boat non-random opportunistic survey was conducted off the island of Guam (HDR, 2011). The surveys covered 553 nmi of trackline over 71 on-effort hours, and resulted in 6 sightings

of green sea turtles, 9 sightings of 3 cetaceans species (primarily spinner dolphin with the exception of one mixed-species group of short-finned pilot whales and bottlenose dolphins), and 1,830 photographs. Biopsy sampling was not part of the study protocol.

Small-boat cetacean surveys - August to September 2011 – small boat surveys were conducted off Guam, Saipan, and Rota (Hill et al., 2011). The surveys covered 1691 nmi of trackline over 205 on-effort hours, and there were 38 sightings of cetaceans of 6 species (short-finned pilot whale, dwarf sperm whale, pygmy killer whale, bottlenose dolphin, pantropical spotted dolphin, spinner dolphin). 89 biopsy samples were collected and 10,782 photographs were taken. Sea turtle effort was not part of the study protocol.

2. MARIANA ISLANDS RANGE COMPLEX MONITORING PLAN

2.1 MONITORING PLAN OBJECTIVES

The overall objective of this monitoring plan is to further our understanding of the occurrence of marine mammals and sea turtles which may be exposed to mid-frequency active sonar and explosives in the MIRC, as a prerequisite to better understanding the impacts of Navy training. This will be achieved by addressing the monitoring questions listed in Table 1.

The data resulting from the MISTCS survey (Fulling et al., 2011; Norris et al., 2012; Thorson et al., 2007) provides the first step in elucidating the large-scale distribution patterns and density estimates of marine mammals in the entirety of the MIRC. However, many potentially sensitive species such as beaked whales may be island-associated with limited ranges (as some populations in the Hawaiian archipelago) and thus may have an additional risk factor for anthropogenic disturbance; such cryptic species (e.g., beaked whales, minke whales) are less likely to be fully characterized during the course of a single or small number of field efforts, and may require specifically tailored and dedicated techniques to improve the description of their occurrence and distribution.

Table 1. Monitoring questions for the MIRC

Question #	Monitoring questions
1	What species of beaked whales and other odontocetes occur around Guam and Saipan?
2	Are there locations of greater relative cetacean and/or sea turtle abundance around Guam and Saipan?
3	What is the baseline abundance and population structure of odontocetes which may be exposed to sonar and/or explosives in the near shore areas of Guam, Saipan, Tinian, and Rota?
4	What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?
5	What is the occurrence and habitat use of sea turtles in areas where the Navy conducts underwater detonations?

Beyond the recommendations of the SAG report, beaked whales continue to be a priority to the Navy because of the conclusion that MFAS was likely a causal factor in mass stranding of Cuvier's beaked whales in the Bahamas in 2000 (Evans and England, 2001). Correlations between strandings and naval exercises employing sonar have also occurred in the Mediterranean and Caribbean seas, but no such correlations have been described in Japan, MIRC, or Southern California (Filadelfo et al., 2009). An unusual event of melon headed whales entering Hanalei Bay, Kauai and remaining for 24 hours during the Navy exercise RIMPAC (Southall et al., 2006) elevates this species in the priority list for monitoring, although the cause of the event has also been postulated to be related to lunar prey cycles due to the observation of a simultaneous and similar event involving the same species in Rota (Mobley et al., 2007). These priorities do not preclude the monitoring of other species of cetaceans in MIRC, as sighting frequencies are low and relatively little is known across all species, although the justification of such priorities can provide a role in influencing types of monitoring effort, for example to focus visual survey techniques to be facilitated toward the study of odontocetes. Based on the absence of even a single baleen whale sighting detected by a cumulative total of 56 days of survey by small boat platforms (HDR, 2011; Hill et al., 2011; Ligon et al., 2011) as compared to their successful detection by methods such as large vessel (DoN, 2007; Oleson and Hill, 2010;) and aerial platforms (Mobley, 2007), baleen whales are likely not to be encountered within the areas amenable to small boat platforms, especially in prevailing conditions of the winter season. The optimal alternative to small-boat methods, as well as other more resource-intensive methods (e.g., large vessel, aerial) would be to detect baleen whales by passive acoustic methods, a prospect facilitated by the relatively larger propagation distances of their vocalizations.

The presence of two mine neutralization areas off the coast of Guam, and in relatively deep water, elevates this region for focused monitoring effort with respect to impacts of underwater explosives, especially in light of a sperm whale sighting in the near shore area ~1 nmi from shore at Orote Point on Guam (Ligon et al., 2011) (Figure 3).

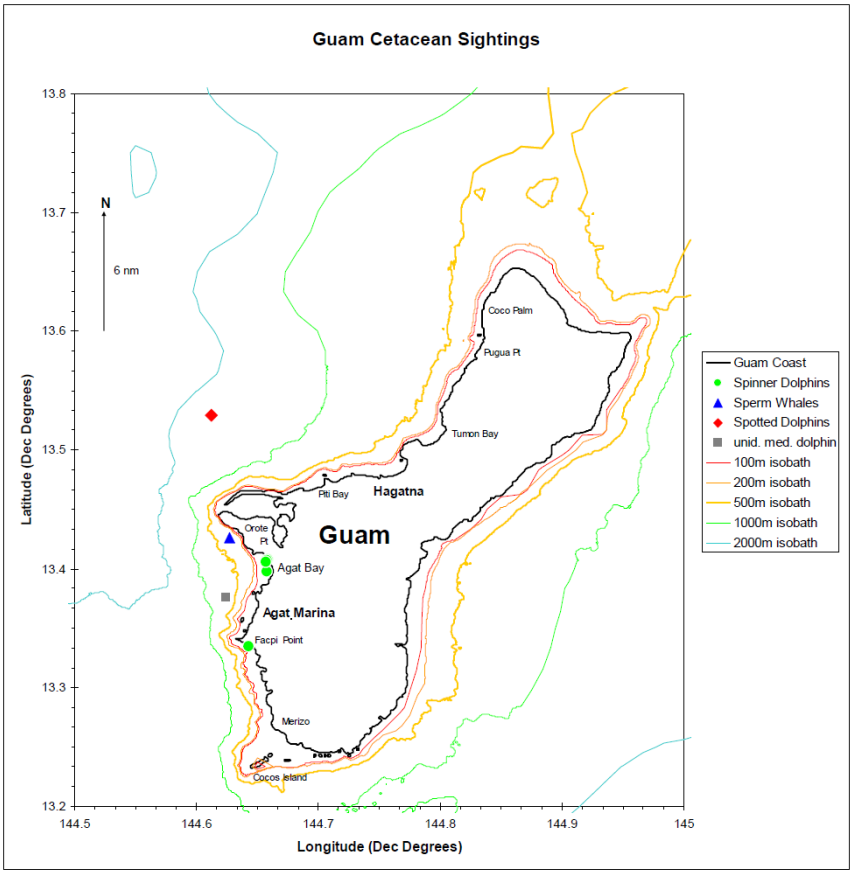

Figure 3. Guam cetacean sightings during the February-March 2010 small boat survey (Ligon et al., 2011).

Based on the recommendations of the SAG report, the Navy is prioritizing the monitoring of marine mammals and sea turtles through small boat visual surveys which include biopsy sampling, photo-ID mark recapture abundance estimates, satellite tagging, and the collection of visually-verified representative acoustic samples with a dipping hydrophone. Because of the current lack of knowledge, each successful satellite tag will generate new information on species' habitat use and distribution. Mark-recapture analysis and biopsy sampling will provide some of the first estimates of resident population sizes and structure. Visually-verified hydrophone recordings will provide the necessary basis for interpreting passive acoustic recordings, such as classifying detections to species, as well as developing resource-effective automated techniques for detection and classification.

Small-vessel visual surveys will address the spatial component of marine mammal occurrence near Guam and Saipan, but may also include Tinian and Rota, and may also include alternate methods given availability of resources. The Navy will maintain passive acoustic monitoring devices along with analysis of the acoustic data in the MIRC in order to address the temporal component of occurrence in the MIRC; given the experience learned through previous years of monitoring, it has been determined that further refining and applying acoustic analysis methods is equally important as collecting more data sets; therefore relatively more effort will be expended towards analysis tasks across fewer devices than in previous years. Because the presence of baleen whales can be addressed more efficiently through the use of passive acoustics, visual

efforts will be focused more on odontocetes (which are more difficult to monitor and identify to species through passive acoustics alone) and will result in a greater return on monitoring investment. Sea turtles will be addressed separately from cetaceans.

While this plan is written for a three year period, it should be noted that projects which address questions 2, 3, and 5 are part of a multi-year goal. Addressing seasonal abundance of baleen whales (question 4) has the potential to be answered within a shorter time frame and at least partially through the analysis of an existing data set.

2.1.1 Shore survey pilot study. Challenging weather and sea states restrict the areas that can be safely surveyed with a small vessel to a greater degree than in the Hawaiian Islands, particularly in the winter months when the sea states are consistently high, as experienced in the previous surveys in the region (see Section 1.4). This limitation reduces the amount of information known about marine mammal distributions on the windward side of Guam and CNMI. Pilot studies of a shore-based survey for marine mammals utilizing theodolite-based fixes is an option to collect better data in areas that are covered by small vessel surveys infrequently. MIRC is the only location that the SAG recommended shore-based surveys could be used, but the method was given the relative priority of "low." The monitoring plan does not propose to use this method everywhere, but as a supplemental means to know more about marine mammals in areas that cannot predictably be surveyed by small vessel.

The theodolite is a surveying instrument that can measure horizontal and vertical angles to sightings, allowing the positioning sightings upon latitude-longitude coordinates (Lerczak and Hobbs, 1998). The technique was first used for marine mammals by Payne in the 1970s for large whales and further developed by Wursig for dolphins (Würsig and Würsig, 1979). Most commonly this shore based survey technique has been used to track animal movements and habitat preferences, for example for bottlenose dolphins (Würsig and Würsig, 1979), dusky dolphins (Cipriano, 1992; Würsig et al., 1991; Yin, 1999), and humpback whales (Frankel et al., 1995; Helweg, 1989; Helweg and Herman, 1994). The technique has also been utilized to examine the reactions of marine mammals to anthropogenic stimuli, for example gray whales (Clark et al., 1983; Malme et al., 1984) and humpback whales (Frankel and Clark, 2002; Mithriel and Würsig, 2011; Smultea, 1994). It has also been utilized for multiple-species reaction studies (Tyack, 1993).

Shore stations typically are outfitted with an electronic theodolite interfaced with a laptop computer for real-time acquisition of sighting fixes (e.g., see http://www.tamug.edu/mmbeg/pythagoras.htm), as well as other visual observers using either handheld or mounted binoculars. Typically only a single species might be expected to be able to be sighted from a shore station. However, in several of the above cases where the shore station was at an ideally high elevation immediately adjacent to deep water, multiple species were sighted, for example off the Big Island of Hawaii, Argentina, and New Zealand. Similarly, a complement of multiple species including humpback whales, dugongs, humpback dolphins, bottlenose dolphins, and killer whales were sighted utilizing a shore station in Australia (Smultea, pers. comm.). Shelden and Rugh (2010) completed a formal survey for cetacean occurrence of all species using a shore station off the coast of central California.

The Mariana Islands are ideal locations for use of shore surveys because they are limestone karst islands with steep cliffs close to shore and deep water adjacent to the near shore environment. The MIRC study area has multiple areas of high elevation adjacent to deep waters, where species such as sperm whales have been sighted ~ 1 nm from shore (Ligon et al., 2011). Data generated by a

shore-based survey will be particularly relevant in this location because this study area also is among the most poorly characterized with respect to marine mammals among all U. S. Navy range complexes such that enhancing knowledge about basic occurrence and distribution is currently one of the initial goals of the monitoring program. Prevailing weather has constrained small-boat surveys on the majority of days to very nearshore waters, and especially in winter almost exclusively to the leeward sides of the islands, especially in winter (HDR, 2011; Ligon et al., 2011)—any shore-based data from windward sides would generate almost entirely new and complementary sets of data on distribution and occurrence.

A pilot study for a general cetacean survey utilizing a shore station is justified by: a) the available and ideal options for locations to establish an effective shore station, b) the emphasis and relative data-deficiency with regard to questions of occurrence and distribution in this range complex, and c) the use of a shore station a complementary technique to boat-based methods, given their relative expense and geographic limitations. Because Yin et al. (2005) noted that in the case of short and intermediate distances, measurements of animal locations using handheld reticled binoculars with a compass may be comparable with those made by theodolite, final determination of equipment to be utilized will depend upon evaluation of the shore station site conditions such as accessibility. If the pilot study is successful in gathering species-specific data on cetacean occurrence, the study may be extended across multiple monitoring years as well as other potential shore station sites identified in the study area.

One of the recommendations of the SAG was to develop local marine mammal expertise in the Mariana Islands. A shore-based study provides an opportunity to involve local interested parties in marine mammal monitoring. Students from University of Guam, officials with Federal or local agencies, or members of the local fishing community could be included in setting up stations, taking data, and analyzing the results.

2.2 MONITORING PLAN IMPLEMENTATION

The MIRC presents a challenging environment for monitoring. The area is well-known for its year round high sea states and frequent unpredictable typhoons. It is also less commercially developed than other range complexes, limiting access to, and increasing expenses for large research vessels and non-military aircraft appropriate for offshore field surveys. There is a lack of local expertise on marine mammals. To the extent practicable, the Navy plans to coordinate with NMFS and local researchers to maximize resources, expertise, equipment, and to extract maximum benefit from the effort expended (e.g., mark recapture abundance estimates can be used for Environmental Impact Statement (EIS) and Navy MMPA take estimates).

The methods recommended in Table 2 reflect the monitoring objectives and questions stated in Section 2.1. Specifically, these methods are expected to address the monitoring questions in the following manner:

Question 1: What species of beaked whales and other odontocetes occur around Guam and Saipan?

- Shore-based and continuation of vessel-based visual surveys will provide visual confirmation of species presence. Vessel surveys will provide opportunities to obtain recordings of visually verified species, and biopsy samples to confirm species identity and gain information on demographics and stock structure.

- Analysis from ongoing PAM deployments will complement the other acoustic data sets to provide acoustic information on acoustically identifiable presence of species in all seasons across almost two years.
- In addition to analysis of Navy-deployed data sets, if additional existing acoustic data sets can be acquired that might further Navy goals, we will consider analysis of those data.

Question 2: Are there locations of greater cetacean and/or sea turtle concentration around Guam and Saipan?

- Continuation of non-random, non-systematic small vessel surveys and passive acoustic monitoring will be used to address this question. The visual survey will be based on the study of Hawaiian Island odontocetes as a model. Weather conditions can greatly affect the productivity of visual surveys (Ligon et al., 2011), therefore the survey days can occur at any time of year. In order to capitalize on the data collection opportunity using the small boat platform, the visual survey will focus on satellite tagging, photo-identification, biopsy, and collection of representative acoustic samples using a dipping hydrophone
- Habitat use patterns can be addressed through satellite tagging to examine spatial movements and dive patterns. Photo-identification and mark-recapture methodologies can be used to examine residency and movement of individuals and groups. Biopsy samples will complement photo-identification methods in identifying sub-groups of species.
- Shore-based visual surveys can establish use patterns in particular areas. Comparison of use patterns between areas can establish the degree of presence of species of marine mammals and sea turtles.
- Comparison of rates of vocalizations among PAM recordings can provide some relative assessment of cetacean activity near PAM deployment sites.

Question 3. What is the baseline abundance and population structure of odontocetes, which may be exposed to sonar and/or explosives in the near shore areas of Guam, Saipan, Tinian, and Rota?

- The two primary methods used for the estimation of the abundance of marine mammals (which do not haul out or pass through migration corridors) are distance sampling and mark-recapture (Buckland et al., 2001; Evans and Hammond, 2004), Mark-recapture methods have advantages over line transect in cases where pragmatic considerations prohibit an effective line transect survey, such as in the current case where Beaufort sea states would require a large and expensive vessel for off-shore sections of a survey. Mark-recapture is thus better suited for smaller populations of local distribution (especially where a large proportion of the total population may be identified) while line-transect for populations dispersed over wide areas, especially those that are infrequently encountered (Buckland and York, 2009; Cañadas et al., 2006). Individually-identifying photographs obtained on visual surveys will be provided to PISFC for archiving and mark-recapture analysis.
- Baseline population abundance estimates will be obtained through mark-recapture techniques based on species-appropriate identification photos such as dorsal fins, flanks, or flukes. To date, photographs have been taken on five separate surveys. Photos taken on the 2007 aerial survey during Valiant Shield would not support individual identification. Photographs taken during MISTCS in 2007, the Navy/PIFSC 2010 small boat visual survey, the 2010 Navy/PIFSC large boat visual survey, and the 2011 Navy/PIFSC small boat visual

survey are currently held at PIFSC. The Navy will continue to support collection of photographs which can be used for mark-recapture abundance analysis throughout the monitoring period.

- In addition to population size, understanding population structure is an important component of natural resource management (Wade and Angliss, 1997), because it identifies management units of particular concern. The Navy will accomplish this through biopsy sampling to investigate genetic differentiation between local populations and photo-identification to investigate residency patterns and movements. The Navy will support biopsies through the purchase of biopsy supplies and equipment to support at least 50 biopsy attempts per year (number of biopsies collected is not guaranteed). Additionally the biopsy samples will be preserved and shipped to the appropriate location for a preliminary processing of samples which includes extraction of DNA, sexing, and storage. No analysis is anticipated until approximately 2015 or until the collection reaches greater maturity.
- The temporal component of baseline abundance will be addressed through analyzing PAM recordings to establish of seasonal presence of vocalizing or clicking animals over multi-year monitoring periods as well as diel behavioral patterns. Density estimation may be possible for species for which both reliable techniques and recordings exist.

Question 4. What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian and Rota?

- PAM data from current and future PAM deployments shall be analyzed to determine if there is a seasonal occurrence of blue whales, fin whales, sei whales, Bryde's whales, humpback whales, and minke whales.
- Any incidental sightings of baleen whales that have: a) successful biopsy sampling can confirm species-identity in the case of questionable visual identifications (e.g., sei, Bryde's, and Omura's whale), and b) successful satellite tagging will generate new information on distribution and movement patterns.

Question 5. What is the occurrence and/or habitat use of sea turtles in areas that the Navy conducts underwater detonations?

- Dive surveys, similar to those successfully established the density of sea turtles in Pearl Harbor, Hawaii and Apra Harbor, Guam will be conducted at the areas in which underwater detonations occur in order to provide an initial estimate of sea turtle presence. The established standardized protocol is designed to enable density estimation.

or

- Turtle tagging of either in-water or on-shore sea turtles near areas where underwater detonations occur in order to establish habitat use patterns.

Table 2. Summary of monitoring methods and level of effort, FY10-FY15

	FY10		FY11		FY12		FY13		FY14		FY15
Passive Acoustic Monitoring		ADAPTIVE MANAGEMENT REVIEW (AMR)	Deploy four passive acoustic monitoring devices around the Mariana Islands that are capable of gathering data throughout the year. Analyze existing acoustic data set which was collected during Navy's 2007 MISTCS survey.	A M R	Deploy four passive acoustic monitoring devices around the Mariana Islands that are capable of gathering data throughout the year. Analyze data from 4 PAM devices deployed in FY12	A M R	- Deploy PAM devices in the Mariana Islands that are capable of gathering data throughout the year. - Opportunistically collect acoustic recordings with a dipping hydrophone during visual survey effort. - Analyze data from PAM devices	A M R	- Deploy PAM devices in the Mariana Islands that are capable of gathering data throughout the year. - Opportunistically collect acoustic recordings with a dipping hydrophone during visual survey effort. - Analyze data from PAM devices	A M R	Opportunistically collect acoustic recordings with a dipping hydrophone during visual survey effort.
Visual Surveys	- Small boat surveys around Guam, Tinian and Saipan. - Visual observations using marine species observers aboard NMFS/PIFSC oceanographic survey in the Region, as well as during transits between Hawaii and Guam.		Conduct summer and winter visual surveys using a small boat and/or airplane around Guam, Tinian, Rota and Saipan in cooperation with NMFS and/or DAWR. Visual surveys would integrate methods such as photo ID that provide data that can be used for distribution and abundance. 45 days total.		Conduct summer and winter visual surveys using a small boat and/or airplane around Guam, Tinian, Rota and Saipan in cooperation with NMFS and/or DAWR. Visual surveys would integrate methods such as photo ID that provide data that can be used for distribution and abundance. 45 days total.		Conduct non-random, non-systematic visual survey or shore based surveys at any time of the year.		Conduct non-random, non-systematic visual survey or shore-based surveys at any time of the year.		Conduct non–random, non-systematic visual survey or shore-based surveys at any time of the year.
Biopsy							Purchase biopsy supplies to support biopsy attempts. Archive (preserve, extract DNA, sex) biopsy samples.		Purchase biopsy supplies to support biopsy attempts. Archive (preserve, extract DNA, sex) biopsy samples.		Purchase biopsy supplies to support biopsy attempts. Archive (preserve, extract DNA, sex) biopsy samples.
Satellite tagging							- Purchase satellite tags to support tagging attempts during visual surveys. - Analyze data from satellite tags.		- Purchase satellite tags to support tagging attempts during visual surveys. - Analyze data from satellite tags.		- Purchase satellite tags to support tagging attempts during visual surveys. - Analyze data from satellite tags.
Photo-ID and mark-recapture abundance estimates											Mark-recapture abundance estimate analysis for species with the highest likelihood of generating a statistically significant result.
Sea turtle distribution and density							Either line transect diving surveys or sea turtle tags along with analysis		Either line transect diving surveys or sea turtle tags along with analysis		Either line transect diving surveys or sea turtle tags along with analysis

2.3 ADAPTIVE MANAGEMENT

Background

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

Implementation

There are annual reporting requirements contained in NMFS' MMPA Letter of Authorization for the MIRC EIS/Overseas Environmental Impact Statement (OEIS). Following the Navy's Annual Report to NMFS, the Navy and NMFS meet to review the past year's results. The goal of this consultation and collaboration is to determine if these research elements and associated results continue to meet the overall objectives of the Plan specific to the MIRC. For instance, if one particular research element does not provide direct or indirect support to one of the objectives listed above, then resources for future instances of that element have be redirected to other research elements that do provide more support.

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

Through the process of adaptive management, the Navy is proposing to implement systematic improvements to the MIRC marine species monitoring in order to increase the likelihood of achieving top-level goals established by NMFS and the Navy. As described above, top-level monitoring goals are described in an ICMP that guides the Navy's monitoring effort. The process of using a SAG, described in section 1.2 is part of the adaptive management process. Incremental changes are implemented in this monitoring plan based on the SAG recommendations and are summarized below.

Table 3. Implemented changes in the monitoring plan based on SAG recommendations through the adaptive management process

Recommendation	**Implementation**
Conceptual shift to the proposed framework of occurrence, exposure, response, and consequence	Development of monitoring question(s) which address basic occurrence of marine species which may be exposed to SONAR and explosives in MIRC.
Increased transparency of MIRC monitoring plan implementation	Submission of MIRC related monitoring plan, literature, and reports to a website accessible to scientists and the public.
Shift of focus from groups of animals to individuals and population structure	Include satellite tagging, biopsy, and photo-ID data collection and analysis
Collection of visually validated acoustic samples for use in developing classifiers and detectors.	Opportunistic use of a dipping hydrophone during visual surveys for collection of representative samples.
Scheduling flexibility due to weather	Visual surveys can be done at any time of year and using shore-based methodologies that can be implemented even when sea conditions prevent vessel surveys.
Potential for shore-based surveys data collection	Pilot study on shore based surveys
Develop local expertise	Attempt to involve local parties in shore-based survey data collection

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