Marine Species Monitoring

for the U.S. Navy's
Mariana Islands Range Complex

2014 Annual Report

15 April 2014

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Prepared for and Submitted to
National Marine Fisheries Service
Office of Protected Resources

Prepared by
Commander, U. S. Pacific Fleet Environmental Readiness Division
Department of the Navy

In accordance with Letter of Authorization, 12 August 2012

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2014 Annual Report

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Submitted By
Department of the Navy
United States Pacific Fleet
250 Makalapa Drive
Pearl Harbor, Hawaii 96860-3131

Submitted To
National Marine Fisheries Service
Office of Protected Resources
1315 East-West Highway
Silver Spring, Maryland 20910-3226

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List of Contributors (Main Document): Kristen Ampela (HDR, Inc.), Jessica M. Aschettino (Naval Facilities Engineering Command, Pacific), Mark Deakos (HDR, Inc.), Dagmar Fertl (HDR, Inc.), Jennifer Latusek-Nabholz (HDR, Inc.), Morgan W. Richie (Naval Facilities Engineering Command, Pacific), Michael Richlen (HDR, Inc.), Julie A. Rivers (Commander, U.S. Pacific Fleet), and Robert K. Uyeyama (Naval Facilities Engineering Command, Pacific).

List of Contributors (Technical Reports): Whitlow W.L. Au (HIMB), Marie Hill (PIFSC), Elizabeth Ferguson (Bio-Waves), T. Todd Jones (PIFSC), Marc O. Lammers (OSI), Allan Ligon (PIFSC), Lisa M. Munger (OSI), Thomas F. Norris (Bio-Waves), Erin M. Oleson (PIFSC), Julie N. Oswald (Bio-Waves), Stephen H. Smith (Naval Facilities Engineering Command, Engineering and Expeditionary Warfare Center), Adam Ü (HDR, Inc.), Kyle S. Van Houtan (PIFSC), and Tina M. Yack (Bio-Waves).

Cover photo: Spinner dolphins (*Stenella longirostris*) photographed during a small-vessel survey in MIRC. Photograph by M. Deakos taken under MMPA permit 15240 issued to PIFSC and CNMI-DFW permit, license no. 02444-12.

EXECUTIVE SUMMARY

The United States (U.S.) Navy uses the Mariana Islands Range Complex (MIRC) for at-sea training, as described in the MIRC Environmental Impact Statement (DoN 2010a). In support of the continuation of training described in the MIRC Environmental Impact Statement and the 5-year Final Rule (NMFS 2010a), the National Marine Fisheries Service (NMFS) issued a Letter of Authorization (LOA) (NMFS 2012a) and a Biological Opinion (NMFS 2012b) to the Commander, U.S. Pacific Fleet in August of 2012. The Final Rule, LOA, and Biological Opinion require the Navy to implement marine mammal and sea turtle monitoring as described in the MIRC Marine Species Monitoring Plan (DoN 2012a). This report presents data gathered 12 February 2013 through 12 February 2014 in support of the U. S. Navy's revised 2013–2015 MIRC Monitoring Plan.

The data-collection period for monitoring and reporting was not specifically stated in the MIRC Final Rule (NMFS 2010a). Therefore, Navy and NMFS agreed that data and results obtained through 12 February of each year would be included in the annual reports.

In compliance with the MIRC 2013-2015 Monitoring Plan (DoN 2012a, **Table 3**), monitoring methods employed in Year 4 include small-boat, diver and shore-based visual surveys; photo-identification; field collection and genetic analysis of biopsy samples; satellite tagging of marine mammals; satellite tagging of sea turtles; and analysis of passive acoustic monitoring (PAM) data. Monitoring for the next annual period will retain the same overall level of effort with a few structural edits to the 2014 and 2015 goals in comparison with the 2013–2015 Monitoring Plan.

The MIRC 2013-2015 monitoring plan introduced the framework of five range-complex-level monitoring questions developed to serve as objectives 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. Considerable progress has been made in Monitoring Year 4 on addressing these five monitoring questions:

1. What species of beaked whales and other odontocetes occur around Guam and Saipan?
2. Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?
3. What is the baseline abundance and population structure of odontocetes that may be exposed to sonar and/or explosives in the nearshore 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 U.S. Navy conducts underwater detonations?

Some highlights of this progress include:

- A pilot study of a shore-based visual survey platform based on Guam shows promise for a new, cost-effective method of surveying marine mammals in the MIRC.
- Satellite tags were deployed on false killer whales (*Pseudorca crassidens*), short-finned pilot whales (*Globicephala macrorhynchus*), common bottlenose dolphins (*Tursiops truncatus*), rough-toothed dolphins (*Steno bredanensis*) and pantropical spotted dolphins (*Stenella attenuata*), revealing habitat utilization patterns and inter-island/offshore movements previously undocumented for these species in the MIRC.

- Sperm whale (*Physeter macrocephalus*) "coda" patterns recorded in the MIRC were similar to vocal repertoires of eastern Pacific vocal clans, suggesting a possible link between eastern and western Pacific Ocean sperm whale social units.
- Baleen whales, including blue (*Balaenoptera musculus)*, fin (*Balaenoptera physalus*), minke (*Balaenoptera acutorostrata*), and humpback (*Megaptera novaeangliae*) whales, were detected using bottom-mounted PAM devices.
- Satellite tags deployed on green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata)* turtles indicate small home ranges, typically less than four square kilometers, and limited movement between islands. One exception was a 286-kilometer, 7-day trek from Tinian to Guam performed by one tagged hawksbill turtle, indicating that long distance, migratory, inter-island movements can also occur.

Overall, monitoring efforts in Year 4 focused on collecting basic biological information about protected marine species in the MIRC study area, a relatively data-poor region. This focus is consistent with the recommendations of NMFS during the MMPA Rule Making Process and reiterated by the Scientific Advisory Group convened by the Navy in March 2011 (DoN 2011) to address monitoring priorities in various Navy training ranges, as well as by the Regional Scientific Advisory Group for the MIRC convened in October 2011.

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ACRONYMS AND ABBREVIATIONS

AMR	Adaptive Management Review
EAR	ecological acoustic recorder
ESA	Endangered Species Act
FY	Fiscal Year
HARP	High-frequency Acoustic Recording Package
ICMP	Integrated Comprehensive Monitoring Program
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
LOA	Letter of Authorization
m	meter(s)
MIRC	Mariana Islands Range Complex
MISTCS	Mariana Islands Sea Turtle and Cetacean Survey
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
PAM	passive acoustic monitoring
PIFSC	Pacific Island Fisheries Science Center
SAG	Scientific Advisory Group
U.S.	United States

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1 INTRODUCTION

1.1 BACKGROUND

The Mariana Islands Range Complex (MIRC) is located in the western North Pacific Ocean and encompasses an area of approximately 1,200,000 square kilometers (km^2). The range complex surrounds the Mariana Islands Archipelago, which includes the Commonwealth of the Northern Mariana Islands and the Territory of Guam (see **Figure 1**). The United States (U.S.) Navy developed the MIRC Monitoring Plan (DoN 2012a) to improve our understanding of anthropogenic impacts to protected marine species during naval training activities, 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 Statement for an activity, the National Marine Fisheries Service (NMFS) must set forth "requirements pertaining to the monitoring and reporting of such taking" (50 Code of Federal Regulations Section 216.101(a)(5)(a)). A request for a Letter of Authorization (LOA) must include a plan to meet the necessary monitoring and reporting requirements while increasing the understanding, and minimizing the disturbance, of marine mammal and sea turtle populations expected to be present. While the ESA itself does not have a specific monitoring requirement, recent Biological Opinions issued by NMFS also have included terms and conditions that require the U.S. Navy to implement a monitoring program (NMFS 2010b, 2011, 2012b).

U.S. Navy marine species monitoring conducted in the MIRC from Fiscal Year (FY)10 through FY12–13 employed a combination of systematic visual and acoustic, large-ship, line-transect surveys; non-systematic, small-vessel, visual surveys; and passive acoustic monitoring (PAM). Through the process of adaptive management, a scientific advisory group (SAG) comprised of independent scientists was formed and convened in March 2011 to provide best practices for achieving the monitoring goals in various Navy training ranges. In October 2011, a regional SAG was also convened to discuss monitoring specific to the MIRC. Based on guidance from the SAG (DoN 2011), the regional SAG and lessons learned from past monitoring, the U.S. Navy recommended revisions to the MIRC monitoring plan for FY14 (DoN 2012a) in order to meet the goals established by the U.S. Navy and NMFS.

The resulting FY14 (2013-2015) MIRC monitoring plan introduced a framework of five range-complex-level monitoring questions developed to serve as concrete objectives 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. The focus of the MIRC Monitoring Plan therefore evolved away from defining metrics of effort quantity (e.g., number of hours of aerial survey flown per year), and towards listing methodologies intended to provide progress on the five monitoring questions. These methodologies included visual surveys from either a vessel- or shore-based station, use of a dipping hydrophone during vessel surveys, support for collection of biopsy samples (including collection, preliminary analysis and archiving), support for satellite tagging including purchase of tags and analysis of data, and either line-transect sea turtle surveys or turtle tagging. The plan also includes maintenance of autonomous PAM devices, analysis of PAM data and mark-recapture abundance estimates.

1.2 INTEGRATED COMPREHENSIVE MONITORING PROGRAM

The Integrated Comprehensive Monitoring Program (ICMP) provides the overarching framework for coordination of the U.S. Navy's monitoring (DoN 2010b). As a framework document, the ICMP applies by regulation to those activities on ranges and operating areas for which the U.S. Navy sought and received an LOA. The ICMP is a planning tool to focus U.S. Navy monitoring priorities pursuant to ESA and MMPA requirements. Top priority will always be given to satisfying the mandated legal requirements across all ranges. Once legal requirements are met, any additional monitoring will be planned

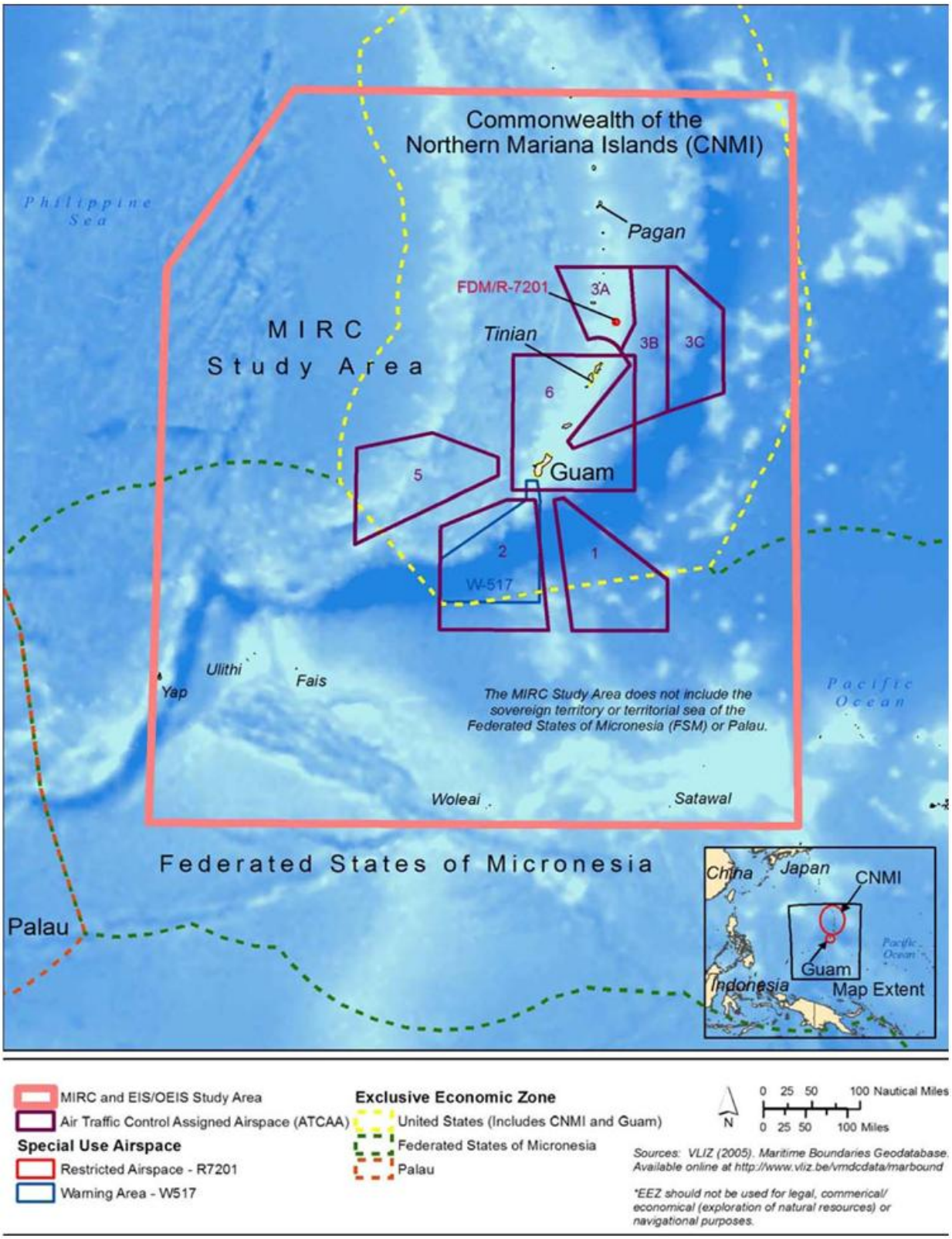

Figure 1. The MIRC Study Area.

and prioritized using guidelines outlined by the ICMP, consistent with availability of both funding and scientific resources. As a planning tool, the ICMP is a "living document" and will be updated as needed. Initial areas of focus for improving U.S. Navy marine species monitoring in 2011/2012 focused on development of a Strategic Planning Process. This will be incorporated into the ICMP to guide investments and help refine specific monitoring actions, in order to address ICMP goals and objectives more effectively and efficiently.

The ICMP is evaluated through the Adaptive Management Review (AMR) process to: (1) assess progress, (2) provide a matrix of goals and objectives for the following year, and (3) make recommendations for refinement and analysis of the monitoring and mitigation techniques. This process includes conducting an annual AMR meeting at which the U.S. Navy and NMFS jointly consider the prior-year goals, monitoring results, and related scientific advances to determine if monitoring plan modifications are warranted, in order to address program goals more effectively. Modifications to the ICMP that result from AMR discussions are incorporated into a revision to the ICMP and submitted to NMFS.

Under the ICMP, monitoring measures prescribed in range-specific monitoring plans, and U.S. Navy-funded monitoring relating to the effects of U.S. Navy training and testing activities on protected marine species, should be designed to accomplish one or more top-level goals as described in the current version of the ICMP (DoN 2010b). Chief of Naval Operations Environmental Readiness Division is responsible for maintaining and updating the ICMP, as necessary, reflecting the results of regulatory agency rulemaking, AMRs, best available science, improved assessment methodologies, and more effective protective measures. This is performed as part of the AMR process, in consultation with U.S. Navy technical experts, Fleet Commanders, and Echelon II Commands as appropriate.

1.3 Report Objectives

The objective of this report is to present NMFS with monitoring results and achieved progress made on the five monitoring questions defined as the primary objectives in the 2013-2015 revision of the MIRC Monitoring Plan (DoN 2012a) developed through the Adaptive Management Review process. As such, the results in this report reflect a new paradigm of marine species monitoring. It is expected that logistic details of implementation will continue to be refined.

This report has two main objectives:

1) Summarize findings from U.S. Navy-funded marine mammal and sea turtle monitoring conducted in the MIRC from 12 February 2013 through 12 February 2014. Detailed technical reports for these efforts are provided as appendices to this report.
2) Continue the adaptive management process by assessing how data collected and/or analyzed over the past year have improved our ability to answer the following MIRC Monitoring Plan questions:
    - Question 1. What species of beaked whales and other odontocetes occur around Guam and Saipan?
    - Question 2. Are there locations of greater relative cetacean and/or sea turtle abundance around Guam and Saipan?
    - Question 3. What is the baseline abundance and population structure of odontocetes which may be exposed to sonar and/or explosives in the nearshore areas of Guam, Saipan, Tinian, and Rota?

- Question 4. What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?
- Question 5. What is the occurrence and habitat use of sea turtles in areas where the U.S. Navy conducts underwater detonations?

2 MARINE SPECIES MONITORING IN THE MIRC

2.1 2013 MONITORING GOALS AND IMPLEMENTATION

Table 1. 2013 Monitoring Goals and Implementation.

Field Method	Monitoring Goal	Total Accomplished
Passive Acoustic Monitoring (PAM)	Deploy PAM devices around the Mariana Islands that are capable of gathering data throughout the year.	Adjusted via adaptive management to shift emphasis to increasing analysis effort on data from earlier deployments of PAM devices. See below.
	Opportunistically collect acoustic recordings with a dipping hydrophone during visual survey effort.	Opportunistically collected acoustic recordings with a dipping hydrophone during visual survey effort.
	Analyze data from PAM devices.	Acoustic data analyzed from seven EARs (three off Guam, two off Saipan, and two off Tinian) deployed in 2011 and 2012; further analysis in progress.
		Preliminary analysis of acoustic data from 2 PIFSC-deployed HARPs off Saipan and Tinian; further analysis in progress.
		Further analyzed sperm whale (*Physeter macrocephalus*) towed array acoustic data from MISTCS large vessel survey (2007).
Visual Surveys	Conduct non-random, non-systematic visual survey or shore-based surveys at any time of the year.	Thirty days of small-vessel visual surveys around Guam, Tinian, Rota, Aguijan and Saipan during June–July 2013.
		Ten days of shore-based visual surveys on Guam during May 2013.
Biopsy	Purchase biopsy supplies to support biopsy attempts[1].	Funding for biopsy equipment purchases was reallocated for biopsy tissue sample analysis[1].
	Archive (preserve, extract DNA, sex) biopsy samples.	Seventy-six biopsy samples were collected from eight cetacean species and eight sloughed skin samples from sperm whales. Six biopsy samples were obtained, four from green (*Chelonia mydas)* and two from hawksbill (*Eretmochelys imbricata*) sea turtles. Analysis of tissue samples is ongoing, including stable-isotope analysis on the turtle samples.
Satellite Tagging	Purchase satellite tags to support tagging attempts during visual surveys.	Ten satellite tags purchased and deployed on four species of cetaceans.
	Analyze data from satellite tags.	Analysis of satellite tag data funded and in progress; some tags are still transmitting and providing data.
Photo-ID and mark-recapture abundance estimates	No specific goal listed.	Cataloged all photos collected from 2010 to present. Catalogs have been created for the three most commonly observed species—spinner dolphins (*Stenella longirostris*), short-finned pilot whales (*Globicephala macrorhynchus)*, common bottlenose dolphins (*Tursiops truncatus*). Discovery curves and abundance estimates are being updated for the 2013 season.
Sea Turtle Distribution and Density	Either line-transect diving surveys or sea turtle tagging and tag data analysis.	6 satellite tags deployed on 2 species of sea turtles. Analysis to be available for the next reporting period. Most satellite tag tracks have been analyzed but some tags are still transmitting and providing data.

Note: EAR = Ecological Acoustic Recorder; FY = Fiscal Year; HARP = High-frequency Acoustic Recording Package; MISTCS = Mariana Islands Sea Turtle and Cetacean Survey; PAM = passive acoustic monitoring; photo-ID = photo-identification; PIFSC = Pacific Islands Fisheries Science Center; U.S. = United States.

[1]Adaptively adjusted from original goal per discussions with NMFS.

Table 1 lists the 2013 monitoring goals as agreed upon by NMFS and the U.S. Navy. All monitoring goals in Monitoring Year 4 were met, with one slight modification. NMFS Pacific Island Fisheries Science

Center (PIFSC), who was conducting the biopsy work, communicated that additional biopsy supplies were not needed due to an existing surplus of this equipment; therefore, fiscal resources were reallocated toward field collection and genetic analysis of biopsy samples. This reallocation of funds was consistent with the adaptive management approach to monitoring also outlined in the MIRC Monitoring Plan (DoN 2012a).

Acoustic monitoring methodologies in the MIRC, including the requirement to deploy PAM devices, was discussed between the Navy and NMFS during the October 2012 Adaptive Management meeting. Due to the number of acoustic datasets already collected in the MIRC that were yet to be analyzed, it was agreed that the emphasis for monitoring efforts should shift away from collection of new data and toward evaluating existing datasets. In accordance with this shift, analysis of data from two previous Navy-funded deployments of multiple ecological acoustic recorders (EARs) is now in progress (see **Appendix B**), and the analysis of recently archived recordings from High-frequency Acoustic Recording Packages (HARPs) deployed by NMFS PIFSC is also in progress (see **Appendix A**). Navy does not currently have any long-term bottom-mounted recorders deployed in the MIRC; however, offshore surveys using autonomous acoustic gliders are planned for summer 2015 and winter 2016.

2.1.1 TIMELINE OF MONITORING EFFORTS

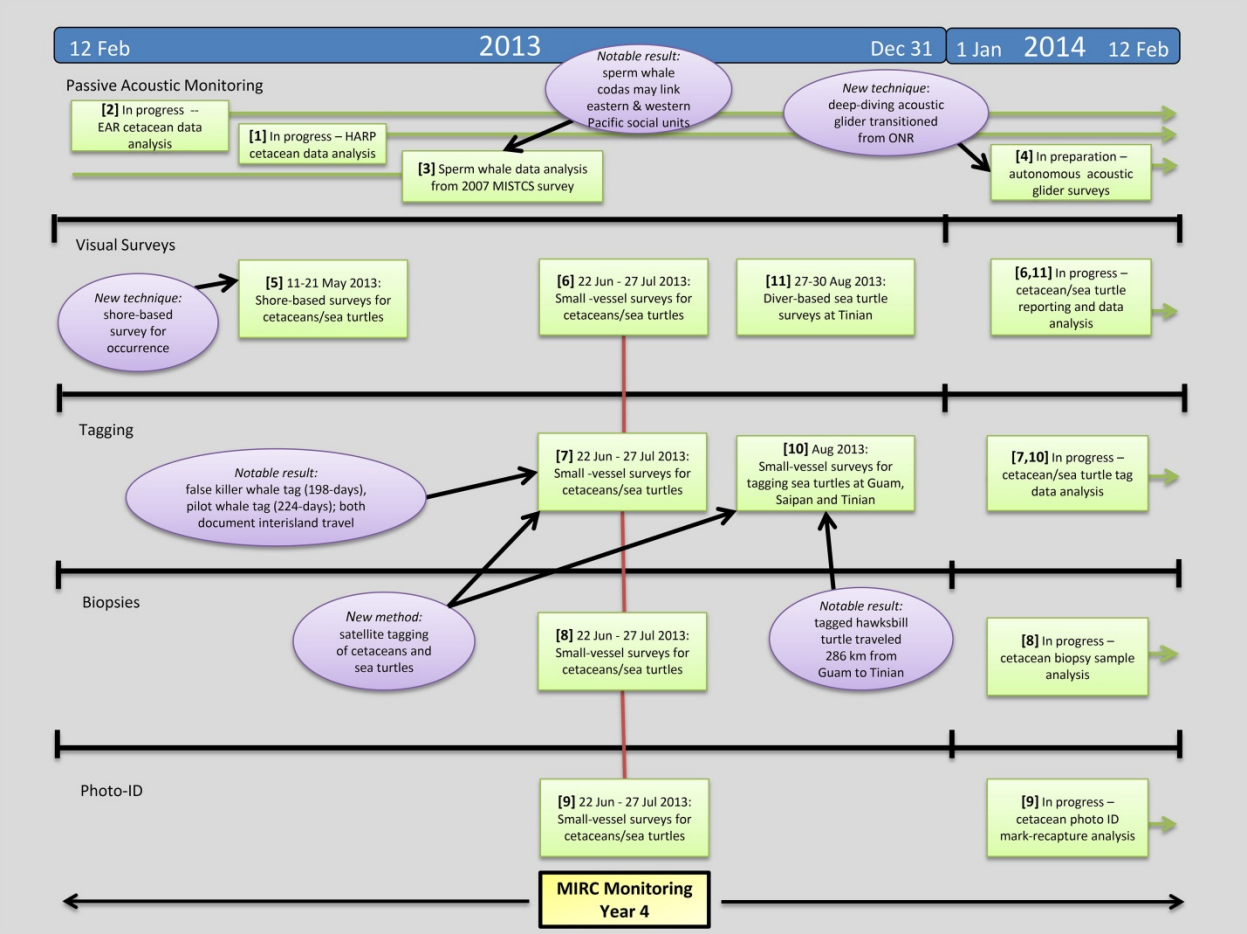

Figure 2. Visual Timeline of Activities in MIRC Monitoring Year 4 (12 February 2013 to 12 February 2014).

All of the monitoring and research tasks implemented in the MIRC from 12 February 2013 through 12 February 2014 are illustrated in **Figure 2**. Details of individual tasks numbered within this figure are given in the sections below.

[1] Passive Acoustic Monitoring: HARPs – Appendix A (Oleson 2014)

PIFSC deployed two HARPs off Tinian and Saipan in 2010, 2011, and 2012 in order to further characterize cetacean occurrence and temporal trends in the MIRC. The U.S. Navy funded PIFSC to analyze some of these data for: (1) modeled sound propagation and detection range for baleen whale calls under 1 kilohertz (kHz); (2) daily occurrence of baleen whales with low-frequency (<1 kHz) calls in all five data sets; (3) daily occurrence of all beaked whales within one dataset; (4) species identification of detected beaked whale sounds; and (5) daily occurrence of minke (*Balaenoptera acutorostrata*) and sperm whales within one dataset. Analysis of 2010 and 2011 Saipan and Tinian datasets for low-frequency (<1 kHz) baleen whales is complete, and analysis of the 2012 and 2013 datasets is underway. A beaked whale echolocation-click detector (see **Appendix A**) was used to analyze all datasets for beaked whale occurrence and temporal trends in vocalizations were examined. Classification of beaked whale click bouts to species is still ongoing.

[2] Passive Acoustic Monitoring: EARs – Appendix B (Munger et al. 2014)

Four EARs were deployed in September 2011 in order to characterize cetacean species occurrence, distribution, and temporal trends in the MIRC (see **Appendix B**, DoN 2012b). Two instruments were deployed off Guam, one off Tinian, and a fourth off Saipan. After four months, the devices were recovered and redeployed in 2012. One of the Guam devices from the second deployment was not recoverable. Datasets from all other deployments were recovered and are currently being analyzed. Automated detectors were utilized to search the recordings for the presence of five species of baleen whales (blue [*Balaenoptera musculus*], fin [*Balaenoptera physalus*], sei [*Balaenoptera borealis*], minke and humpback [*Megaptera novaeangliae*]), two genera of beaked whales [*Ziphius and Mesoplodon*], and sperm whales. Manual analysis was used to detect odontocete whistles and clicks (excluding beaked whale clicks), as well as "high-frequency" sei whale calls. The automated analysis is complete, and manual analysis has been completed for three of the seven deployments. Diel, monthly, lunar, and seasonal patterns in cetacean occurrence are currently being investigated, including spatial patterns in species assemblages. Also being investigated is whether or not detection rates change during mid-frequency active sonar exposure. Lastly, autodetector performance is being evaluated to measure the proportion of positive, false and missed detections of humpback, fin, blue, minke, sperm, and beaked whale calls. This will elucidate whether call templates developed in other regions are appropriate for application to species residing in the MIRC.

[3] Passive Acoustic Monitoring: MISTCS (2007) Sperm Whale Data Analysis – Appendix C (Norris et al. 2012)

The 2007 Mariana Islands Sea Turtle and Cetacean Survey [MISTCS] (DoN 2007; Fulling et al. 2011) followed standard line-transect methodology, and also included PAM using a towed hydrophone array (see **Table 2** in **Section 2.2**). During this cruise, more than 60 unique acoustic encounters of sperm whales were reported. In 2013, these acoustic data were subjected to additional post-processing and analysis in order to: (1) localize sperm whale encounters in MIRC waters; (2) estimate sperm whale acoustic detection functions that can be used for line-transect abundance/density estimation; and (3) to identify, characterize, and classify sperm whale codas (broadband click patterns) detected during the cruise (see **Appendix C**). A comparison of coda types identified from the MISTCS study area to those identified in other areas can provide insight to the population structure of sperm whales in the MISTCS study area.

[4] Unmanned Acoustic Gliders – (Planned)

Unmanned acoustic monitoring glider surveys, including post-survey acoustic analysis, were contracted in 2013, to occur in two seasons in the Marianas, and are part of a series of acoustic glider surveys in other Pacific Navy range complexes. The recordings will be made at high frequency (192-kHz sampling rate), and post-processed after the survey. The survey cruise plan for this series of glider surveys was completed in December 2013 and the surveys are scheduled for 2014/15. Results from these surveys have the potential to provide relative abundance information across wide ranges of the MIRC study area, including offshore waters.

[5] Visual Surveys: Shore-based Survey – Appendix D (Deakos et al. 2014)

A 10-day visual survey from two shore stations at the Andersen Air Force Base on Guam was conducted in May 2013 (see **Appendix D**). The first station was on the northeastern side of the island at an elevation of 157 meters (m) and the second station was on the north side of the island at an elevation of 193 m. This was a pilot study to determine the feasibility of a cost-effective platform for visually surveying waters within the MIRC where prevailing sea states typically make small-boat visual surveys

challenging. These areas include the windward side of the islands and most MIRC waters during the winter season due to strong wind and large swells. The shore-based observers were equipped with a theodolite for fixing sighting locations, and a pair of Fujinon 25 × 150-millimeter "bigeye" binoculars for scanning long distances away from the shore station. The accuracy of each optic method for estimating sighting location was quantified and compared.

[6,7,8,9] Visual Surveys: Small-vessel Surveys – Appendix E (Hill et al. 2013b)

Visual surveys were conducted from 22 June through 27 July 2013 on small vessels (< 12 m in length) in the waters surrounding Guam, Rota, Saipan, Tinian, and Aguijan (see **Appendix E**). Survey effort was designed to cover representative habitat within the study area, and did not conform to systematic (i.e., line-transect) methods (see **Figure 3**). All cetacean groups encountered were approached for species confirmation, group-size estimates, photo-identification, and biopsy sampling including sloughed skin (for assessment of genetic population structure) when possible, and satellite tags (Wildlife Computers SPOT5) were deployed on individuals of certain species to investigate their movements. Opportunistic acoustic recordings were collected using a dipping hydrophone. Multi-year mark-recapture photo-identification and biopsy analyses are ongoing.

[10] Visual Surveys: Sea Turtle Surveys – Appendix F (Jones and Van Houtan 2013)

During August 2013, dedicated sea turtle surveys were conducted from small vessels in the nearshore and coastal waters of Guam (e.g., Cocos Lagoon), Saipan, and Tinian (see **Appendix F**). When green (*Chelonia mydas)* and hawksbill (*Eretmochelys imbricata)* sea turtles were encountered, they were captured by hand while snorkeling or diving, and instrumented with either a temperature-depth tag or an ARGOS temperature-only Platform Transmitter Terminal tag in order to characterize sea turtle movements and habitat use in the MIRC. Additional surveys are planned for 2014, as well as a complete analysis of biotelemetry data to help understand home ranges, preferred depths and temperatures, and inter-island movements.

[11] Diver-based Tinian Sea Turtle Surveys (Ongoing)

During August 2013, diver-based sea turtle surveys were conducted off Tinian. Surveys were performed along depth contours from 6 to 28 m, between the north end of Unai Bubui and the south end of Unai Chulu. Marine mammal sightings were also recorded during all transits between Saipan and Tinian. The survey area corresponds to that of previous surveys conducted in June and September of 2011. A cold-season survey is planned for the winter of 2014/15.

2.2 RESULTS: PROGRESS MADE ON 2012–2016 MONITORING PLAN STUDY QUESTIONS

Table 2 summarizes progress made this monitoring year on addressing the study questions found in the MIRC Monitoring Plan (DoN 2012a). The following sections provide more details about this progress, and are organized by study question. Full descriptions of each study are available in the cited Appendices.

Table 2. Summary of Progress Made on Monitoring Questions

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Four	Planned or In-progress (funded in Year Five)
1. What species of beaked whales and other odontocetes occur around Guam and Saipan?	[1] Acoustics/ PIFSC HARPs	Odontocete occurrence in the MIRC, as measured by visual and acoustic methods, was consistent with that observed in previous years. Cuvier's beaked whale, *Mesoplodon species*, and unidentified beaked whales were identified around Saipan and Tinian. Vocalizations of beaked whales heard year-round, no seasonality.	Determine species identification for detected beaked whales. Assess daily occurrence of minke and sperm whales.
	[2] Acoustics/EARs	Cuvier's beaked whale and *Mesoplodon species* calls were grouped together and occurred nearly daily as well as sperm whales.	Triton analysis on four of seven EAR deployments. Examination of temporal and spatial patterns of cetacean occurrence. Validation of automatic classifiers performance.
	[3] Acoustics/ MISTCS towed array analysis	Acoustic validation of sperm whale sightings in the MIRC.	TBD
	[4] Acoustics/ Autonomic gliders	A work execution plan was completed for winter and summer deployment of a pair of autonomous, acoustic gliders in the MIRC, and a contract was awarded to carry out the work.	A 30-day acoustic glider survey is slated for the winter and summer of 2015. Results from this survey have the potential to provide relative abundance information across wide ranges of the MIRC study area, including offshore waters.
	[5] Visual survey/Shore Station	Species observed were consistent with other visual survey platforms. No beaked or baleen whales observed. A sighting rate of 0.47 sightings per hour or 2.6 sightings per day (65% being spinner dolphins) suggests low densities of marine mammals in the surveyed areas. This pilot study is showing promise for a new, cost-effective method to survey marine mammals in waters that are challenging by boat.	TBD
	[6] Visual survey/ Small-boat surveys	Pygmy killer whales and rough-toothed dolphins were new species observed during small-boat surveys in addition to the six other species observed in previous years. No baleen or beaked whales observed. A sighting rate of 0.22 species per hour or 1.7 species per day (48% being spinner dolphins) suggests low densities of marine mammals in the surveyed areas.	Surveys planned for April 2014.
	[7] Tagging/Small-boat surveys	Ten satellite tags deployed on four species; revealing habitat utilization patterns and inter-island/offshore movements previously undocumented for sperm and short-finned pilot whales, common bottlenose dolphins, and pantropical spotted dolphins in MIRC.	Surveys planned for April 2014.

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Four	Planned or In-progress (funded in Year Five)
2. Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?	[1] Acoustics/ PIFSC HARPs	Blue whales heard off Tinian but not Saipan, minke and humpback whales off Saipan but not Tinian. Fin whales detected at Saipan and Tinian. Unidentified baleen whales detected off Tinian.	The preliminary results from PIFSC HARP data analysis are not yet sufficient to address the question of relative abundance of marine mammals and/or sea turtles in MIRC waters. Analysis of daily occurrence rates of various species groups is in-progress at each HARP location.
	[2] Acoustics/ EARs	Highest delphinid encounter rates overall around Saipan, followed by Tinian and Guam, possibly due to higher density, longer residency, or both. Low-frequency whistlers more likely to occur around Guam than high-frequency whistlers. Low encounter rates at Guam may be an artifact of EAR positioned on remote pinnacle. Greatest sperm whale encounter rates at Tinian W, then Guam, followed by Saipan, but max encounter durations of 10, 7, and 14 hours respectively, suggesting some short-term site fidelity to these areas. Saipan by far had the most low-frequency, clicking, and high-frequency followed by Tinian and Guam. Guam was surprisingly quiet. Sperm whale results were questionable and need further validation.	Complete EAR data analysis on remaining four EARs; will provide longer timespan for lunar, monthly, seasonal trends and cycles.
	[3] Acoustics/ MISTCS towed array analysis	Sperm whale detections were clustered in the northeast, central, and southwest portions of the MIRC study area, with relatively few detections in the trench and offshore regions. May reflect preference by at least some animals to inhabit waters near islands. Improved detection-function model for sperm whale clicks by stratifying localizations by click type (slow vs. regular), allowing more accurate density estimation for this species.	Improve localization and abundance estimates by reducing encounter rate variance. Compare uncertainty in resulting density estimates for regular and slow-clicking individuals using both pooled and stratified data to determine best approach.
	[4] Acoustics/ Autonomic gliders	A work execution plan was completed for winter and summer deployments of a pair of autonomous, acoustic gliders in the MIRC, and a contract was awarded to carry out the work.	A 30-day acoustic glider survey is slated for the winter and summer of 2015. Results from this survey have the potential to provide relative abundance information across wide ranges of the MIRC study area, including offshore waters.
	[5] Visual survey/ Shore Station	A greater number of spinner dolphin sightings occurred on the northeastern side of Guam compared with the north side. Many more offshore odontocete sightings occurred on the north-facing side, possibly due to greater concentrations of marine mammals in this area or due to greater visual detection capability in calmer waters.	TBD

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Four	Planned or In-progress (funded in Year Five)
2. Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan? (continued)	[6] Visual survey/ Small-boat surveys	All sightings around Guam, Rota, Aguijan, and Tinian were within 8 kilometers (km) of land. Saipan surveys, which generated the greatest number of sightings, had the majority of sightings within 8 km of land however three species (sperm whales, pantropical spotted and spinner dolphins) were sighted 25, 18, and 15 km offshore of Saipan respectively. The three offshore spinner dolphin sightings occurred at Marpi Reef, where depths can be shallower than 100 m.	Surveys planned for April 2014.
	[7] Tagging/ Small-boat surveys	Satellite tag data from 3 short-finned pilot whales (longest tag 235 days) indicate strong site fidelity to the island of Guam with occasional bouts to the south across the Marianas Trench. Satellite tag data from 4 false killer whales (longest duration 198 days) indicate large-scale movements across the entire MIRC region with frequent migrations occurring beyond the 200-nautical mile exclusive economic zone boundary. A single tagged rough-toothed dolphin moved between islands but remained almost consistently on the west side of the islands, remaining within 15 km from shore. Two tagged common bottlenose dolphins moved between islands concentrating mainly on the west side of the islands except for Guam. While the one common bottlenose dolphin remained in range of the main islands, the other migrated over 100 km north of Saipan, past the island of Anatahan. These tag data are preliminary.	Analysis of tag data is ongoing.
	[9] Photo-ID/ Small-boat surveys	No updated data available for 2013, work in-progress.	Update photo-matching of odontocetes to produce new discovery curves and minimum abundance estimates.
	[10] Sea Turtle Tagging/ Small-boat surveys	The six tags deployed on green and hawksbill sea turtles indicate small home ranges, typically less than 4 km^2, and limited movement between islands. However, the 286-km, 7-day trek from Tinian to Guam performed by one tagged hawksbill sea turtle suggests large, migratory, inter-island movements can also occur. Some diel migration from deeper water in daytime to shallower water at night. Average depth for green sea turtles is 12.6 ± 5.3 m and 10.0 ± 3.3 m for day and night, respectively. Hawksbill sea turtle average depth was 22.6 ± 13.8 m and 17.4 ± 6.4 m for day and night, respectively.	Tags continue to transmit new information. DNA and stable isotope analysis ongoing. More surveys in 2014 (E Saipan, Tinian, Cocos Lagoon - Guam) to deploy 10 more tags. Complete analyses of the biotelemetry data will allow understanding of home range, habitat hotspots, and preferred depths and temperature, as well as any movement between islands within the archipelago.
	[11] Sea Turtle Dive Survey	No updated data available for 2013, work in-progress.	Winter 2014/15 survey planned; final report will also cover the August 2013, June 2011, and September 2011 surveys conducted in the same area at Tinian.

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Four	Planned or In-progress (funded in Year Five)
3. What is the baseline abundance and population structure of odontocetes which may be exposed to sonar and/or explosives in the nearshore areas of Guam, Saipan, Tinian, and Rota?	[3] Acoustics/ MISTCS towed array analysis	Sperm whale "coda" patterns recorded in the MIRC displayed similarities to vocal repertoires of eastern Pacific vocal clans, suggesting a possible link between eastern and western Pacific Ocean sperm whale social units.	TBD
	[8] Biopsy/ Small-boat surveys	No updated data available for 2013, work in-progress.	Biopsy samples are currently being analyzed.
	[9] Photo-ID/ Small-boat surveys	No updated data available for 2013, work in-progress.	Update photo-matching of odontocete to produce new discovery curves and minimum abundance estimates.
4. What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?	[1] Acoustics/ PIFSC HARPs	Blue, fin, minke, and humpback whales were detected using PAM; blue, fin, and minke whales were detected between February and May and peaked in March/April; Blue whales were more consistent in winter but peaked in May and stayed until July. Unidentified baleen whales were detected from August to December off Tinian but not Saipan. This suggests some evidence of seasonality but further analysis is pending.	Further assessment of the daily occurrence of minke whale calls is ongoing.
	[2] Acoustics/ EARs	Very few minke and humpbacks whale detections suggest very little use of the area at least during the summer months since no recordings occurred during the winter period (January–April). No sei whale calls detected.	Additional EAR data are being analyzed.
	[5] Visual survey/ Shore Station	No baleen whales observed during the 11–21 May 2013 survey.	TBD
	[6] Visual survey/ Small-boat surveys	No baleen whales observed during the 22 Jun–27 Jul 2013 survey.	Surveys planned for April 2014.
5. What is the occurrence and habitat use of sea turtles in areas where the Navy conducts underwater detonations?	[6] Visual survey/ Small-boat surveys	Sea turtle sighting locations were recorded and reported in the field report.	Surveys planned for April 2014.
	[10] Sea Turtle Tagging/ Small-boat surveys	Sea turtle sighting locations were reported in interim report and a map of the DoD UNDET sites are provided for comparison.	Survey and tagging planned for spring 2014.

[1] UNDET = Underwater Detonation

2.2.1 WHAT SPECIES OF BEAKED WHALES AND OTHER ODONTOCETES OCCUR AROUND GUAM AND SAIPAN?

Several species of odontocetes, or toothed whales, were identified in MIRC waters using a combination of visual and acoustic detection methods (see **Table 3**; **Figures 3, 4, 5** and **6**). These included beaked whales (Cuvier's beaked whale [*Ziphius cavirostris]* and a member of the *Mesoplodon* genus) as well as nine other toothed whale species (pygmy killer whales *[Feresa attenuata]*, short-finned pilot whales, sperm whales, false killer whales *[Pseudorca crassidens]*, melon-headed whales *[Peponocephala electra]*, pantropical spotted dolphins *[Stenella attenuata)*] rough-toothed dolphins *[Steno bredanensis]*, spinner dolphins, and common bottlenose dolphins). During the 2012 small-vessel surveys, there was one sighting each of a *Mesoplodon* sp. and unidentified beaked whale (see **Appendix E**), but none were observed during the 2013 surveys. Beaked whales detected acoustically included Cuvier's beaked whales, unidentified *Mesoplodon* species, and unidentified beaked whale (Family Ziphiidae). Seven species of delphinids were identified using visual methods, whereas acoustic methods classified delphinid vocalizations only into categories of low-frequency (<10 kHz), high-frequency (>10 kHz), or a mix of both.

Table 3. Species encountered/detected in MIRC monitoring.

Monitoring Platform	General Location and Maximum Depth	Animal Group Encountered/Detected	Date/Timeframe
Passive Acoustic Monitoring (EARs)	N Guam – 820 m S Guam – 952 m W Tinian – 869 m N Saipan – 850 m	Minke whale Humpback whale Sperm whale Unidentified beaked whale Unidentified Ziphius or Mesoplodon Unidentified small dolphin	10 Sep 2011–6 Jan 2012 6 Apr–22 Sep 2012
Passive Acoustic Monitoring (HARPs)	W Saipan – 330 m SE Tinian – 330 m	Blue whale Fin whale Minke whale Humpback whale Unidentified baleen whale Unidentified beaked whale[1]	Mar–Aug 2010 Apr–Oct 2011 Jun 2012–May 2013
Small-vessel Survey	Guam – to 980 m Rota – to 991 m Saipan – to 1,224 m	Hawksbill sea turtle Pygmy killer whale Short-finned pilot whale Sperm whale Common bottlenose dolphin Pantropical spotted dolphin Rough-toothed dolphin Spinner dolphin Unidentified hardshell turtle	22 Jun–27 Jul 2013
Shore-based Survey	N Guam – to 800 m NE Guam – to 1,200 m	Short-finned pilot whale Spinner dolphin Unidentified small cetacean Unidentified small dolphin	11–23 May 2013
Turtle Surveys	Guam SW – to 60 m Saipan – to 60 m Tinian – to 60 m	Green sea turtle Hawksbill sea turtle	15–16 Aug 2013 18–21 Aug 2013

[1] Classification to species not completed.

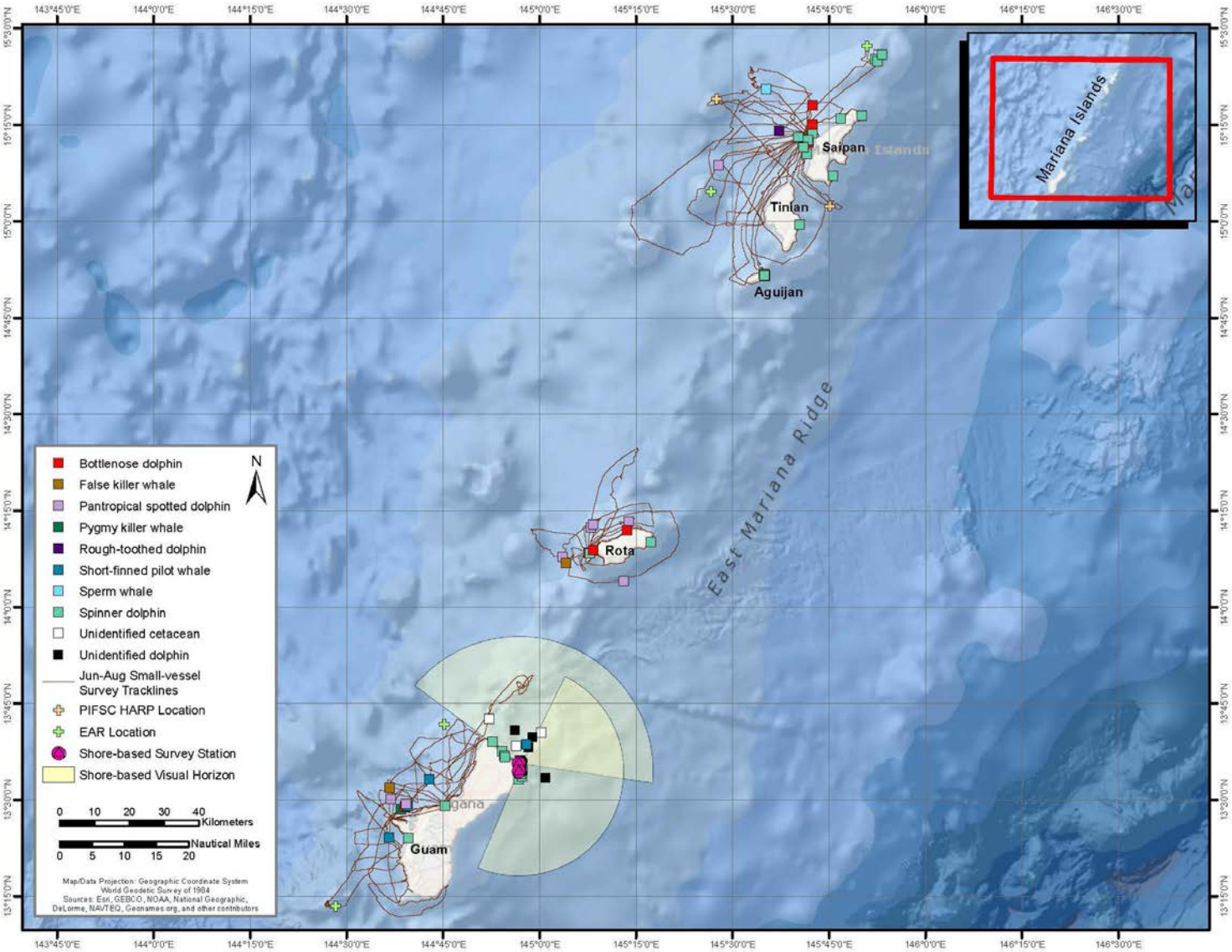

Figure 3. Monitoring Year 4 sightings, effort, and passive acoustic monitoring device locations in the MIRC study area
(Deployment of HARPs funded by NMFS PIFSC)

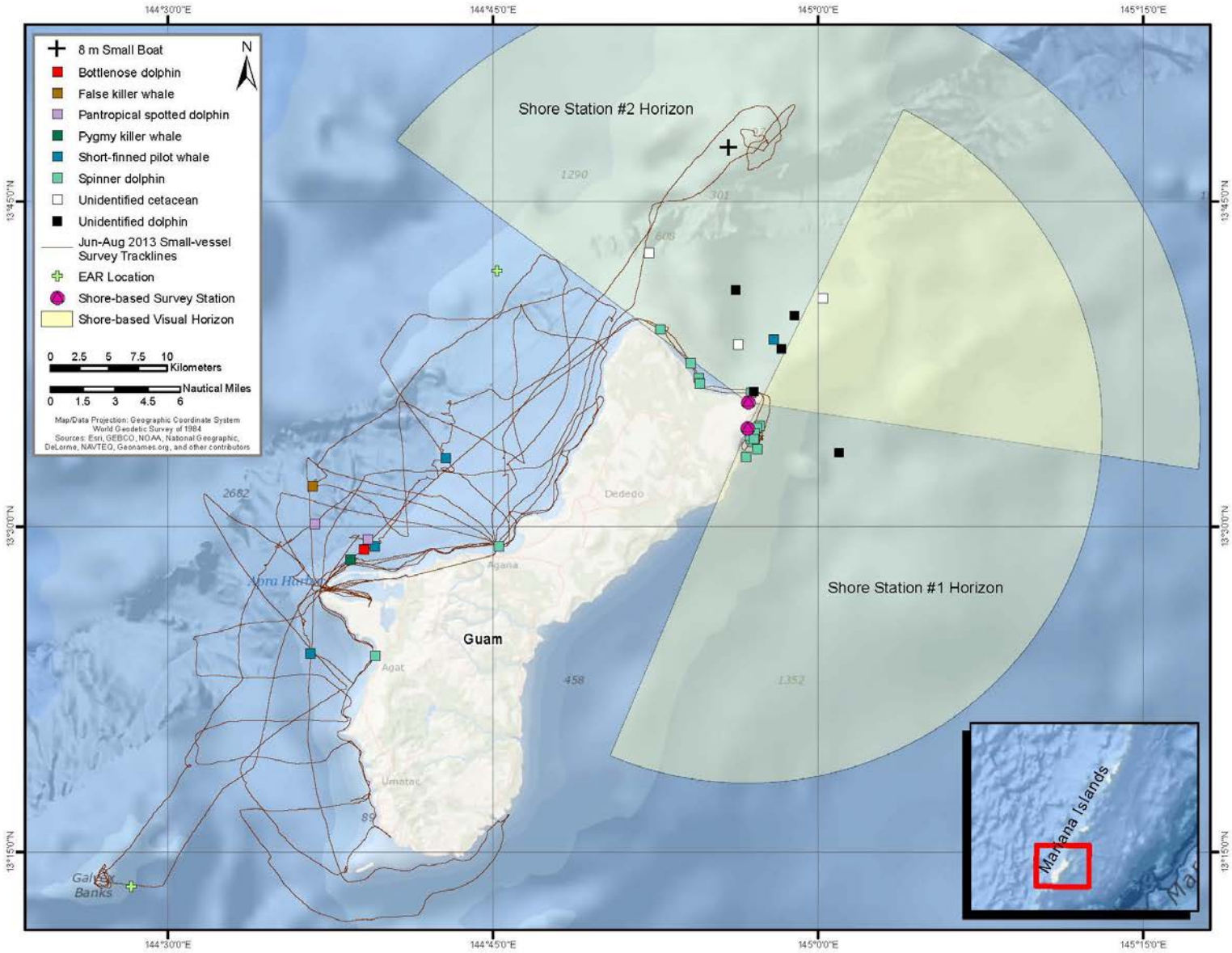

Figure 4. Monitoring Year 4 sightings, effort, and passive acoustic monitoring device locations on and off Guam

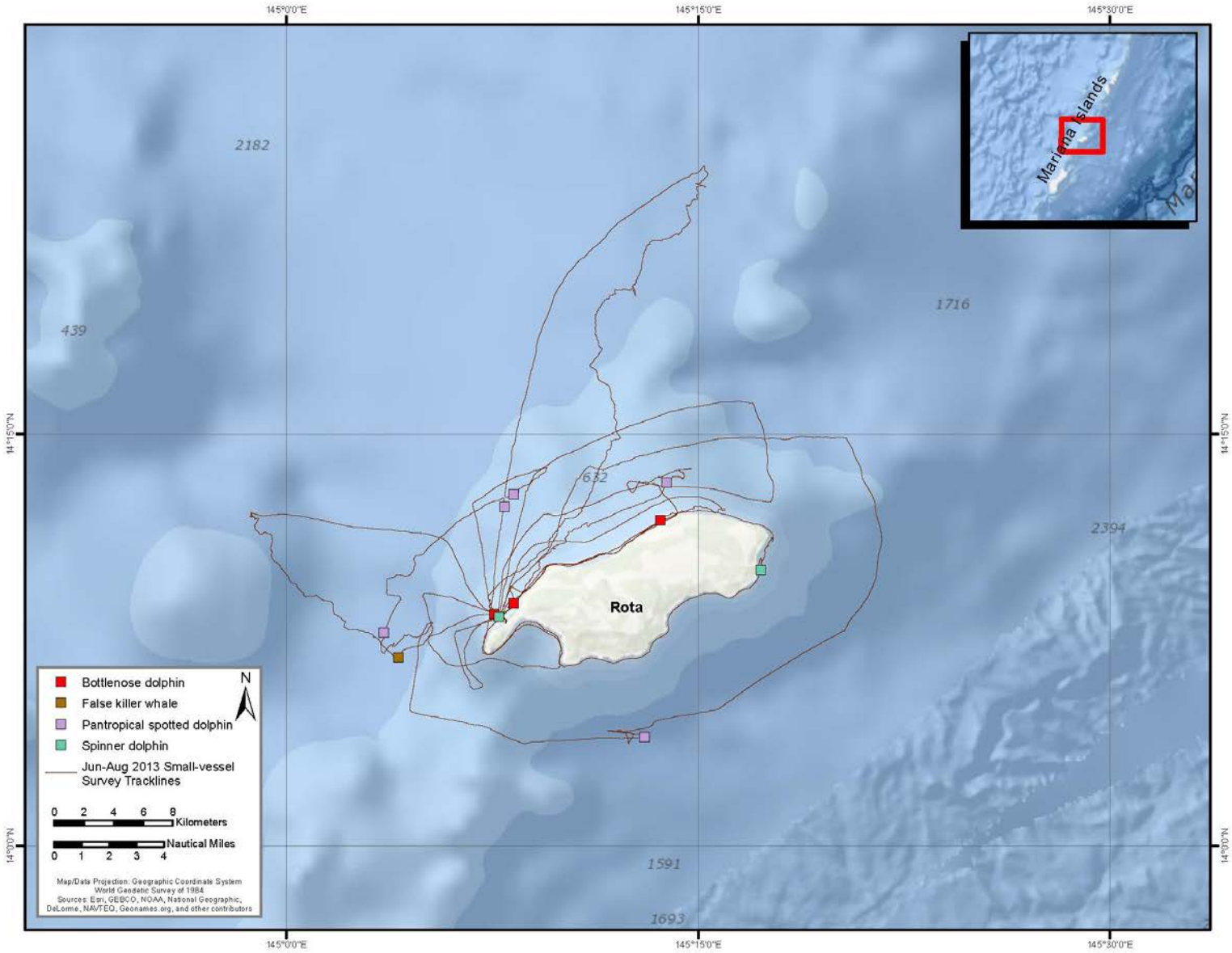

Figure 5. Monitoring Year 4 sightings and effort off Rota

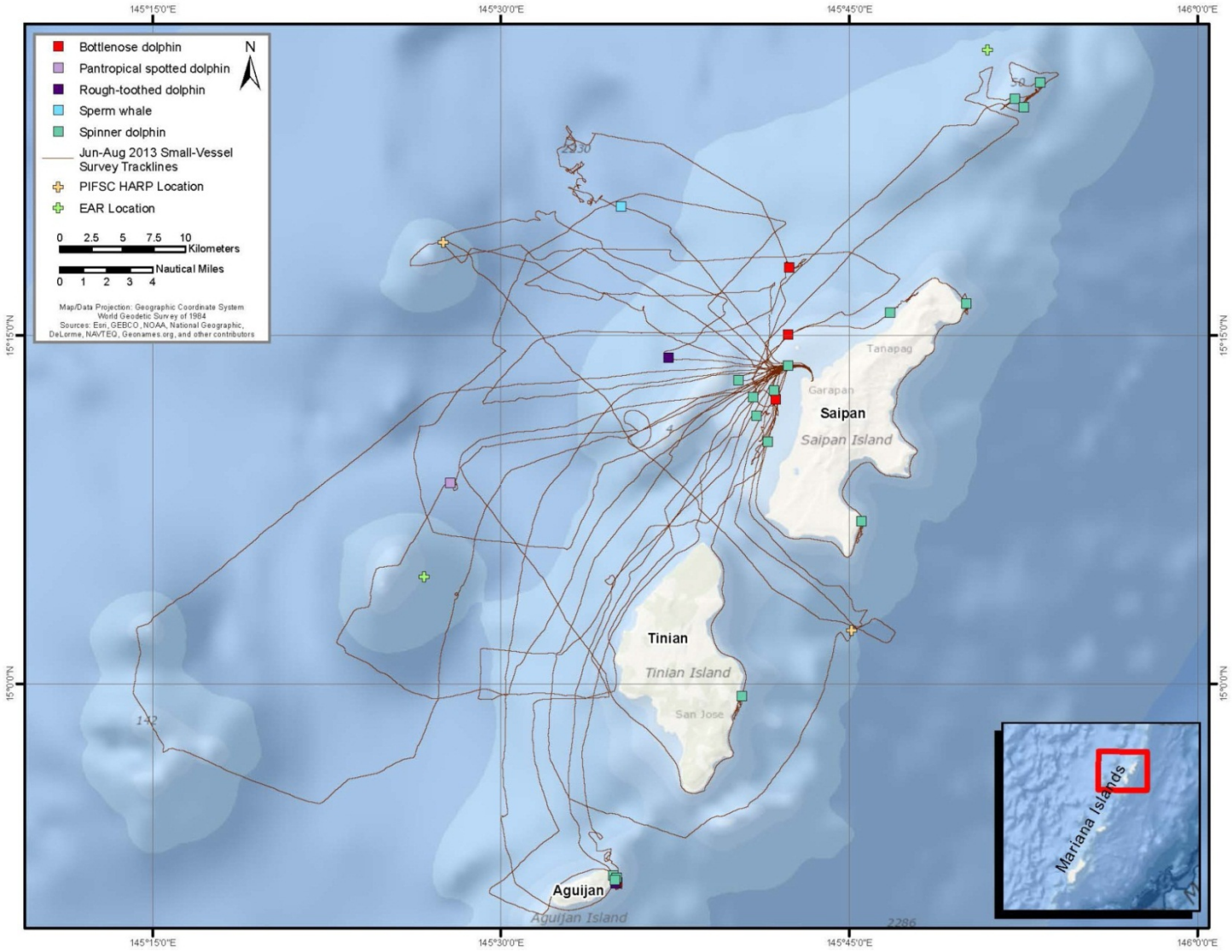

Figure 6. Monitoring Year 4 sightings, effort, and passive acoustic monitoring device locations off Tinian and Saipan
(Deployment of HARPs funded by NMFS PIFSC)

2.2.1.1 Passive Acoustic Monitoring: EARs [2]

Data recovered from the four EARs deployed in the MIRC (two off Guam, one off Tinian, one off Saipan) were analyzed for odontocete whistles and clicks. Detections included unidentified beaked whales (*Mesoplodon* or *Ziphius* genus), unidentified delphinids, and sperm whales (see **Appendix B**). Further data analysis is ongoing.

2.2.1.2 Passive Acoustic Monitoring: HARPs [1]

Analysis of 2010–2011 acoustic data files from PIFSC Saipan and Tinian HARPs (see **Appendix A**) revealed that beaked whales are present year-round at both sites (**Figure 6**). The automated beaked whale detector employed for this analysis does not classify beaked whale click bouts to species, so all detections were classified as unidentified beaked whales. However, limited assessment of beaked whale occurrence by species was reported by Baumann-Pickering et al. (2013, 2014), indicating that Cuvier's, Blainville's (*Mesoplodon densirostris*) and an as-yet unidentified beaked whale were detected at the Saipan and Tinian sites. Further data analysis is ongoing.

2.2.1.3 Visual Surveys: Small-vessel Surveys [6]

Similar species were observed during the 2013 small-vessel surveys as on previous surveys in the MIRC (see **Appendix E**, DoN 2013) as well as two additional species: pygmy killer whales and rough-toothed dolphins. Although not previously seen on small-vessel surveys, they were observed on the 2007 MISTCS (DoN 2007). Overall, there were 42 sightings of eight cetacean species: bottlenose dolphin, false killer whale, pantropical spotted dolphin, pygmy killer whale, rough-toothed dolphin, short-finned pilot whale, sperm whale, and spinner dolphin (see **Figure 6, Table 3)**

2.2.1.4 Visual Surveys: Shore-based Survey [5]

There were no new species to report from this field effort to contribute to the monitoring question. However, the pilot study is showing promise as a new, cost-effective, visual observation platform for identifying marine mammals and sea turtles in waters that are often challenging to survey by small-boat, due to persistent strong winds and large swell (see **Appendix D**). These conditions can occur in all waters surrounding the MIRC in the winter months and predominantly on the windward side of the islands during non-winter months. A shore-based platform could improve visual marine species monitoring during the winter, when baleen whales are more likely to be seen, and could complement small-boat visual surveys by providing coverage of the windward side of the island. Two species were seen off the north and northeast sides of Guam during the 10-day survey. There was one sighting of short-finned pilot whales, and frequent sightings of spinner dolphins close to shore. In addition, there were seven unidentified species sightings, including five small dolphins, one small whale, and one medium cetacean (see **Figure 3 and 4, Table 3**). No beaked whales were observed.

2.2.2 Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?

2.2.2.1 Passive Acoustic Monitoring: EARs [2]

Data analyses are ongoing, and have been completed for three of the four sites from the first round of EAR deployments—Guam, Saipan and Tinian—and indicate potential differences in abundance, species assemblages, and temporal patterns in these areas (see **Appendix B**). The greatest delphinid encounter rates overall were at Saipan. Moderate encounter rates occurred at Tinian, and the lowest encounter rates were at the southwestern Guam site, potentially indicating high, medium, and low relative abundance of delphinids at these sites, respectively. Within the three whistle groupings (low-frequency, mixed low- and high-frequency, and high-frequency), low-frequency whistling species were more often

encountered at Guam than the other two categories, whereas at Saipan and Tinian mixed low- and high-frequency whistles were the most commonly encountered of the three classes. Sperm whale encounters were logged manually as well, and occurred sporadically throughout the three deployments analyzed to date. Periods of one to three days with encounters were separated by periods of up to four weeks with no sperm whale detections.

Beaked whale and sperm whale signals were detected on approximately 80 percent of the recording days within each data set except for the Guam site, which had a very low beaked whale detection rate. Detection rates varied widely from day to day, but showed a strong diel pattern, with higher detection rates during nighttime hours between 1800 and 0600. Temporal patterns in daily and hourly detection rates were nearly identical for both beaked and sperm whales, suggesting either very similar vocal patterns, or detector inaccuracy. The latter possibility highlights the need for further validation of automated results.

2.2.2.2 Passive Acoustic Monitoring: HARPs [1]

Work is ongoing, and preliminary results from the analysis of PIFSC HARP data are not sufficient to address the question of relative abundance of marine mammals and/or sea turtles in MIRC waters. Analysis of daily occurrence rates of various species groups encountered at each HARP location is in-progress (see **Appendix A**).

2.2.2.3 Passive Acoustic Monitoring: MISTCS (2007) Sperm Whale Data Analysis [3]

Localization of Sperm Whale Acoustic Encounters: In total, 103 sperm whale acoustic encounters were localized during post-processing (see **Appendix C**). Of these, 91 encounters were determined to be of sufficient quality to include in subsequent analysis. These consisted of 54 encounters of the regular click type (Inter-Call Interval < 2 seconds) and 37 encounters of slow click type. The survey region encompassed approximately 584,800 km^2 including the islands of Guam, Rota, Tinian and Saipan (**Figure 7**). Based on a qualitative assessment of the localizations plotted on a map (**Figure 7**), the distribution of sperm whales appears to be clustered in three main regions within the study area: the northeast, central, and southwest portions, respectively, with only 23 localizations located in the trench and offshore regions. The central cluster may reflect a preference by at least some animals to inhabit waters near islands.

Development of an Acoustic Detection Function for Sperm Whales: An improved acoustic detection function was developed for sperm whales using the MISTCS towed-array acoustic data (see **Appendix C**). This was achieved by stratifying animal localizations by click type (slow vs. regular) for each of the 91 acoustic encounters. These detection functions can be used for an acoustic-based estimate of abundance of sperm whales in this region, which is advantageous since these whales dive for extended periods of time and can be easily missed by visual observers

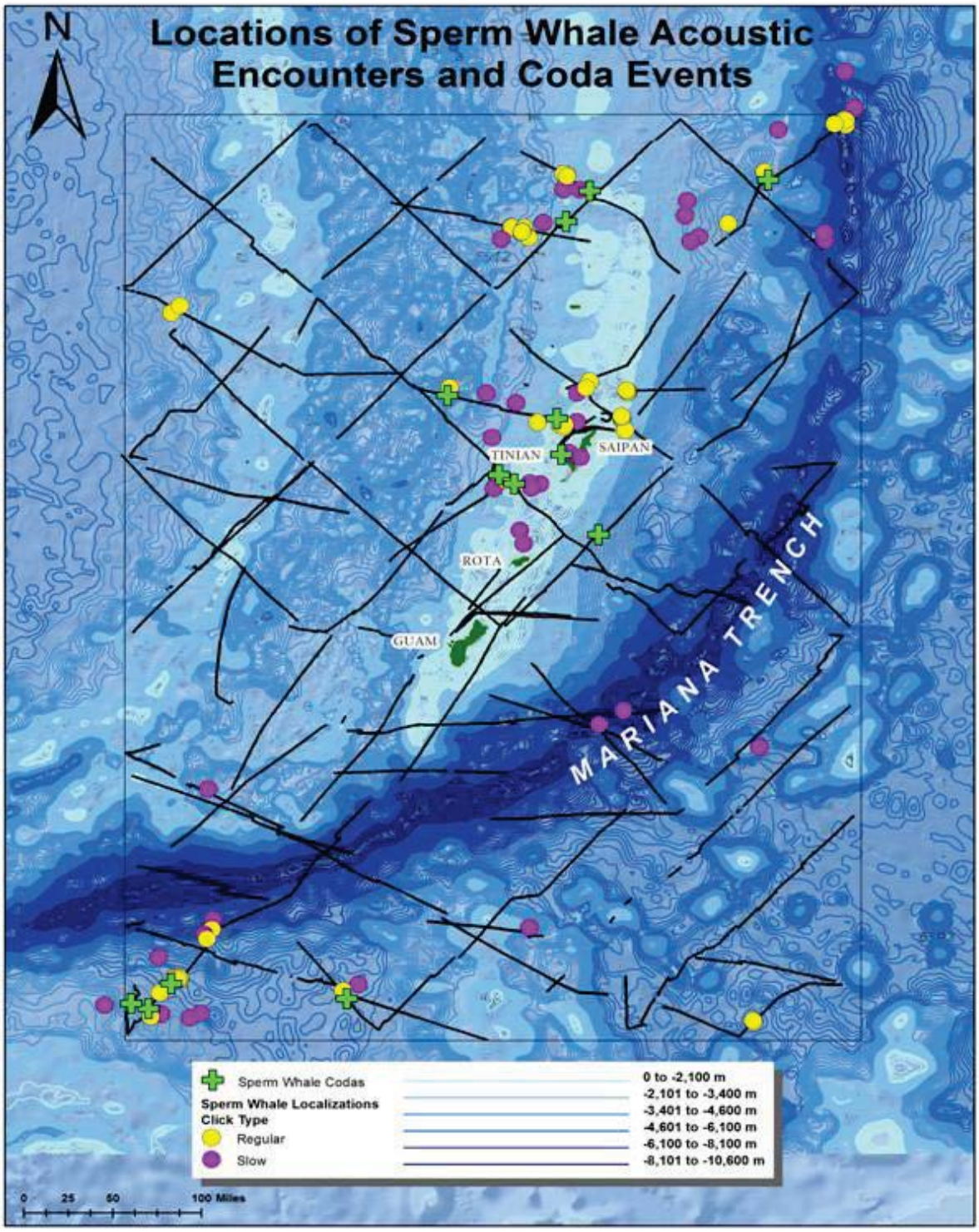

Figure 7. MISTCS 2007 sperm whale acoustic encounters and coda events occurring in and around the Northern Mariana Islands region.

Regular clicks (yellow circles), slow clicks (magenta circles), and regular clicking groups that produced codas (green crosses) are represented. Ship tracklines are represented by black lines (taken from Appendix C).

2.2.2.4 Visual Surveys: Small-vessel Surveys [6,7]

During the 30 days of small-boat survey effort (see **Appendix E;** see also Hill et al. 2013a), 3,208 km of effort was carried out from Guam to the south to Saipan in the north (**Figure 3**). This effort resulted in 42 sightings involving eight species (**Table 3**). Off Guam and Rota, the pantropical spotted dolphin was the most frequently sighted species (*n*=5) and was the most abundant (105 animals, **Figures 4 and 5**). Off Saipan, Tinian, and Aguijan, spinner dolphin was the most frequently sighted species (*n*=16) and was the most abundant (423 animals, **Figure 6**).

Results from tagged animals (including two still-active tags that have transmitted for 198 days on a false killer whale and over 224 days on a short-finned pilot whale) demonstrate that many odontocete populations are utilizing the entire island chain of the MIRC and beyond, similar to odontocete habitat use patterns that occur in Hawaii (see also Hill et al. 2013a, c, d, e). Some individuals made very long-distance movements in short periods of time. For example, a short-finned pilot whale tagged off Guam traveled 500 km south of the tagging area in five days, crossing over the Mariana Trench, and later returned to Guam. Some odontocete groups can separate into subgroups, with each subgroup going a different direction for many days, only to merge together again. This was evident in two false killer whales that were tagged within the same group, moved apart, and later rejoined. While some species utilize the entire MIRC area, other species appear to have much more site fidelity to an area. For example, a tagged rough-toothed dolphin remained along the west side of Saipan for the 12 days the tag transmitted.

More in-depth analysis of the tag, biopsy, and photo-ID data is ongoing and will continue to improve the understanding of species habitat use, abundance, and group dynamics.

2.2.2.5 Visual Surveys: Shore-Based Surveys [5]

The shore-based visual surveys revealed the nearshore waters off northeastern Guam as an area frequented by spinner dolphins, which were observed transiting through this area several times per day. Of the seven sightings of unidentified species of dolphin or small whale, six were on the north side of Guam in waters less than 1,200 m, although sighting conditions were be better in those waters. In total, 26 marine mammal sightings were made during the 10 days of surveys. Of these, 17 were from the eastern-facing shore station and 9 were from the north-facing shore station on Guam (see **Appendix D**). The majority of sightings (69 percent) were spinner dolphins. Sightings occurred in areas not covered by small-vessel surveys (**Figure 4**), suggesting that data collected using shore-based monitoring methods complements those collected using other platforms. The remaining marine mammal sightings included five unidentified small dolphins, one group of short-finned pilot whales, an unidentified small whale, and an unidentified medium cetacean. Water depths at sighting locations ranged from 17 m (spinner dolphin sighting 530 m offshore) to 1,203 m (unidentified small delphinid sighted 7.91 km offshore). The furthest sighting from the island was an unidentified medium cetacean at 15.18 km offshore. Sixteen sea turtle sightings were made, 10 on the east side and six on the north side of the island.

Sea turtles were also very common in waters shallower than 100 m and were commonly sighted within 200 m from the shoreline (14 from the northeast-facing shore station, and 6 from the north-facing shore station) during the 10 days of survey (see **Appendix D, Figure 10**). All turtle sightings were within 1 km from shore in water less than 101 m deep. The farthest turtle sighted from the theodolite station was 1.22 km away but no more than 170 m from shore. The closest turtle sighting was 290 m away, and species could not be determined.

2.2.3 WHAT IS THE BASELINE ABUNDANCE AND POPULATION STRUCTURE OF ODONTOCETES WHICH MAY BE EXPOSED TO SONAR AND/OR EXPLOSIVES IN THE NEARSHORE AREAS OF GUAM, SAIPAN, TINIAN, AND ROTA?

2.2.3.1 Passive Acoustic Monitoring: MISTCS (2007) Sperm Whale Data Analysis [3]

Sperm Whale Coda Analysis: Sperm whales are known to produce stereotyped patterns of 3 to 40 broadband clicks, termed 'codas,' that typically occur within a period of 3 seconds or less (see **Appendix C**). These vocalizations are typically produced by sperm whales existing in matrilineal social units, defined as "sets of whales who live and move together over periods of years" (Whitehead 2003). Documentation of similar vocal repertoires in social units that are geographically isolated has led researchers to believe that sperm whales occur in culturally linked populations defined as 'vocal clans' (Whitehead 2003).

There were 13 coda-producing acoustic encounters with sperm whales during the MISTCS. A qualitative assessment of these coda patterns revealed similarities to vocal repertoires of eastern Pacific vocal clans (see **Appendix C**); specifically, the "short" and "regular" vocal clans (so-named based on relative length of click sounds) typically encountered near the Galapagos Islands, off the coast of Ecuador (Weilgart and Whitehead 1997). The presence of both short and regular vocal clans identified from the acoustic encounters in this dataset can be used as putative indicators of sperm whale stock structure for this region. Additionally, the similarity of sperm whale vocal repertoires in the Northern Mariana Islands to those in the eastern Pacific Ocean provides previously undocumented evidence of a possible link between eastern and western Pacific Ocean social units, and may indicate that short and regular vocal clans have a much greater distribution that previously known.

2.2.3.2 Visual Surveys: Small-Vessel Surveys [6,7,8,9]

During the June–July small-vessel surveys, biopsy samples were collected from eight cetacean species: spinner dolphin, pantropical spotted dolphin, false killer whale, short-finned pilot whale, bottlenose dolphin, pygmy killer whale, rough-toothed dolphin, and sperm whale. Additionally, sloughed-skin samples were collected from sperm whales (see **Appendix E**; see also Hill et al. 2013a). One vial of each sample is stored at the PIFSC, and the other was submitted (via PIFSC) to the NMFS Southwest Fisheries Science Center (SWFSC) for tissue archiving. A subset of tissue samples collected since 2010 are in the progress of being analyzed by the SWFSC's genetics lab to evaluate the phylogeography of Marianas cetaceans and should provide valuable information on genetically distinct population stocks as well as the frequency of genetic interchange among subpopulations occurring in the MIRC.

During these small-vessel surveys, photographs were taken of eight species (bottlenose dolphin, false killer whale, pantropical spotted dolphin, pygmy killer whale, rough-toothed dolphin, short-finned pilot whale, sperm whale, and spinner dolphin) for photo-identification purposes (see **Appendix E**; Hill et al. 2013a,b). A long-term goal of this research is the evaluation of the population status of each cetacean stock. This includes producing population abundance estimates using mark-recapture techniques. The first step in the process was the creation of species photo-identification catalogs, which began during the summer of 2012.

Resightings of individual short-finned pilot whale, bottlenose dolphin, and spinner dolphin individuals within years and across years indicate long-term site fidelity to the MIRC areas. Resightings of short-finned pilot whales, bottlenose dolphins, and spinner dolphins, in addition to satellite-tracking data from short-finned pilot whales, false killer whales, common bottlenose dolphins, and rough-toothed dolphins, indicate inter-island movements of these four species within the MIRC.

There are currently 129 short-finned pilot whales in the PIFSC photo-identification catalog. This catalog is being updated as photo-identifications from the 2013 field season are being processed. PIFSC has a catalog of spinner dolphins that includes 89 individuals from Saipan, Tinian, Aguijan, and Rota. Resightings of individuals within this catalog reveal movements of individuals throughout the islands from Rota north to Marpi Reef. Photos from the 2013 field season are being processed and PIFSC is currently working on the photo-identification catalog from Guam.

2.2.4 WHAT IS THE SEASONAL OCCURRENCE OF BALEEN WHALES AROUND GUAM, SAIPAN, TINIAN, AND ROTA?

2.2.4.1 Passive Acoustic Monitoring: EARs [2]

Although EAR data contained several baleen whale detections in the MIRC (see **Appendix B**), the number of baleen whale detections was relatively small compared to the number of odontocete detections. The automated baleen whale detector applied to EAR data detected only a few files with minke whale and humpback whale vocalizations during the first deployment at northern Guam and Saipan, respectively, and only two days with 39 humpback whale detections at Saipan during the second deployment. Additionally, two of the EAR datasets (Guam and Saipan) were scanned for "high-frequency" sei whale calls. These sei whale calls have a higher frequency than blue and fin whale calls (< 100 Hertz), a characteristic seemingly unique to sei whales in the Marianas (DoN 2007). Scanning was performed by visually browsing the long-term spectral average within the frequency band of these calls; however, none were detected. The lack of baleen whale detections may be related to a lack of recording during most of winter (i.e., January–April), which is when baleen whales are known to occur in other tropical habitats in the northern hemisphere, or it may reflect very little use of these areas by baleen whales.

2.2.4.2 Passive Acoustic Monitoring: HARPs [1]

Acoustic datasets from PIFSC HARPs deployed off Saipan and Tinian in 2010 were analyzed for low-frequency (<1 kHz) baleen whale vocalizations (see **Appendix A**). Analysis of 2010 and 2011 Saipan and Tinian datasets is complete, and analysis of the 2012–2013 datasets is underway. Data were scanned as compressed spectrograms in 1-hour bins. When signal was evident above the background noise, the raw spectrogram was visually inspected. Species detected include fin whale, blue whale, humpback whale, and minke whale. Seasonal occurrence was analyzed in monthly bins across the 2010–2011 datasets (**Figure 8**). A more comprehensive analysis, including data from 2012–2013, is ongoing.

2.2.4.3 Visual Surveys: Small-Vessel Surveys [6]

There were no sightings of baleen whales during the 216 hours of small-vessel surveys around Guam, Saipan, Tinian, and Rota (see **Appendix E**). However, the lack of baleen whale sightings may be a result of survey timing, since surveys were performed in summer (22 June through 27 July 2013), and baleen whales in other tropical habitats (e.g., Hawaii) are known to occur in peak numbers from January through April (Nishiwaki 1966).

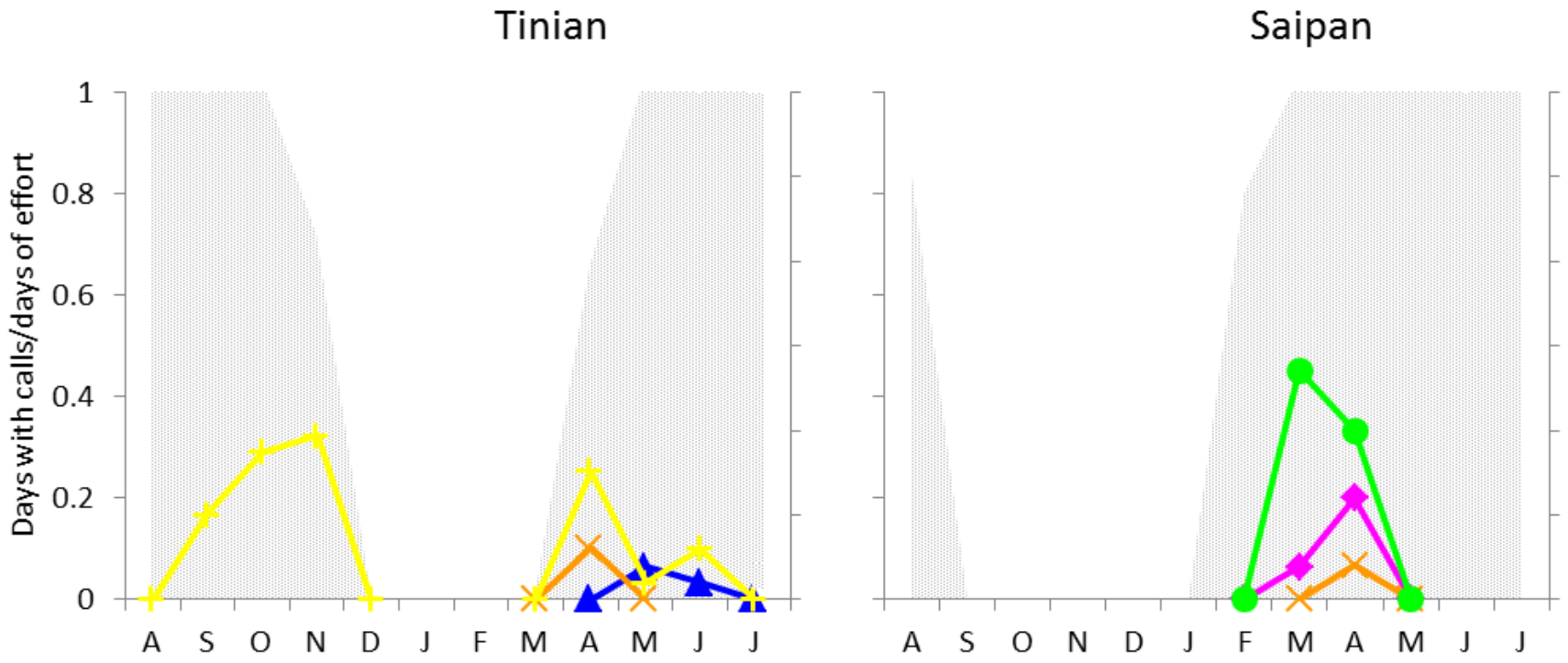

Figure 8. Proportion of days with calls in relation to recording effort, by month with recording effort combined across years.
Lines and symbols represent different large whale species, with proportion of calls to effort quantified on left vertical axis. Light gray shading quantified days of recording effort for each month, right vertical axis. Orange = fin whale, Blue = blue whale, Green = humpback whale, Pink = minke whale, and Yellow = Unidentified whale. From Oleson 2014 (Appendix B).

2.2.4.4 Visual Surveys: Shore-Based Survey [5]

There were no sightings of baleen whales during the 10 days of shore-based visual surveys from Guam (See **Appendix D**). However, the lack of sightings may be a result of survey timing, since surveys were performed from 11–21 May, and baleen whales in other tropical habitats (e.g., Hawaii) are known to occur in peak numbers from January through April (Nishiwaki 1966).

2.2.5 WHAT IS THE OCCURRENCE AND HABITAT USE OF SEA TURTLES IN AREAS WHERE THE U.S. NAVY CONDUCTS UNDERWATER DETONATIONS?

2.2.5.1 Visual Surveys: Small-Vessel Surveys [6]

Sixty-eight sea turtles were seen during 30 days of small-vessel surveys conducted from 22 June–27 July. Fourteen turtles were seen off Guam, 4 off Rota, and 50 off Saipan. All animals were identified either as green turtles or as "small," "medium," or "large" unidentified sea turtles (see **Appendix E**). Figure 10 shows relative position of underwater detonation sites.

2.2.5.2 Visual Surveys: Sea Turtle Surveys/Tagging [10]

Of the five species of sea turtle associated with the MIRC (DoN 2010a), only green turtles and hawksbill turtles were encountered on these surveys (see **Appendix F**). Four green turtles and two hawksbill turtles were captured and instrumented with satellite tags. Kernel density estimates revealed habitat fidelity and limited movements for one hawksbill while resident off Tinian and Guam. The other five turtles remained in the nearshore environment off Garapan, Saipan. Kernel density estimates show sustained use and residency by all five in the area of original capture. The area stretching from the Balisa Channel to Managaha Island is a patch reef community were the turtles both forage and rest. Dive patterns suggest that both hawksbill and green turtles remain in deeper waters during daylight hours and move nearshore during the night. Hawksbills spent more time in deeper waters than the greens, reaching depths of 100 m or more. Green turtle average depth was 12.6 ± 5.3 m and 10.0 ± 3.3 m for day and night, respectively. Hawksbill turtle average depth was 22.6 ± 13.8 m and 17.4 ± 6.4 m for day and night, respectively. The data suggest a dichotomy in selected habitat and habitat use for green and hawksbill turtles, which is unsurprising given their unique foraging habits. However, both species display small home ranges, typically less than 4 km^2, and limited movement between islands with only one turtle, a hawksbill, making a 286-km, seven-day trek from Tinian to Guam (**Figure 9**).

2.2.5.3 Visual Surveys: Shore-Based Survey [5]

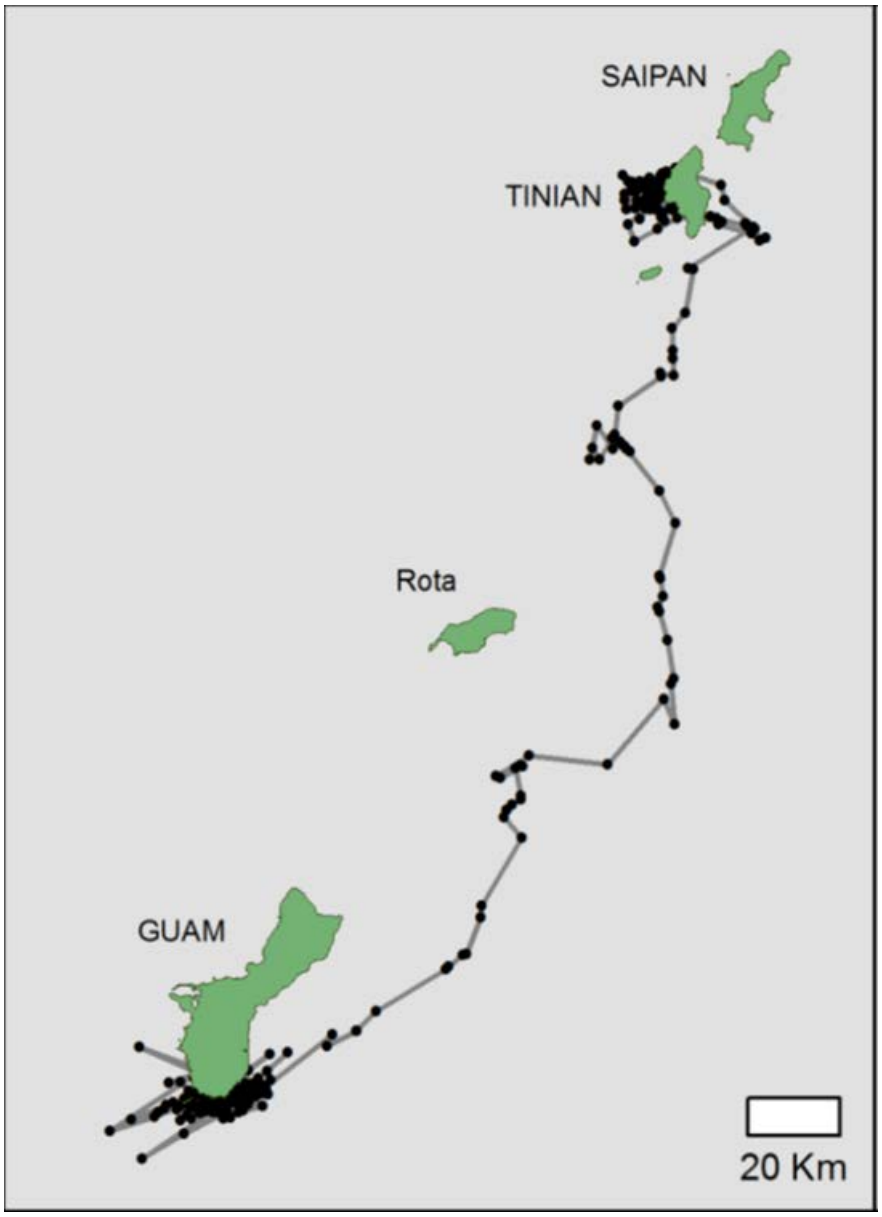

Figure 9. Migration of subadult hawksbill turtle from Tinian, Commonwealth of the Northern Mariana Islands to Guam.
From Jones and Van Houtan 2013 (Appendix F).

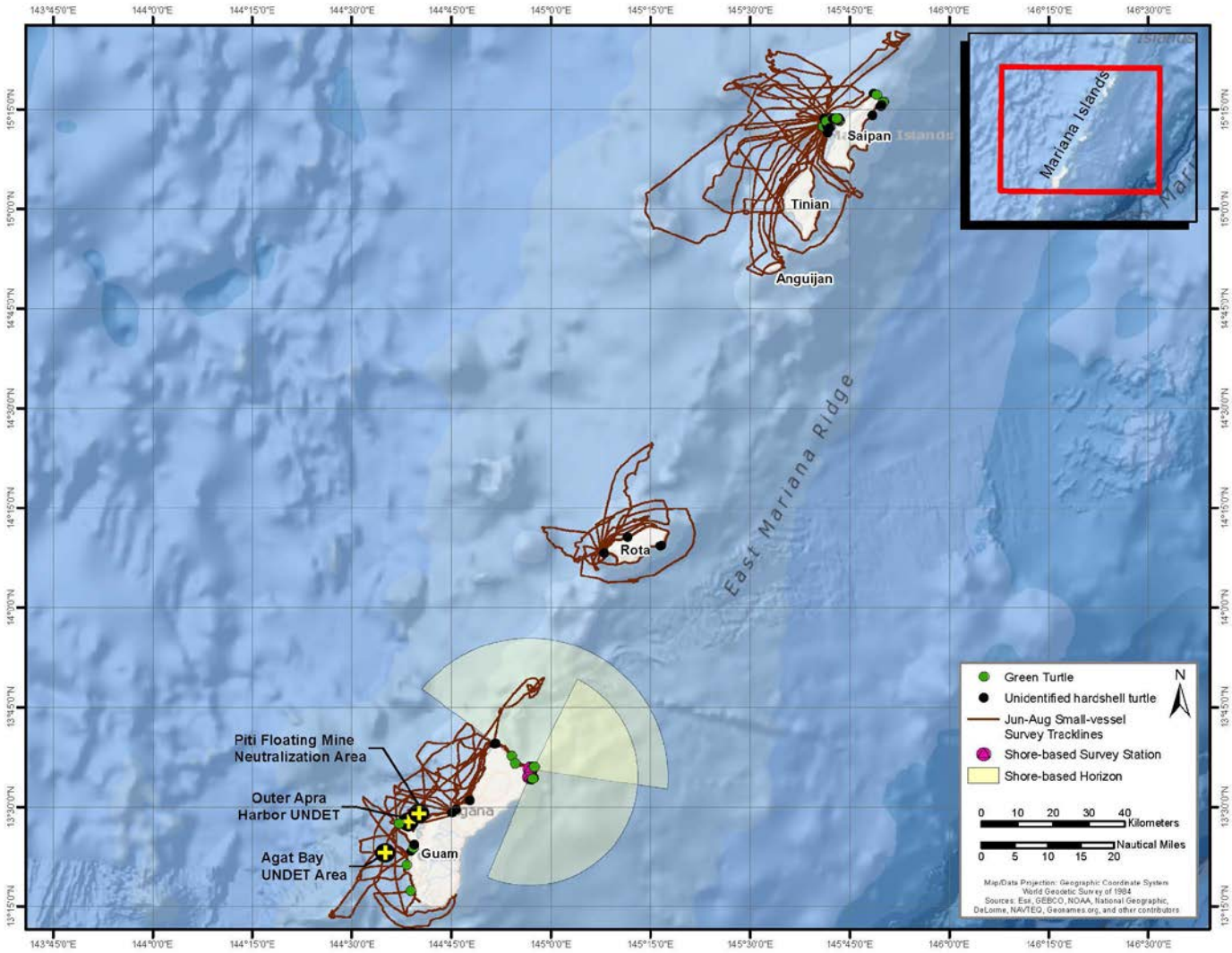

Figure 10. Monitoring Year 4 sea turtle sightings from small-vessel and shore-based surveys
Turtle tagging data not shown here. Also displayed are three Navy underwater detonation areas.

3 ADAPTIVE MANAGEMENT AND YEARLY MONITORING GOALS

Table 4. Summary of monitoring goals, FY14–FY15.

Monitoring Plan Questions		Implementation goals		
		FY14		FY15
1. What species of beaked whales and other odontocetes occur around Guam and Saipan?	ADAPTIVE MANAGEMENT REVIEW (AMR)	-Continue acoustic methodologies *(may include analysis of previously collected moored PAM datasets, deployment of autonomous devices in offshore waters, and opportunistic dipping hydrophone recordings)* -Continue visual methodologies *(may include small boat surveys, shore-based surveys, satellite tagging)*	AMR	-Continue acoustic methodologies *(may include deployment of autonomous devices in offshore waters, however analysis of previously collected PAM data sets is likely to be prioritized over deployment of additional devices. Continue opportunistic dipping hydrophone recordings)* -Continue visual methodologies *(may include small boat surveys, shore-based surveys, satellite tagging)*
2. Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?		-Continue acoustic methodologies *(may include analysis of previously collected moored PAM datasets, deployment of offshore autonomous devices, and opportunistic dipping hydrophone recordings)* -Continue visual methodologies in multiple locations *(may include small boat surveys, shore-based surveys, diver surveys, satellite tagging)*		-Continue acoustic methodologies *(may include continued analysis of additional PAM datasets, or applying new analysis methods to previously-analyzed datasets; and/or deployment of offshore autonomous devices; and/or and opportunistic dipping hydrophone recordings)* -Continue visual methodologies in multiple locations *(may include small boat surveys, diver surveys, satellite tagging)*
3. What is the baseline abundance and population structure of odontocetes which may be exposed to sonar and/or explosives in the nearshore areas of Guam, Saipan, Tinian, and Rota?		-Continue population structure analyses *(may include collection and analysis of tissue samples)* - Continue mark-recapture photo ID collection and analysis		-Continue population structure analyses *(may include collection and analysis of tissue samples)* - Continue mark-recapture photo ID collection and analysis - Consider additional acoustic analysis methodologies of collected PAM datasets that may provide progress on this question
4. What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?		-Continue acoustic methodologies *(may include analysis of previously collected moored PAM datasets, deployment of offshore autonomous devices, and opportunistic dipping hydrophone recordings)* -Continue visual methodologies *(may include small boat and shore surveys, and opportunistic satellite tagging)* -Consider other methodologies		-Continue acoustic methodologies *(may include analysis of previously collected moored PAM datasets, deployment of offshore autonomous devices, and opportunistic dipping hydrophone recordings)* -Continue visual methodologies *(may include small boat and shore surveys, and opportunistic satellite tagging)*
5. What is the occurrence and habitat use of sea turtles in areas where the Navy conducts underwater detonations?		-Continue visual methodologies *(may include continued turtle observation on cetacean visual surveys, continued dedicated turtle survey; tagging and/or diver surveys)*		-Continue visual methodologies *(may include continued turtle observation on cetacean visual surveys, continued dedicated turtle survey; tagging and/or diver surveys)*

Table 4 summarizes the AMR and planned monitoring goals in the MIRC for FY14–FY15. The monitoring goals above in **Table 4** have been organized according to the study questions defined in the MIRC Monitoring Plan, rather than by methodology type as had previously been done in the corresponding table in the 2013 MIRC Annual Report. Therefore, **Table 4** replaces that previous version of the monitoring goals table, which is reproduced below for comparison **(Table 5)**.

Table 5. Previously-planned summary of monitoring methods and level of effort, FY10–FY15 (DoN 2012a). Replaced by Summary of monitoring goals, FY14–FY15 (Above, Table 4).

	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.	AMR	- 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	AMR	- 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	AMR	- 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	AMR	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 and/or - Analyze data from satellite tags		- Purchase satellite tags to support tagging attempts during visual surveys and/or - 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

4 LITERATURE CITED

Baumann-Pickering, S., M.A. McDonald, A.E. Simonis, A. Salson Berga, K.P.B. Merkens, E.M. Oleson, A.R. Roch, S.M. Wiggins, S. Rankin, T.M. Yack, and J.A. Hildebrand. 2013. Species specific beaked whale echolocation signals. *Journal of the Acoustical Society of America* 134(3): 2293-2301.

Baumann-Pickering, S., M.A. Roch, R.L. Brownell, A.E. Simonis, M.A. McDonald, A. Solsona-Berga, E.M. Oleson, S.M. Wiggins, and J.A. Hildebrand. 2014. Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific. *PlosONE* 9(1): e86072. doi:10.1371/journal.pone.0086072.

DoN (Department of the Navy). 2007. Marine Mammal and Sea Turtle Survey and Density Estimates for Guam and the Commonwealth of the Northern Mariana Islands. Primary authors: P. Thorson, G. Fulling, T. Norris, C. Hall, and K. Sawyer. Prepared under Contract no. N68711-02-D-8043 Task Order 0036 by Man-Tech SRS Technologies and Geo-Marine for the Department of the Navy, Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii.

Deakos, M.H., R.K. Uyeyama, M.F. Richlen, J.M. Aschettino, 2014. Guam Marine Species Monitoring Survey, Shore Station Feasibility Study. Report prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, HI. Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific EV2 Environmental Planning, Pearl Harbor, Hawaii under Contract No. N62470-10-D-3011, Task Order KB23, issued to HDR Inc., Honolulu, Hawaii. Submitted by HDR Inc., Honolulu, HI, 24 March 2014.

DoN (Department of the Navy). 2010a. Mariana Islands Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (Final). Naval Facilities Engineering Command, Pacific, Pearl Harbor, HI. Retrieved from https://mircairspaceea.com/DocumentsandReferences/Documents.aspx

DoN (Department of the Navy). 2010b. United States Navy Integrated Comprehensive Monitoring Program. 2010 update. U.S. Navy, Chief of Naval Operations Environmental Readiness Division, Washington, D.C.

DoN (Department of the Navy). 2011. Scientific Advisory Group for Navy Marine Species Monitoring: Workshop Report and Recommendations, 10 October 2011, Arlington, Virginia.

DoN (Department of the Navy). 2012a. Mariana Islands Range Complex Marine Species Monitoring Plan, FY13-2015. Prepared for the National Marine Fisheries Service, Office of Protected Resources by U.S. Pacific Fleet Environmental Readiness Division, Pearl Harbor, HI.

DoN (Department of Navy). 2012b. Deployment of Four Ecological Acoustic Recorders in the Mariana Islands Range Complex (MIRC), September 2011. Authors: M. Richlen and K. Ampela. Prepared for Naval Facilities Engineering Command, Pacific, Pearl Harbor, HI under Contract No. N62470-10-D-3011, CTO KB10 issued to HDR, Inc., San Diego, CA.

DoN (Department of the Navy) 2013. Marine Species Monitoring for the U.S. Navy's Mariana Island Range Complex - Annual Report. Author: Julie Rivers. Department of the Navy, Commander, U.S. Pacific Fleet, Pearl Harbor, HI. 11 April 2013.

Fulling, G.L., P.H. Thorson, and J. Rivers. 2011. Distribution and abundance estimates for cetaceans in the waters off Guam and the Commonwealth of the Northern Mariana Islands. *Pacific Science* 65: 321-343.

Hill, M., A. Ligon, A. Ü, M. Deakos, and E. Oleson. 2013a. Marianas Cetacean Surveys 2013: Guam, Rota, Saipan, Tinian and Aguijan (19 June – 31 July). PIFSC Data Report DR-13-017. National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, HI. 40 pp.

Hill M.C., A.D. Ligon, M.H. Deakos, A.C. Ü, and E.M. Oleson. 2013b. Cetacean Surveys of Guam and CNMI Waters: June – July, 2013. PIFSC Data Report DR-13-019. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, HI. 21 pp.

Hill M.C., A.D. Ligon, A.C. Ü, and M.H. Deakos. 2013c. Marianas Cetacean Surveys 2013: Updates on Our Satellite Tagged Short-finned Pilot Whales (July 12 – 26). July 29. National Marine Fisheries Service, Pacific Islands Fisheries Science Center blog entry, retrieved March 01, 2014 from: http://pifscblog.wordpress.com/2013/07/29/marianas-cetacean-surveys-2013-updates-on-our-satellite-tagged-short-finned-pilot-whales-july-12-26/

Hill M.C., A.D. Ligon, A.C. Ü, and M.H. Deakos. 2013d. Marianas Cetacean Surveys 2013: Updates on Our Satellite Tagged False Killer Whales (July 12 – 27). July 30. National Marine Fisheries Service, Pacific Islands Fisheries Science Center blog entry, retrieved March 01, 2014 from: http://pifscblog.wordpress.com/2013/07/30/marianas-cetacean-surveys-2013-updates-on-our-satellite-tagged-false-killer-whales-july-12-27/

Hill M.C., A.D. Ligon, A.C. Ü, M.H. Deakos, and E.M. Oleson. 2013e. Marianas Cetacean Surveys 2013: Saipan, Tinian, Aguijan Summary (July 12-27). August 5. National Marine Fisheries Service, Pacific Islands Fisheries Science Center blog entry, retrieved March 01, 2014 from: http://pifscblog.wordpress.com/2013/08/05/marianas-cetacean-surveys-2013-saipan-tinian-aguijan-summary-july-12-27/

Jones, T.J., and K.S. Van Houtan. 2013. Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC). Interim Report. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, HI. Submitted by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Marine Turtle Assessment Group, Honolulu, Hawaii.

Munger, L.M., M.O. Lammers, and W.W.L. Au. 2014. Passive Acoustic Monitoring for Cetaceans within the Mariana Islands Range Complex (MIRC). Preliminary Report. Submitted to Naval Facilities Engineering Command Pacific, Pearl Harbor, HI under Contract No. N62470-10-D-3011, Task Orders KB14 and KB17, issued to HDR Inc., Honolulu, HI. Prepared by Oceanwide Science Institute, Honolulu, Hawaii and Hawaii Institute of Marine Biology, Kaneohe, HI. February 2014.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. *Whales, Dolphins and Porpoises. University of California Press, Berkeley*, 171-191.

NMFS (National Marine Fisheries Service). 2010a. Taking and importing marine mammals; military training activities and research, development, testing and evaluation conducted within the

Mariana Islands Range Complex; final rule. *Federal Register* 75(148): 45527-45556. August 3, 2010.

NMFS (National Marine Fisheries Service). 2010b. Programmatic Biological Opinion for U.S. Navy training in the Mariana Islands Range Complex from June 2010 to June 2015. Prepared for U.S. Navy, Pacific Fleet, Pearl Harbor, HI by National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. Issued June 28, 2010.

NMFS (National Marine Fisheries Service). 2011 Biological Opinion for U.S. Navy training in the Mariana Islands Range Complex from August 2011 to August 2012. Prepared for U.S. Navy, Pacific Fleet, Pearl Harbor, HI by National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. Issued August 9, 2011.

NMFS (National Marine Fisheries Service). 2012a. Letter of Authorization for Navy exercises conducted in the Mariana Islands Range Complex from August 12, 2012 to August 3, 2015. Prepared for U.S. Navy, Pacific Fleet, Pearl Harbor, HI by National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. Issued July 31, 2012.

NMFS (National Marine Fisheries Service). 2012b. Biological Opinion for U.S. Navy training in the Mariana Islands Range Complex from August 2012 to August 2013. Prepared for U.S. Navy, Pacific Fleet, Pearl Harbor, HI by National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. Issued July 31, 2012.

Norris, T.F., J. Oswald, T. Yack, E. Ferguson, C. Hom-Weaver, K. Dunleavy, S. Coates, and T. Dominello. 2012. An Analysis of Acoustic Data from the Mariana Islands Sea Turtle and Cetacean Survey (MISTCS): March 2014 Revision. Prepared for Commander, Pacific Fleet, Pearl Harbor, HI. Submitted to Naval Facilities Engineering Command Pacific, EV2 Environmental Planning, Pearl Harbor, HI, 96860-3134, under Contract No. N62470-10D-3011 Task Order KB08 issued to HDR, Inc. Submitted by Bio-Waves Inc., Encinitas, CA 92024. March 2012. Revised March 2014.

Oleson, E. 2014. Interim Progress Report: Analysis of Long-term Acoustic Datasets from MIRC. Report prepared under Agreement No. NOAA-NMFS-PIFSC-13-008 between National Marine Fisheries Service and the U.S. Navy.

Weilgart, L., and H. Whitehead. 1997. Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales. *Behavioral Ecology and Sociobiology* 40: 277-285.

Whitehead, H. 2003. Sperm Whales: Social Evolution in the Ocean. University of Chicago Press, Chicago, IL.

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