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

2015 Annual Report

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National Marine Fisheries Service
Office of Protected Resources

Prepared by
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Cover Photos:
(from left to right) Blainville's beaked whale (*Mesoplodon densirostris*) photographed off Rota during June 2014 by Marie C. Hill; bottlenose dolphin (*Tursiops truncatus*) and rough-toothed dolphin *(Steno bredanensis*, in the foreground) photographed off Aguijan during April 2014 by Daniel Webster; melon-headed whale (*Peponocephala electra*) photographed off Saipan during April 2014 by Jessica M. Aschettino; and false killer whales (*Pseudorca crassidens*) photographed off Guam during May 2014 by Marie C. Hill. All photographs were taken under NMFS permit 15240 and CNMI-DFW permit, license no. 02868-2014.

Executive Summary

The United States (U.S.) Navy conducts training and testing activities in the Mariana Islands Range Complex (MIRC), as described in the MIRC Environmental Impact Statement (EIS) (Department of the Navy [DoN] 2010a). The National Marine Fisheries Service (NMFS) issued a 5-year Final Rule (NMFS 2010a), a Letter of Authorization (LOA) (NMFS 2012a), and a Biological Opinion (NMFS 2012b) to the Commander, U.S. Pacific Fleet in August of 2012 authorizing these activities The Final Rule, LOA, and Biological Opinion, covering the period from August 2010 through August 2015, required the U.S. Navy to implement marine mammal and sea turtle monitoring as described in the MIRC Monitoring Plan (DoN 2012, DoN 2014a). In 2015, the MIRC EIS was superseded by the Mariana Islands Training and Testing EIS (DoN 2015), and NMFS issued a new 5-year Final Rule (NMFS 2015a), new LOAs (NMFS 2015b,c), and Biological Opinion (NMFS 2015d) to cover the time frame of 03 August 2015 through 03 August 2020. Year 5 of the MIRC Monitoring Plan, which initially covered the period from 13 February 2014 through 12 February 2015, was extended through 02 August 2015. Therefore, this report presents data gathered to support Year 5 of the MIRC Monitoring Plan (DoN 2014a) from 13 February 2014 through 02 August 2015.

Monitoring methods employed include small-vessel and shore-based visual surveys; photo-identification, biopsies, and satellite tagging of marine mammals; satellite tagging of sea turtles; and analysis of passive acoustic monitoring (PAM) data.

In compliance with the MIRC Monitoring Plan (Year 5), the following activities were performed:

- Deployment of PAM gliders and associated data analysis; analysis of data from moored PAM devices
- Vessel-based and shore-based visual surveys
- Cetacean and sea turtle tagging and data analysis
- Biopsy sampling of cetaceans
- Analysis of archived biopsy samples
- Mark-recapture photo-identification collection and analysis.

Substantial progress has been made in Monitoring Year 5 on addressing the five monitoring questions developed for the MIRC:

- What species of beaked whales and other odontocetes occur around Guam and Saipan?
- Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?
- 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?

- What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?
- 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 the following:

- Long-term high-frequency acoustic recording package acoustic datasets from Tinian and Saipan (2010–2013) were analyzed for presence of mysticetes and odontocetes. Species of beaked whales detected included Cuvier's beaked whales (*Ziphius cavirostris*), *Mesoplodon* species, and unidentified beaked whale "BWC" (Cross seamount beaked whale call type, which is possibly the ginkgo-toothed beaked whale, *Mesoplodon ginkgodens*).
- There were marked differences in large whale (baleen whale and sperm whale [*Physeter macrocephalus*]) detection between the Saipan and Tinian high-frequency acoustic recording package sites, with far more days with large whale calls at Saipan than at Tinian.
- Sixteen satellite tags were deployed on four species of odontocetes: false killer whale (*Pseudorca crassidens*), short-finned pilot whale (*Globicephala macrorhynchus*), melon-headed whale (*Peponocephala electra*), and bottlenose dolphin (*Tursiops truncatus*).
- Six new odontocete photo-ID catalogs were established: bottlenose dolphin, false killer whale, short-finned pilot whale, pygmy killer whale (*Feresa attenuata*), rough-toothed dolphin (*Steno bredanensis*), and spinner dolphin (*Stenella longirostris*).
- Baleen whales, including blue (*Balaenoptera musculus)*, fin (*Balaenoptera physalus*), minke (*Balaenoptera acutorostrata*), sei (*Balaenoptera borealis*), humpback (*Megaptera novaeangliae*), and possible Bryde's (*Balaenoptera edeni*) whales were detected using bottom-mounted and autonomous glider PAM devices.
- Genetic analyses suggest the Mariana Islands bottlenose dolphin is a small, genetically isolated population which has a history of hybridization with Fraser's dolphins (*Lagenodelphis hosei*).
- Biopsy tissue samples collected from short-finned pilot whales in the Mariana Islands were included in a larger study of short-finned pilot whale population structure in the Pacific. Results from the study indicate there are three major groups in the pilot whale phylogeny, corresponding to the two known morphotypes (called *Naisa* and *Shiho* based on original descriptions in Japan), and a third, widely distributed group spaning the range of the other two groups in the Pacific.
- In 2013–2014, 19 sea turtles were instrumented with satellite tags (four hawksbill turtles (*Eretmochelys imbricata*) and 15 green (*Chelonia mydas*) turtles). Kernel density estimates revealed high site fidelity and limited movements for the green turtles and two of the hawksbills; the other two hawksbills exhibited long-range movements.

- Historical data from aerial surveys of coastal fisheries, performed by Guam's Department of Agriculture's Division of Aquatic and Wildlife Resources since 1963, were analyzed for trends in occurrence patterns of sea turtles and marine mammals. Small delphinid counts fluctuated across time, large delphinid counts showed a slight increase, and sea turtle counts increased eight-fold along the coast of Guam, mostly driven by a local increase in the Cocos Lagoon area.

Monitoring efforts in Year 5 balanced analysis of existing marine species data (e.g., passive acoustic data collected since 2010; biopsy samples collected since 1973, and historical data from aerial surveys conducted since 1963) with new data collection efforts. Ongoing acoustic and visual monitoring projects continued in Year 5, but efforts also included new data collection methods, such as autonomous acoustic glider pilot studies. These activities are consistent with the recommendations of the Scientific Advisory Group convened by the U.S. Navy in 2011 (DoN 2011) to address monitoring priorities in various U.S. Navy training ranges.

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Acronyms and Abbreviations

AMR	Adaptive Management Review
APL	Applied Physics Laboratory
BWC	Cross Seamount beaked whale
CNMI	Commonwealth of the Northern Mariana Islands
CRED	Coral Reef Ecosystem Division
CNO	Chief of Naval Operations
DAA	Daily Acoustic Abundance
DAWR	Guam's Department of Agriculture's Division of Aquatic and Wildlife Resources
DoN	Department of the Navy
DFW	Division of Fish and Wildlife
EAR	ecological acoustic recorder
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FY	Fiscal Year
GIS	Geographic Information System
hr	hour(s)
HARP	high-frequency acoustic recording package
HF	high frequency
HIMB	Hawaii Institute of Marine Biology
Hz	Hertz
ICMP	Integrated Comprehensive Monitoring Program
ID	identification
KDE	kernel density estimation
kHz	kilohertz
km	kilometer(s)
LF	low frequency
LOA	Letter of Authorization
LOESS	locally weighted scatterplot smoothing
m	meter(s)
MFAS	mid-frequency active sonar
MIRC	Mariana Islands Range Complex
MISTCS	Mariana Islands Sea Turtle and Cetacean Survey
MITT	Mariana Islands Training and Testing
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
ONR	Office of Naval Research
OSI	Oceanwide Science Institute
OSU	Oregon State University
PAM	passive acoustic monitoring
photo-ID	photo-identification
PIFSC	Pacific Islands Fisheries Science Center
PIT	Passive Integrated Transponder
PMEL	Pacific Marine Environmental Laboratory
SAG	Scientific Advisory Group
s.d.	standard deviation
SIO	Scripps Institution of Oceanography
SWFSC	Southwest Fisheries Science Center
UNDET	underwater detonation
U.S.	United States
UW	University of Washington

1. Introduction

The United States (U.S.) Navy conducts training and testing activities in the Mariana Islands Range Complex (MIRC), as described in the MIRC Environmental Impact Statement (EIS) (Department of the Navy [DoN] 2010a). The National Marine Fisheries Service (NMFS) issued a 5-year Final Rule (NMFS 2010a), a Letter of Authorization (LOA) (NMFS 2012a) and a Biological Opinion (NMFS 2012b) to the Commander, U.S. Pacific Fleet in August of 2012 authorizing these activities. The Final Rule, LOA, and Biological Opinion, covering the period from August 2010 through August 2015, require the U.S. Navy to implement marine mammal and sea turtle monitoring as described in the MIRC Monitoring Plan (DoN 2012, revised DoN 2014a). In 2015, the MIRC EIS was superseded by the Mariana Islands Training and Testing EIS (DoN 2015). NMFS issued a new 5-year Final Rule (NMFS 2015a), LOAs (NMFS 2015b,c), and a Biological Opinion (NMFS 2015d) to cover the time frame of 03 August 2015 through 03 August 2020. Year 5 of the MIRC Monitoring Plan, which initially covered the period from 13 February 2014 through 12 February 2015, was extended through 02 August 2015. Therefore, this report presents data gathered to support Year 5 of the MIRC Monitoring Plan (DoN 2014a) from 13 February 2014 through 02 August 2015. Results in this report are organized by monitoring questions and objectives, and specifically how these were addressed by a particular project.

1.1 Background

The MIRC Study Area encompasses a 501,873-square-nautical mile area around the islands of Guam, Tinian, Saipan, Rota, Farallon de Medinilla, and other islands also including ocean areas in both the western North Pacific Ocean and the Philippine Sea (DoN 2010a; **Figure 1)**. The range complex surrounds the Mariana Islands Archipelago, which includes the Commonwealth of the Northern Mariana Islands and the Territory of Guam. In order to issue an Incidental Take Statement for an activity that has the potential to affect protected marine species, NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking" (50 Code of Federal Regulations § 216.101(a)(5)(a)). A request for an 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.

The U.S. Navy developed the 2010 MIRC Monitoring Plan (DoN 2010b) as required under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). As outlined in the 2010 MIRC Monitoring Plan (DoN 2010b), U.S. Pacific Fleet's marine species monitoring program from 2010 to 2015 in the MIRC was designed to better understand the distribution and abundance of marine mammals and sea turtles in the Mariana Islands. Marine species monitoring in the MIRC has included annual visual surveys from either a vessel- or shore-based station, use of a dipping hydrophone during vessel surveys, collection of biopsy samples (including preliminary analysis and archiving), and satellite tagging (DoN 2014b). MIRC monitoring projects also have included deployment of autonomous passive acoustic monitoring (PAM) devices, analysis of archived PAM data, and mark-recapture photo-identification (photo-ID) collection and analysis.

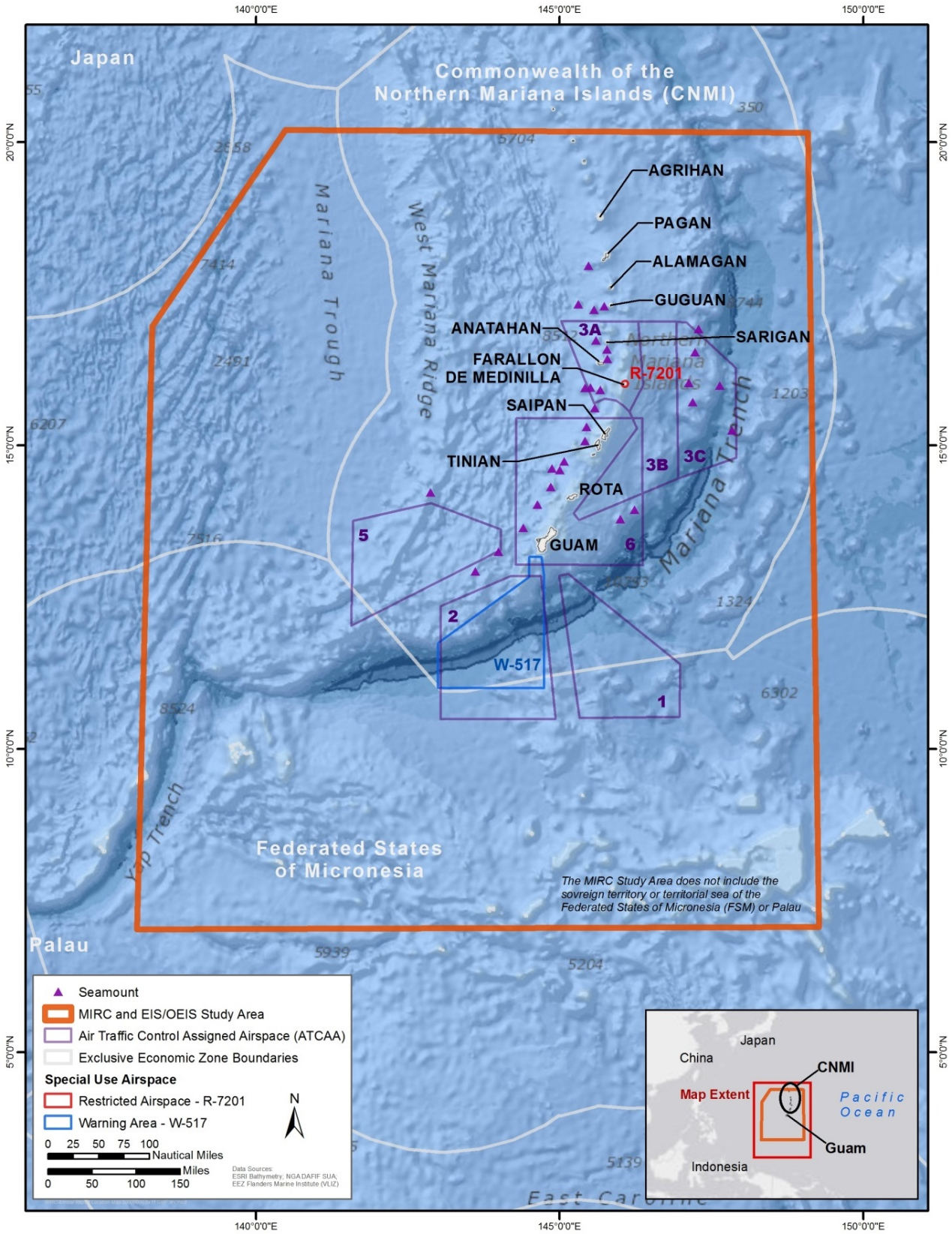

Figure 1. The MIRC Study Area.

A Scientific Advisory Group (SAG) was assembled by the U.S. Navy to provide recommendations for achieving the monitoring goals. Based on guidance from the SAG (DoN 2011), a smaller regional SAG for the MIRC (see DoN 2014a), and lessons learned from past monitoring in the MIRC and in other U.S. Navy range complexes, the U.S. Navy recommended a series of successive revisions to the original version of the MIRC Monitoring Plan (DoN 2010b) in order to meet the goals established by the U.S. Navy and NMFS. The MIRC Monitoring Plan was updated first in 2012, followed by smaller incremental updates in 2013 and 2014. The 2012 revision (DoN 2012) introduced five scientific monitoring questions specific to the MIRC (refer to **Section 1.3**), which facilitated removal of quantitative metrics of effort, and introduction of monitoring projects utilizing additional monitoring methods. The 2013 MIRC Monitoring Plan (DoN 2013) made an adjustment in listed projects related to tagging, and the 2014 update (DoN 2014a) removed lists of specifically named monitoring projects as goals, and replaced these with general categories of planned monitoring methods to be used as tools to answer each of the five MIRC monitoring questions. These monitoring goals of the 2014 update were addressed by marine species monitoring projects described in this report. This report contains a review of progress made on these projects during 13 February 2014 through 02 August 2015. Final reports and data from these projects will be made available on the individual project profile pages and the Reading Room at the U.S. Navy Marine Species Monitoring website as they become available. Current marine species monitoring projects being conducted in the MIRC Study Area in support of MMPA and ESA authorizations are listed on the U.S. Navy Marine Species Monitoring website (http://www.navymarinespeciesmonitoring.us/regions/pacific/current-projects/).

1.2 Integrated Comprehensive Monitoring Program

The Integrated Comprehensive Monitoring Program (ICMP) serves as a framework and planning tool to focus U.S. Navy monitoring priorities pursuant to ESA and MMPA requirements (DoN 2010c). The ICMP coordinates monitoring efforts across all regions and allocates the most appropriate level and type of monitoring effort for each range complex based on a set of standardized objectives, regional expertise, and resource availability. Although the ICMP does not identify specific monitoring or field projects, it provides a flexible, scalable, and adaptable framework for such projects using adaptive management and strategic planning processes that periodically assess progress and reevaluate objectives.

The ICMP is evaluated annually 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 review 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 by revision to the ICMP. As a planning tool, the ICMP is a "living document." It is routinely updated as the program progresses, with the most recent revision in 2013/2014 including the addition of the Strategic Planning Process (Chief of Naval Operations [CNO] 2013). This process uses an underlying framework designed around top-level program goals, a conceptual

framework incorporating a progression of knowledge toward these goals, and consultation with the SAG and other regional experts.

Under the ICMP, 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 2010c). Chief of Naval Operations Environmental Readiness Division maintains and updates the ICMP, as necessary, reflecting the results of regulatory agency rulemaking, AMRs, best available science, improved assessment methods, and more effective protective measures. This is performed as part of the AMR process, in consultation with U.S. Navy technical experts, U.S. Pacific Fleet, and Echelon II Commands as appropriate.

1.3 Report Objectives

This report presents NMFS with monitoring data, results and progress that address the monitoring questions outlined in the 2014 revision of the MIRC Monitoring Plan (DoN 2014a).

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 13 February 2014 through 02 August 2015. 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 the 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 Navy conducts underwater detonations?

2. Marine Species Monitoring in the MIRC

2.1 2014 Monitoring Goals and Implementation

Table 1 lists the 2014 monitoring period goals as agreed upon by NMFS and the U.S. Navy. All monitoring goals in Monitoring Year 5 were met.

Table 1. 2014 Monitoring goals.

Monitoring Question	Monitoring Goal	Total Accomplished
1. What species of beaked whales and other odontocetes occur around Guam and Saipan?	-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)	-Acoustic data analyzed from 7 EARs (3 off Guam, 2 off Saipan, and 2 off Tinian), and 2 HARPs off Saipan and Tinian. A 26-day acoustic glider survey was performed with 2 gliders in both fall 2014 and spring 2015, and analysis completed for 1 glider from the fall 2014 deployment. -Small-vessel surveys and satellite tagging were conducted off Guam, Rota, Tinian, Saipan, and Aguijan in spring and summer 2014.
2. Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?	-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 opportunistic dipping hydrophone recordings) -Continue visual methodologies in multiple locations (may include small boat surveys, diver surveys, satellite tagging)	-Acoustic data analyzed from 7 EARs (3 off Guam, 2 off Saipan, and 2 off Tinian), and 2 HARPs off Saipan and Tinian. A 26-day acoustic glider survey was performed with 2 gliders in both fall 2014 and spring 2015, and analysis completed for 1 glider from the fall 2014 deployment. -Small-vessel surveys and satellite tagging were conducted off Guam, Rota, Tinian, Saipan, and Aguijan in spring and summer 2014.
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 - Consider additional acoustic analysis methodologies of collected PAM datasets that may provide progress on this question	-2 genetics projects were conducted in 2014 on existing biopsy samples collected from bottlenose dolphins and short-finned pilot whales. -Mark-recapture photo-ID work and biopsy collection was continued during small-vessel surveys; photos added to existing catalogs

Monitoring Question	Monitoring Goal	Total Accomplished
		(for bottlenose dolphins, spinner dolphins, and short-finned pilot whales). Photo-ID catalogs established for 3 new species (false killer whale, rough-toothed dolphin, and pygmy killer whale). New catalog for melon-headed whale in development. Mark-recapture analysis ongoing. -Data generated by acoustic glider survey were provided to ongoing project funded by the Office of Naval Research to develop a framework for density estimation of marine mammals using slow-moving underwater vehicles.
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	-Acoustic data analyzed from 7 EARs (3 off Guam, 2 off Saipan, and 2 off Tinian), and 2 HARPs off Saipan and Tinian. A 26-day acoustic glider survey was performed with 2 gliders in both fall 2014 and spring 2015, and analysis completed for 1 glider from the fall 2014 deployment. -Small-vessel surveys and satellite tagging were conducted off Guam, Rota, Tinian, Saipan, and Aguijan in spring and summer 2014. -Pilot survey for humpback whales utilizing new methodology (combined shore and vessel survey) conducted in February-March 2015 at Saipan; analysis and reporting in progress.
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)	-Small-vessel surveys were conducted off Guam in spring and summer 2014. Sea turtle tagging surveys were conducted off Guam in summer 2014.

Key: EAR = ecological acoustic recorder; HARP = high-frequency acoustic recording package; PAM = passive acoustic monitoring; and photo-ID = photo-identification.

During the October 2012 Adaptive Management meeting, the U.S. Navy and NMFS discussed acoustic monitoring methods in the MIRC, including the requirement to deploy PAM devices. Due to the number of acoustic datasets already collected by NMFS Pacific Islands Fisheries Science Center (PIFSC) in the MIRC yet to be analyzed, it was agreed the emphasis for monitoring efforts could transition into less collection of new data and more analysis of existing datasets. In accordance with this shift, during Monitoring Year 5, data analysis was completed for recent archived recordings obtained using high-frequency acoustic recording packages (HARPs) by NMFS PIFSC (see **Appendix A**), and ecological acoustic recorders (EARs; see **Appendix B**). Autonomous gliders also were deployed in the MIRC in fall 2014 and spring 2015. Data from the 2014 deployment were analyzed and are presented in this report (see **Appendix C**); data analysis from the 2015 deployment is still underway.

2.1.1 Timeline of Monitoring Efforts

Figure 2 illustrates all of the monitoring and research tasks implemented in the MIRC from 13 February 2014 through 02 August 2015. The following sections present details of tasks (green boxes) numbered 1–9. **Table 2** describes events (tan boxes), and the comprehensive monitoring report for MIRC (2010–2014) contains details of tasks numbered 10–12 (DoN 2014b: Task 10 is Appendix B [Hill et al. 2014]; Task 11 is Appendix A [HDR 2014]; and Task 12 is Appendix C [Uyeyama 2014]).

Table 2. Notable events during Monitoring Year 5.

E1	03–04 April 2014 – Adaptive Management Meeting, NMFS & U.S. Navy, Arlington, Virginia.
E2	15 June 2014 -- Finalization by NMFS of 2014 MIRC Annual Monitoring Report. Format of this report (originally submitted 15 March 2014) was the first of any U.S. Navy range to report results by applying a qualitative metric of progress on monitoring questions.
E3	08 October 2014 -- MIRC monitoring program review.
E4	03 June 2015 -- Adaptive Management Meeting, NMFS & U.S. Navy, Arlington, Virginia.
E5	03 August 2015 – Beginning of MITT LOA, end of monitoring under MIRC LOA.

Key: E = event; LOA = Letter of Authorization; MIRC = Mariana Islands Range Complex: MITT = Mariana Islands Training and Testing; NMFS =National Marine Fisheries Service; U.S. = United States.

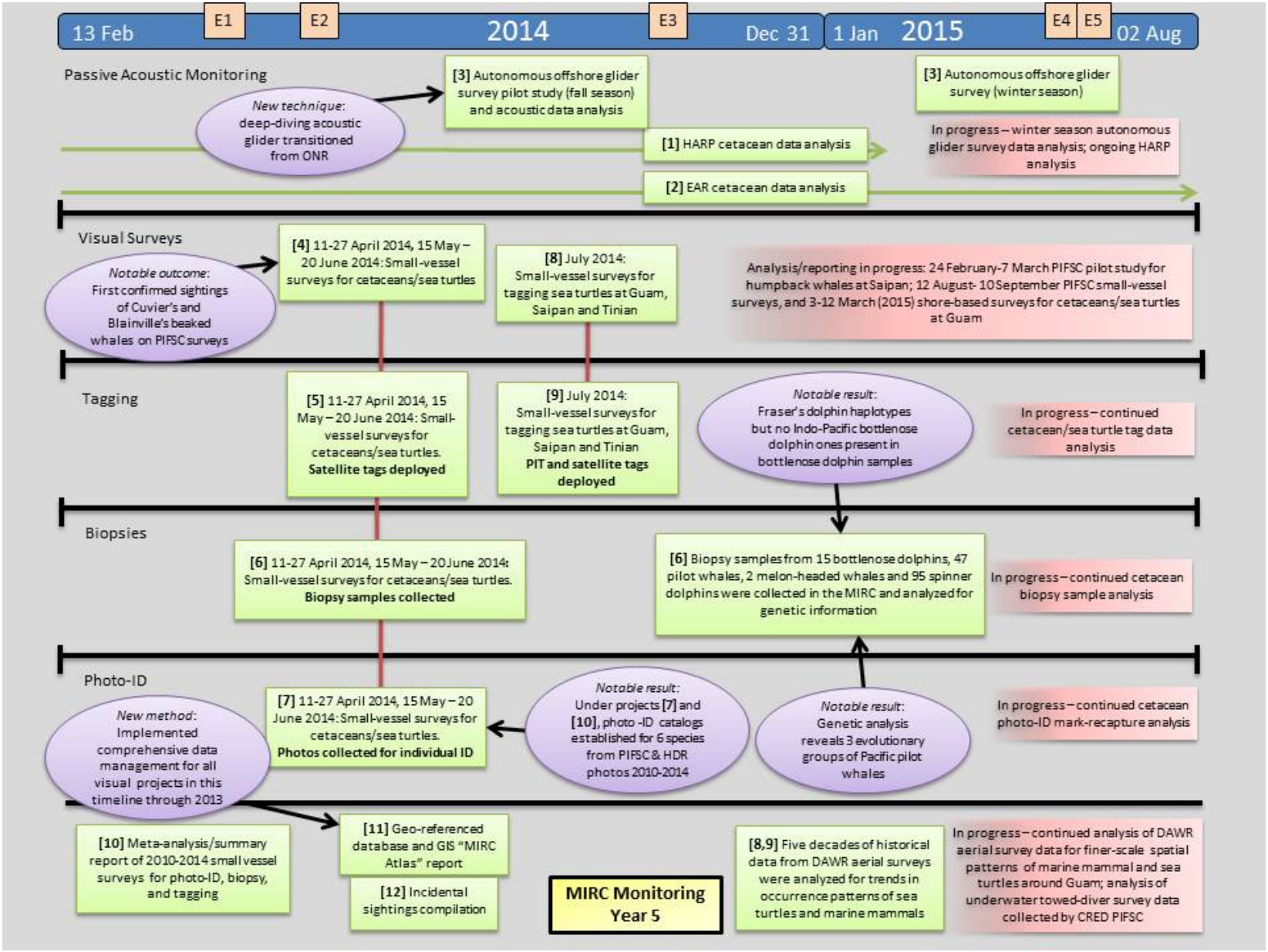

Figure 2. Visual timeline of activities in MIRC Monitoring Year 5 (13 February 2014 to 02 August 2015).

[1] Passive Acoustic Monitoring: Analysis of Long-term Acoustic Datasets in MIRC, 2010-2013 – Appendix A (Oleson et al. 2015)

NMFS PIFSC deployed HARPs off Tinian and Saipan to characterize cetacean occurrence and temporal trends in the Mariana Islands. The U.S. Navy reviewed the available data collected from 2010 through 2013, and funded NMFS to: (1) model sound propagation and detection range for baleen whale calls under 1 kilohertz (kHz); (2) assess daily occurrence of baleen whales with low-frequency (LF; <1 kHz) calls in all five data sets; (3) assess daily occurrence of all beaked whales within one dataset; (4) determine species identification of detected beaked whale sounds; and (5) assess daily occurrence of minke (*Balaenoptera acutorostrata*) and sperm (*Physeter macrocephalus*) whales within one dataset. 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.

[2] Passive Acoustic Monitoring: EARs – Appendix B (Munger et al. 2015)

Four EARs were deployed at two sites off Guam, one at Saipan and one at Tinian, in September 2011 and again in April 2012, in order to characterize cetacean species occurrence, distribution, and temporal trends in the MIRC (see **Appendix B**). Three of the four units were recovered in January 2013; one of the Guam devices was not recoverable.

Data from the EARs were analyzed for cetacean signals using automated detectors, manual searching, or both, depending on the taxon. The two automated detectors included: the Marine Mammal Monitoring Class Specific Support Vector Machine for detecting two species of beaked whales (Cuvier's beaked whale [*Ziphius cavirostris*] and Blainville's beaked whale [*Mesoplodon densirostris*]) and sperm whales, and Baleen5 for detecting blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), humpback (*Megaptera novaeangliae*), and minke (*Balaenoptera acutorostrata*) whales.

As a follow-up, manual validation of the automated detector results were conducted on a subset of data and detector outputs were reinterpreted using threshold criteria that resulted in improved measures of detector performance. The performance of autodetectors was evaluated by quantifying the proportion of true positive (accurate classification), false positive (inaccurate classification), negative (accurately dismissed) and false negative (missed) detections of humpback, fin, blue, minke, sperm, and beaked whale vocalizations.

Delphinid and sperm whale signals were manually detected using Triton and by visually examining characteristics of their long-term spectral average and corresponding spectrogram. Delphinid whistles were separated into low-frequency (LF), high-frequency (HF) and HF/LF whistle categories representing different delphinid species assemblages.

A large portion of the data was scanned manually for baleen whale calls including call types that the automated detector was not programmed to recognize such as HF sei whale calls. Both sperm whale clicks and baleen whale calls were readily identifiable in the long-term spectral average as was mid-frequency active sonar (MFAS). Cetacean detection rates relative to MFAS exposure were also examined.

[3] Passive Acoustic Monitoring: Autonomous Gliders – Appendix C (Klinck et al. 2015)

Between 19 September and 14 November 2014, a passive-acoustic glider survey was conducted by Oregon State University and the Applied Physics Laboratory of the University of Washington (see **Appendix C**). Two Seagliders™ were deployed off the west coast of Guam. After the survey area was reached, the PAM system was activated and captured sounds near-continuously in waters east, south, and southwest of the island, in the 25 to 1,000-meter (m) depth range. One glider experienced a malfunction during transit to the deployment location and only collected environmental data during the survey. The second glider collected both acoustic and environmental data, which were thoroughly analyzed in the lab after recovery of both instruments. The functional glider successfully surveyed offshore waters, which are difficult to monitor with traditional visual and acoustic methods. The environmental and acoustic data sets provided valuable information on the sound propagation conditions in the area as well as the spatial and temporal distribution of odontocetes and mysticetes in offshore areas adjacent to Guam, Rota, Tinian, and Saipan. This glider survey was the first of a two-season series, with the second survey being performed in spring 2015 (from 02 March through 28 April 2015); analysis and reporting for the spring survey is underway.

[4,5,6,7] Visual Surveys: Small-vessel Surveys – Appendix D (Hill et al. 2015)

In summer 2014 (15 May through 20 June), NMFS PIFSC conducted non-systematic visual surveys from small vessels (5.8 to 12.2 m) in waters surrounding Guam, Saipan, Tinian, Aguijan, and Rota (**Figure 3**, also see **Appendix D**). These surveys were a continuation of Navy/NMFS collaborative surveys conducted in previous years (e.g. Hill et al. 2014; DoN 2014b). All cetacean groups encountered were approached for species confirmation, group-size estimates, photo-ID, and biopsy sampling, including sloughed skin (for assessment of genetic population structure) when possible. Satellite tags (Wildlife Computers, Redmond, Washington: SPOT5 and SPLASH10) were deployed on individuals of certain species to investigate their movements. Multi-year mark-recapture photo-ID and biopsy analyses are ongoing. Existing photo-ID catalogs were updated, and new ones were established.

Genetic analysis was conducted in 2014 on archived biopsy samples collected from bottlenose dolphins (*Tursiops truncatus*) and short-finned pilot whales (*Globicephala macrorynchus*) (Martien et al. 2014, 2015; Morin et al. 2015).

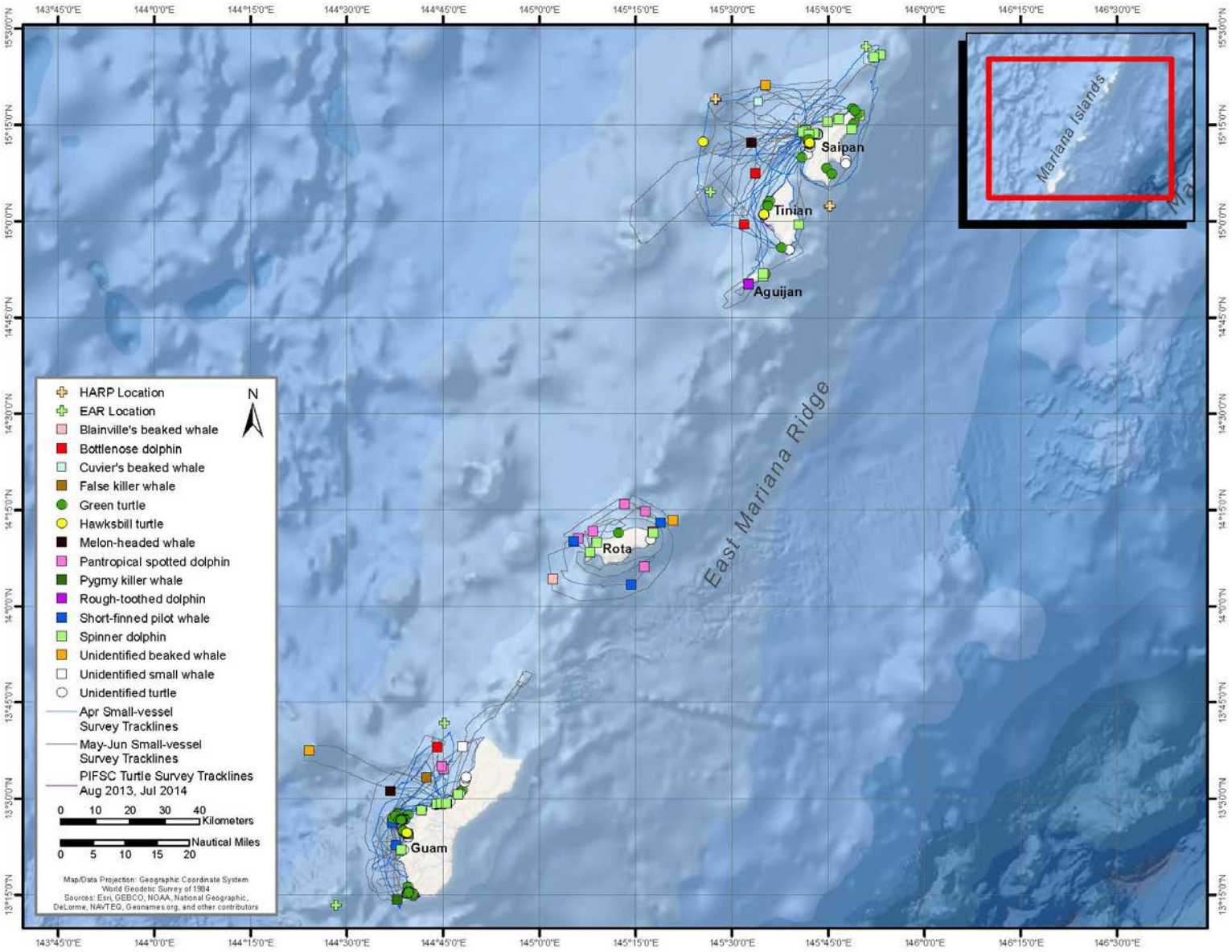

Figure 3. Monitoring Year 5 sightings, effort, and PAM device locations in the MIRC Study Area. (Deployment of HARPs funded by NMFS PIFSC)

[8,9] Visual/Tagging Surveys: Sea Turtle Surveys – Appendix E (Jones et al. 2015)

During July 2014, dedicated sea turtle surveys were conducted jointly by personnel from NMFS PIFSC, Guam Division of Aquatic and Wildlife Resources (DAWR), and the Commonwealth of the Northern Mariana Islands (CNMI) Department of Fish and Wildlife (see **Appendix E**). Tagging surveys were conducted from small vessels in the nearshore and coastal waters of Guam (Cocos Lagoon and Apra Harbor), Saipan, and Tinian. When sea turtles were encountered, they were captured by hand, and full morphometric measurements were recorded. Turtles were instrumented with metal flipper tags, microchips (Passive Integrated Responder tags) and satellite-tracked tags. Satellite tracks were examined for movement patterns and to develop kernel density estimates (KDEs) of habitat use.

In a separate project, historical data from aerial surveys of coastal fisheries, performed by Guam DAWR since 1963, were analyzed for trends in occurrence patterns of sea turtles and marine mammals (see **Appendix E**). Although the primary goal of these surveys was to collect data about coastal fishing activity, sightings of marine mammals and sea turtles observed during the course of these surveys were also recorded. Aerial surveys occurred on an occasional basis from 1963 to 1965 and then from 1975 to 1979, and then on a regular, semi-monthly basis (contingent upon funding and weather conditions) from 1989 to 2012. The survey platform was a small fixed-wing aircraft that circumnavigated the island of Guam, following the reef slope. The study compared historical sightings (measured by counts per survey) of small delphinids, large delphinids, and sea turtles across 12 geographical zones of Guam's coastline.

[10] Meta-analysis: Summary of 2010-2014 small vessel surveys for photo-ID, biopsy, and tagging – (Hill et al. 2014 [Appendix B of DoN 2014b])

[11] Meta-analysis: Geo-referenced database and "MIRC Atlas" report – (HDR 2014 [Appendix A of DoN 2014b])

[12] Meta-analysis: Incidental sightings compilation – (Uyeyama 2014 [Appendix C of DON 2014b])

These three meta-analysis efforts ([10], [11] and [12]) were previously described and presented in the MIRC Comprehensive Monitoring Report (DoN 2014b).Because the MIRC Comprehensive Report was prepared during the past monitoring year, these projects are depicted in the timeline for this annual report (Figure 2).

2.2 Results: Progress made on 2012–2016 Monitoring Plan study questions

Table 3 summarizes progress made this monitoring year on addressing the study questions found in the updated MIRC Monitoring Plan Fiscal Year (FY) 14 – FY15 summary included as part of the 2014 MIRC Annual Monitoring Report (DoN 2014a). 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 3. Sightings and notable outcomes.

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Five	Planned or In-progress (funded in MITT Year 1)
1. What species of beaked whales and other odontocetes occur around Guam and Saipan?	[1] Acoustics/ HARPs	Species identification analyses were conducted on beaked whale detections recorded during 2010–2013 HARP deployments at Tinian and Saipan. Species identified included Cuvier's beaked whale, *Mesoplodon* species, and unidentified beaked whale BWC (possibly ginkgo-toothed beaked whale). Seven odontocete species and one genus (*Kogia* spp.) were detected in the 2013–2014 Tinian HARP dataset. All of these species except killer whale and unidentified beaked whale BWC have been visually observed during prior NMFS PIFSC surveys in the region.	Continue with analysis of the seasonal occurrence of beaked whales using PAM data collected by HARPs that are deployed at Tinian and Saipan by NMFS PIFSC. Analysis of other odontocetes and of beaked whale acoustic variability in consideration.
	[2] Acoustics/ EARs	Detections included Cuvier's and Blainville's beaked whales, sperm whales, and unidentified species of delphinids. Delphinid acoustic encounters in this study were classified based on HF, LF, and HF/LF whistle call types. All 3 signal groups were detected at all MIRC EAR sites. Relative patterns in these delphinid signal groups varied among sites and between years, suggesting spatial and seasonal differences in species assemblages.	—
	[3] Acoustics/ Autonomous Gliders	A variety of HF acoustic encounters were recorded, indicating that there are numerous species present offshore of Guam in the fall. Acoustically identified species included Blainville's beaked whale, sperm whale, killer whale, and Risso's dolphin. There were few detections of beaked whale vocalizations. Out of 7 encounters, 3 were identified as Blainville's beaked whales and 4 as potential beaked whales. Cuvier's beaked whale vocalizations were not identified.	A 30-day acoustic glider survey was conducted in the MIRC in spring 2015. Analysis and reporting in progress.
	[4] Visual Survey/ Small-vessel Surveys	Ten cetacean species were visually detected. The overall sighting/encounter rate for May–June 2014 was 1.39 encounters/100 km of survey effort. Although beaked whales had been encountered during prior NMFS PIFSC surveys, they had not been identified to species; Cuvier's and Blainville's beaked whales were visually detected during May–June 2014 surveys.	Summer season survey performed 12 August–10 September 2015, analysis and reporting in progress
	[5] Tagging/ Small-vessel Surveys	Sixteen satellite tags deployed on three species (8 tags on short-finned pilot whales; 4 on false killer whales; 3 on melon-headed whales; and 1 on a bottlenose dolphin).	Summer season survey performed 12 August–10 September 2015, analysis and reporting in progress.
2. Are there locations of greater cetacean and/or sea turtle relative abundance around Guam and Saipan?	[1] Acoustics/ HARPs	From the 2010–2013 data, there were marked differences in large whale (baleen whale and sperm whale) detections between the Saipan and Tinian HARP sites, with far more days with large whale calls at Saipan than at Tinian. Sperm whales were the most common large whale detected at both Saipan and Tinian during 2010–2013, though the species is less common at Tinian. Blue and fin whale calls were rarely detected in the Saipan and Tinian datasets, and minke whale boings were detected on a few occasions at Saipan only.	Continue with analysis for baleen whales and beaked whales in PAM data collected by HARPs that are deployed at Tinian and Saipan by NMFS PIFSC. Analysis of other odontocetes in consideration.

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Five	Planned or In-progress (funded in MITT Year 1)
	[2] Acoustics/ EARs	The highest overall proportion of time that delphinids were present was documented for Guam N, followed by Saipan, Tinian, and lastly Guam S. The abundance of different signal groups varied geographically. The HF and LF groups were more acoustically abundant at Saipan N than at the other EAR sites, suggesting higher densities of spinner dolphins/*Stenella* sp. and blackfish/rough-toothed dolphins at Saipan compared to the other sites. The HF/LF whistle group was most abundant at Guam N compared to the other three EAR sites, suggesting higher densities of bottlenose dolphins and *Stenella* sp. north of Guam compared to other locations. Sperm whales were most acoustically abundant at the EAR north of Guam compared to other EAR sites. Occurrence was highest during the autumn months (September–October) and lowest during summer months (April–July). Humpback whales were detected only at Saipan N.	—
	[4] Visual Survey/ Small-vessel Surveys	The spinner dolphin remained the most frequently encountered species on small-vessel surveys, they were identified at Marpi Reef and at all islands surveyed. Melon-headed whales were encountered off Saipan and Guam, and false killer whales were encountered off Guam and Tinian in a broad range of habitats. A Cuvier's beaked whale was identified 19 km off the west side of Saipan, and a Blainville's beaked whale was identified 11 km west-southwest of Rota. The two unidentified Mesoplodont whale encounters were made off Guam (at Tracey Seamount) and Saipan.	Summer season survey performed 12 August–10 September 2015, analysis and reporting in progress.
	[5] Tagging/ Small-vessel Surveys	Sixteen satellite tags were deployed on four cetacean species (melon-headed whale, short-finned pilot whale, false killer whale, and bottlenose dolphin). For melon-headed whales, tag locations reveal broad movements throughout the southernmost islands between Rota and shallow banks north of Saipan. For short-finned pilot whales, satellite tag locations demonstrate the continued use of areas close to shore, from the shallow banks south of Guam to just north of Farallon de Medinilla. Most of the filtered satellite tag locations for false killer whales were to the west of the islands, with some as far offshore as the West Mariana Ridge. Two Individuals traveled up the island chain as far north as Pagan.	Summer season survey performed 12 August–10 September 2015, analysis and reporting in progress
	[7] Photo-ID/ Small-vessel Surveys	Photo analyses conducted during 2014 added individuals from newly collected photographs to six newly established photo-ID catalogs: 178 short-finned pilot whales, 52 bottlenose dolphins, 307 spinner dolphins, 40 false killer whales, 6 rough-toothed dolphins, and 6 pygmy killer whales. Photo catalogs also were newly created for false killer whales (the resulting catalog includes 40 photo-IDed individuals), rough-toothed dolphins (6 individuals), and pygmy killer whales (6 individuals) were also created. The photo-ID data continue to show that some individual short-finned pilot whales, false killer whales, and bottlenose dolphins associate with the	Summer season survey performed 12 August–10 September 2015, analysis and reporting in progress. Photo catalog maintenance continuing for 6 species, and a new catalog for melon-headed whales in preparation.

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Five	Planned or In-progress (funded in MITT Year 1)
		southern islands of the Mariana Archipelago and do so over many years.	
	[8] Tagging/ Sea Turtle Surveys	In 2013–2014, 19 turtles (15 green, 4 hawksbill) were satellite tagged. KDEs revealed high site fidelity and limited movements for the tagged green turtles, as well as for two of the tagged hawksbill turtles, The other 2 hawksbills displayed long-range movements, 1 traveling from Tinian to Guam, and the other from Tinian towards the Federated States of Micronesia. Areas of high turtle density included waters inside and outside Apra Harbor (Guam), as well as the area stretching from the Balisa Channel to Mañagaha Island (Saipan). Analysis of historic DAWR aerial survey records showed trends in relative sighting rates of sea turtles, small delphinids, and large delphinids across 12 zones of the shoreline of Guam.	Surveys planned for summer 2015
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?	[6] Biopsy/ Small-vessel Surveys	Genetic analyses suggest that the Mariana Islands bottlenose dolphin is a small, genetically isolated population that has a history of hybridization with Fraser's dolphins. Biopsy tissue samples collected from short-finned pilot whales in the Mariana Islands were included in a larger study of short-finned pilot whale population structure in the Pacific. Results from the study indicate that there are three major groups in the pilot whale phylogeny, corresponding to the two known morphotypes (called Naisa and Shiho based on original descriptions in Japan), and a third, widely distributed group that spans the range of the other two groups in the Pacific.	Summer season survey including biopsy performed 12 August–10 September 2015. Focus of planned analysis is basin-wide genetic structure of short-finned pilot whales to examine the roles of social structure and male-mediated gene flow.
	[7] Photo-ID/ Small-vessel Surveys	New individual photo-ID catalogs established for 6 species: short-finned pilot whales, bottlenose dolphins, spinner dolphins, rough-toothed dolphins, false killer whales, and pygmy killer whales. Re-sightings of individual short-finned pilot whales, bottlenose dolphins, and spinner dolphins indicate inter-island movements by these species.	Summer season survey performed 12 August–10 September 2015, analysis and reporting in progress. Photo-ID catalog maintenance continuing for six species, and a new catalog for melon-headed whales in preparation. Mark-recapture abundance analysis for these catalogs is pending sufficient encounter rates and numbers of distinctive individuals.
4. What is the seasonal occurrence of baleen whales around Guam, Saipan, Tinian, and Rota?	[1] Acoustics/ HARPs	Blue, fin, minke, sei, humpback, and possibly Bryde's whales were detected. Humpback whales were the most commonly detected baleen whale species. All baleen whale calls were detected in the winter and spring, with very few acoustic detections outside of that period, with the exception of unidentified tonal and pulsed calls possibly produced by Bryde's whales, and humpback whale sounds infrequently detected at Tinian during the *summer* months, June–October 2012.	Continue with analysis of baleen whale seasonal occurrence using PAM data collected by HARPs that are continued to be deployed at Tinian and Saipan by NMFS PIFSC. Analysis of blue whale population identity analysis in consideration.
	[2] Acoustics/ EARs	Few detections of baleen whales were recorded, however due to gaps in temporal and spatial coverage, the paucity of baleen whale detections in EAR data is not a clear indication of the absence of these whales in the MIRC. Humpback whale calls were detected in December 2011 and April 2012	—

Monitoring Question	Timeline Project #	Progress Made on Monitoring Questions, Year Five	Planned or In-progress (funded in MITT Year 1)
		(with a recording data gap between these months), which is consistent with the known pattern of winter-spring seasonal occurrence of humpback whales in other areas of the central tropical Pacific. No HF sei whale calls were detected. Three unidentified baleen whale calls (most probably Bryde's whale) were detected – one in October and two in November 2011.	
	[3] Acoustics/ Gliders	Gliders detected few sounds from baleen whales, most likely because this effort occurred during the fall months. Sounds from a humpback whale were recorded in October 2014 in offshore waters and were likely partial song or from an animal transiting through the area. Sounds from a previously undescribed call type produced by an unidentified species comprised the majority of mysticete detections.	A 30-day acoustic glider survey was conducted in the MIRC in spring 2015. Analysis and reporting in progress.
	[4] Visual Survey/ Small-vessel Surveys	No baleen whales observed during the 11–27 April or 15 May–20 June 2014 surveys, suggesting a low occurrence of baleen whales using the monitored areas during this time of year.	Winter season humpback whale pilot study utilizing shore station and small-vessel surveys performed 24 February–07 March; and summer season survey performed 12 August–10 September 2015. Analysis and reporting in progress.
5. What is the occurrence and habitat use of sea turtles in areas where the Navy conducts underwater detonations?	[4] Visual Survey/ Small-vessel Surveys	No sea turtle sightings were recorded in close proximity to U.S. Navy UNDET areas. The closest turtle sighting was over 2.8 km away from the Piti Floating Mine Neutralization Area.	Summer season survey performed 12 August–10 September 2015. Analysis and reporting in progress
	[9] Tagging/ Sea Turtle Surveys	KDEs of satellite tag data from 2013–2014 reveal high site fidelity and limited movements for the green turtles while resident in Guam, Tinian and Saipan. The waters inside and outside Apra Harbor were shown to be high-density areas for turtles. Future analysis will further reveal movements of satellite tagged-turtles in relation to the Agat Bay UNDET Area and the Piti Floating Mine Neutralization Area.	Tagging surveys planned for Saipan, Tinian and Guam in November 2015.

Key: BWC = Cross Seamount beaked whale; EAR = ecological acoustic recorder; FY = Fiscal Year; HARP = high-frequency recording package; HF = high frequency; hr = hour(s); KDE = kernel density estimate; km = kilometer(s); LF = low frequency; m = meter(s); min = minute(s); MIRC = Mariana Islands Range Complex; MITT = Mariana Islands Training and Testing; N = north; NMFS = National Marine Fisheries Service; PAM = passive acoustic monitoring; photo-ID = photo-identification; PIFSC = Pacific Islands Fisheries Science Center; sp. = species; spp. = species; UNDET = underwater detonation; and U.S. = United States.

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 **Tables 3** and **4**; **Figures 3** through **6**). These included beaked whales (Cuvier's beaked whale; Blainville's beaked whale*, and* unidentified beaked whale BWC (Cross Seamount beaked whale; possibly ginkgo-toothed beaked whale [*Mesoplodon ginkgodens]*)) as well as 12 other toothed whale genus/species (pygmy killer whale *[Feresa attenuata]*, short-finned pilot whale, killer whale [*Orcinus orca*], sperm whale, pygmy/dwarf sperm whales [*Kogia* spp.], false killer whale *[Pseudorca crassidens]*, melon-headed whale *[Peponocephala electra]*, Risso's dolphin [*Grampus griseus*], pantropical spotted dolphin *[Stenella attenuata)*], rough-toothed dolphin *[Steno bredanensis]*, spinner dolphin, and bottlenose dolphin).

Table 4. Species encountered/detected in MIRC waters.

Monitoring Platform	General Location and Maximum Depth	Animal Group Encountered/Detected	Date/Timeframe
PAM (HARPs)	W Saipan – 700 m SE Tinian – 998 m	Blue whale Fin whale Humpback whale Minke whale Sei whale Unidentified baleen whale[1] Blainville's beaked whale Cuvier's beaked whale Unidentified beaked whale BWC[2] False killer whale Killer whale *Kogia* spp. Risso's dolphin Short-finned pilot whale Sperm whale	Mar–Aug 2010 Apr–Oct 2011 Jun 2012–May 2013 Jul 2013–Jun 2014 (Tinian only) *Note: HARP deployments are not U.S. Navy-funded; only acoustic analysis is U.S. Navy-funded.*
PAM (EARs)	N Guam – 820 m S Guam – 952 m W Tinian – 869 m N Saipan – 850 m	Humpback whale Unidentified baleen whale[3] Sperm whale Cuvier's beaked whale Blainville's beaked whale Cuvier's/Blainville's beaked whale Unidentified delphinid	10 Sep 2011–06 Jan 2012 06 Apr–22 Sep 2012
PAM (Gliders)	Guam – >5,000 m	Humpback whale Unidentified mysticete[4] Blainville's beaked whale Sperm whale Killer whale Risso's dolphin Unknown delphinid	19 Sep–14 Nov 2014

Monitoring Platform	General Location and Maximum Depth	Animal Group Encountered/Detected	Date/Timeframe
Small-vessel Surveys	Guam – 980 m Rota – 991 m Saipan – 1,224 m	Blainville's beaked whale Cuvier's beaked whale Unidentified beaked whale Unidentified Mesoplodont Unidentified Ziphiid whale Bottlenose dolphin False killer whale Melon-headed whale Pantropical spotted dolphin Pygmy killer whale Rough-toothed dolphin Short-finned pilot whale	11–27 Apr 2014; 15 May–20 Jun 2014
Sea Turtle Surveys	Guam SW – 60 m Saipan – 60 m Tinian – 60 m	Green turtle Hawksbill turtle	15–18 Jul 2014 20–23 Jul 2014

Key: BWC = Cross Seamount beaked whale; EAR = ecological acoustic recorder; HARP = high-frequency recording package; m = meter(s); MITT = Mariana Islands Training and Testing; N = north; PAM = passive acoustic monitoring; S = south; SE = southeast; spp = species; SW = southwest; U.S. = United States; and W = west

[1] No known Bryde's whale sounds were detected, though two unidentified whale sounds were commonly heard (50- or 38-Hertz (Hz) tonals, and these may have been produced by Bryde's whales based on their similarity to Bryde's whale sounds recorded in other regions.

[2] Matches "BWC" call type described by Baumann-Pickering et al. (2014). Possibly gingko-toothed beaked whale.

[3] Possibly Bryde's whale; calls were of two slightly different types; both types had a similar near-constant tonal portion with fundamental frequency < 200 Hz and harmonics between 400 and 600 Hz, but this tonal call was followed either by a 0.5-second upsweep from 700 to 800 Hz or an approximate 0.2-second downsweep at approximately 400 Hz.

[4] 30-Hz tone followed by a quick upsweep to 7.5 kilohertz, and resembles the minke whale "star wars" call described by Gedamke et al. (2001) and also has some characteristics of the minke whale "boing" vocalization (Rankin and Barlow 2005).

2.2.1.1 PASSIVE ACOUSTIC MONITORING: HARPS [1]

At both Saipan and Tinian HARP sites, three different beaked whale frequency-modulated pulse signal types were detected during 2010–2013. In last year's MIRC Annual Monitoring Report, Oleson (2014) reported on initial results of 2010 and 2011 Saipan and Tinian dataset analyses. This year's MIRC Annual Monitoring Report discusses findings for 2010–2013. Manual analyses of 2012–2013 (single dataset) data revealed sounds produced by Blainville's beaked whales, Cuvier's beaked whales, and acoustic detections of a "BWC" signal type by an unidentified Mesopolodont beaked whale. A signal type with beaked whale typical characteristics was first recorded at Cross Seamount (McDonald et al. 2009) and subsequently shown to occur at most subtropical and tropical recording sites, referred to as BWC (Baumann-Pickering et al. 2013). Ginkgo-toothed beaked whales may produce the BWC signal type (Baumann-Pickering et al. 2014). Oleson et al. (2015) concluded that the unidentified Mesopolodont whale BWC detected in MIRC is most likely a ginkgo-toothed beaked whale (Oleson et al. 2015). It is not yet possible to distinguish the occurrence of Longman's beaked whale (*Indopacetus pacificus*) from more standard echolocation clicks produced by delphinids, so their occurrence in this region has not been assessed within these data (Oleson et al. 2015).

Sperm whales were identified within the Saipan and Tinian HARP 2010–2013 datasets (Oleson et al. 2015). Large whales (including sperm whales) were detected more often at Saipan than at Tinian. Sperm whales were detected on 241 out of 607 days of recording effort at Saipan, and on 44 of 550 days of recording effort at Tinian. Sperm whales were heard during all months with

recording effort at Saipan, with the exception of April 2011, when only 4 days of recording effort occurred during that month.

Hill et al. (2015) reported on analyses of acoustic data collected during the 2013–2014 HARP deployment at Tinian. Several odontocete species were detected within the 2013–2014 Tinian HARP dataset including sperm whale, *Kogia* spp, Blainville's beaked whale, unidentified Mesoplodont whale BWC, killer whale, short-finned pilot whale, false killer whale, and Risso's dolphin. A variety of additional delphinid sounds were detected that could not be identified to species. All of these species except killer whales and the unidentified Mesoplodont BWC have been observed during prior surveys in the region. The occurrence of beaked whales was evaluated in earlier (2010–2013) Tinian and Saipan HARP datasets (Oleson et al. 2015), with the only notable difference being the absence of Cuvier's beaked whale within the 2013–2014 Tinian HARP dataset (Hill et al. 2015).

2.2.1.2 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. Last year's MIRC Annual Monitoring Report (DoN 2014a) contained preliminary results of these analyses, conducted by Munger et al. (2014). Additional analyses and findings are presented here. Detections included Cuvier's and Blainville's beaked whales, sperm whales, and unidentified species of delphinids (see **Appendix B**). However, Munger et al. (2015) noted that the use of the Marine Mammal Monitoring Class Specific Support Vector Machine detector, and subsequent validation efforts on Cuvier's and Blainville's beaked whales, does not exclude the possibility that other species of beaked whale occur in the MIRC. Sperm whales were detected on all EARs and during both deployments. Delphinid acoustic encounters for the EARs study were classified based on whistle frequencies into "signal groups," a proxy for species assemblages. All signal groups were detected at all MIRC EAR sites. Based on whistle characteristics reported in Oswald et al. (2003, 2007), the delphinid species most commonly encountered during visual surveys in the MIRC region (Hill et al. 2013a,b) would most often be classified into the following whistle categories: LF whistles = false killer whale, short-finned pilot whale, and rough-toothed dolphins; HF/LF whistles = bottlenose, pantropical spotted, and striped dolphins [*Stenella coeruleoalba*]; and HF whistles = spinner, pantropical spotted, and striped dolphins. Munger et al. (2015) cautioned that these identifications are tentative and do not exclude the presence of other odontocete species for which acoustic behavior is not well known. For example, few confirmed acoustic recordings exist for melon-headed whales and pygmy killer whales, two species known to occur in the MIRC, and therefore it was not possible to investigate their occurrence in the EAR data.

Dolphins were detected on days during and days following MFAS at most sites, with the exception of one instance at Guam S, where dolphins were not acoustically detected for a period of 12 days, which was the 3 consecutive-day occurrence of MFAS from 17 to 19 October 2011 and the 8 days afterward. This was the longest period without an acoustic detection at this EAR site. The 12 days was significantly longer than the mean duration of 2.1 days with no acoustic detection at this EAR site.

2.2.1.3 PASSIVE ACOUSTIC MONITORING: AUTONOMOUS GLIDERS [3]

Odontocete acoustic encounters were abundant during glider surveys. The majority of the detections occurred in the last two-thirds of the survey when the glider was in deep water and on the shelf. Recordings made by gliders deployed off Guam included few detections of beaked whale vocalizations. Out of seven encounters, three were identified as Blainville's beaked whales and four as potential beaked whales. The low detection rates are consistent with the few beaked whale detections reported for an EAR that was moored south of Guam (see **Appendix C**, Munger et al. 2014). Other acoustically identified species included sperm whales (**Figure 7**), killer whales, and Risso's dolphins. Most acoustic encounters recorded by the glider could not be classified to the species level, but were likely small and medium-sized delphinid species. The variety of HF acoustic encounters indicates there are numerous species present offshore of Guam in the fall. Few detections of odontocetes (and mysticetes) were made during the first 10 days of the survey. It is unclear if this was due to spatial (i.e., animals are not common in this area) or temporal (i.e., animals are not common in this area during fall) reasons. Klinck et al. (2015) noted that data collected during the spring 2015 glider deployment in MIRC will help address some of these spatio-temporal questions.

2.2.1.4 VISUAL SURVEYS: SMALL-VESSEL SURVEYS [4,5,6,7]

Similar species were observed during the 2014 NMFS PIFSC small-vessel surveys as during previous NMFS PIFSC-conducted surveys in the MIRC (DoN 2014a; DoN 2014b; Hill et al. 2012, 2013a, 2013b, 2013c, 2014; Oleson and Hill 2010). During this reporting period, 10 species of odontocetes were positively identified in MIRC waters, using visual detection methods (**Table 4; Figures 3, 4, 5** and **6**): Blainville's beaked whale, bottlenose dolphin, Cuvier's beaked whale, false killer whale, melon-headed whale, pantropical spotted dolphin, pygmy killer whale, rough-toothed dolphin, short-finned pilot whale, and spinner dolphin (**Table 4**). The May-June 2014 encounters were the first confirmed sightings of Cuvier's and Blainville's beaked whales during NMFS PIFSC small-vessel surveys. The spinner dolphin was the species sighted most frequently (n=27 sightings). Ranked in order of encounter frequency, the other species were: pantropical spotted dolphin (seven sightings), five sightings each of short-finned pilot whales and bottlenose dolphins, two sightings each of melon-headed whale and false killer whale, and one sighting each of pygmy killer whale, rough-toothed dolphin, Cuvier's beaked whale, and Blainville's beaked whale. Additionally, there were two sightings of unidentified Mesoplodont whales.

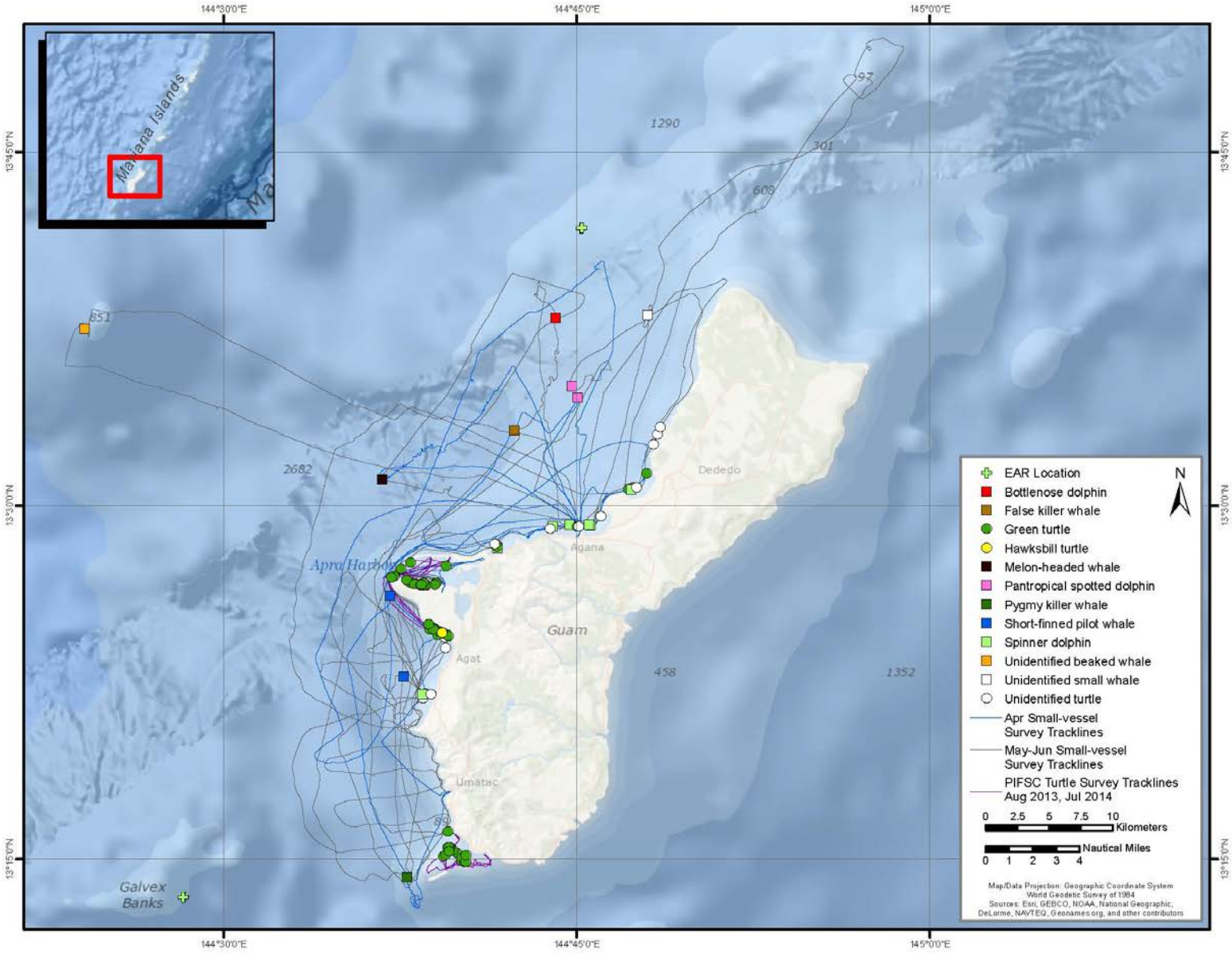

Figure 4. Monitoring Year 5 sightings, effort, and PAM device locations off Guam.

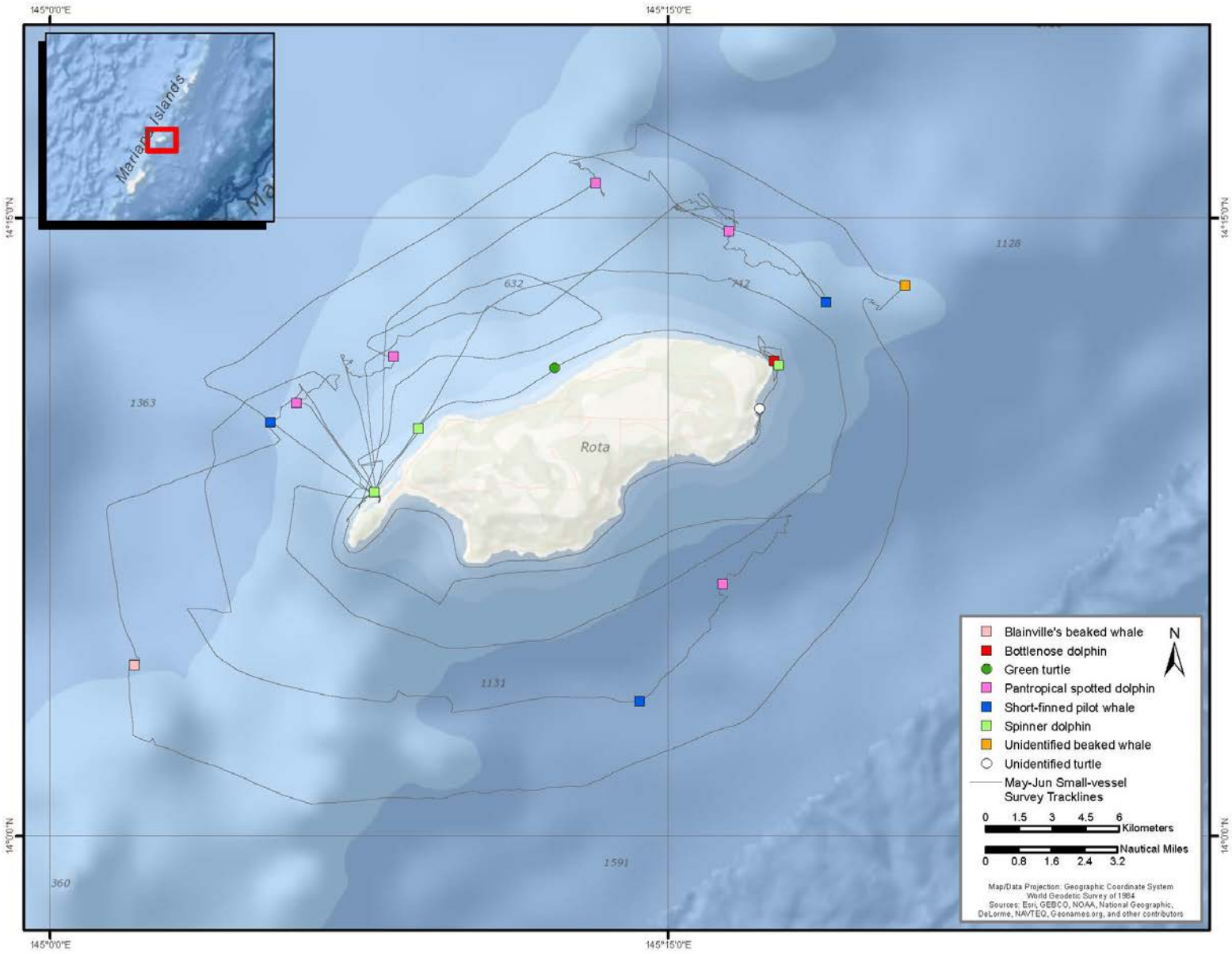

Figure 5. Monitoring Year 5 sightings, effort, and PAM device locations off Rota.

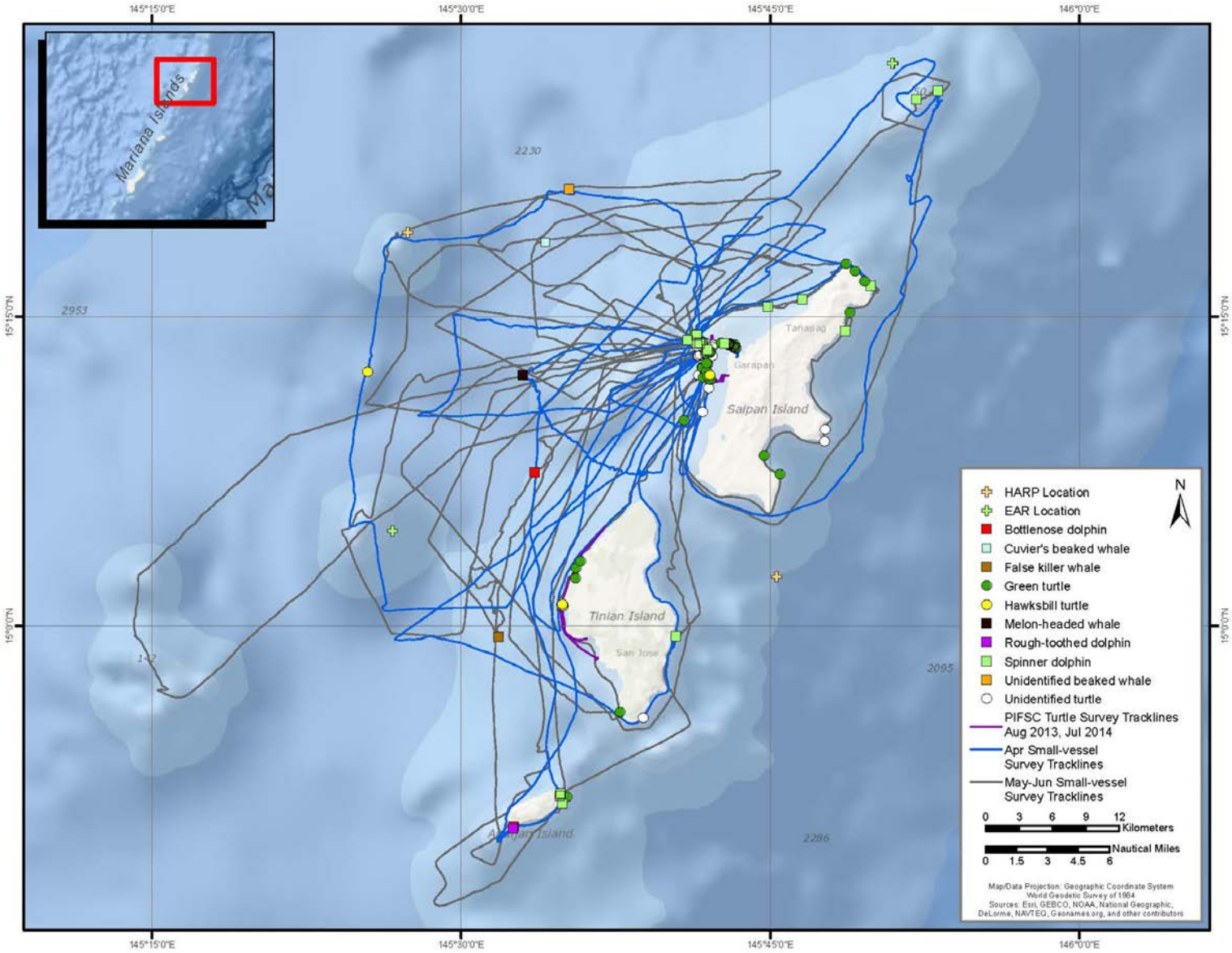

Figure 6. Monitoring Year 5 sightings, effort, and PAM device locations off Tinian and Saipan.(Deployment of HARPs funded by NMFS PIFSC)

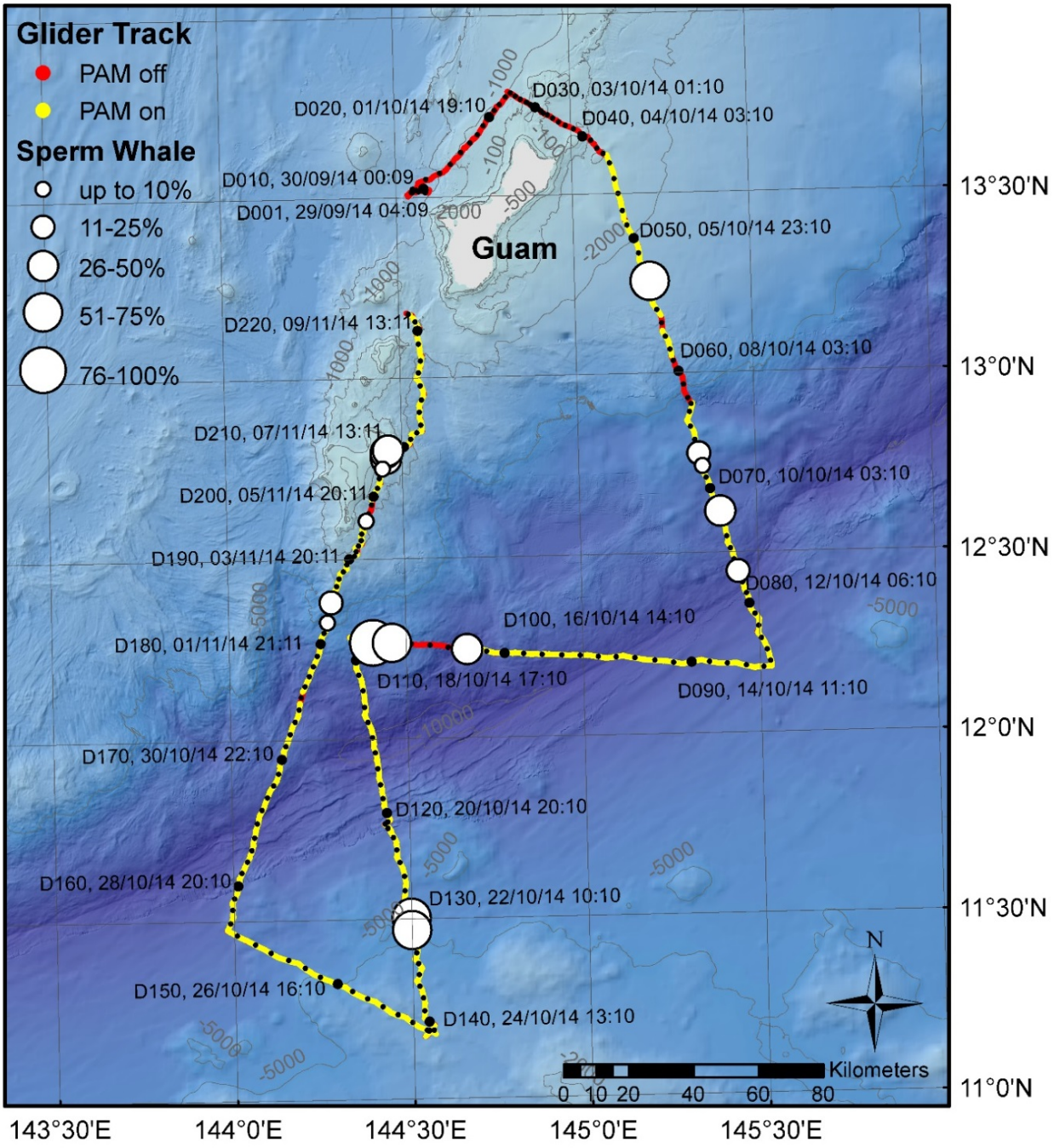

Figure 7: Sperm whale encounters recorded by the autonomous glider deployed in fall 2014. The circle size indicates percentage of recording time per dive with target signals. Figure from Klinck et al. 2015 (Appendix C).

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: HARPS [1]

Blue, fin, humpback, minke, and sperm whales were identified within the Saipan and Tinian acoustic datasets (see Figure 6 for HARP deployment locations). There were many more days with large whale calls at Saipan than at Tinian. Sperm whales were the most common large whale detected at both sites. It appears that sperm whales may move in and out of the region over the course of a few months with temporary increases or decreases in detection over time. Humpback whales were the second most common large whale detected at the Saipan and Tinian HARP sites. Humpback whale song was heard December through April at Saipan in all years with recording effort, with no humpback song or calls heard outside the winter period. Humpback whale sounds were infrequently detected at Tinian during the summer months (June to October 2012).

Blainville's beaked whales were the most commonly detected beaked whale species at both sites, occurring on 40 percent and 26 percent of total monitoring days at Saipan and Tinian, respectively (**Figure 8**). The relative occurrence of Cuvier's and unidentified beaked whale sounds varied between the two monitoring sites, with higher occurrence of Cuvier's beaked whales at Saipan, and higher occurrence of unidentified beaked whales at Tinian. No other beaked whale sound types have been detected at these sites.

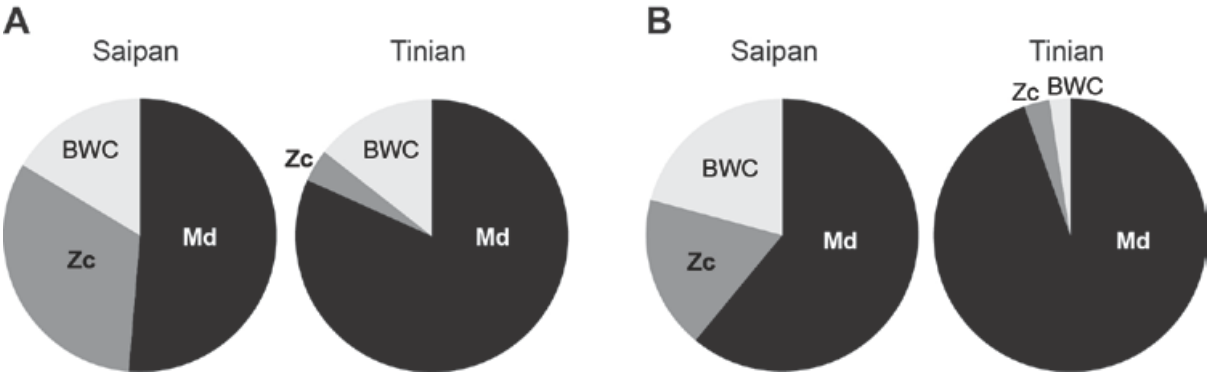

Figure 8. Relative presence of acoustic encounters at Saipan and Tinian of Blainville's beaked whale, Md, Cuvier's beaked whale, Zc, and beaked whale BWC (possibly ginkgo-toothed beaked whale). A) Relative species presence based on number of days with detections. B) Relative species presence based on cumulative duration of acoustic encounters. Figure from Oleson et al. 2015 (Appendix A).

Beaked whales were more commonly detected at the Saipan HARP site than at Tinian, with just over half of monitoring days at Saipan containing beaked whale calls and less than one-third of monitoring days at Tinian containing beaked whale calls.

2.2.2.2 PASSIVE ACOUSTIC MONITORING: EARS [2]

Manual analyses of EAR datasets suggested spatial differences in delphinid occurrence (see **Appendix B**). The highest overall proportion of time that delphinids were present was recorded by the EAR north of Guam, followed by Saipan, Tinian, and lastly southwest Guam. The abundance of different signal groups varied geographically. The HF and LF groups were more

acoustically abundant at Saipan N than at the other EAR sites, suggesting higher densities of spinner dolphins and other *Stenella* sp. and blackfish/rough-toothed dolphins at Saipan compared to the other sites. The HF/LF whistle group was most abundant at Guam N compared to the other three EAR sites, suggesting higher densities of bottlenose dolphins and *Stenella* sp. north of Guam compared to other locations.

The delphinid signal groups exhibited some site-specific differences in seasonal variation (**Table 5**). Metrics of occurrence for the HF/LF and HF groups at Guam N were all higher during deployment 2 (April–September) than deployment 1 (September–January), whereas they were lower for the LF group during deployment 2. This suggests higher activity of bottlenose dolphins and *Stenella* sp. in late spring and summer months (deployment 2) than in autumn/winter (deployment 1), and lower activity of blackfish and rough-toothed dolphins at Guam N in spring/summer compared to autumn/winter. However, at Saipan N, although encounter rates were slightly lower during the second deployment, the mean encounter duration and normalized total Daily Acoustic Abundance (a metric of relative dolphin acoustic signaling) for all signal groups were higher in deployment 2 than deployment 1, suggesting a seasonal increase in signaling by all delphinid species in spring/summer compared to autumn/winter. This increase in most delphinid groups in spring/summer compared to autumn/winter contrasts with the pattern of sperm whale occurrence, which was higher in the autumn/winter deployment than the spring/summer deployment. Alternatively, these patterns may reflect inter-annual variability rather than seasonal variability; additional recording over multiple seasons and years would be needed to investigate this.

Table 5. Delphinid detections by signal group for each site and deployment.

		Clicks only	HF/LF whistles	HF whistles	LF whistles
A. Guam N					
Encounters per effort-day	Dep 1	0.75	1.3	0.24	0.51
	Dep 2	0.84	2.2	1.2	0.34
Mean encounter duration	Dep 1	0:14:27	1:10:08	0:41:51	1:11:19
	Dep 2	0:12:50	1:24:47	0:24:03	0:33:58
Total DAA per effort-day x 100	Dep 1	0.68	12.8	0.84	5.53
	Dep 2	0.58	25.4	2.19	1.71
B: Guam S					
Encounters per effort-day	Dep 1	0.21	0.16	0.048	0.25
	Dep 2	NA	NA	NA	NA
Mean encounter duration	Dep 1	0:15:44	0:49:42	0:18:30	1:09:30
	Dep 2	NA	NA	NA	NA
Total DAA per effort-day × 100	Dep 1	0.21	0.96	0.07	2.83
	Dep 2	NA	NA	NA	NA
C: Tinian W					
Encounters per effort-day	Dep 1	0.62	0.60	0.33	0.31
	Dep 2	0.25	1.1	0.31	0.25
Mean encounter duration	Dep 1	0:08:24	0:54:33	0:31:25	0:54:38
	Dep 2	0:03:00	0:59:55	0:20:30	0:18:00
Total DAA per effort-day × 100	Dep 1	0.24	3.69	0.83	2.43
	Dep 2	0.02	8.99	0.44	0.49
D: Saipan N					
Encounters per effort-day	Dep 1	0.54	1.2	1.1	0.68
	Dep 2	0.77	1.0	1.0	0.40
Mean encounter duration	Dep 1	0:09:45	0:57:41	0:19:15	0:48:40
	Dep 2	0:16:37	1:11:55	1:04:27	1:38:25
Total DAA per effort-day × 100	Dep 1	0.27	8.82	1.74	4.99
	Dep 2	0.77	9.84	6.95	7.04

Table Source: Munger et al. 2015 (Appendix B)

Key: DAA = Daily Acoustic Abundance; Dep = deployment; HF = high frequency (>10 kHz) whistles; LF = low frequency (<10 kHz) whistles; N = north; S = south; W = west; and x = times

Sperm whales were most acoustically abundant at the EAR north of Guam compared to the other sites. There were insufficient baleen whale detections to provide information about high-use areas by these species in MIRC. However, the relatively few humpback whale calls and three unidentified baleen whale calls were only detected at Saipan N EAR. Beaked whales were detected at all EAR sites, except for Guam S.

2.2.2.3 VISUAL SURVEYS: SMALL-VESSEL SURVEYS [4,5,6,7]

During the 45 days of small-vessel survey effort conducted by NMFS PIFSC during April through June 2014 (see **Appendix D**; Hill et al. 2014), 4,152 km of trackline were surveyed from Guam to Saipan (**Figure 3**). This effort resulted in 52 sightings of 11 species (**Table 4**). Off Guam and Saipan, the spinner dolphin was the most frequently sighted species (*n*=8 and 9,

respectively) while the pantropical spotted dolphin was the most frequently sighted at Rota (*n*=5).

Patterns of habitat use (depth and distance from shore) evident from the April through June 2014 NMFS PIFSC small-vessel surveys were similar to those described for 2010 through 2013 by Hill et al. 2014. Spinner dolphins remained the most frequently encountered species and were seen at Marpi Reef and at all islands. Most of the encounters were within 1 km of shore and in waters with bottom depths less than 300 m.

The pantropical spotted dolphin remained the second most frequently encountered species as was reported by Hill et al. (2014) for 2010 to 2013. Except for two sightings off Guam, all pantropical spotted dolphins were encountered only around Rota (Hill et al. 2014, 2015). All of the sightings occurred within 8 km from shore and were in locations where the bottom depth was 500 to 1,600 m.

Short-finned pilot whales were encountered off Guam and Rota. Short-finned pilot whale sighting locations and filtered satellite-tag locations reflect the continued use of areas close to shore by short-finned pilot whales as was reported by Hill et al. 2014. Median distances from shore for encounter locations and filtered satellite-tag locations were 3.8 and 17.1 km respectively. The median bottom depth of sighting locations was 794 m and that of satellite-tag locations was 1,188 m. Preliminary dive data from a single SPLASH10 tag revealed that short-finned pilot whales in the Marianas will dive to a maximum depth of 1,168 m and for maximum periods of 24.4 minutes (Hill et al. 2015). In addition, the tag recorded deep dives (> 800 m) during the day and night.

Melon-headed whales were encountered off Saipan and Guam during April 2014 (Hill et al. 2014). Though only observed twice, this species was found in large groups, making it collectively the third most abundant species encountered during NMFS PIFSC small-vessel surveys during 2014. The first encounter was a group of 325 animals off Saipan, during which three satellite tags were deployed. The bottom depth of the sighting was 1,014 m and the distance from shore was 15.1 km. The second encounter was a group of 85 animals off Guam. The bottom depth of the sighting was 1,975 m and the distance from shore was 6.5 km.

False killer whales were encountered off Guam and Tinian and continued to exhibit a broad range of habitat use based on sighting data and filtered satellite tag locations from the May-June 2014 small-vessel surveys. Most of the filtered satellite tag locations were to the west of the islands with some as far offshore as the West Mariana Ridge. Two individuals (tag IDs 128888 and 128902) traveled up the island chain as far north as Pagan. Distances from shore ranged 5.9 to 8.4 km for sightings and 0.3 to 216 km for filtered satellite tag locations (Hill et al. 2015). Bottom depths at sighting locations were 673 to 1,003 m and those of filtered satellite tag locations were 52 to 4,959 m. Preliminary data from two SPLASH10 tags revealed that false killer whales in the Marianas will dive to depths of 1,360 m and for periods as long as 17.6 minutes.

Bottlenose dolphins were encountered off Guam, Tinian, Rota, and Aguijan at a median distance from shore of 6.0 km and median bottom depth of 800 m. The filtered satellite tag locations from the single bottlenose dolphin tagged in June 2014 revealed the individual's

moving in waters with a wide range of bottom depths (12 to 1,407 m) over the 3.7 days of the satellite tag's deployment (see **Appendix D**).

The Cuvier's beaked whale encounter occurred 19 km off the west side of Saipan in waters with a bottom depth of 1,700 m (see **Appendix D**). The Blainville's beaked whale encounter occurred 11 km west-southwest of Rota in waters with a bottom depth of 1,200 m (Hill et al. 2015). The two unidentified Mesoplodont whale encounters were made off Guam (at Tracey Seamount) and Saipan (30.6 and 20.3 km from shore and bottom depths of 1,074 and 1,614 m, respectively) during the May–June 2014 visual surveys.

2.2.2.4 VISUAL/TAGGING SURVEYS: SEA TURTLE SURVEYS [8,9]

During August 2013, the first dedicated sea turtle tagging surveys were conducted by NMFS PIFSC in the nearshore and coastal waters of Guam (Cocos Lagoon), Saipan and Tinian (Jones and Van Houtan 2014). This year's MIRC Annual Monitoring Report summarizes details on tagging efforts during 2013–2014; satellite tags were outfitted on 19 captured sea turtles: four on hawksbill turtles (*Eretmochelys imbricata*) and 15 on green turtles (*Chelonia mydas*). Eight turtles (all greens) were satellite tagged in the Apra Harbor area on Guam, four (one green and three hawksbills) in the waters of western Tinian, and seven turtles (six greens and one hawksbill) in the nearshore waters of northwestern and northeastern Saipan.

KDEs revealed high site fidelity and limited movements for the green turtles as well as for two of the hawksbills while resident at Guam, Tinian, and Saipan (**Appendix E** Figures 3-5). At Guam, areas of high turtle density include the waters around the Orote Peninsula, inside Apra Harbor near San Luis and Gab Gab Beaches, west to Spanish Steps, and Dadi and south to Tipalao beaches outside of the harbor. At Saipan, KDEs revealed high turtle density in the area stretching from the Balisa Channel to Mañagaha Island. These areas are dominated by patch reef communities where turtles both forage and rest.

At Guam, one large home range (95 percent KDE) for tagged green turtles included the entire Orote Peninsula south through Agat Bay, most of outer Apra Harbor, the western edge of inner Apra Harbor, and the Glass Breakwater. A smaller patch of home range area was determined to be in Sasa Bay. There are likely key microhabitat features of the sites that make these areas particularly suitable for green turtles, either as a foraging area or a refuge site. The core area (50 percent KDE) was located in outer Apra Harbor and centered at Gab Gab Beach.

At Saipan, the home range (95 percent KDE) for tagged green and hawksbill turtles was on the west side of the island in Saipan Lagoon, and included the southern edge of Tanapag Harbor south to Garapan. The west side of Saipan has sea grass beds and reefs that include this home range estimated from tagging. The core area (50 percent KDE) was centered off the intersection of Tanapag and Garapan lagoons. A second area of concentration was off the north side of Saipan, with a home range (95 percent KDE) extending primarily to the east, and to a lesser degree, west of Banzai Cliff. The core area (50 percent KDE) was centered off Puntan Laggua off the northwest tip of Saipan.

Two hawksbill turtles tagged off Tinian made long-range movements: one left Tinian and traveled to southern Guam in the Cocos Lagoon region (migration covered a distance of 286 km and lasted 7 days); the other turtle left Tinian and traveled eastward along the northern edge of

the Federated States of Micronesia (see **Appendix E**: Figures 6 and 7). At Tinian, the home range (95 percent KDE) for tagged green and hawksbill turtles was on the west side of the island, between Lamanibot and Peipeinigul bays, with the core area (50 percent KDE) close to shore in the middle of the area between the two aforementioned bays.

As noted earlier, NMFS PIFSC also analyzed historical data from Guam DAWR's aerial surveys of coastal fisheries that circumnavigated the island of Guam, following the reef slope. In 32 years over a 50-year span, 632 surveys were completed, representing approximately 809 hours of survey effort of Guam's nearshore marine environment. During these surveys, observers recorded a total of 7,515 small delphinids, 95 large delphinids, and 10,622 turtles.
Small delphinid counts per survey fluctuated through time, peaking in late 1970s and late 1990s, and were shown to be comparatively low in recent years (**Figure 9**). Most small delphinid sightings are likely to have been spinner dolphins due to their habitat preference and consistent presence around Guam. The highest numbers of small delphinids were observed in the northeast region of Guam, while the lowest were in Apra Harbor and Cocos Lagoon. No dolphin sightings occurred on the east side of Guam, and sightings were likewise rare on the west side of the island. Large delphinid counts were consistently low in space and time, but showed a slight increase since 1989 (**Figure 9**). Large delphinids were most commonly observed off the southwest corner of Guam. Because species identification among large delphinids is difficult for aerial surveys not dedicated to marine mammals, these sightings likely included short-finned pilot whales and possibly false killer whales, pygmy killer whales, or melon-headed whales. Since 1989, no large delphinids have been observed in the northwest or central west nearshore regions, including the Apra Harbor area. Sea turtles were found to have an eight-fold increase over the five decades, mostly driven by a local increase in the Cocos Lagoon area. Island-wide increases in turtle counts since the 1990s were driven primarily by an increase in Zone 8 on the southern coast of Guam (**Figure 10**), which includes Cocos Lagoon and Cocos Island. Sea turtles forage on sea grass beds in Cocos Lagoon, and turtle nesting on Guam primarily occurs on Cocos Island (DoN 2015).

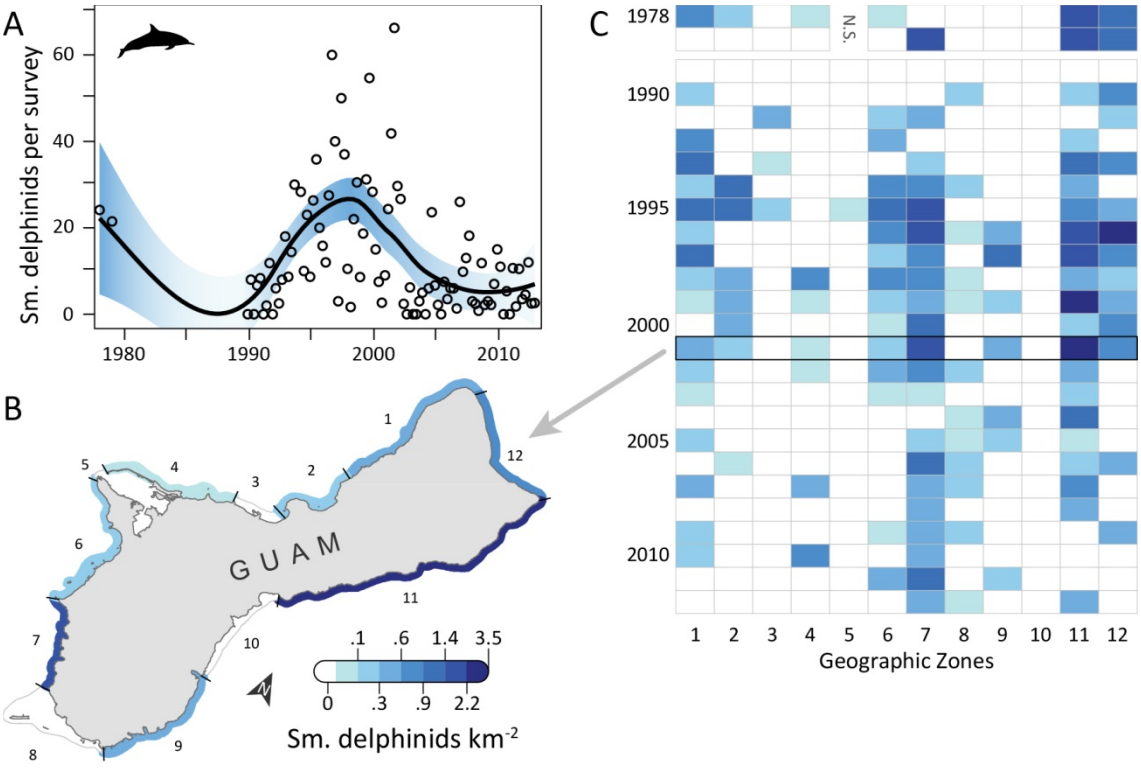

Figure 9. Fluctuating trend in small delphinid observations around Guam since 1978. (A) Trend in small delphinid observations from semimonthly aerial surveys conducted by Guam Division of Aquatic and Wildlife Resources (DAWR). Open circles are observations (individuals) per survey (OPS) by year or quarter. Model fit with shaded 95% confidence interval shows that observations were highly variable over the time series. Correspondingly, mean observation growth rate (OGR) was negative in 1978-1989 (mean = -0.22, SD = 0.06, CV = 28%) and 1999-2009 (mean = -0.15, SD = 0.07, CV = 44%) and positive in 1990-1998 (mean = 0.35, SD = 0.30, CV = 87%) and 2010-2012 (mean = 0.06, SD = 0.03, CV = 52%). (B) Map of observed densities for 2001, the year with the highest annual OPS. Density was highest in zone 11 and lowest in zones 3, 5, 8 and 10. (C) The highest, most widespread positive densities were observed throughout the 1990s and early 2000s. Densities decreased over time in zones 1, 2, 6, 11 and 12. Observations were rare in zones 3-5, and never occurred in zone 10. Military restrictions prohibited surveys in zone 5 in 1978-1979.. Figure from Jones et al. 2015 (Appendix E).

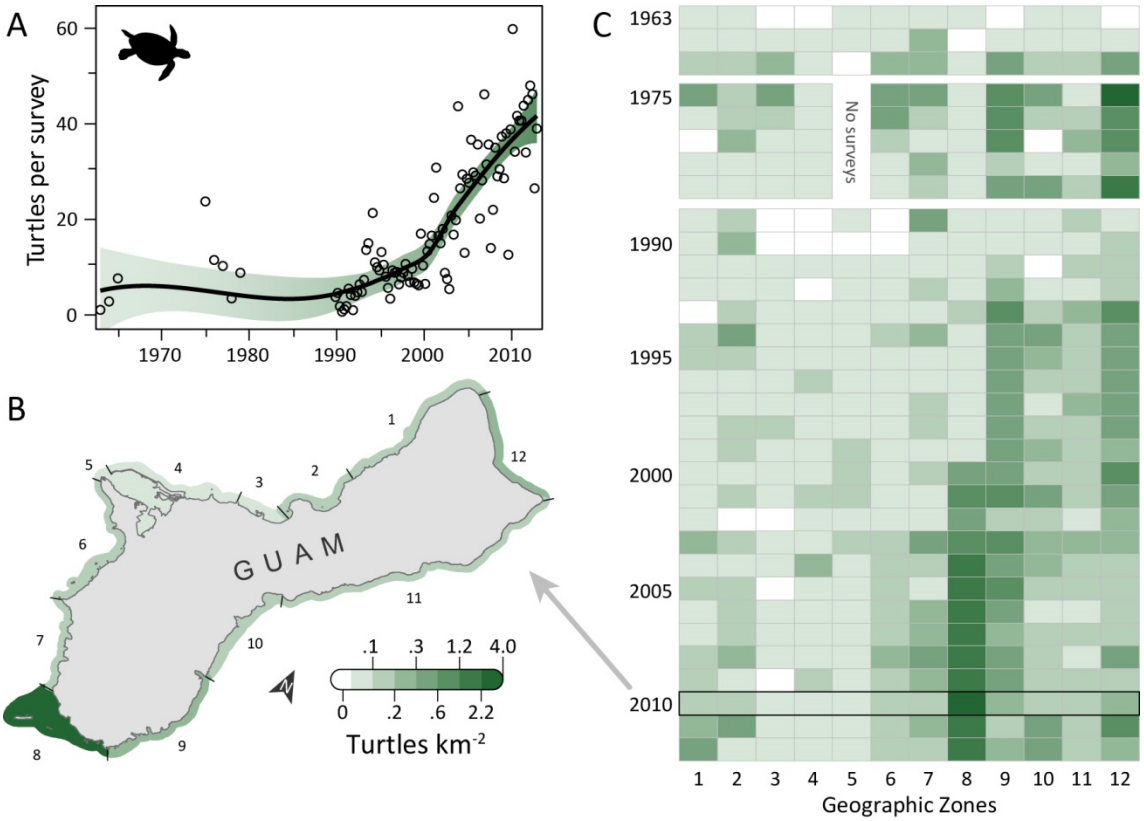

Figure 10. Eight-fold increase in observed sea turtles on Guam's reefs in the last five decades (A) Trend in turtle observations from semimonthly aerial surveys conducted by Guam Division of Aquatic and Wildlife Resources (DAWR). Open circles are annual or quarterly observations (turtles) per survey (OPS). Smoothed line is a model fit, with 95% confidence interval shaded. Mean population growth rate (PGR) was 0.07 (SD = 0.06, CV = 90%) since 1963 and 0.10 (SD = 0.04, CV = 37%) since 1989. (B) Map of 12 geographic survey zones; shading depicts observed densities for 2010, when annual OPS was highest. (C) Trends in densities for the 12 zones. Zone 5 was closed to surveys in 1975-1979 due to military restrictions. The west coast (zones 1-7) generally had lower densities than the rest of Guam after the 1970s. The increase in zone 8 drives the overall increase observed in (A). Figure from Jones et al. 2015 (Appendix E).

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 VISUAL SURVEYS: SMALL-VESSEL SURVEYS [4,5,6,7,10]

During the small-vessel surveys conducted April through June 2014, 55 biopsy samples were collected from four cetacean species: melon-headed whale (*n*=19), false killer whale (*n*=16), short-finned pilot whale (*n*=18), and bottlenose dolphin (*n*=2).

During these surveys, 31,949 photographs were taken of 10 species (Blainville's beaked whale, bottlenose dolphin, Cuvier's beaked whale, false killer whale, melon-headed whale, pantropical spotted dolphin, pygmy killer whale, rough-toothed dolphin, short-finned pilot whale, and spinner dolphin) as well as unidentified Mesoplodont beaked whales for photo-ID purposes (see **Appendix D**; Hill et al. 2014). Photo analysis was continued (including review of photographs taken during the 2007 U.S. Navy-contracted Mariana Islands Sea Turtle and Cetacean Survey [MISTCS]; DoN 2007, Fulling et al. 2011) to add to the existing individual photo-ID catalogs for short-finned pilot whales, bottlenose dolphins, and spinner dolphins described by Hill et al. (2014) in the MIRC Comprehensive Report (DoN 2014b); since that time new catalogs for false killer whales, rough-toothed dolphins, and pygmy killer whales were created*. In total, new photo-ID catalogs have been established for six species since last year's MIRC annual report* (DoN 2014a): bottlenose dolphin, false killer whale, pygmy killer whale, rough-toothed dolphin, short-finned pilot whale, and spinner dolphin.

A long-term goal of this monitoring project is to make progress on addressing the monitoring question above. This includes producing population abundance estimates using mark-recapture techniques. However photo analysis has also been useful through comparisons of individual movement patterns to genetic evidence, as summarized below by species. NMFS SWFSC conducted genetic analyses of biopsy samples collected from four species in the Marianas: short-finned pilot whales, bottlenose dolphins, spinner dolphins, and melon-headed whales, in part to better understand how the Marianas animals relate to populations elsewhere in the Pacific (Martien et al. 2014, 2015; Morin et al. 2015).

As previously addressed by Hill et al. (2014), baseline abundance and population structure are not straightforward and require further investigation to determine which cetaceans may be exposed to sonar and explosives. Based on filtered satellite-tag locations from pilot whales and false killer whales, as well as the observed habitat use of pilot whales, false killer whales, pantropical spotted dolphins and beaked whales during the May–June 2014 surveys, it is possible that these species could be exposed to underwater detonations at the Piti Floating Mine Neutralization Area and the Agat Bay Underwater Detonation Area sites off Guam (see **Appendix D:** Tables 4 and 6, Figures 7 and 21).

Short-finned pilot whale: There are currently 178 short-finned pilot whales in the NMFS PIFSC photo-ID catalog. Noteworthy is the matching of four individuals from an encounter off the northeastern coast of Guam during the 2007 U.S. Navy-contracted MISTCS (DoN 2007). These individuals were photographed together off the west side of Tinian in September 2011 and off the west side of Guam in March 2012 (Hill et al. 2015).

The photo-ID data continue to show that individual short-finned pilot whales tend to associate with the southern islands of the Mariana Archipelago and do so over many years. All resightings near Saipan, Tinian, and Rota have been of individuals photographed off Guam, with no resightings among the islands of CNMI. Some groups have only been photographed on a single occasion, suggesting some segment of the populations may prefer offshore waters or those near the northern islands, and occur near the southernmost islands intermittently (Hill et al. 2014). None of the eight short-finned pilot whales satellite-tagged during the 2014 surveys traveled long distances offshore as the individual in 2013 (tag 128885) that traveled over 400km south of Guam toward the Federated States of Micronesia (Hill et al. 2014, 2015).

Analysis of mitochondrial DNA of biopsy samples collected from short-finned pilot whales revealed significant genetic differentiation between samples collected from individuals off Saipan, Tinian, and Aguijan (3-Islands) and those collected from individuals off Guam and Rota, suggesting limited gene flow (Martien et al. 2014). The photographic resights of individuals between these locations suggest that the genetic differences detected may be a reflection of social structure, that there is male-mediated gene flow, or that the 3-islands region is an area of overlap between the two populations (Martien et al. 2014).

Biopsy tissue samples collected from short-finned pilot whales in the Mariana Islands were also included in a larger study of short-finned pilot whale population structure in the Pacific (Morin et al. 2015). Results from the study indicate that there are three major groups in the pilot whale phylogeny, corresponding to the two known morphotypes (called *Naisa* and *Shiho* based on original descriptions in Japan), and a third, widely distributed group that spans the range of the other two groups in the Pacific.

Bottlenose dolphin: The bottlenose dolphin catalog now totals 52 individuals with the addition of 5 new individuals from four encounters during the May-June 2014 survey (Hill et al. 2015). The photo-ID data demonstrate that most of the cataloged individuals move between all of the southernmost islands of the Marianas and associate with the islands over periods of years. Genetic analyses revealed that these animals exhibited low genetic diversity compared to other bottlenose dolphin populations elsewhere in the western Pacific and the Hawaiian Archipelago, suggesting that bottlenose dolphins in the Mariana Islands represent a small, genetically isolated population (Martien et al. 2014, 2015). Genetic analyses also suggest that the Mariana Islands bottlenose dolphin has a history of hybridization with Fraser's dolphins (*Lagenodelphis hosei*), although photographs confirmed that the samples came from what appeared to be morphologically normal bottlenose dolphins (Martien et al. 2014, 2015). No Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) haplotypes were identified in any of these biopsy samples (Martien et al. 2014).

Spinner dolphin: The spinner dolphin photo-ID catalog currently includes 307 individuals. Photographs from both surveys of the 2014 field season are being processed for matching and incorporation into the existing catalog (Hill et al. 2015). Resights of individuals have occurred between Saipan, Tinian, Aguijan, Rota, and Marpi Reef. Three individuals from the Guam catalog were also photographed at Rota Bank, but no matches were found between any of the CNMI locations with Guam or Rota Bank (Hill et al. 2014). In contrast genetic analysis of

mitochondrial DNA does not indicate structure. Martien et al. (2014) suggest that the genetic transfer within the Marianas may be facilitated by offshore individuals that make temporary visits or by males within the insular population. Also, spinner dolphins sampled in the Marianas exhibited high haplotypic diversity, similar to that observed in animals sampled around the Society Islands of French Polynesia, suggesting the Marianas animals are not as genetically isolated as Hawaiian spinner dolphins.

False killer whale: The false killer whale photo-ID catalog contains 40 individuals. The photo-ID data suggest that some individuals repeatedly associate with the southernmost islands of the Marianas but that there is likely a larger population that travels throughout the Exclusive Economic Zone waters and beyond. Nine of the 40 individuals were photographed twice, with inter-island movements. Two individuals were photographed off Guam during June 2013 and May 2014. Two individuals were photographed off Rota in July 2013 and then off Tinian in June 2014. Five individuals were photographed off Rota in July 2013 and then off Guam in May 2014. A single individual, photographed within the offshore waters of the southern part of the Exclusive Economic Zone during the February 2007 MISTCS survey (DoN 2007), was added to the photo-ID catalog but was not photographed during any subsequent surveys. Tag telemetry from both 2013 (Hill et al. 2014) and 2014 (Hill et al. 2015) shows long distance movements both through the islands of the archipelago between Pagan and Guam and offshore movements westward toward the West Mariana Ridge, as well as one individual that traveled offshore to the east beyond the Mariana Trench.

Pygmy killer whale: The pygmy killer whale photo-ID catalog includes eight individuals first photographed off Guam during 2013. The same eight individuals were resighted together, with a calf, northwest of Cocos Island, during April 2014 (Hill et al. 2015).

Rough-toothed dolphin: The rough-toothed dolphin photo-ID catalog includes six individuals. Four of the six individuals were subsequently photographed off Saipan on 20 July 2013. The same four individuals were resighted off Aguijan on 16 April 2014, in a mixed-species group with bottlenose dolphins (Hill et al. 2015). Only a single rough-toothed dolphin was satellite-tagged, in 2013 off Aguijan, and it remained in nearshore areas west of Aguijan, Tinian, and Saipan (Hill et al. 2014).

Melon-headed whale: Only two melon-headed whales were sampled in the Marianas, and both possessed haplotypes similar to those of melon-headed whales sampled around the main Hawaiian Islands. Although there were insufficient samples to quantify the degree of connectivity between the Marianas animals and those in the rest of the Pacific, preliminary results suggest that they are not part of a small, genetically isolated population (Martien et al. 2014). A photo-ID catalog for this species is under development.

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

2.2.4.1 PASSIVE ACOUSTIC MONITORING: HARPS [1]

Blue, fin, humpback, sei, minke, and possibly Bryde's (*Balaenoptera edeni*) whales were detected in the HARP datasets for 2010–2014 (see Figure 6 for HARP deployment locations). The sei whale was only detected in the acoustic dataset from the 2013–2014 Tinian HARP.

Blue, fin, humpback, and minke whales were identified within the Saipan and Tinian 2010–2013 HARP datasets. An unidentified whale sound described as 50- or 38-Hertz (Hz) tonals was detected; based on comparison to recordings from other locations, Oleson et al. (2015) suspected this sound may be produced by Bryde's whales, but noted that though visually verified recordings will be needed to be certain about the species identity.

Manual scanning of the Saipan and Tinian HARP data revealed that baleen whales were heard infrequently in this region relative to elsewhere in the central Pacific. Blue, fin, and minke whale detections were rare across all 3 years of monitoring effort. Although the acoustic monitoring data span a 3-year period, only one year of data collection spanned the winter months, or part thereof, at both monitoring sites. This limitation in the available dataset limits conclusions that may be drawn from these analyses, as interannual variability may be significant in this region. There were marked differences in large whale detection between the Saipan and Tinian HARP sites, with far more days with large whale calls at Saipan than at Tinian.

The humpback whale was the most common baleen whale species detected at the Saipan and Tinian HARP sites (see **Appendices A** and **D**). Humpback whale song was heard December through April at Saipan in all years with recording effort during that period. No humpback whale song or calls were heard outside of that winter period at Saipan, such that there were no detections in 2011 when effort spanned only the period from May to October, and few detections in 2010 and 2012 when recording effort was similarly constrained. Humpback whale sounds were infrequently detected at Tinian during the summer months, from June to October 2012. There was no detection of humpback whales at Tinian during the period of acoustic effort in 2011.

Blue and fin whale calls were rarely detected in the Saipan and Tinian datasets, and minke whale boings were detected on a few occasions at Saipan only. Blue whale 20-Hz tonal calls were detected on 7 of 607 days of monitoring effort at Saipan (in September 2010 – 1 day, and 2011 – 2 days; November – 1 day, and December 2012 – 2 days; January 2013 – 1 day) and downswept D calls were detected on 4 of 379 monitoring days at Tinian (May 2011 – 1 day; June 2012 – 2 days; August 2012 – 1 day). The 20-Hz tonal calls were consistent with those previously identified as belonging to the central Pacific blue whales. Downswept D calls are generally not identifiable to population. Fin whale 20-Hz calls were detected on 4 days off Saipan (April 2010 – 2 days; May 2011 – 2 days) and 2 days in April 2011 off Tinian. Minke whale boings were detected during 6 days in March and April 2010 at Saipan.

Analysis of the acoustic dataset from the 2013-2014 Tinian HARP revealed that blue, fin, humpback, and sei whales, and two types of unidentified whale calls were detected, though fin and humpback whales were the most common within this group. The unidentified whale calls

were similar in structure to calls previously reported from Bryde's whales in other parts of the Pacific (Oleson et al. 2003), though there are currently no visually verified reference signals from the Marianas or elsewhere in the western Pacific to determine species-ID of these signals. All baleen whale calls were detected in the winter and spring, with very few acoustic detections outside of that period, with the exception of the unidentified tonal and pulsed calls. All of these baleen species, except for the sei whale, were present within the HARP datasets collected from near Tinian and Saipan during 2010–2013 (Oleson et al. 2015). Fin whales were detected more frequently at Tinian in 2013–2014 than in prior years. Two sounds that were likely produced by Bryde's whales, but whose species-identity cannot be confirmed at this time, occurred year-round and were more prevalent in 2013–2014 than in previous years.

Based on measured received levels and propagation models, Oleson et al. (2015) concluded that there appears to be a spatial separation between different species of baleen whales that occur in the vicinity of Saipan. Based on the models from Saipan, minke whales appeared to be closest to the HARP deployment location, mostly at ranges 10 to 30 km (**Figure 11**). Calling fin whales may have occurred over a range of distances, from as close to 10 or 20 km to potentially even beyond the modeled detection range (100 km). The one blue whale call sequence measured was likely from a relatively distant whale (farther than 60 km). Calling humpback whales likely occurred within a range of 20 to 60 km, although more distant detections were also possible (see **Appendix A**). At Tinian, there was substantially less variation in range distributions in the measured examples of blue, fin and humpback whales, with all three species likely calling at a distance of more than 20 km, but with most closer than 100 km. This contrast could be attributed to the more complex bathymetry near the Saipan site which would produce greater differences in propagation distance for a single call.

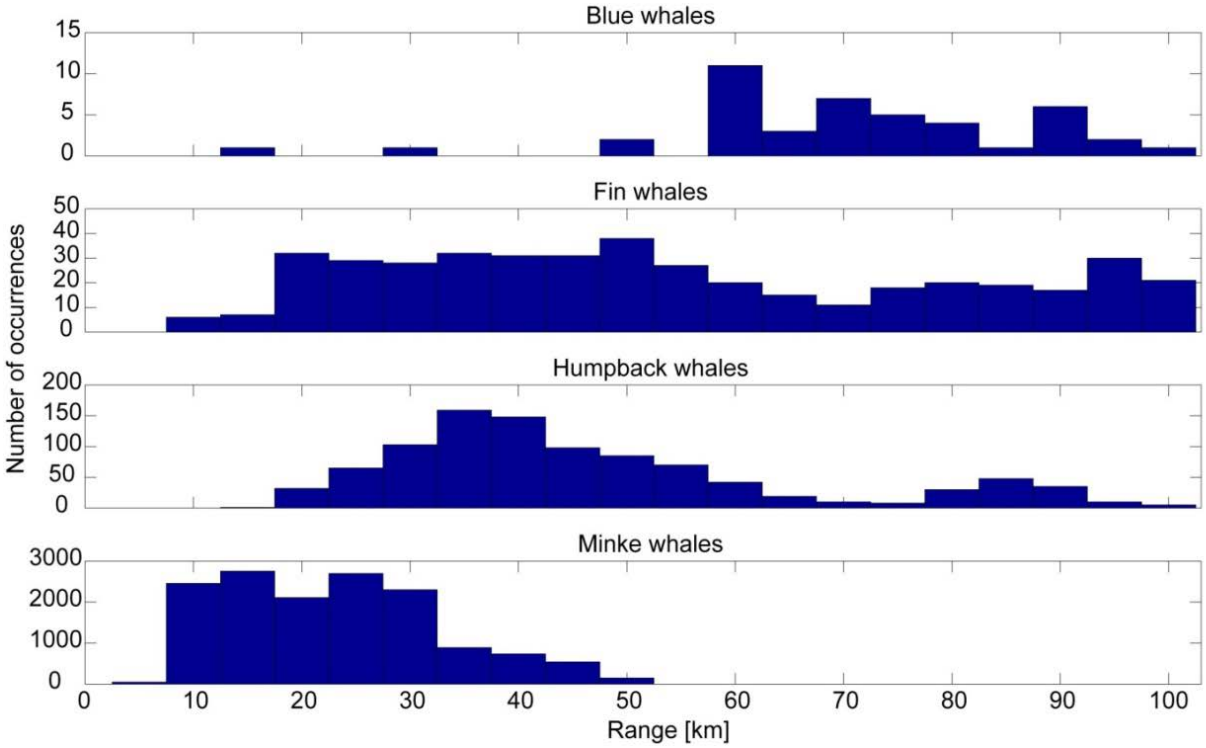

Figure 11. Distribution of possible range estimates based on measured received level and modeled transmission level for calling blue (top), fin (middle-top), humpback (middle-bottom), and minke whales (bottom) recorded at Saipan. Figure from Oleson et al. 2015 (Appendix A).

2.2.4.2 PASSIVE ACOUSTIC MONITORING: EARS [2]

Humpback whale calls (song units) were only detected at Saipan N, where they were detected on 4 days in December 2011 and 2 days in April 2012 (see **Appendix B**). These detections are consistent with the known pattern of winter-spring seasonal occurrence of humpback whales in other areas of the central tropical Pacific. No calls that matched HF sei whale calls (Norris et al. 2012) were detected, and likewise no blue or fin whale calls were detected in the recordings. Gaps in temporal coverage of the recordings prevent direct comparison of EAR results with HARP results at this time.

Three unidentified baleen whale calls were found by manually searching data collected at the EAR north of Guam, one in October and two in November 2011. The three unidentified calls were of two slightly different types; both types had a similar near-constant tonal portion with fundamental frequency < 200 Hz and harmonics between 400 and 600 Hz, but this tonal call was followed either by a 0.5-second upsweep from 700 to 800 Hz (October call) or an approximate 0.2-second downsweep at approximately 400 Hz (November calls). Munger et al. (2015) stated these calls may have been produced by Bryde's or sei whales. No seasonal trend could be inferred from so few detections.

One explanation for the rarity of baleen whale detections may be that the timing of recording was offset from seasonal migrations and the peak occurrence of baleen whales in the area. Humpback whales and other migratory baleen whale species are documented to occur primarily in winter months in other tropical and subtropical habitats. However, only two of the MIRC EARs (Guam N and Saipan N) deployed in September 2011 recorded through December and only one recorded into early January; no recordings took place between 06 January and 06 April. Thus, the study potentially missed the peak whale overwintering period for northern hemisphere habitats. Alternatively, few baleen whales may use the MIRC region, or they may occur outside the recording range of the EARs (e.g., farther offshore). Overall, due to gaps in temporal and spatial coverage, the paucity of baleen whale detections in EAR data is not a clear indication of the absence of these whales in the MIRC.

2.2.4.3 PASSIVE ACOUSTIC MONITORING: AUTONOMOUS GLIDERS [3]

There was comparatively little baleen whale activity in the area at the time of the fall glider survey. Sounds from at least one humpback whale were recorded on 22 October 2014 in offshore waters. The majority of mysticete detections were a new call type that Klinck et al. (2015) noted has not been described in the peer-reviewed literature to date (see **Appendix C**). This vocalization consisted of a short, approximately 30-Hz tone followed by a quick upsweep to 7.5 kHz, and resembles the minke whale "star wars" call described by Gedamke et al. (2001) and also has some characteristics of the minke whale "boing" vocalization (Rankin and Barlow 2005). This call was recorded in 45 encounters between 14 October and 06 November 2014.

2.2.4.4 VISUAL SURVEYS: SMALL-VESSEL SURVEYS [4,5,6,7]

Similar to NMFS PIFSC small-vessel survey effort in previous years, there were no sightings of baleen whales during the approximately 273 hr of NMFS PIFSC small-vessel surveys during

April through June 2014 around Guam, Saipan, Tinian, Aguijan, and Rota. Baleen whales in tropical habitats (e.g., Hawaii) are known to occur in peak numbers from January through April (Nishiwaki 1966), and were regularly observed in these months during the 2007 MISTCS (DoN 2007, Fulling et al. 2011). The primary intent of the April 2014 (winter/spring) survey effort was to locate humpback whales known to occur in the Marianas during winter months, although NMFS PIFSC did not encounter any during that survey (Hill et al. 2014). Nearshore, small-vessel surveys appear to be ill-suited to detect baleen whales in the region and may best be combined with other methods (e.g., PAM) in order to obtain more complete information about cetacean occurrence and distribution (HDR 2014).

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 [4,5,6,7]

Eighty-nine individual sea turtles were observed during 45 days of small-vessel surveys conducted from April through June 2014 (see **Appendix D**). Forty-eight percent (*n*=43) of turtles sighted were identified as green turtles, and there was one confirmed sighting of a hawksbill turtle. The majority (74 percent) of turtle sightings was made off Saipan, and most of those were either in or near the Smiling Cove Channel (**Figure 12**).

Twenty-four sea turtles were observed during 15 days of small-vessel surveys conducted during April 2014. Twelve green turtles, one hawksbill turtle, and 11 sea turtles of unknown species were observed. Twenty-two turtles (including the hawksbill turtle) were seen off Saipan and two turtles off Tinian.

Sixty-five sea turtles were observed during 30 days of small-vessel surveys conducted during May-June 2014. Thirty-one green turtles and 34 sea turtles of unknown species were observed. Seventeen turtles were seen off Guam — 2 off Rota, 1 off Aguijan, 1 Tinian, and 44 off Saipan. No sea turtle sightings were recorded in close proximity to U.S. Navy UNDET areas. The closest sighting to a U.S. Navy UNDET site was of an unidentified turtle, observed over 2.8 km from the Piti Floating Mine Neutralization Area (**Figure 13**).

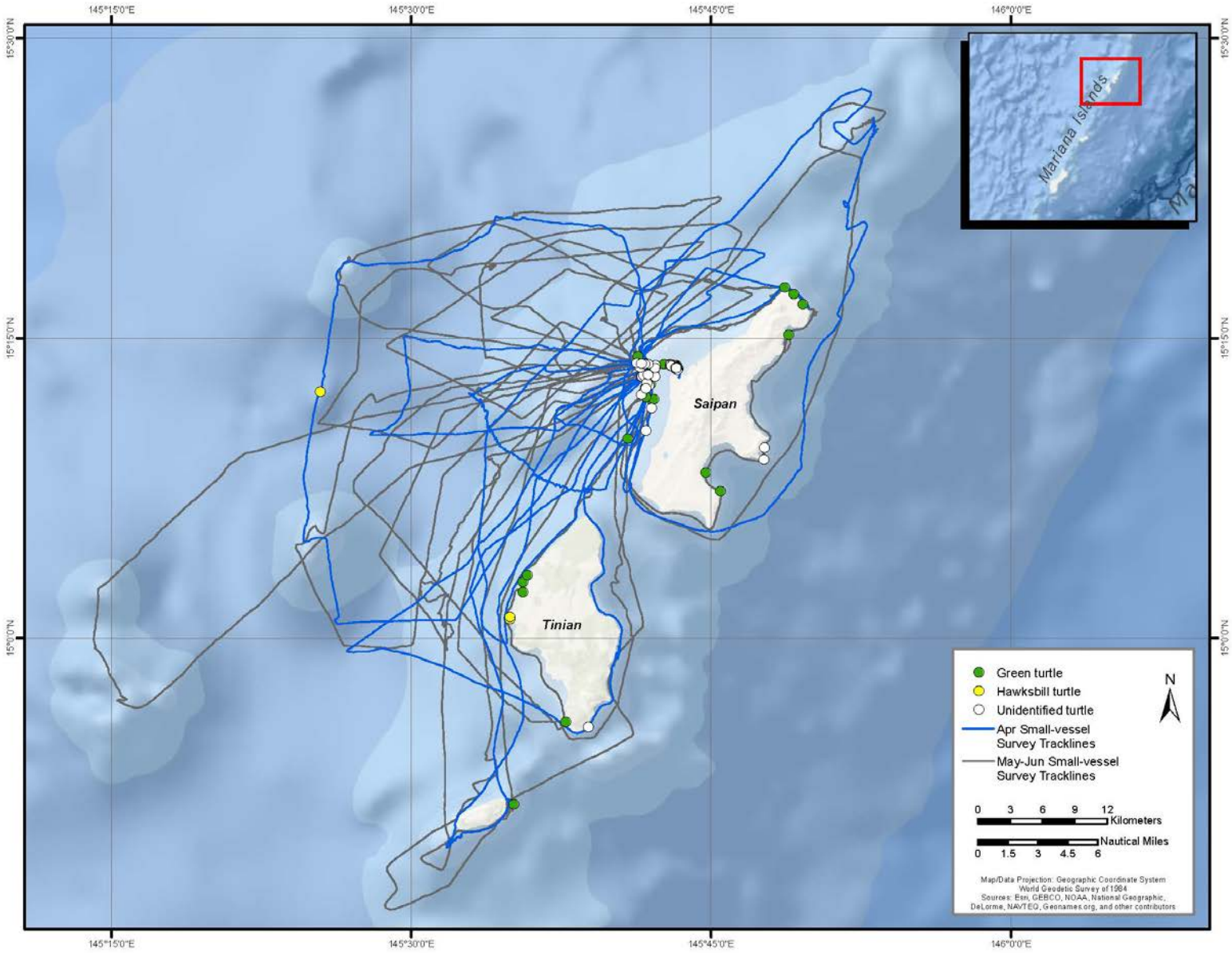

Figure 12. Sea turtle sightings and survey effort at Tinian and Saipan during small-vessel surveys conducted by NMFS PIFSC April--June 2014 [4].

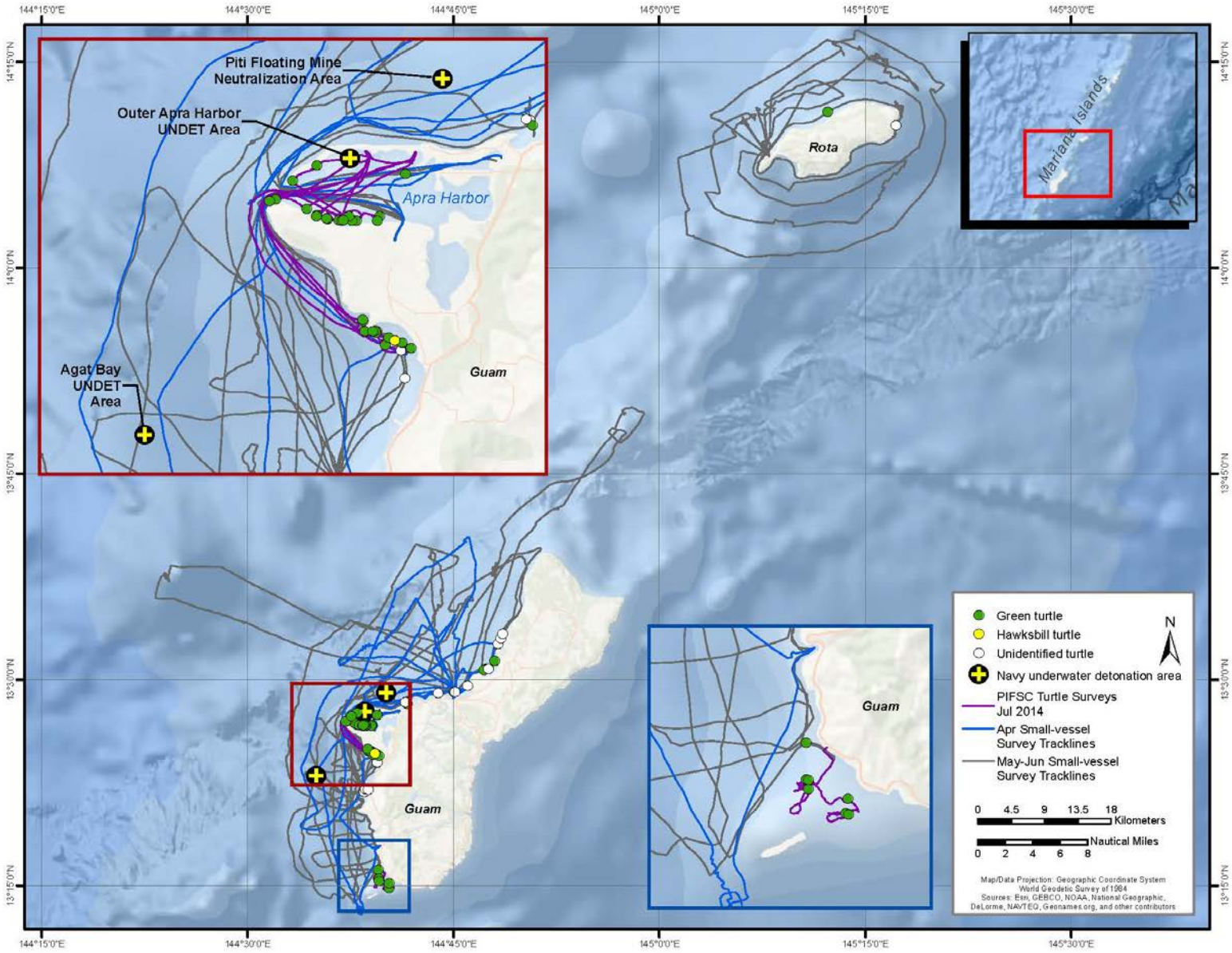

Figure 13. Sea turtle sightings and survey effort at Guam and Rota during small-vessel surveys conducted by NMFS PIFSC April--June 2014 [4] and sea turtle tagging surveys conducted by NMFS PIFSC in July 2014 [9]. (Tag data are not shown here).

2.2.5.2 VISUAL/TAGGING SURVEYS: SEA TURTLE SURVEYS [8,9]

During 2013[1] and 2014, 19 turtles (15 green, 4 hawksbill) were satellite tagged at Guam, Tinian and Saipan (**Figures 13** through **16**; also see **Appendix E**). In 2013, tagging survey effort at Guam was confined to the Cocos Lagoon region (**Figure 14**). In 2014, tagging survey effort took place in and around Apra Harbor, and at Cocos Lagoon (**Figure 13**). Kernel density estimates revealed high site fidelity and limited movements for the tagged green turtles, as well as for two of the tagged hawksbill turtles. The other two hawksbills displayed long-range movements, one traveling from Tinian to Guam, and the other from Tinian towards the Federated States of Micronesia. Areas of high turtle density included the waters inside and outside Apra Harbor (Guam) (**Figure 15)**, as well as the area stretching from the Balisa Channel to Mañagaha Island (Saipan) (**Figure 16**). Based on results from kernel density analysis, the area of highest potential overlap of sea turtles with U.S. Navy UNDET sites appears to be the Outer Apra Harbor UNDET Area. The closest turtle sighting to this U.S. Navy UNDET area was observed approximately 1 km away from the training site (**Figures 13** and **15**). A total of eight turtles have been instrumented with satellite tags in and near Apra Harbor. Future analysis will likely show more detailed movements in relation to the Outer Apra Harbor and Agat Bay UNDET Areas, as well as the Piti Floating Mine Neutralization Area (**Figure 13**).

[1] Although the 2013 portion of the turtle tagging work was conducted outside of the monitoring period for this annual report, analysis and reporting for both 2013 and 2014 were completed in August 2015 and are therefore discussed here. Data for 2013 and 2014 are presented separately in **Figures 12, 13, 15** and **16**.

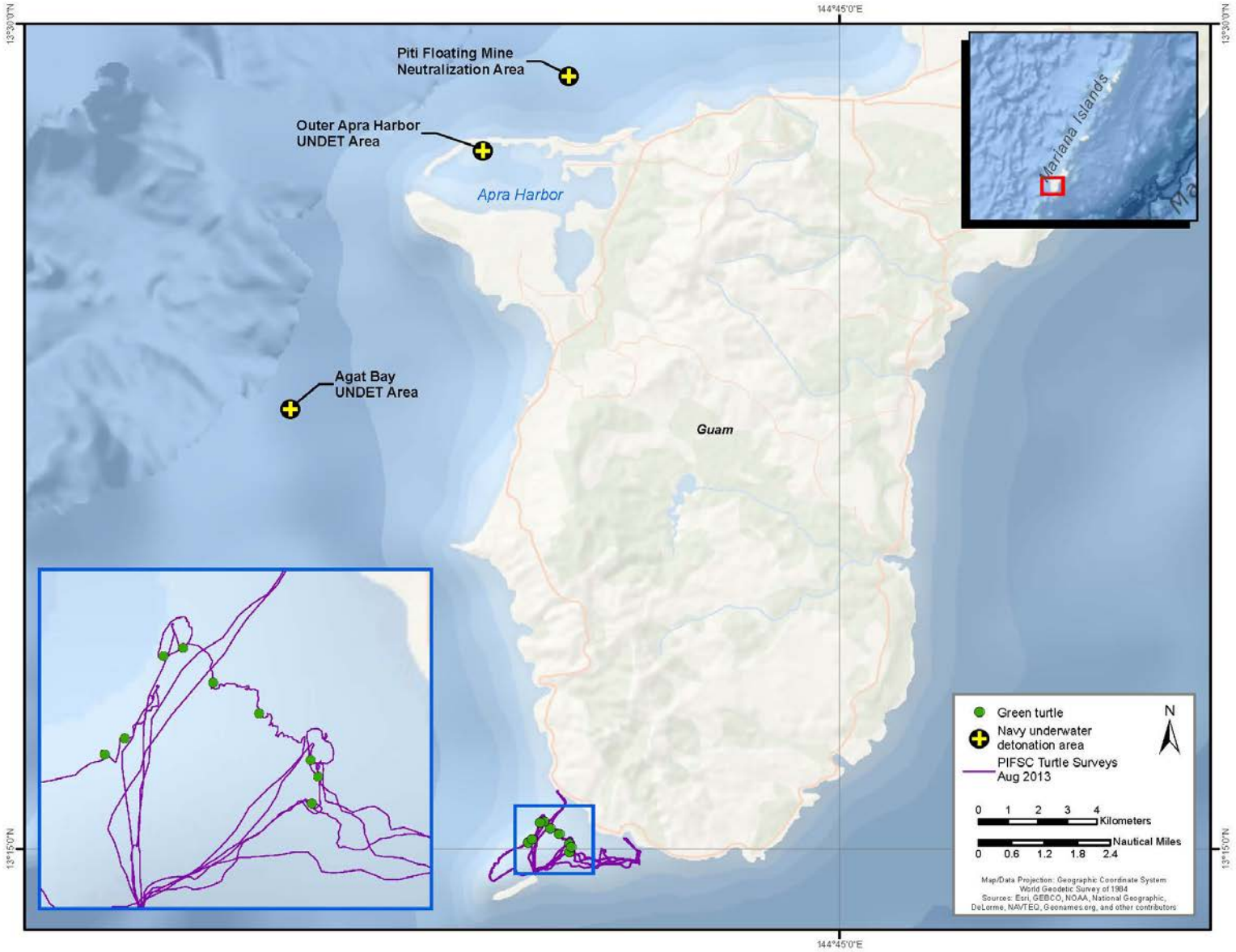

Figure 14. Sea turtle sightings and survey effort at Guam during sea turtle tagging surveys conducted by NMFS PIFSC in August 2013 [9]. (Tag telemetry data are not shown here).

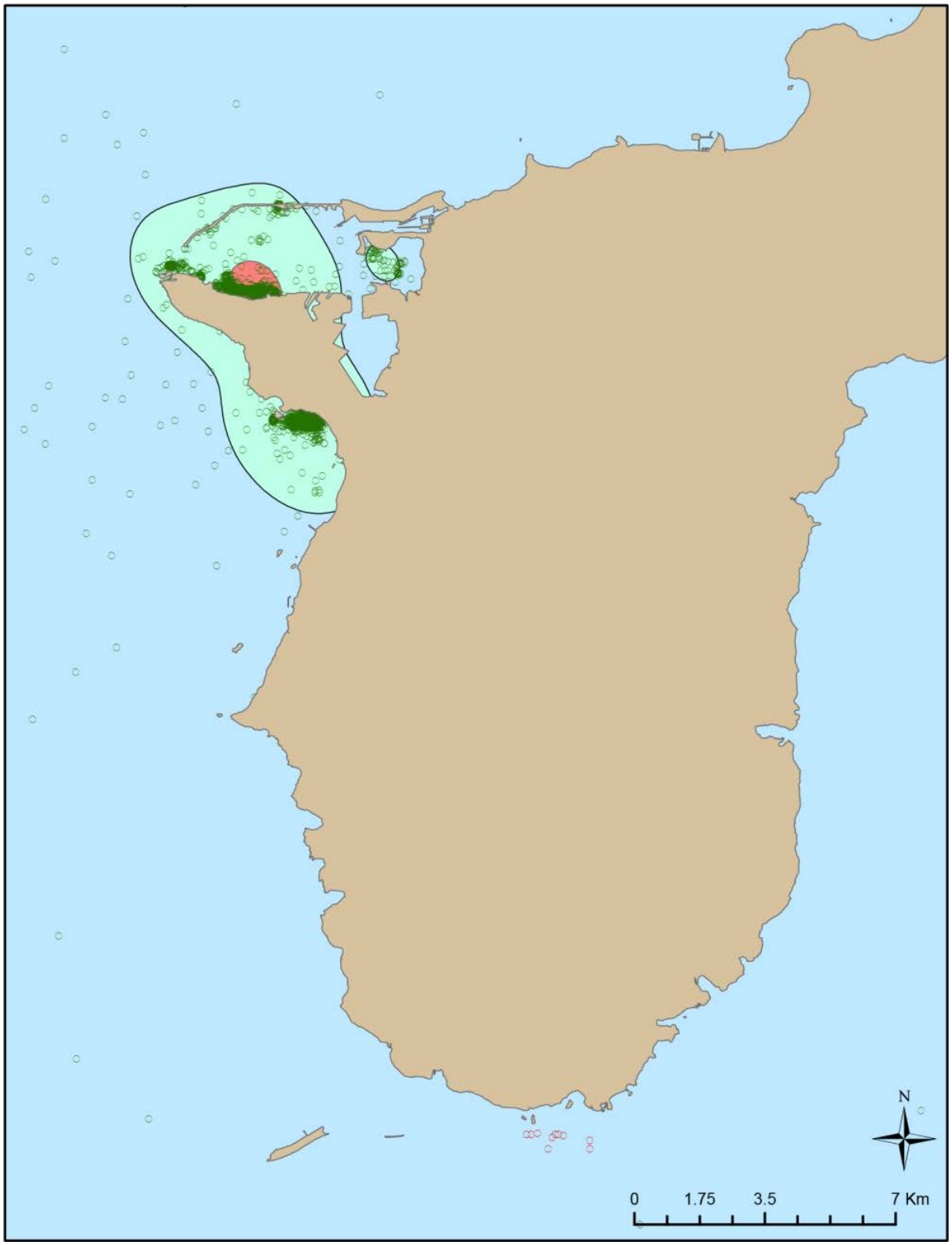

Figure 15. Map of Guam depicting spatial use of green turtles within Apra Harbor. Core-use areas (50 percent kernel density) are shown in orange, and overall home ranges (95 percent kernel density) are in light green. Green turtle tag locations are indicated by open green circles and hawksbill locations by open orange circles (3,911 locations from 8 turtles). Figure from Jones et al. 2015 (Appendix E).

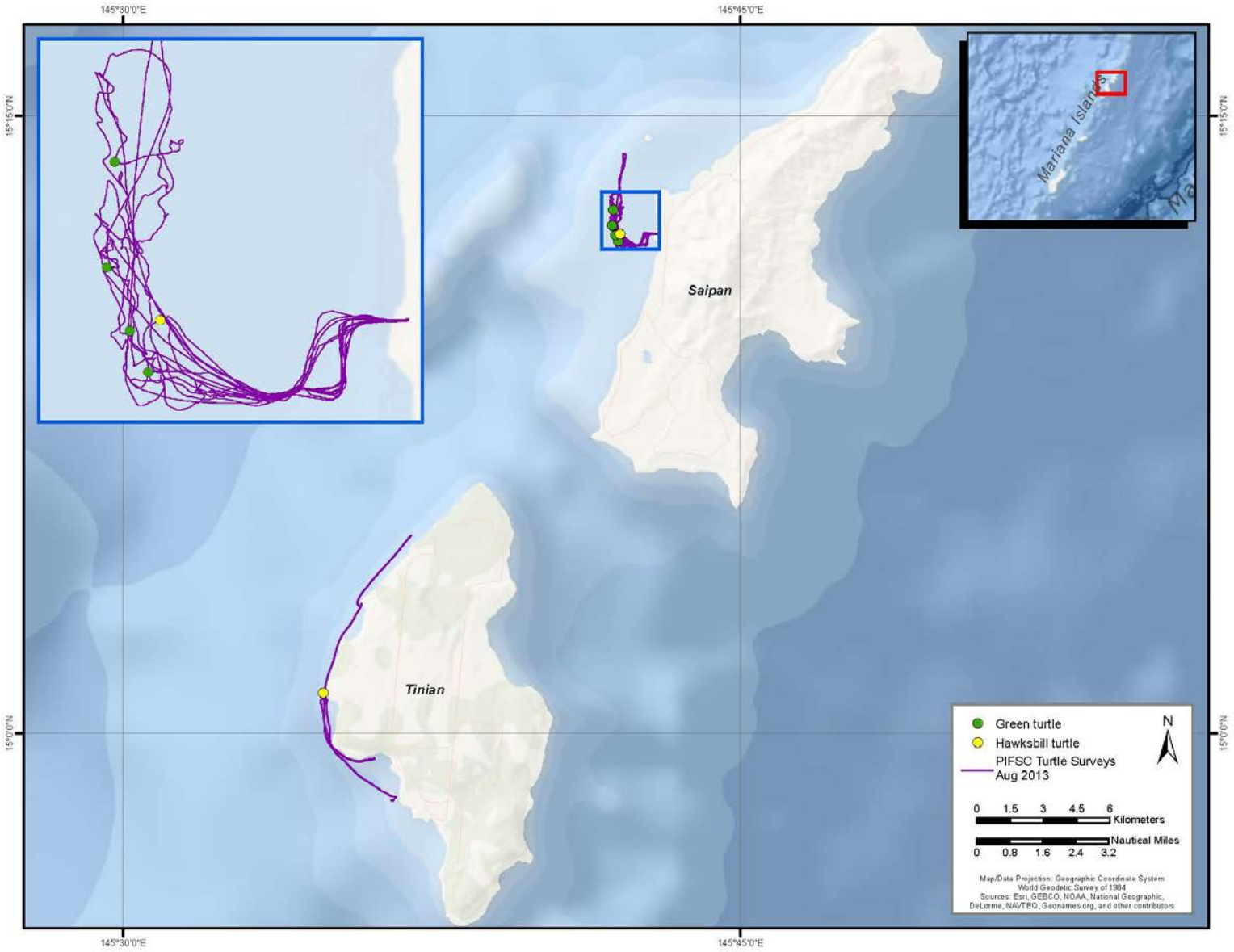

Figure 16. Sea turtle sightings and survey effort at Tinian and Saipan during sea turtle tagging surveys conducted by NMFS PIFSC in August 2013 [9]. (Tag data are not shown here).

3. Adaptive Management and Yearly Monitoring Goals

Planned FY16 monitoring implementation goals in the MITT study area are organized by monitoring questions, and are summarized in **Table 6**. Each monitoring question is accompanied by the corresponding overarching Intermediate Scientific Objectives developed for the Strategic Planning Process for Marine Species Monitoring (CNO 2013). The adaptive management review process will continue in FY16.

Table 6. Summary of monitoring implementation goals, FY16.

Monitoring Questions		Implementation goals	
		FY16	**Intermediate Scientific Objectives**
1. What species of marine mammals occur in the nearshore and offshore areas of the MITT study area?	ADAPTIVE MANAGEMENT REVIEW (AMR)	-Continue acoustic methodologies *(may include continued analysis of additional PAM datasets, applying new analysis methods to previously analyzed datasets, and/or deployment of PAM devices; and/or opportunistic dipping hydrophone recording; analysis of previously collected PAM data sets is likely to be prioritized over deployment of additional devices.)* -Continue visual methodologies *(may include small boat surveys, shore-based surveys, satellite tagging).*	Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals
2. What is the habitat use of cetaceans in the nearshore and offshore areas of the MITT study area?		-Continue acoustic methodologies *(may include continued analysis of additional PAM datasets, applying new analysis methods to previously analyzed datasets, and/or deployment of PAM devices; and/or opportunistic dipping hydrophone recording; analysis of previously collected PAM data sets is likely to be prioritized over deployment of additional devices.)* -Continue visual methodologies *(may include small boat surveys, diver surveys, satellite tagging)*	Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur Evaluate trends in distribution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives

Monitoring Questions	Implementation goals	
	FY16	Intermediate Scientific Objectives
3. What is the abundance and population structure of marine mammals in the MITT study area?	-Continue abundance and/or population structure analyses *(may include collection and analysis of tissue samples, mark-recapture photo-ID collection and analysis, and/or additional acoustic analysis methodologies of collected PAM datasets that may provide progress on this question)*	Estimate the distribution, abundance, and density of marine mammals and sea turtles in Navy range complexes, testing ranges, and in specific training and testing areas Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur Evaluate trends in distribution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives
4. What is the seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area?	-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.)*	Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals
5. What is the occurrence, habitat use, abundance and population structure of sea turtles in the MITT study area?	-Continue visual methodologies (*may include continued turtle observation on cetacean visual surveys, continued dedicated turtle survey; tagging and/or diver surveys.)*	Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur Evaluate trends in distribution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives

Monitoring Questions	Implementation goals	
	FY16	Intermediate Scientific Objectives
6. What is the exposure of cetaceans and sea turtles to explosives and/or sonar in the MITT study area?	*-Continue methodologies from #2, #3 and/or #5 above, for comparison to locations of explosive and/or sonar training*	Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur
7. What is the baseline vocalization behavior of marine mammals in the MITT study area?	-Continue acoustic methodologies (*may include analysis of previously collected moored PAM datasets, deployment of offshore autonomous devices, and opportunistic dipping hydrophone recordings)*	Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals

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4. Literature Cited

Baumann-Pickering, S., M.A. McDonald, A.E. Simonis, A. Solsona Berga, K.P.B. Merkens, E.M. Oleson, M.A. 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 134:2293-2301.

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

CNO (Chief of Naval Operations). 2013. U.S. Navy Strategic Planning Process for Marine Species Monitoring. Chief of Naval Operations, Arlington, Virginia.

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. Authors: Thorson P., Fulling G., Norris T., Hall C., Sawyer K. Prepared by Man-Tech SRS Technologies and Geo-Marine under Contract #N68711-02-D-8043 Task Order 0036, for Commander, US Pacific Fleet, Pearl Harbor, Hawaii.

DoN (Department of the Navy). 2010a. Mariana Islands Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement. Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawaii.

DoN (Department of the Navy). 2010b. Marine Species Monitoring Plan for the Mariana Islands Range Complex. Prepared for National Marine Fisheries Service, Protected Resources, Silver Spring, Maryland by U.S. Pacific Fleet Environmental Readiness Division, Pearl Harbor, Hawaii. May 2010.

DoN (Department of the Navy). 2010c. 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). 2012. Mariana Islands Range Complex Marine Species Monitoring Plan, FY13-2015. Prepared for the National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland by U.S. Pacific Fleet Environmental Readiness Division, Pearl Harbor, Hawaii.

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

DoN (Department of the Navy). 2014a. Marine Species Monitoring Report for the U.S. Navy's Mariana Island Range Complex – 2014 Annual Report. Department of the Navy, Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii. 15 April 2014

DoN (Department of the Navy). 2014b. Comprehensive Exercise and Marine Species Monitoring Report for The U.S. Navy's Mariana Islands Range Complex 2010-2014. Department of the Navy, Commander, US Pacific Fleet, Pearl Harbor, Hawaii. 31 October 2014.

DoN (Department of the Navy). 2015. Mariana Islands Training and Testing Activities Final Environmental Impact Statement/Overseas Environmental Impact Statement. Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawaii. May 2015.

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.Gedamke, J., D.P. Costa, and A. Dunstan. 2001. Localization and visual verification of a complex minke whale vocalization. Journal of the Acoustical Society of America 109:3038-3047.

HDR. 2014. Summary Report: Compilation of Visual Survey Effort and Sightings for Marine Species Monitoring in the Mariana Islands Range Complex. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii. Submitted to Naval Facilities Engineering Command Pacific (NAVFAC), EV2 Environmental Planning, Pearl Harbor, Hawaii under Contract No. N62470-10-D-3011, Task Order KB23, issued to HDR, Inc., Honolulu, Hawaii. 1 October 2014.

Hill, M., A. Ligon, M. Deakos, A. Ü, E. Norris, and E. Oleson. 2012. Cetacean Surveys of Guam and CNMI Waters: August - September, 2011. PIFSC Data Report DR-12-002. Pacific Islands Fisheries Science Center, National Marine Fisheries Service, Honolulu, Hawaii. Hill, M., A. Ligon, M. Deakos, A. Ü, A. Milette-Winfree, and E. Oleson. 2013a. Cetacean Surveys in the Waters of the Southern Mariana Archipelago (2010 –- 2012). PIFSC Data Report DR-13-005. Prepared for the U.S. Pacific Fleet Environmental Readiness Office, Pearl Harbor, Hawaii by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii. 25 February 2013.

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 the U.S. Pacific Fleet Environmental Readiness Office, Pearl Harbor, Hawaii by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii. 2 September 2014.

Hill, M.C., A.D. Ligon, M.H. Deakos, A.C. Ü, A.J. Milette-Winfree, and E.M. Oleson. 2013c. Cetacean Surveys of Guam and CNMI Waters: May - July, 2012: Including Individual Photo-identification of Pilot Whales, Spinner Dolphins and Bottlenose Dolphins (2010-2012). PIFSC Data Report DR-13-001. Prepared for the U.S. Pacific Fleet Environmental Readiness Office by the National Marine Fisheries Service, Pacific Island Fisheries Science Center, Honolulu, Hawaii.

Hill M.C., A.D. Ligon, M.H. Deakos, A.C. Ü, A. Milette-Winfree, A.R. Bendlin, and E.M. Oleson. 2014. Cetacean Surveys in the Waters of the Southern Mariana Archipelago (February 2010 – April 2014). PIFSC Data Report DR-14-013. Prepared for the U.S. Pacific Fleet Environmental Readiness Office, Pearl Harbor, Hawaii by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii. 2 September 2014

Hill M.C., E.M. Oleson, A.D. Ligon, K.K. Martien, F.I. Archer, S. Baumann-Pickering, A.R. Bendlin, L. Dolar, K.P.B. Merkens, A. Milette-Winfree, P.A. Morin, A. Rice, K. M. Robertson, J.S. Trickey, A.C. Ü., A.M. Van Cise, and S.M. Woodman. 2015. Cetacean Monitoring in the Mariana Islands Range Complex, 2014. PIFSC Data Report DR-15-003. Prepared for the U.S. Pacific Fleet Environmental Readiness Office, Pearl Harbor, Hawaii by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii. 27 March 2015.

Jones, T.T., and K.S. Van Houtan. 2014. Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC). Interim Report. Prepared for the U.S. Navy by the Marine Turtle Assessment Group, Protected Species Division, Pacific Islands Fisheries Science Center, National Marine Fisheries Service, Honolulu, Hawaii. May 2014.

Jones, T.T., S.L. Martin, and K.S. Van Houtan. 2015. Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC) – Progress Report. Prepared for the Commander, U.S. Pacific Environmental Readiness Office, Pearl Harbor, Hawaii by NOAA Fisheries, Marine Turtle Assessment Group, Protected Species Division, Pacific Islands Fisheries Science Center, Honolulu, Hawaii. September 2015.

Klinck, H., S.L. Nieukirk, S. Fregosi, K. Klinck, D.K. Mellinger, S. Lastuka, G.N. Shilling, and J.C. Luby. 2015. Cetacean Studies on the Mariana Islands Range Complex in September-November 2014: Passive Acoustic Monitoring of Marine Mammals Using Gliders. Final Report. Prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command Pacific, Pearl Harbor, Hawaii under Contract No. N62470-10-D-3011, Task Order KB25, issued to HDR Inc., Honolulu, Hawaii. August 2015.

Martien, K.K., M.C. Hill, A.M. Van Cise, K.M. Robertson, S.M. Woodman, L. Dollar, V.L. Pease, and E.M. Oleson. 2014. Genetic Diversity and Population Structure in Four Species of Cetaceans Around the Mariana Islands. NOAA Technical Memorandum NMFS-SWFSC-536. National Marine Fisheries Service, La Jolla, California. August 2014.

Martien, K.K., S.M. Woodman, K.M. Robertson, M.C. Hill, L. Dolar, F.I. Archer, and E.M. Oleson. 2015. Appendix I: Introgressive Hybridization of Fraser's Dolphin Mitochondrial and Nuclear DNA into Mariana Islands Bottlenose Dolphins. In: Hill, M.C., E.M. Oleson, A.D. Ligon, K.K. Martien, F.I. Archer, S. Baumann-Pickering, A.R. Bendlin, L. Dolar, K.P.B. Merkens, A. Milette-Winfree, P.A. Morin, A. Rice, K. M. Robertson, J.S. Trickey, A.C. Ü., A.M. Van Cise, and S.M. Woodman. 2015. Cetacean Monitoring in the Mariana Islands Range Complex, 2014. PIFSC Data Report, DR-15-003. National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, D.W. Johnston, and J.J. Polovina. 2009. An acoustic survey of beaked whales at Cross Seamount near Hawaii. Journal of the Acoustical Society of America 125:624-627.

Morin, P.A., A.M. Van Cise, and K.K. Martien. 2015. Appendix II: Mitogenome Phylogeography of Short-finned Pilot Whales in the North Pacific, With Reference to the Mariana Islands. In: Hill, M.C., E.M. Oleson, A.D. Ligon, K.K. Martien, F.I. Archer, S. Baumann-Pickering, A.R. Bendlin, L. Dolar, K.P.B. Merkens, A. Milette-Winfree, P.A. Morin, A. Rice, K. M. Robertson, J.S. Trickey, A.C. Ü., A.M. Van Cise , and S.M. Woodman. 2015. Cetacean Monitoring in the Mariana Islands Range Complex, 2014. PIFSC Data Report, DR-15-003. National Marine Fisheries Service, Pacific Islands Fisheries Science Center, 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. Prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command Pacific, Pearl Harbor, HI under Contract No. N62470-10-D-3011, Task Orders KB14 and KB 17, issued to HDR Inc., Honolulu, Hawaii. Prepared by Oceanwide Science Institute, Honolulu, Hawaii and Hawaii Institute of Marine Biology, Kaneohe, Hawaii. February 2014.

Munger, L.M., M.O. Lammers, J.N. Oswald, T.M. Yack, and W.W.L. Au. 2015. Passive Acoustic Monitoring of Cetaceans within the Mariana Islands Range Complex (MIRC) Using Ecological Acoustic Recorders (EARs). Final Report. Prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command Pacific, Pearl Harbor, Hawaii, under Contract No. N62470-10-D-3011, Task Orders KB14 and KB22, issued to HDR Inc., Honolulu, Hawaii. 29 September 2015.

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

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. 3 August 2010.

NMFS (National Marine Fisheries Service). 2012a. Letter of Authorization to Take Marine Mammals Incidental to Navy Exercises Conducted in the Mariana Islands Range Complex. Valid for 12 August 2012 through 3 August 2015. 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 2015. Prepared for U.S. Navy, Pacific Fleet, Pearl Harbor, Hawaii by National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. Issued June 31, 2012.

NMFS (National Marine Fisheries Service). 2015a. Takes of marine mammals incidental to specified activities; U.S. Navy training and testing activities in the Mariana Islands Training and Testing Study Area; Final Rule. Federal Register 80(148):46111 -46171.

NMFS (National Marine Fisheries Service). 2015b. Letter of Authorization for Navy Training Activities Conducted in the Mariana Islands Training and Testing Study Area. Valid for 3 August 2015 through 3 August 2020. Issued July 31, 2015.

NMFS (National Marine Fisheries Service). 2015c. Letter of Authorization for Navy Testing Activities Conducted in the Mariana Islands Training and Testing Study Area. Valid for 3 August 2015 through 3 August 2020. Issued July 31, 2015.

NMFS (National Marine Fisheries Service). 2015d. Biological Opinion for U.S. Military Mariana Islands Testing and Training Activities from August 2015 to August 2020. Prepared for U.S. Navy, Pacific Fleet, Pearl Harbor, Hawaii by National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. Issued June 12, 2015.

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, U.S. Pacific Fleet, Pearl Harbor, Hawaii. Submitted to Naval Facilities Engineering Command Pacific, EV2 Environmental Planning, Pearl Harbor, Hawaii, under Contract No. N62470-10D-3011, CTO KB08 issued to HDR, Inc., Honolulu, HI. March 2012. Updated 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.

Oleson, E.M., and M.C. Hill. 2010. 2010 Report to PACFLT: Report of Cetacean Surveys in Guam, CNMI, and the High-seas. Prepared for U.S. Pacific Fleet Environmental Readiness Office by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii.

Oleson, E.M., J. Barlow, J. Gordon, S. Rankin, and J.A. Hildebrand. 2003. Low frequency calls of Bryde's whales. Marine Mammal Science 19:407-419.

Oleson, E.M., S. Baumann-Pickering, A. Širović, K.P. Merkens, L.M. Munger, J.S. Trickey, and P. Fisher-Pool. 2015. Analysis of Long-term Acoustic Datasets for Baleen Whales and Beaked Whales Within the Mariana Islands Range Complex (MIRC) for 2010 to 2013. PIFSC Data Report DR-15-002. Prepared for the U.S. Pacific Fleet Environmental Readiness Office, Pearl Harbor, Hawaii by National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii. 18 February 2015.

Oswald, J.N., J. Barlow, and T.F. Norris. 2003. Acoustic identification of nine delphinid species in the eastern tropical Pacific Ocean. Marine Mammal Science 19:20-37.

Oswald, J.N., S. Rankin, J. Barlow, and M.O. Lammers. 2007. A tool for real-time acoustic species identification of delphinid whistles. Journal of the Acoustical Society of America 122:587-595.

Rankin, S., and J. Barlow. 2005. Source of the North Pacific "boing" sound attributed to minke whales, Journal of the Acoustical Society of America 118:3346-3351.

Uyeyama, R.K. 2014. Compilation of Incidental Marine Mammal and Sea Turtle Sightings in the Mariana Islands Range Complex. Prepared for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii by Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawaii. September 2014.