2015 U.S. Navy Annual Marine Species Monitoring Report for the Pacific:

A Multi-Range Complex Monitoring Report for Hawaii-Southern California Training and Testing (HSTT), Mariana Islands Training and Testing (MITT), Northwest Training and Testing (NWTT), and the Gulf of Alaska Temporary Maritime Activities Area (GOA TMAA)

Prepared For and Submitted To

National Marine Fisheries Service

Office of Protected Resources

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Photo Credit:
False killer whales (*Pseudorca crassidens*) in the Mariana Islands photographed by NMFS-PIFSC under NMFS Permit No. 15240 and CNMI-DFW permit, license no. 03086-2015.

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14. ABSTRACT
This is the first “multi-Range Complex” report that describes progress of knowledge made during 2015 with respect to monitoring plan study questions across multiple U.S. Navy training and testing ranges, with similar study questions treated together so that progress on each topic may be summarized across multiple ranges: U.S. Navy's Hawaii-Southern California Training and Testing (HSTT), Mariana Islands Training and Testing (MITT), Northwest Training and Testing (NWTT), and the Gulf of Alaska Temporary Maritime Activities Area (GOA TMAA). In 2015, the majority of U.S. Pacific Fleet-funded monitoring efforts focused on documenting the occurrence of protected marine species in U.S. Navy training and testing ranges. Highlights of this progress include the following:

- Analyzed passive acoustic monitoring data from High-frequency Acoustic Recording Packages (HARPs) in the MITT, SOCAL, NWTT, and GOA TMAA, providing information on marine mammal species’ presence and seasonal occurrence.
- Analyzed passive acoustic monitoring data from a series of pilot surveys using autonomous high-frequency gliders in deep offshore waters of MITT, HRC, NWTT, and GOA TMAA providing information on marine mammal species’ presence in these remote locations.
- Conducted visual cetacean surveys and tagging, and recorded acoustic activity with dipping hydrophones offshore of Guam and Rota, illuminating species’ presence in nearshore waters of the MITT. Photographs, tags, and biopsy samples are being processed to provide information on habitat use and population structure.
- Conducted a shore-station pilot survey in Guam that confirmed spinner dolphin (Stenella longirostris), bottlenose dolphin (Tursiops truncatus), and melon-headed whale (Peponocephala electra) presence offshore in waters relatively

inaccessible to small boat surveys, and also validated this methodology for consideration in future surveys at other locations

- Used genetic analyses to a) study the regional and local genetic structure in Pacific short-finned pilot whales (Globicephala macrorhynchus), and b) determine that male pilot whales in the Mariana Islands tend to stay in familial social groups, and prefer to mate outside social groups.
- Examined archived acoustic data collected by Pacific Missile Range Facility (PMRF) hydrophones from limited archives in 2011 to 2013 to assess changes in Blainville's beaked whale (Mesoplodon densirostris) dive counts; system operation was arranged to result in near-continuous data records beginning early 2016.
- The capability of using the instrumented range at PMRF is being developed to detect, localize, and track various species including humpback whale (Megaptera novaeangliae), minke whale (Balaenoptera acutorostrata), sperm whale (Physeter macrocephalus), beaked whales, and low-frequency baleen whales. This capability is intended to be combined with Navy exercise products to estimate received level of mid-frequency active sonar (MFAS) at the animals. A case study of estimation of received levels and acoustic behavioral response was conducted with fin and minke whales during a Navy training event in February 2015.
- Conducted odontocete visual surveys (including photography, biopsy, and satellite tagging) to collect data to be used in conjunction with marine mammal monitoring on Navy ranges passive acoustic monitoring at PMRF; established fin whale (Balaenoptera physalus) photo-identification (photo-ID) catalog with 13 unique individuals; first fin whales sighted during small-vessel surveys off Kauai and Niihau; first dwarf sperm whales (Kogia sima) identified during these surveys since 2003.
- Analyzed existing acoustic detections, tentatively attributed to false killer whales (Pseudorca crassidens), recorded at PMRF during periods when false killer whales equipped with satellite tags were present; used Real-time Odontocete Call Classification Algorithm to confirm species classification.
- Deployed satellite tags on blue whales (Balaenoptera musculus), fin whales, a blue/fin hybrid whale, and a Bryde's whale (Balaenoptera edeni) to study movement patterns and habitat use along the West Coast; analyzed genetics samples to determine sex of the individuals, to define haplotypes for stock analysis, and to confirm species identification. Other achievements include:
  - Documented travel of satellite-tagged baleen whales in SOCAL moving throughout the range and into the NWTT.
  - Advanced dive behavior tags allowed identification of foraging lunges, and description of individual variations in foraging with respect to habitat type.
  - One tagged animal confirmed as a blue/fin whale hybrid; obtained the first-ever tracking data on such a hybrid. Also obtained some of the first information on Bryde's whale movement patterns in SOCAL; determined different blue whale individuals may preferentially use different portions of waters in SOCAL.
- Deployed satellite tags on Southern Resident Killer Whales (SRKW) (Orcinus orca) in the NWTT and documented their nearshore preference of offshore coastal waters.
- Deployed satellite tags on California sea lions (Zalophus californianus) in NWTT to document movement patterns and foraging areas in relation to U.S. Navy bases in Puget Sound. Study efforts also identified differences in dive duration and depth between inland and offshore waters, as well as provided data on the amount of time spent in-water vs hauled out.
- Advanced the state of science for passive acoustic analysis of anthropogenic impacts to select marine mammal species in SOCAL. This multipart effort continued annual data collection and reporting of marine mammal vocalizations and echolocation signals as well as anthropogenic sounds recorded from three bottom-mounted passive acoustic devices. A related effort explores the entire multiyear passive datasets to prepare data for future statistical analysis on anthropogenic effects to blue whales, fin whales, and Cuvier's beaked whales (Ziphius cavirostris). Another project aspect is to further define fin whale population structure specific to Southern California. Finally, initial steps to define passive acoustic derived Cuvier's beaked whale densities in SOCAL was begun.
- Conducted systematic line-transect aerial surveys for marine mammals in Puget Sound, Washington; estimated in-water density and abundance of marine mammals, particularly harbor porpoise (Phocoena phocoena) and harbor seals (Phoca vitulina); confirmed recolonization of the region by harbor porpoise.
- Recorded acoustic activity of Stejneger's beaked whale (Mesoplodon stejnegeri) in the NWTT and demonstrated ability for gliders to monitor marine mammals in remote offshore areas of the HRC, MITT, NWTT and the GOA TMAA.
- Continued transition of the Marine Mammal Monitoring on Navy Ranges (M3R) project from the Navy's Living Marine Resources applied research program to U.S. Pacific Fleet compliance monitoring.

15. SUBJECT TERMS
Monitoring, marine mammal, sea turtles, adaptive management review, Hawaii Range Complex, Southern California Range Complex, Northwest Training Range Complex, Mariana Islands Range Complex, Gulf of Alaska Maritime Activities Area

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Executive Summary

The United States (U.S.) Navy conducts training and testing activities in the study areas described in the following Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) documents: Hawaii-Southern California Training and Testing (HSTT) (Department of Navy [DoN] 2013a), Mariana Islands Training and Testing (MITT) (DoN 2015a), Northwest Training and Testing (NWTT) (DoN 2015b), and the Gulf of Alaska Navy Training Activities (DoN 2011a). The ranges covered by these documents include the Hawaii Range Complex (HRC), Southern California Range Complex (SOCAL), Mariana Islands Range Complex (MIRC), Northwest Training Range Complex (NWTRC), Keyport Range Complex, and the Gulf of Alaska Temporary Maritime Activities Area (GOA TMAA).

To authorize these actions, the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (MMPA) issued 5-year Final Rules to Commander, U.S. Pacific Fleet and Commander, Naval Sea Systems Command for HSTT (NMFS 2013a), MITT (NMFS 2015a), NWTT (NMFS 2015e), and GOA TMAA (NMFS 2011a, b); Letters of Authorization (LOA) under the MMPA for HSTT (NMFS 2013b, c), MITT (NMFS 2015b), NWTT (NMFS 2015f, g), and GOA TMAA (NMFS 2011c, 2013d); and Biological Opinions under the Endangered Species Act (ESA) for HSTT (NMFS 2014a), MITT (NMFS 2015c), NWTT (NMFS 2015h), and the GOA TMAA (NMFS 2011d, 2013e).

The U.S. Navy is required by the Final Rules, LOAs, and Biological Opinions above to implement marine species monitoring. The regulations issued with the Final Rules for HSTT, MITT, NWTT, and GOA TMAA require the U.S. Navy to submit an annual monitoring report, as specified at 50 Code of Federal Regulations (CFR) § 218.75(e) (HSTT), § 218.95(e) (MITT), § 218.145(f) (NWTT), and § 218.125(d) (GOA TMAA).

This monitoring report was prepared in accordance with the annual monitoring reporting requirements for 2015, as described in these regulations.

The marine species monitoring described in this report was conducted in accordance with project objectives listed on the U.S. Navy's Marine Species Monitoring website: http://www.navymarinespeciesmonitoring.us/regions/pacific/current-projects/.

MMPA authorizations are issued for a period of 5 years. Monitoring under the first five (5) year permits focused on effort-based metrics while monitoring under the second set of five (5) year permits are focused on question-based scientific objectives. The MITT and HSTT monitoring programs are currently within the second set of five (5) year authorizations and environmental planning for the U.S. Navy and therefore, monitoring goals are framed in terms of progress made on scientific monitoring questions and programmatic Intermediate Scientific Objectives. NWTT also transitioned late in 2015 to a monitoring program associated with its second set of five (5) year authorizations. Therefore, monitoring associated with NWTT for 2015 includes ongoing data collection spanning the shift from the original effort-based compliance metrics to programmatic question-based scientific objectives. For 2015, the GOA TMAA remains in its

original effort-based compliance regime, so in this report, monitoring goals for this range are related to effort metrics, e.g., numbers of instruments deployed.

Within the Integrated Comprehensive Monitoring Plan, a Scientific Advisory Group (SAG) assembled in 2011 developed a conceptual framework to assess monitoring for marine protected species. The overall approach is to address opportunities and goals throughout naval ranges to assess monitoring within four (4) **conceptual framework categories**:

- **Occurrence** – gathers basic information on the presence and diversity of species that occur in a Navy range or area of proposed training activity; information by patterns of habitat use, population structure, density, abundance, and behavioral ecology (e.g., feeding, mating, migrating).
- **Exposure** – examines Navy training activities including where, when, and how often sources are being used, types and properties of generated sounds, and sound propagation to determine received levels and other metrics. Exposure and occurrence information may be coupled to estimate number of individuals from each population that are exposed to specific sound levels.
- **Response** – investigates how animals react to exposure across spatial (e.g., changes in habitat) and temporal (short-term, medium-term, and long-term) scales, behavioral and social interactions. The findings on responses may be useful in refining exposure estimates.
- **Consequences** – considers species occurrence and habitat use cumulatively to determine long-term impacts of exposure and responses. These investigations include evaluating long-term impacts on distribution, behavior, social groups, and foraging success and their effects to fitness through reproduction, growth, and survival.

In 2015, the majority of monitoring efforts focused on documenting the occurrence of protected marine species in U.S. Navy training and testing ranges. Several projects also involved estimating the exposure of these animals to sonar and explosives, and assessing animals' responses to underwater noise generated by U.S. Navy training and testing activities. Highlights of this progress include the following:

- Analyzed passive acoustic monitoring data from High-frequency Acoustic Recording Packages (HARPs) in the MITT, SOCAL, NWTT, and GOA TMAA, providing information on marine mammal species' presence and seasonal occurrence.
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Acronyms and Abbreviations

ADB	advanced dive behavior
ASW	anti-submarine warfare
AUTEC	Atlantic Undersea Test and Evaluation Center
BSS	Beaufort sea state
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CE	Cape Elizabeth
CFR	Code of Federal Regulations
CNMI	Commonwealth of the Northern Mariana Islands
CRC	Cascadia Research Collective
CSBW	Cross Seamount beaked whale
dB re 1µPa	decibel(s) referenced to 1 micro Pascal
DDG	guided missile destroyer
EAR	Ecological Acoustic Recorder
EIS	Environmental Impact Statement
ESA	Endangered Species Act of 1973
FY	fiscal year
GOA TMAA	Gulf of Alaska Temporary Maritime Activities Area
HARP	High-frequency Acoustic Recording Package
HPU	Hawaii Pacific University
hr	hour(s)
HRC	Hawaii Range Complex
HSTT	Hawaii-Southern California Training and Testing
Hz	Hertz
ISO	Intermediate Scientific Objective
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
M3R	Marine Mammal Monitoring on Navy Ranges
MFAS	mid-frequency active sonar
min	minute(s)
MIRC	Mariana Islands Range Complex
MITT	Mariana Islands Training and Testing
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act of 1972
mtDNA	mitochondrial DNA
MTE	major training event
NMFS	National Marine Fisheries Service
NUWC	Naval Undersea Warfare Center
NWTRC	Northwest Training Range Complex
NWTT	Northwest Training and Testing
NOAA	National Oceanic and Atmospheric Administration
OEIS	Overseas Environmental Impact Statement
PAM	passive acoustic monitoring
Photo-ID	photo-identification
PIFSC	Pacific Islands Fisheries Science Center
PMEL	Pacific Marine Environmental Laboratory
PMRF	Pacific Missile Range Facility
PTT	Platform Transmitter Terminal
QC	Quinault Canyon
QRS	Quinault Range Site
ROCCA	Real-time Odontocete Call Classification Algorithm
SAG	Scientific Advisory Group
SCC	Submarine Commanders Course
SCI	San Clemente Island
SCORE	Southern California Offshore Range
SD	standard deviation
SOAR	Southern California Offshore Antisubmarine Warfare Range
SOCAL	Southern California Range Complex
SPAWAR	Space and Naval Warfare Systems Command
SPOT	Smart Position and Temperature
SRKW	Southern Resident Killer Whale
SWFSC	Southwest Fisheries Science Center
TMAA	Temporary Maritime Activities Area
U.S.	United States
YOY	young of the year

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1. Introduction

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To authorize these actions, the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (MMPA) issued 5-year Final Rules to Commander, U.S. Pacific Fleet and Commander, Naval Sea Systems Command for HSTT (NMFS 2013a), MITT (NMFS 2015a), NWTT (NMFS 2015e), and GOA TMAA (NMFS 2011a, b); Letters of Authorization (LOA) under the MMPA for HSTT (NMFS 2013b, c), MITT (NMFS 2015b), NWTT (NMFS 2015f, g), and GOA TMAA (NMFS 2011c, 2013d); and Biological Opinions under the Endangered Species Act (ESA) for HSTT (NMFS 2014a), MITT (NMFS 2015c), NWTT (NMFS 2015h), and the GOA TMAA (NMFS 2011d, 2013e).

The Final Rules, LOAs, and Biological Opinions above require the U.S. Navy to implement marine species monitoring. The regulations issued with the Final Rules for HSTT, MITT, NWTT, and GOA TMAA require the U.S. Navy to submit an annual monitoring report, as specified at 50 CFR § 218.75(e) (HSTT), § 218.95(e) (MITT), § 218.145(f) (NWTT), and § 218.125(d) (GOA TMAA).

This monitoring report was prepared in accordance with the annual monitoring reporting requirements for 2015, as described in these regulations.

Because a) the annual monitoring reporting period coincides with the calendar year, and b) some of the Final Rules listed above were published in the middle of the calendar year, the monitoring described in this report covers various periods that all culminate on the last day of the calendar year: 1 January to 31 December 2015 for HSTT, 3 August to 31 December 2015 for MITT, 24 November[1] to 31 December 2015 for NWTT, and 1 November to 31 December 2015 for GOA TMAA. The above regulations also specify that the annual monitoring reports present cumulative results through the period of the authorizations. Therefore, the results for HSTT monitoring, which is in its second year, will also include cumulative results incorporating results from the previous year of monitoring, previously presented in the HSTT year-1 annual monitoring report (DoN 2015e).

[1] The NWTT LOA (NMFS 2015f) lists an *effective date* of 24 November, 2015, and an *applicability date* of 9 November 2015 through 8 November 2020.

Furthermore, the regulations cited above for HSTT, MITT, and NWTT (i.e., § 218.75(e), § 218.95(e), and § 218.145(f), respectively) are associated with the second set of five (5) year authorizations for these ranges, and have in common an option for satisfying the monitoring report requirement with a multi-range report:

> *"…the Navy may submit a multi-Range Complex annual Monitoring Plan report to fulfill this requirement. Such a report would describe progress of knowledge made with respect to monitoring plan study questions across all Navy ranges associated with the Integrated Comprehensive Monitoring Program. Similar study questions shall be treated together so that progress on each topic shall be summarized across all Navy ranges. The report need not include analyses and content that does not provide direct assessment of cumulative progress on the monitoring plan study questions."*

GOA TMAA is in its first five (5) year cycle of authorization, and its regulation at § 218.125(d) similarly reads: "The Navy shall standardize data collection methods across ranges to allow for comparison in different geographic locations." Therefore, monitoring results from all Pacific Navy ranges, i.e., HSTT, MITT, NWTT, and GOA, are treated in this report in an integrated fashion to order to allow comparison across ranges and a cumulative view of progress made on monitoring goals across ranges. This is the first such "multi-range" annual monitoring report.

Monitoring Programs That Transitioned to New Authorizations in 2015

The final rules for MITT and NWTT became effective during the 2015 calendar year for their second cycle of five (5)-year authorizations, 3 August 2015 for the MITT Final Rule (NMFS 2015a), and 24 November 2015 for the NWTT Final Rule (NMFS 2015e). Therefore, the monitoring programs associated with these ranges transitioned from the preceding monitoring requirements associated with the Mariana Islands Range Complex (MIRC) EIS/OEIS (DoN 2010a), and the Northwest Training Range Complex (NWTRC) EIS/OEIS (DoN 2010b), respectively. The closeout year-5 annual monitoring reports for these ranges were prepared on 23 October 2015 for MIRC (DoN 2015c), and 1 July 2015 for NWTRC (DoN 2015d), in accordance with the respective LOAs (for MIRC [NMFS 2012e], NWTRC [NMFS 2012f]), Biological Opinions (for MIRC [NMFS 2012g], NWTRC [NMFS 2012h], and Final Rules [for MIRC (NMFS 2010a), NWTRC (NMFS 2010b).

The MIRC year-5 annual monitoring report described monitoring conducted through 2 August 2015, whereupon monitoring projects transitioned to MITT year-1 beginning from 3 August 2015. Therefore, for the Marianas, this current report contains only coverage of MITT monitoring, and does not cover MIRC monitoring.

The NWTRC year-5 annual monitoring report covered the period through 1 May 2015. Therefore, this current report also incorporates results from ongoing monitoring projects for NWTRC from 2 May 2015 through the transition to NWTT year-1 monitoring which became applicable on 24 November 2015.

Similarly, the closeout year-5 annual monitoring report for GOA TMAA (DoN 2015f) described monitoring results completed through 31 October 2015. The LOA (NMFS 2013d) and Final Rule (NMFS 2011b) for GOA TMAA are effective beyond 2015 through 4 May 2016; therefore, this report incorporates updates of monitoring projects in GOA from 1 November 2015 through the end of the calendar year, 31 December 2015.

1.1 Background

Current marine species monitoring projects being conducted in the HSTT, MITT, NWTT, and GOA TMAA Study Areas 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/). This report contains a review of progress made on these projects in the year 2015 monitoring period. 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 (http://www.navymarinespeciesmonitoring.us/reading-room/pacific/).

HSTT

The HSTT Study Area (DoN 2013a) is comprised of established operating and warning areas in the north-central Pacific Ocean, from Southern California west to Hawaii and the International Date Line (**Figure 1**). The Study Area includes three existing U.S. Navy range complexes: the Hawaii Range Complex (HRC) (**Figure 2**), Southern California Range Complex (SOCAL) (**Figure 3**), and Silver Strand Training Complex (SSTC) (**Figure 4**).

A range complex is a designated set of specifically bounded geographic areas and encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occurs. Range complexes include established ocean operating areas (also known as OPAREAs), Restricted Areas (RAs), and special use airspace, which may be further divided to provide better control of the area and events for safety reasons.

In addition to naval range complexes, the HSTT Study Area includes other areas where training and testing activities occur, including pier-side locations in San Diego Bay and Pearl Harbor, the transit corridor between SOCAL and HRC, and other locations throughout north and central San Diego Bay. Vessel transit corridors are the routes typically used by Navy ships to traverse from one area to another, where training and sonar testing may occur during vessel transit. The majority of active sonar occurs in SOCAL and HRC. SSTC is used primarily for explosive and pile-driving activities.

MITT

The MITT Study Area (DoN 2015a) (**Figure 5)** is composed of the established ranges (at-sea ranges and land based training areas on Guam and Commonwealth of the Northern Mariana Islands [CNMI]), operating areas, and special use airspace in the region of the Mariana Islands that are part of the Mariana Islands Range Complex (MIRC) (**Figure 6**) and its surrounding seas, and includes a transit corridor. The transit corridor is outside the geographic boundaries of

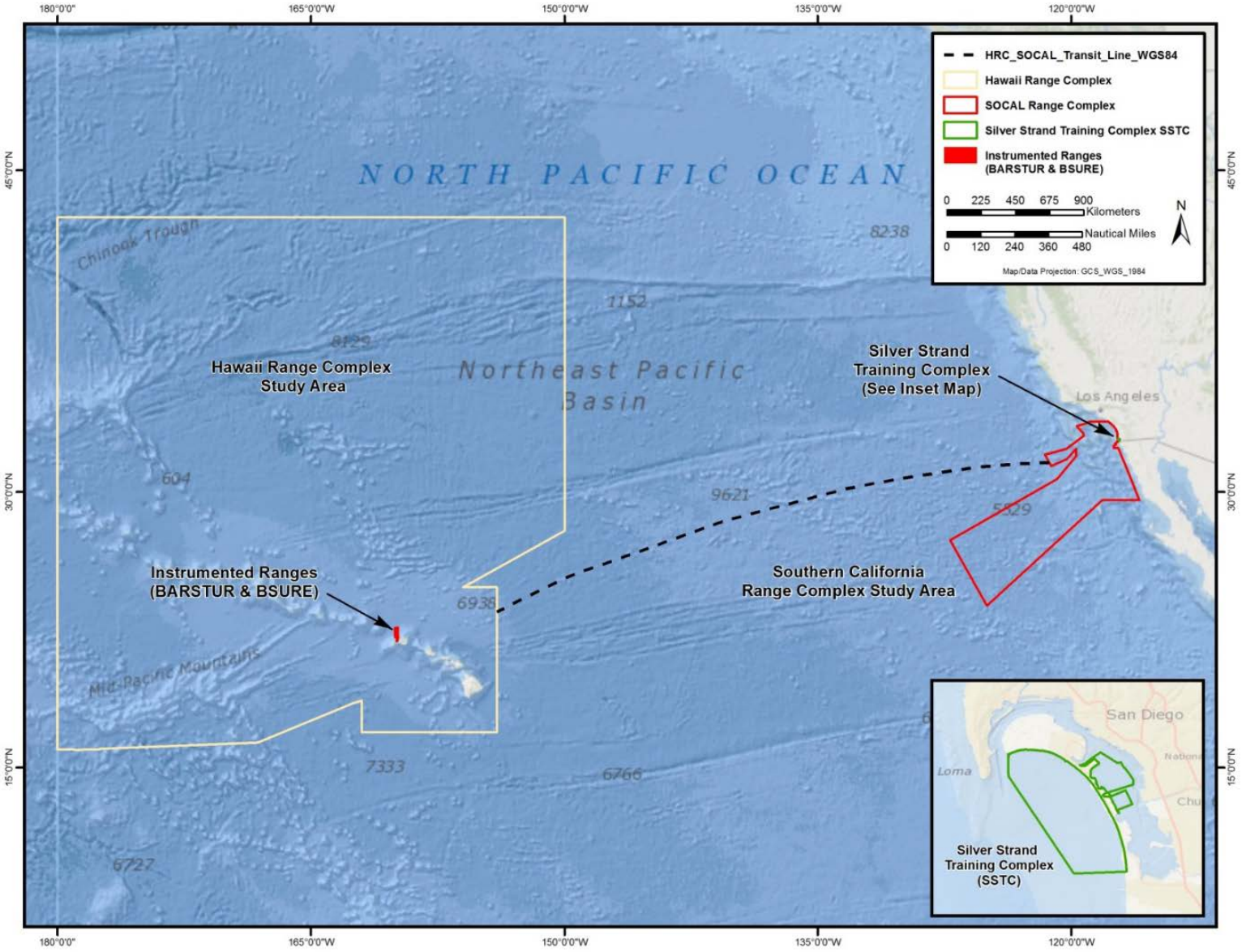

Figure 1. Hawaii-Southern California Training and Testing Study Area, showing Hawaii Range Complex, Southern California Range Complex, the transit lane between them, and Silver Strand Training Complex . From DoN (2013a).

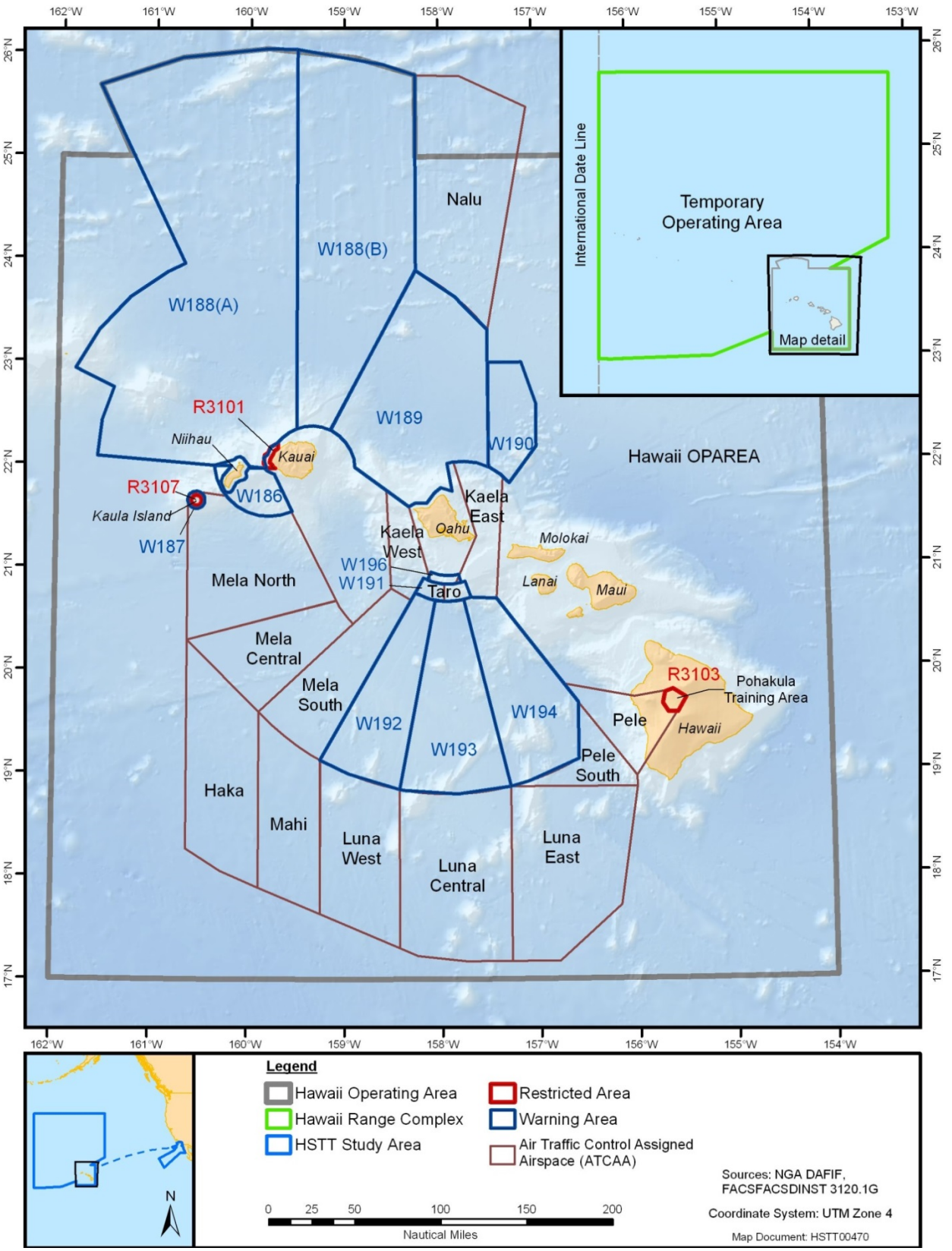

Figure 2. Hawaii Range Complex. From DoN (2013a).

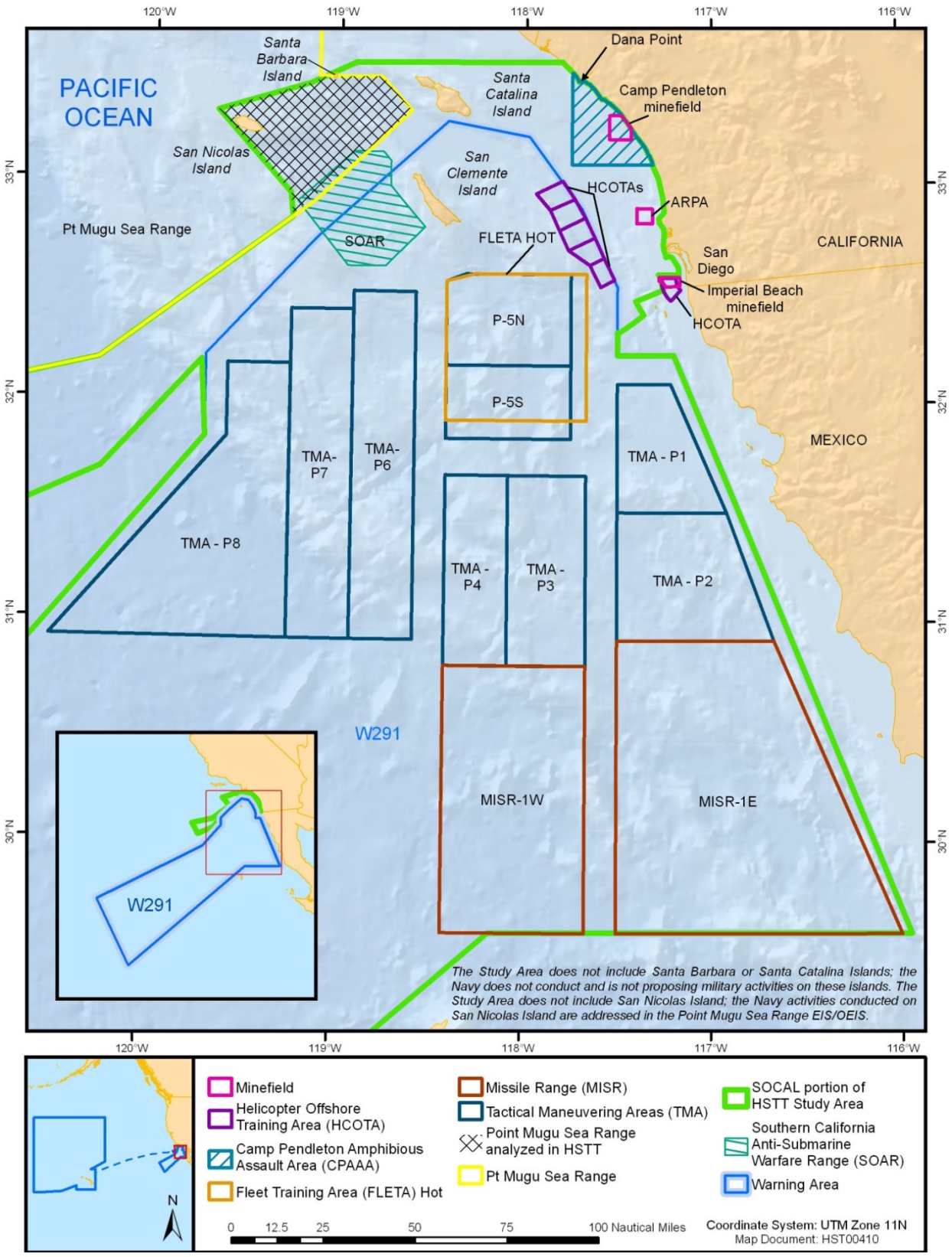

Figure 3. Southern California Range Complex. From DoN (2013a).

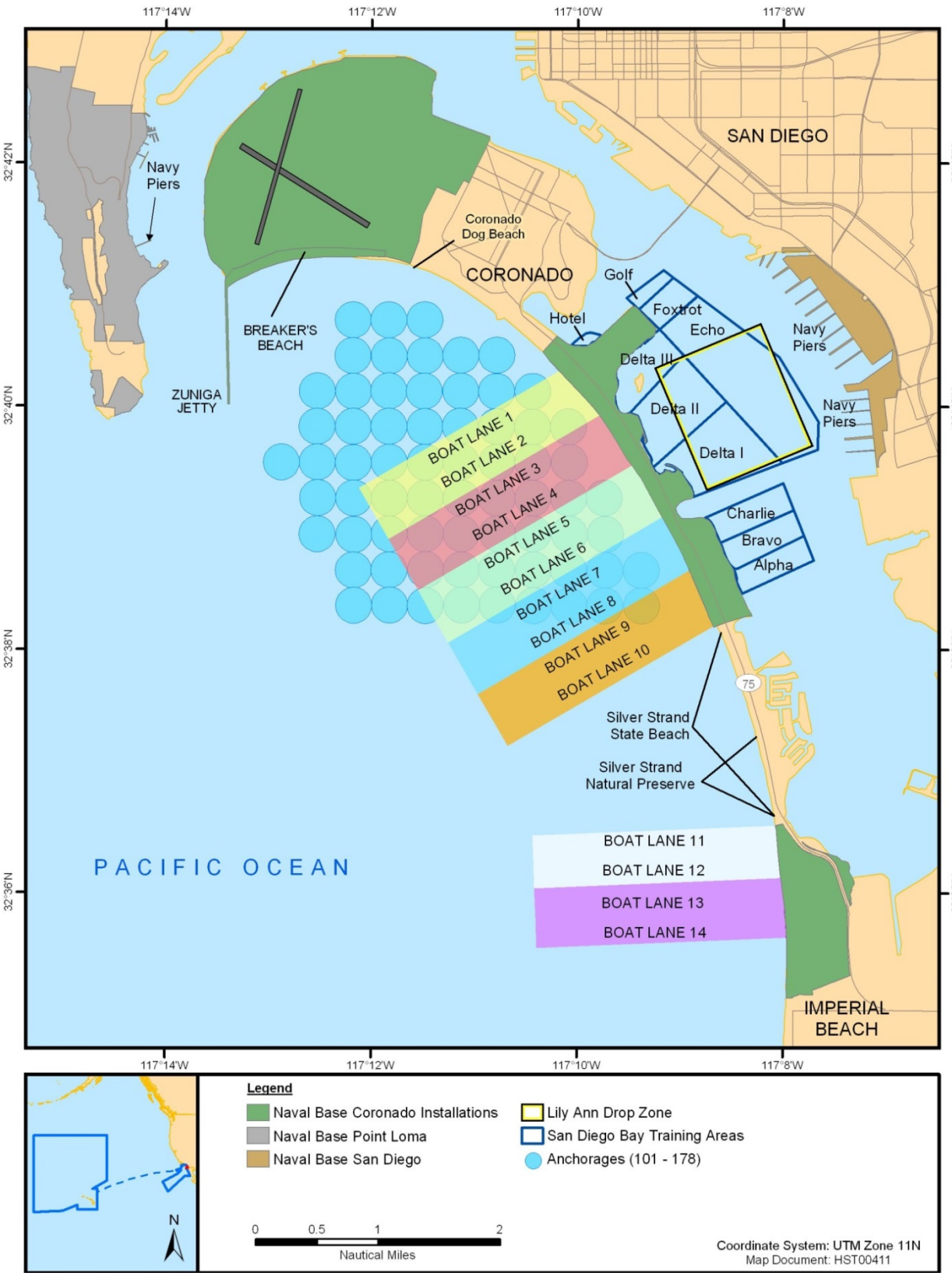

Figure 4. Silver Strand Training Complex. From DoN (2013a).

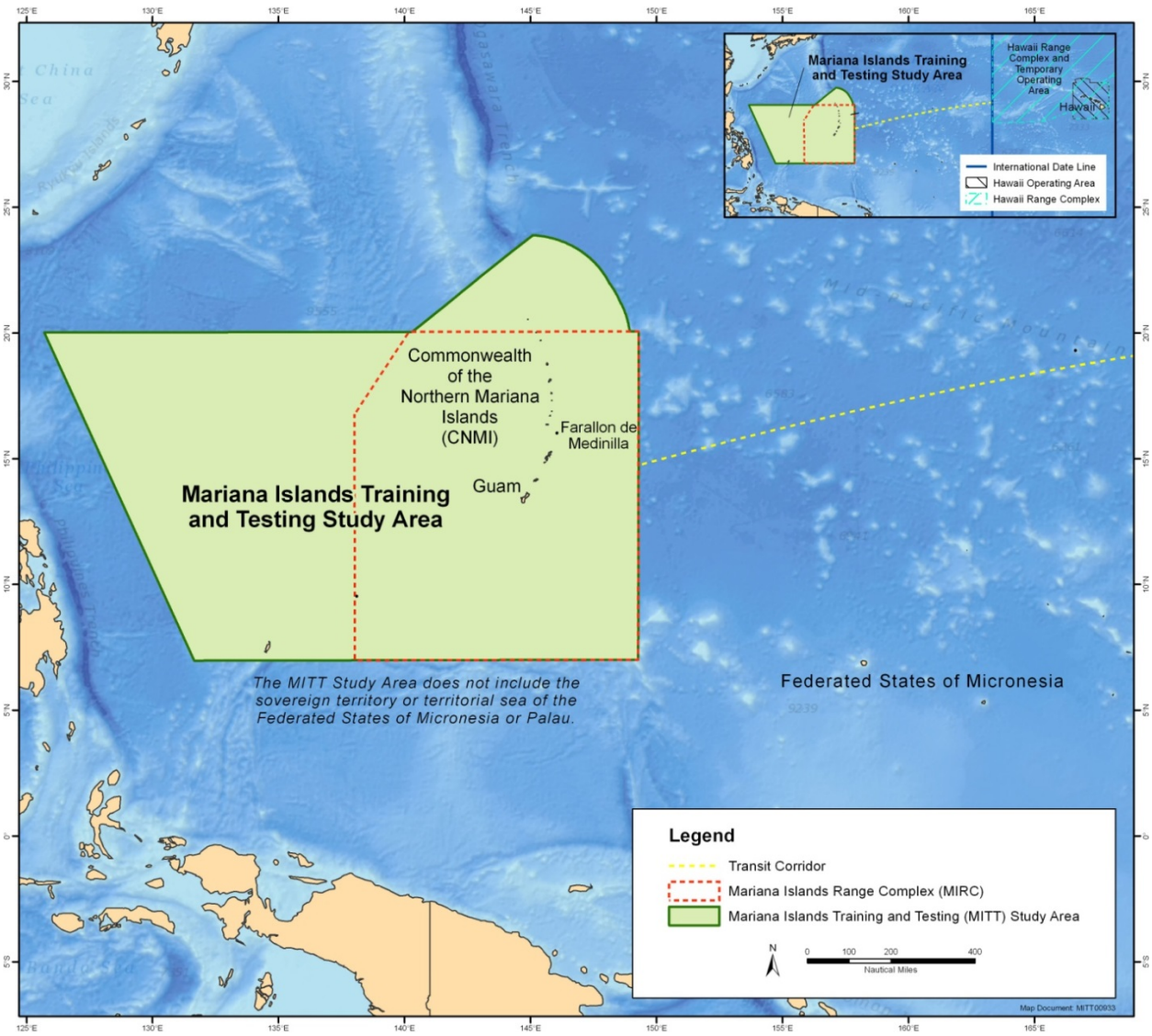

Figure 5. Mariana Islands Training and Testing Study Area. From DoN (2015a).

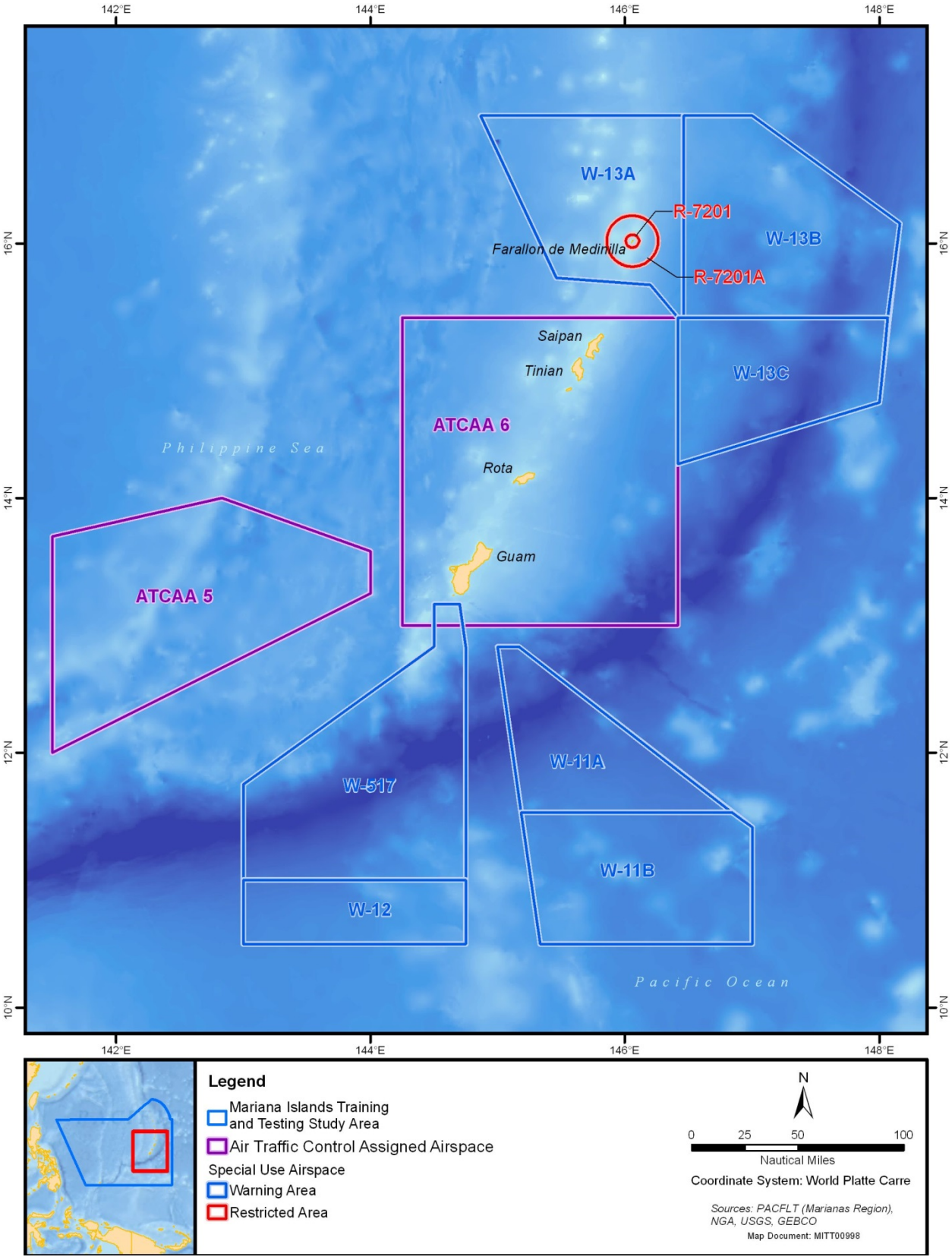

Figure 6. Mariana Islands Range Complex. From DoN (2015a).

the MIRC and is a direct route across the high seas for Navy ships in transit between the MIRC and the HRC. The MITT Study Area also includes pier-side locations within Inner Apra Harbor where surface ship and submarine sonar maintenance and testing occur. In addition, The MITT Study Area includes the MIRC at-sea operating areas and land training areas that were previously addressed in the MIRC EIS/OEIS (DoN 2010a) with modifications to the special use air-space that were addressed in the MIRC Airspace Environmental Assessment (EA)/Overseas EA (OEA) (DoN 2013b), and the seaward extensions to the northern and western edges of the MIRC. The MIRC ocean surface and subsurface areas, and special use airspace. These areas extend from the waters south of Guam, and northward to the waters surrounding the CNMI, and from the Pacific Ocean east of the Mariana Islands to the Philippine Sea to the west, encompassing 501,873 square nautical miles of open ocean.

NWTT

The NWTT Study Area (DoN 2015b) (**Figure 7**) is composed of established maritime operating and warning areas in the eastern north Pacific Ocean region, to include the Strait of Juan de Fuca, Puget Sound, and western Behm Canal in southeastern Alaska. The area includes air and water space within and outside Washington state waters, and air and water space outside of the state waters of Oregon and California (**Figures 7 and 8**). The Study Area includes four existing range complexes and facilities: the Northwest Training Range Complex (NWTRC), the Keyport Range Complex, Carr Inlet Operations Area, and Southeast Alaska Acoustic Measurement Facility (SEAFAC) (**Figure 7**). In addition to these range complexes, the Study Area also includes Navy pier-side locations where sonar maintenance and testing occur as part of overhaul, modernization, maintenance, and repair activities at Navy piers at Naval Base (NAVBASE) Kitsap Bremerton, NAVBASE Kitsap Bangor, and Naval Station Everett.

GOA TMAA

The GOA TMAA (DoN 2011a) is a temporary area that is established in conjunction with the Federal Aviation Administration for up to 21 days per year between April to October as needed to support the Northern Edge exercise. The TMAA is a surface, undersea space and airspace maneuver area within the GOA for ships, submarines, and aircraft to conduct required training activities. As depicted in **Figure 9**, the TMAA is a polygon that roughly resembles a rectangle oriented from northwest to southeast, approximately 300 nautical miles (nm) (555.6 kilometers [km]) in length by 150 nm (277.8 km) in width, located south of Prince William Sound and east of Kodiak Island. With the exception of Cape Cleare on Montague Island located over 12 nm (22 km) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm (259 km) offshore.

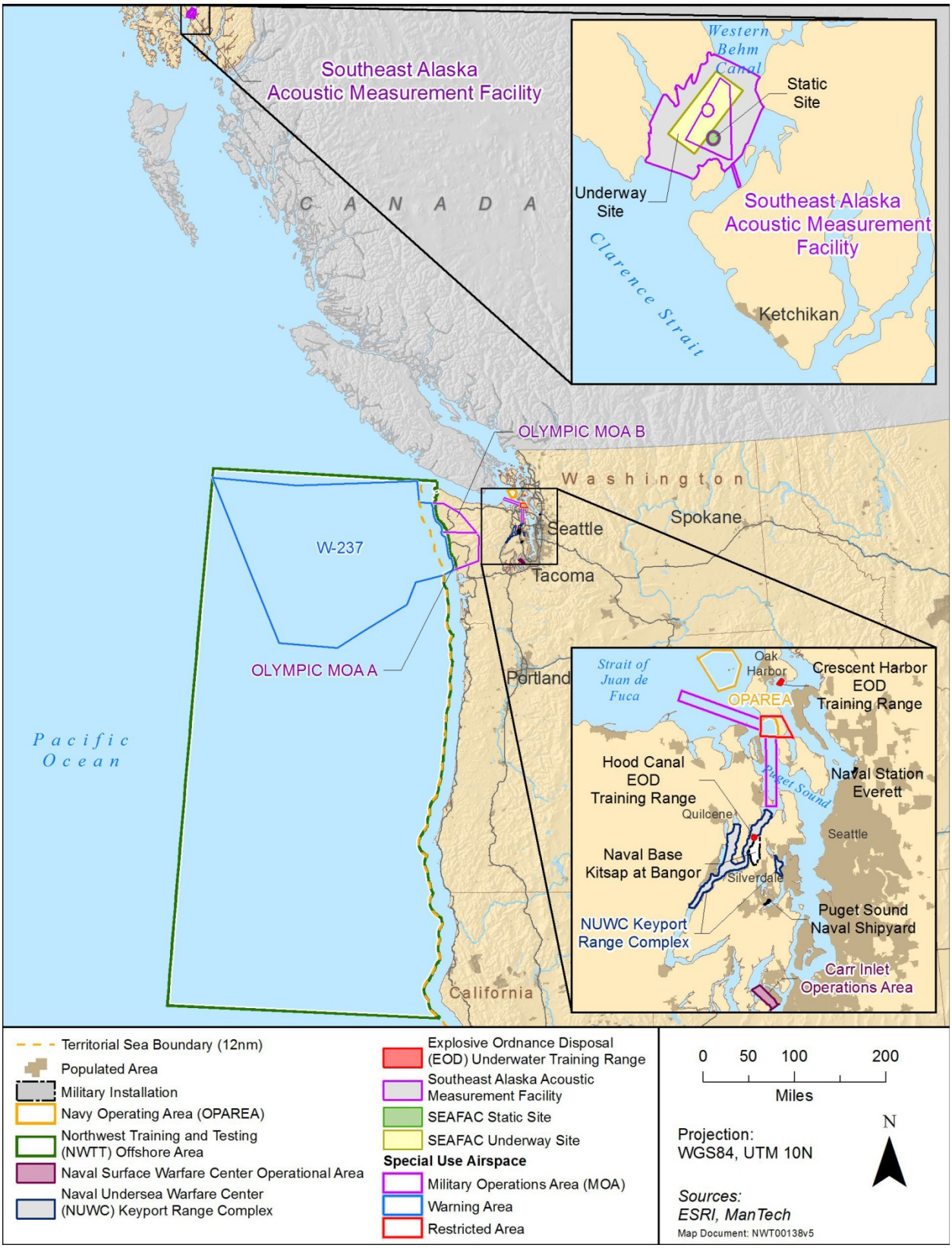

Figure 7. Northwest Training and Testing Study Area. From DoN (2015b).

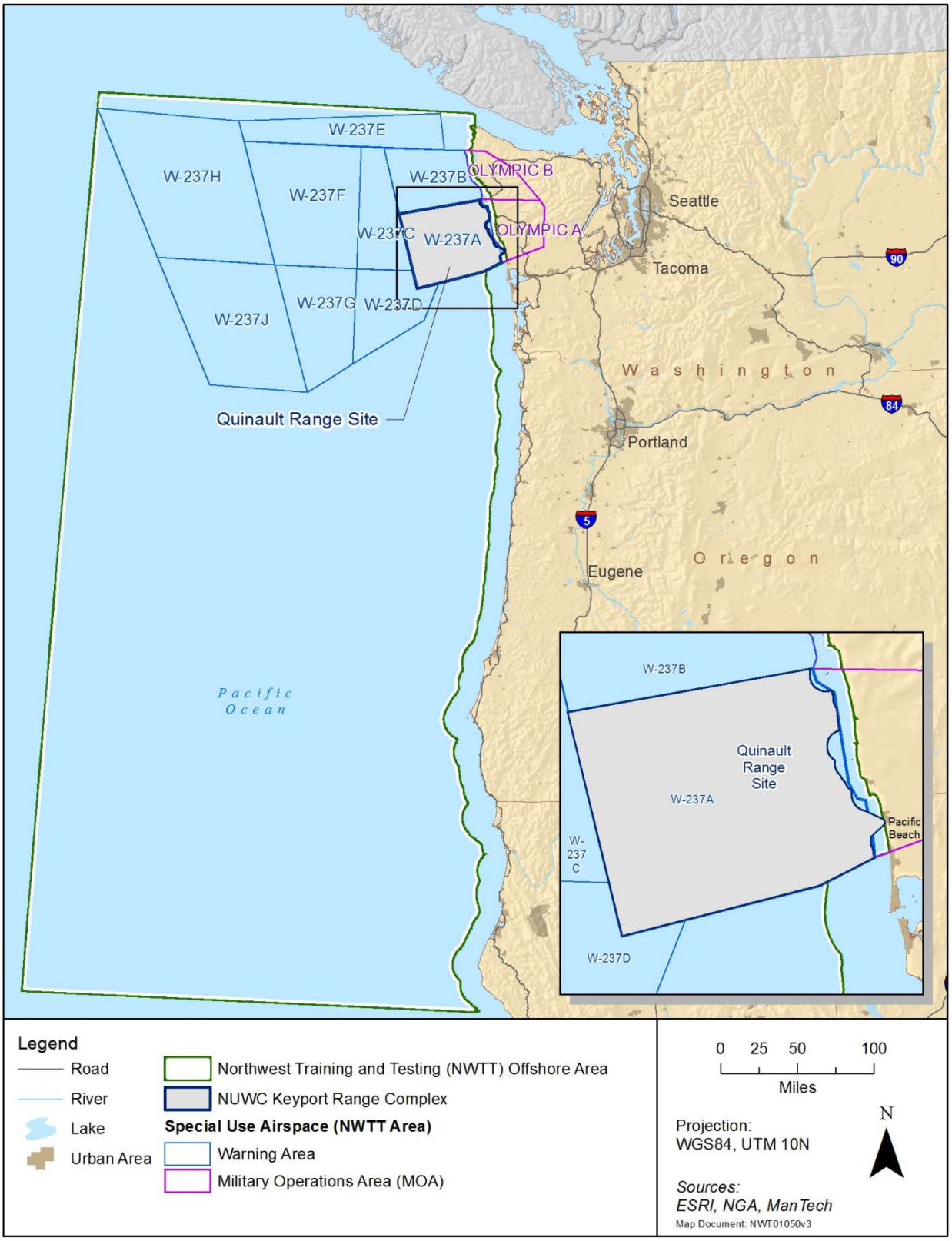

Figure 8. Offshore area of the NWTT Study Area. From DoN (2015b).

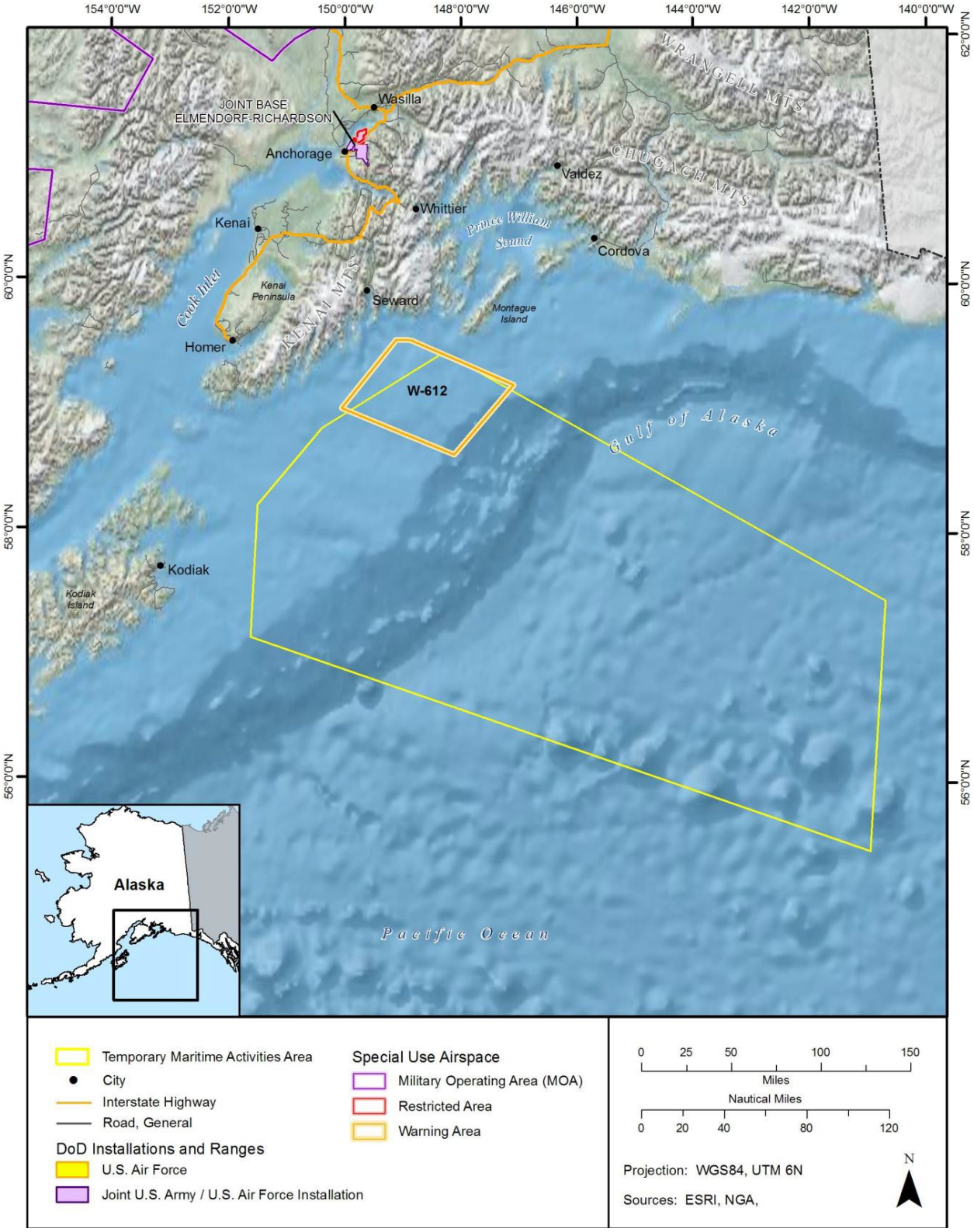

Figure 9. Gulf of Alaska Temporary Maritime Activities Area. From DoN (2011a).

1.2 Integrated Comprehensive Monitoring Program and Strategic Planning Process

Integrated Comprehensive Monitoring Program

The Navy's Integrated Comprehensive Monitoring Program (ICMP) (DoN 2010c) is intended to coordinate monitoring efforts across all training ranges and testing areas and to allocate the most appropriate level and type of effort for each range complex based on a set of standardized objectives, and in acknowledgement of regional expertise and resource availability. The ICMP is designed to be flexible, scalable, and adaptable through the adaptive management and strategic planning processes to periodically assess progress and reevaluate objectives. Although the ICMP does not specify actual monitoring fieldwork or projects, it does establish top-level goals that have been developed in coordination with NMFS. As the ICMP is implemented, detailed and specific studies are developed which support these top-level monitoring goals. In essence, the ICMP directs that monitoring activities relating to the effects of Navy training and testing activities on marine species should be designed to accomplish one or more top-level goals.

Monitoring addresses the ICMP top-level goals through a collection of specific regional and ocean basin studies based on scientific objectives. Quantitative metrics of monitoring effort (e.g., 20 days of aerial surveys) are not to be a specific requirement. The adaptive management process and reporting requirements serve as the basis for evaluating performance and compliance, primarily considering the quality of the work and results produced, as well as peer review and publications, and public dissemination of information, reports and data. Details of the current ICMP are available online at http://www.navymarinespeciesmonitoring.us/).

Strategic Planning Process, Scientific Advisory Group, and the Conceptual Framework Categories

The most recent revision of the ICMP resulted in the addition of the Strategic Planning Process for Marine Species Monitoring (CNO 2013), which establishes the guidelines and processes necessary to develop, evaluate, and fund individual projects based on objective scientific study questions. The process uses an underlying framework designed around a conceptual framework incorporating a progression of knowledge, and in consultation with the SAG and other regional experts.

The SAG program review (DON 2011b) laid out both over-arching and range-specific recommendations that follow a **conceptual framework** of knowledge which considers the occurrence of marine mammals, particular Navy training activities, potential response to those activities, and potential consequences of the interactions. Specifically, the SAG recommendations included defining a conceptual framework centered on developing information on "*occurrence, exposure, response, and consequences"* as a progression of knowledge on marine species and their interaction with Navy activities:

- **Occurrence** – gathers basic information on the presence and diversity of species that occur in a Navy range or area of proposed training activity; information by patterns of

habitat use, population structure, density, abundance, and behavioral ecology (e.g., feeding, mating, migrating).

- **Exposure** – examines Navy training activities including where, when, and how often sources are being used, types and properties of generated sounds, and sound propagation to determine received levels and other metrics. Exposure and occurrence information may be coupled to estimate number of individuals from each population that are exposed to specific sound levels.
- **Response** – investigates how animals react to exposure across spatial (e.g., changes in habitat) and temporal (short-term, medium-term, and long-term) scales, behavioral and social interactions. The findings on responses may be useful in refining exposure estimates.
- **Consequences** – considers species occurrence and habitat use cumulatively to determine long-term population-level impacts of exposure and responses. These investigations include evaluating long-term impacts on distribution, behavior, social groups, and foraging success and their effects to fitness through reproduction, growth, and survival.

Other keystone recommendations from the SAG include:

- Strive to move away from a "box-checking" mentality - monitoring studies should be designed and conducted according to scientific objectives, rather than on merely cataloging effort expended
- Approach the monitoring program holistically and select projects that offer the best opportunity to advance understanding of the issues, as opposed to establishing range-specific requirements
- Facilitate collaboration among researchers in each region, with the intent to develop a coherent and synergistic regional monitoring and research effort

Informed by these conceptual framework categories, the Strategic Planning Process for Marine Species Monitoring is therefore used to set Intermediate Scientific Objectives (ISOs) for the ICMP, identify potential species of interest at a regional scale, and evaluate and select specific monitoring projects to fund or continue supporting for a given fiscal year; the current list of 13 ISOs applied for this monitoring report are included in **Figure 10** (located in **Section 2.1**). This process also addresses relative investments to different range complexes based on goals across all range complexes, and the benefits of leveraging multiple techniques for data acquisition and analysis whenever possible.

Adaptive Management Review

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 consider the prior-year goals, monitoring results, and related scientific

advances to determine if monitoring plan modifications are warranted, in order to address program goals more effectively. Modifications to the ICMP that result from AMR discussions are incorporated by an addendum or revision to the ICMP. As a planning tool, the ICMP is a "living document." It will be updated as needed.

1.3 Report Objectives

This report presents NMFS with monitoring results and progress that address the monitoring goals of marine species monitoring in HSTT, MITT, NWTT, and GOA TMAA in accordance with 50 CFR § 218.75(e), § 218.95(e), § 218.145(f), and § 218.125(d). This report is the first annual monitoring report prepared by the Navy that implements the option in these regulations to prepare a "multi-Range Complex" report that describes progress of knowledge made with respect to monitoring plan study questions across multiple training and testing ranges, with similar study questions treated together so that progress on each topic may be summarized across multiple ranges. These results are intended to iteratively inform future cycles of AMR and application of the Strategic Planning Process. In addition, detailed technical reports for the individual monitoring projects are provided as appendices to this report.

2. Marine Species Monitoring in the Pacific

2.1 2015 Monitoring Goals and Implementation

The U.S. Navy training ranges in the Pacific are located in the MITT Study Area, HSTT Study Area, NWTT Study Area, and GOA TMAA. The ranges vary in terms of monitoring goals implemented for protected marine species including marine mammals and sea turtles, in support of each study area's Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) requirements (NMFS 2011a, 2011b, 2011c, 2011d, 2013a, 2013b, 2013c, 2013d, 2013e, 2014a, 2015a, 2015b, 2015c, 2015e, 2015f, 2015h).

As described in more detail in **section 1**, above, the MITT and HSTT are in the second cycle of five (5) year environmental planning and authorizations under the MMPA and ESA. The current monitoring goals for the ranges under MITT and HSTT are framed in terms of progress made on scientific monitoring questions and Intermediate Scientific Objectives (ISOs) (**Table 1**). In November 2015, the NWTT transitioned to its second cycle of five (5) year environmental planning and authorizations under the MMPA and ESA, and its monitoring goals are framed in terms of scientific objectives (**Table 2**). The GOA TMAA is still under its original coverage of authorizations, and its monitoring goals for 2015 are still related to quantitative metrics of monitoring effort (e.g., the numbers of tags and instruments deployed) (**Table 3**). **Figures 10 and 11** summarize all monitoring projects across all Pacific ranges. **Figure 10** shows the distribution of monitoring questions and study objectives with respect to monitoring projects and conceptual framework categories (Occurrence, Exposure, Response, Consequences), as well as illustrate which ISOs are addressed by each monitoring project. **Figure 11** illustrates the relative number of monitoring projects associated with each ISO, and how this varies by range, as well the relation of ISOs and ranges to the conceptual framework categories.

Table 1. Monitoring goals and accomplishments for training ranges in second cycle of five (5) year authorizations (MITT and HSTT).

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
MITT				
[M1] MIRC Unmanned Acoustic Glider (Klinck et al. 2016a)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• What is the baseline vocalization behavior of marine mammals in the MITT Study Area? • What species of marine mammals occur in the nearshore and offshore areas of the MITT study area? • What is the seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area?	• Deployed autonomous passive acoustic glider off the coast of Guam from 2 March to 27 April 2015, the second such effort in this region. • Analyzed the spatial and temporal distribution of odontocetes and mysticetes in deep offshore waters near Guam off the Mariana Trench, and compared seasonal differences to a previous winter season survey. Detected species included Blainville's beaked whale, the "Cross Seamount beaked whale" call, humpback whales, Risso's dolphin, and an unidentified mysticete.
[M2] PIFSC HARPs (Hill et al. 2016)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• What is the baseline vocalization behavior of marine mammals in the MITT Study Area? • What species of marine mammals occur in the nearshore and offshore areas of the MITT study area? • What is the seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area?	• Analyzed data from HARPs deployed off Saipan and Tinian during 2013-2015 for beaked whale calls; Cuvier's beaked whale, Blainville's beaked whale, and the "Cross Seamount beaked whale" call were detected.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
MITT (continued)				
[M3] Cetacean Monitoring (Hill et al. 2016)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur.	• What species of marine mammals occur in the nearshore and offshore areas of the MITT study area? • What is the habitat use of cetaceans in the nearshore and offshore areas of the MITT study area? • What is the abundance and population structure of marine mammals in the MITT study area? • What is the seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area?	• Conducted winter humpback whale surveys from shore and small vessel off Saipan, succeeded in sighting several mother-calf pairs. Also collected fluke photographs and biopsies for population studies. • Conducted small- and large-vessel visual summer surveys from Guam to Uracas (out to 93 km) and off Rota, including biopsy and satellite tagging. One false killer whale tagged at Asuncion traveled well past the Western Mariana Ridge toward the Philippines. Also made first sighting of a Bryde's whale in this survey series. • Used mtDNA, including samples from the Mariana Islands, to describe the regional and local genetic structure in island-associated and pelagic Pacific short-finned pilot whales.
[M4] Sea Turtle Surveys (Jones and Martin 2016)	Occurrence Exposure	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur.	• What is the occurrence, habitat use, abundance, and population structure of sea turtles in the MITT study area? • What is the exposure of cetaceans and sea turtles to explosives and/or sonar in the MITT study area?	• Conducted sea turtle tagging surveys in near shore and coastal waters of Guam, Saipan, and Tinian, including new areas not previously surveyed—the southwest corner of Tinian, Lao Bay in southeast Saipan, and Agat Bay in Guam. • Deployed satellite (temperature-depth and temperature), Inconel, and PIT tags on green and hawksbill turtles; satellite tags are still transmitting as of January 2016, and habitat analysis is planned.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
MITT (continued)				
[M5] Shore Station Survey (Deakos et al. 2016)	Occurrence	#1. Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• What species of marine mammals occur in the near shore and offshore areas of the MITT study area? • What is the seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area?	• Conducted second 10-day shore station pilot survey in Guam, using Big Eye binoculars, surveying waters relatively inaccessible by small vessels. • Sighted one species of sea turtle, and four species of cetaceans including melon-headed whales sighted 13 km away; no large whales observed despite survey being conducted concurrently with PIFSC survey at Saipan which did sight humpback whales. • Observability of large whales related to distance was measured at two shore station sites in Hawaii. • Successfully layered time and place of this survey with underwater acoustic glider survey [M1]; confirmed lack of acoustic baleen whale detections in viewshed of shore survey.
HRC				
[H1] HRC Unmanned Acoustic Glider (Klinck et al. 2015a)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• Which species of toothed whales (and especially beaked whales) occur in offshore areas of the HRC and what is their spatial distribution?	• Field effort: Deployed a passive acoustic autonomous glider from December 2014 through January 2015, the first such Fleet-funded effort in the HRC. • Investigated spatial and temporal distribution of cetaceans in offshore waters at seamounts southwest of the Main Hawaiian Islands.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
HRC (continued)				
[H2] Marine Mammal Monitoring on PMRF (Martin et al. 2015a)	Occurrence, Exposure, Response	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes. #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where U.S. Navy training and testing activities occur. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #12: Evaluate trends in distibution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives #13: Assess existing data sets which could be utilized to address the current objectives	• What are the occurrence and estimated received levels of MFAS on 'blackfish' and humpback, minke, sperm, and Blainville's beaked whales within the PMRF instrumented range? • What, if any, are the short-term behavioral responses of 'blackfish' and humpback, minke, sperm, and Blainville's beaked whales when exposed to MFAS/explosions at different levels/conditions at PMRF?	*In 2015:* • Used archived acoustic data collected by PMRF hydrophones from 2011 through 2013 to assess changes in Blainville's beaked whale dive counts correlated with periods of MFAS use. • Developed and validated an automated beaked whale click detector. • Calculated number of beaked whale foraging dives relative to sonar use (in progress). *In 2014:* • Estimated received levels during an ASW training event for humpback whales and short-finned pilot whales, ranged from 158 to 174 dB re 1 µPa. • Identified decrease in minke whale boing call counts in the presence of MFAS. • Documented decrease in Blainville's beaked whale foraging dive rates during periods of MFAS transmission.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
HRC (continued)				
[H3] Long-term PAM of Cetaceans at PMRF and SCORE (Moretti 2016)	Occurrence, Exposure, Response	#1: Determine what species and populations of marine mammals and sea turtles are present in Navy range complexes. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #9: Develop and validate analytic methods to evaluate exposure and/or behavioral responses based on passive acoustic monitoirng techniques. #12: Evaluate trends in distibution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives #13: Assess existing data sets which could be utilized to address the current objectives	• What are the long-term trends in occurrence of marine mammals (e.g., minke, humpback, fin, Bryde's, Blainville's) on the PMRF range?	• Upgraded hardware/software for M3R Linux-based cluster signal processor at SCORE and PMRF which includes a full range of broadband recording and integrated data archives. • Conducting initial analysis of beaked whale detection archives to establish methods and baseline abundance at PMRF and SCORE.
[H4] Analysis of False Killer Whale Acoustic Data from PMRF (Oswald and Hom-Weaver 2015)	Occurrence	#8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals. #13: Assess existing data sets which could be utilized to address the current objectives.	• What are the occurrence and estimated received levels of MFAS on 'blackfish' and humpback, minke, sperm, and Blainville's beaked whales within the PMRF instrumented range?	*In 2014-2015:* • Re-examined delphinid sounds recorded at PMRF that were tentatively attributed to false killer whales to confirm species classification. • Examined recordings collected at PMRF when false killer whales equipped with satellite tags were present. • Used ROCCA to classify whistles recorded in the presence of satellite-tagged false killer whales.
[H5] SCC Lookout Effectiveness Study (Watwood et al. 2016)	Occurrence, Exposure, Response	#1: Determine what species and populations of marine mammals and sea turtles are present in Navy range complexes. #11: Collect data to support impact and effects analyses (e.g., sound source measurements and propagation modelling).	• What is the effectiveness of Navy lookouts on Navy surface ships for mitigation and what species are sighted during sonar training events?	*In 2014-2015:* • MMOs embarked on U.S. Navy warships during a total of four training events: one SCC event in 2015, and one Koa Kai and two SCC events in 2014. • Recorded marine mammal and sea turtle sighting data to determine which species and populations are exposed to U.S. Navy training events.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
HRC (continued)				
[H6] Shoreline Survey and Stranding Summary [2]	Occurrence, Exposure, Response	#1: Determine what species and populations of marine mammals and sea turtles are present in Navy range complexes. #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities.	• Do marine mammals strand along shorelines of the Main Hawaiian Islands within one week following U.S. Navy training?	• Compiling data from reported marine mammal strandings in the Hawaiian Islands from 2010 to 2014. • Summarizing sightings and effort from 16 aerial shoreline surveys conducted from 2010 to 2014. • Using aerial survey data to determine the effectiveness of aerial surveys to detect strandings in populated versus remote areas. • Evaluating how long after initial stranding an animal is likely to be detected using aerial monitoring surveys.
[H7] Cetacean Studies on PMRF (Baird et al. 2016)	Occurrence, Exposure, Response [3]	#4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur. #12: Evaluate trends in distribution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives.	• What are the spatial-movement and habitat-use patterns (e.g., island-associated or open-ocean, restricted ranges vs. large ranges) of species that are exposed to MFAS, and how do these patterns influence exposure and potential responses?	*In 2015:* • Small-vessel surveys (non-random and non-systematic) were conducted prior to an SCC training event. • M3R detections were used to locate animals; collected high-resolution photographs for individual photo-ID. • Satellite tags were deployed on short-finned pilot whales, bottlenose dolphins, and rough-toothed dolphins. *In 2014:* • A satellite-tag track for a Blainville's beaked whale was the first detailed movement data available for this species around Kauai and Niihau. • An encounter with false killer whales was cued by an acoustic detection from the M3R system.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
SOCAL				
[S1] Impact assessment at Non-Instrumented Range Locations using HARPs (Hildebrand et al. 2016; Širović et al. 2016; Baumann-Pickering et al. 2016)	Occurrence, Exposure, Response [3]	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes. #2: 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. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where U.S. Navy training and testing activities occur. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #13: Assess existing data sets which could be utilized to address the current objectives	• What, if any, are the short-term behavioral and/or vocal responses when exposed to sonar or explosions at different levels or conditions?	*In 2014-2015:* • Deployed HARPS at three locations in SOCAL to record marine mammal sounds and anthropogenic noise • Continued refining understanding of fin whale population in SOCAL though analysis of fin whale song patterns identified songs from resident and “transient” (pan-Pacific) populations of fin whales. • Continued detailed analysis on the presence of anthropogenic sources of sound for the study of impact of sonar on blue whales, fin whales, and beaked whales. • Continued analyis of seasonal presence of fin whales, blue whales, Cuvier’s beaked whales, and the “BW43” beaked whale call (possibly Perrin’s beaked whale [*Mesoplodon perrini*]). • Began new effort to characterize SOCAL regional Cuvier’s beaked whale densities based on passive acoustic data

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
SOCAL (continued)				
[S2] Cuvier's beaked whale impact assessment at SOAR (Moretti 2016)	Occurrence, Exposure, Response	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes. #2: 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. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where U.S. Navy training and testing activities occur. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals. #12: Evaluate trends in distribution and abundance for populations of protected species regularly exposed to sonar and underwater explosives.	• Does exposure to sonar or explosives impact the long-term fitness and survival of individuals or the population, species, or stock of beaked whales? (With focus on blue whale, fin whale, humpback whale, Cuvier's beaked whale, and other regional beaked whale species.)	*In 2015:* • Completed hardware/software upgrades for a M3R Linux-based cluster signal processor at SCORE, which includes a full range of broadband recording and integrated data archives. *In 2014-2015:* • Ongoing multi-year analysis of Cuvier's beaked and fin whale occurrence in SOCAL. Analyzed beaked whale detections from 2011 to 2014 to establish methods and baseline abundance. Beaked whale density estimation in progress. • Collected sufficient sighting and photo-ID data for Cuvier's beaked whales to begin estimation of key population vital rates for impact analyses.

Project (technical report)	**Conceptual Framework Category**	**Corresponding Intermediate Scientific Objectives** (numbered as per Figures 11-12)	**Monitoring Questions**	**Accomplishments**[1]
SOCAL (continued)				
[S3] Marine mammal sightings during CalCOFI cruises[2]	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes. #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur.	• What is the seasonal occurrence and density of cetaceans within the Navy's Southern California Range Complex?	*In 2015:* • Performed visual and acoustic monitoring for marine mammals aboard CalCOFI cruises in 2014 and 2015, continuning in 2016. • Platform provides an opportunity to asses the full range of marine mammal species present in SOCAL. • Habitat modeling underway to predict marine mammal presence in the SOCAL Range Complex. *In 2014:* • Gathered sufficient data for generation of species-specific seasonal densities and abundance trends at finer spatial and temporal scales than standard NMFS U.S. West Coast surveys, which are performed every 3 to 6 years.
[S4] SOCAL Blue and Fin Whale Tagging and Genetics (Mate et al. 2016)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur. #5: Establish the baseline behavior (foraging, dive patterns, etc.) of marine mammals where Navy trianing and testing activities occur.	• What are the occurrence, movement patterns, and residency patterns of blue and fin whales within Navy U.S West Coast at-sea ranges as compared to the rest of their distribution throughout the Pacific Ocean?	*In 2015:* • Instrumented blue whales, fin whales, a blue/fin hybrid whale, and a Bryde's whale with location-only and ADB satellite tags. • Analyzed genetic samples from blue whales and fin whales biopsied in 2014 and 2015 to determine sex of the individuals. • Used mtDNA sequences to define haplotypes for stock analysis and to confirm species identification. *In 2014:* • Instrumented blue whales and fin whales with location-only and ADB satellite tags. • Data from ADB tags revealed strong and consistent diel feeding patterns in blue whales.

[1] As per the regulations implementing monitoring reporting requirements (described in Section 1. Introduction), accomplishments from monitoring in the second cycle of five (5) year authorizations are reported in a cumulative fashion. HSTT monitoring is in its second year of monitoring, so 2 years of accomplishments are listed for HRC and SOCAL.

[2] The project is in progress, and results were not available at the time of this report.

[3] Current project results did not address all conceptual framework categories at the time of this report.

Key: ADB = Advanced Dive Behavior; dB re 1 µPa = decibels referenced to 1 micro Pascal; ESA = Endangered Species Act; HARP = High-frequency Acoustic Recording Package; hr = hour(s); HRC = Hawaii Range Complex; HSTT = Hawaii-Southern California Training and Testing; Hz = Hertz;; kHz = kilohertz; km = kilometer; M3R = marine mammal monitoring on Navy ranges; MFAS = mid-frequency active sonar; MITT = Mariana Islands Training and Testing; MMO = marine mammal observer; mtDNA = mitochondrial DNA; PAM = passive acoustic monitoring; photo-ID = photo-identification; PIFSC = Pacific Islands Fisheries Science Center; PMRF = Pacific Missile Range Facility; ROCCA = Real-time Odontocete Call Classification Algorithm; SCC = Submarine Commanders Course; SCORE = Southern California Offshore Range; SOCAL = Southern California Range Complex; U.S. = United States

Table 2. Monitoring goals and accomplishments for training ranges transitioning from first to second cycle of five (5) year authorizations (NWTT).

Project	Conceptual Framework Category	Corresponding ISO	Monitoring Objective	Accomplishments
NWTT				
[N1] QRS Unmanned Acoustic Glider (Klinck et al. 2015b)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• Analyze data collected during a 2012 glider deployment off the Washington coast.	• In 2015, completed manual analysis of acoustic data from a 2012 passive-acoustic glider survey in deep water (>1,000 m) off the coast of Washington in the QRS; also processed associated environmental data.
[N2] PAM for Marine Mammals in the NWTRC [2]	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• Analyze passive acoustic data in NWTRC for the presence of dolphin echolocation clicks, whale vocalizations, and anthropogenic sounds.	• In 2015, report on marine mammal and anthropogenic detections from July 2103 to April 2014, and a separate report on seasonality of killer whale ecotype calls from January 2011 to April 2014. These technical reports were previously submitted under NWTRC reporting (DoN 2015d). • Began cumulative analysis of collected HARP passive acoustic data collected from 2004 through 2015 with final reporting available after June 2016.

Project	Conceptual Framework Category	Corresponding ISO	Monitoring Objective	Accomplishments
NWTT (continued)				
[N3] Modeling Offshore Distribution of Southern Resident Killer Whales [2]	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur	• Identify and classify Southern Resident killer whale detections from acoustic recorders and satellite tag tracking; develop a model to estimate the seasonal and annual occurrence patterns of southern resident killer whales relative to offshore Navy training ranges.	• Completed review of acoustic data for 13 EARs recovered along the U.S. West Coast from fall 2014 to summer 2015; vocalizations of killer whales were identified and calls used to classify these to ecotype. • Conducted small-vessel tagging surveys to deploy location-only tags on SRKW. • Collected photos for the purposes of individual photo-ID, as well as samples of prey remains, feces, mucus and regurgitation. • In December 2015, deployed a Wildlife Computers satellite-linked tag on one SRKW adult male, a member of K pod. • Continued development and refinement of state-based spatial habitat model for SRKW offshore coastal distribution.
[N4] Marine Mammal Density Surveys in the Pacific Northwest (Inland Puget Sound) (Smultea et al. 2015)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities.	• Determine abundance, distribution, and densities of marine mammals in inland waters of Puget Sound via aerial surveys	• Conducted systematic line-transect aerial surveys for marine mammals in eight sub-regions of Puget Sound, Washington. • Estimated in-water density and abundance of marine mammals, particularly harbor porpoise and harbor seals. • Collected high-resolution photographs and video of marine mammal encounters.

Project	Conceptual Framework Category	Corresponding ISO	Monitoring Objective	Accomplishments
NWTT (continued)				
[N5] NWTRC Blue and Fin Whale Tagging and Genetics (Mate et al. 2016) (This project a component of HSTT SOCAL tagging, see project [S4] above)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities. #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur. #5: Establish the baseline behavior (foraging, dive patterns, etc.) of marine mammals where Navy trianing and testing activities occur.	• Deploy satellite-tracked tags on fin and blue whales in order to detail their occurrence, migration, and local residency patterns along the U.S. West Coast including within and outside of NWTRC.	• Instrumented blue whales, fin whales, a blue/fin hybrid whale, and a Bryde's whale with location-only and ADB satellite tags. • Analyzed genetic samples from blue whales and fin whales biopsied in 2014 and 2015 to determine sex of the individuals. • Used mtDNA sequences to define haplotypes for stock analysis and to confirm species identification.
[N6] Tagging and Behavioral Monitoring of Sea Lions in the Pacific Northwest in Proximity to Navy Facilities [2]	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat-use and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur.	• Deploy satellite tags; Estimate the number of California sea lions and Steller sea lions that haul out at Navy facilities in Puget Sound; Develop population estimates; Describe regional marine habitat usage by pinnipeds relative to Navy training, testing, and pile driving activities.	• Deployed satellite-linked time-depth-recording tags on 18 California sea lions and 1 Steller sea lion. • Collected sea lion behavioral data. • Documented percentage of time animals haul-out each month on structures and assets in Puget Sound.

Project	Conceptual Framework Category	Corresponding ISO	Monitoring Objective	Accomplishments
NWTT (continued)				
[N7] Harbor Seal Density Estimation [2]	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #11: Collect data to support impacts and effects analyses	• Refine harbor seal density estimates for Puget Sound using Fleet-funded monitoring data.	• Convened a workshop in October 2015 to assess existing monitoring datasets and chart a way forward to refine existing harbor seal density and abundance estimates in eight geographic subregions of Hood Canal.

[1] The project is in progress and results are not available at the time of this report

Key: EAR = Ecological Acoustic Recorder; ESA = Endangered Species Act; HARP = High-frequency Acoustic Recording Package; mtDNA = mitochondrial DNA; ISO = Intermediate Scientific Objective; min = minute(s); NWTRC = Northwest Training Range Complex; NWTT = Northwest Training and Testing; PAM = passive acoustic monitoring; QRS = Quinault Range Site; SRKW = Southern Resident Killer Whale.

Table 3. Monitoring goals and accomplishments for training ranges in first cycle of five (5) year authorizations (GOA TMAA).

Project	Conceptual Framework Category	Corresponding ISO	Monitoring Metric	Accomplishments
GOA TMAA				
[G1] GOA TMAA Unmanned Acoustic Glider (Klinck et al. 2016b)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.	• Determine spatial distribution and occurrence of beaked whales, other odontocetes, and baleen whales in offshore areas using a deep-diving autonomous glider.	• Deployed passive acoustic glider from 11 July through 11 August 2015, the first such Fleet-funded effort in this region. • Investigated spatial distribution and temporal occurrence of odontocetes and mysticetes in the northern Gulf of Alaska.
[G2] PAM of Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area using Bottom-Mounted Devices [2]	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #2: 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur. #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals.seasonality and acoustic characteristics, of marine mammals where Navy training and testing activities occur.	• Maintain passive acoustic data collection from two HARPs.	• Deployed and recovered two HARPs within GOA TMAA. • In 2015, concluded monitoring from two HARPs for presence of marine mammals in GOA, with a particular focus on endangered species and beaked whales. • In 2015, report on data analysis from five GOA HARPs from April 2014 to May 2015 with particular focus on endangered species and beaked whales. (Rice et al. 2015; previously submitted with GOA TMAA Year-5 annual report). • Final reporting with analytical focus on passive acoustic detections before, during, and after a Navy exercise in the GOA TMAA in June 2015 is ongoing with final reporting after September 2016.

Key: GOA TMMA = Gulf of Alaska Temporary Maritime Activities Area; ESA = Endangered Species Act; HARP = High-frequency Acoustic Recording Package; hr = hour(s); ISO = Intermediate Scientific Objective; PAM = passive acoustic monitoring.

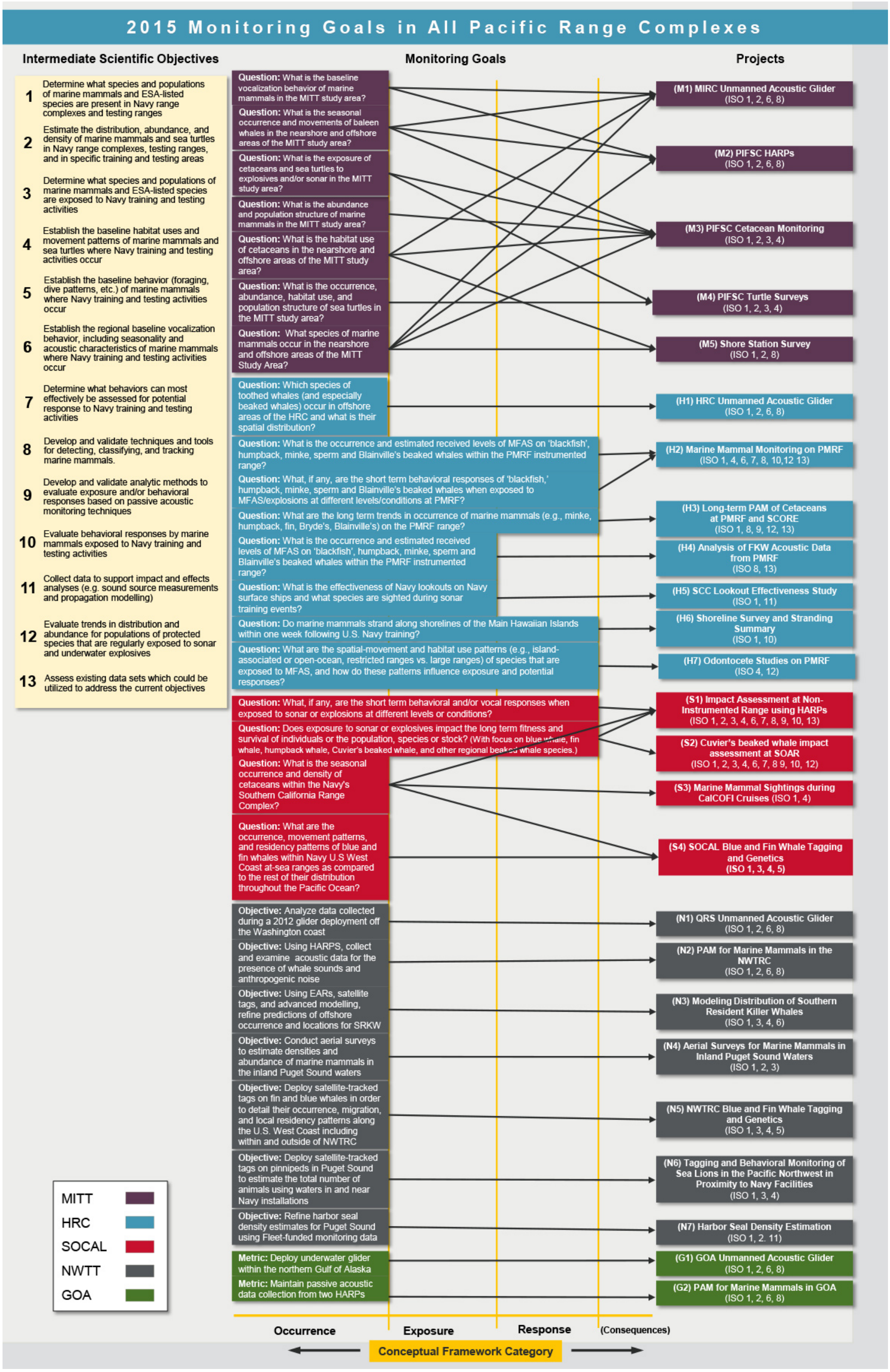

Figure 10. 2015 Monitoring goals in all Pacific range complexes. (*Note*: In some cases, project results did not address all associated conceptual framework categories or ISOs at the time of this report.)

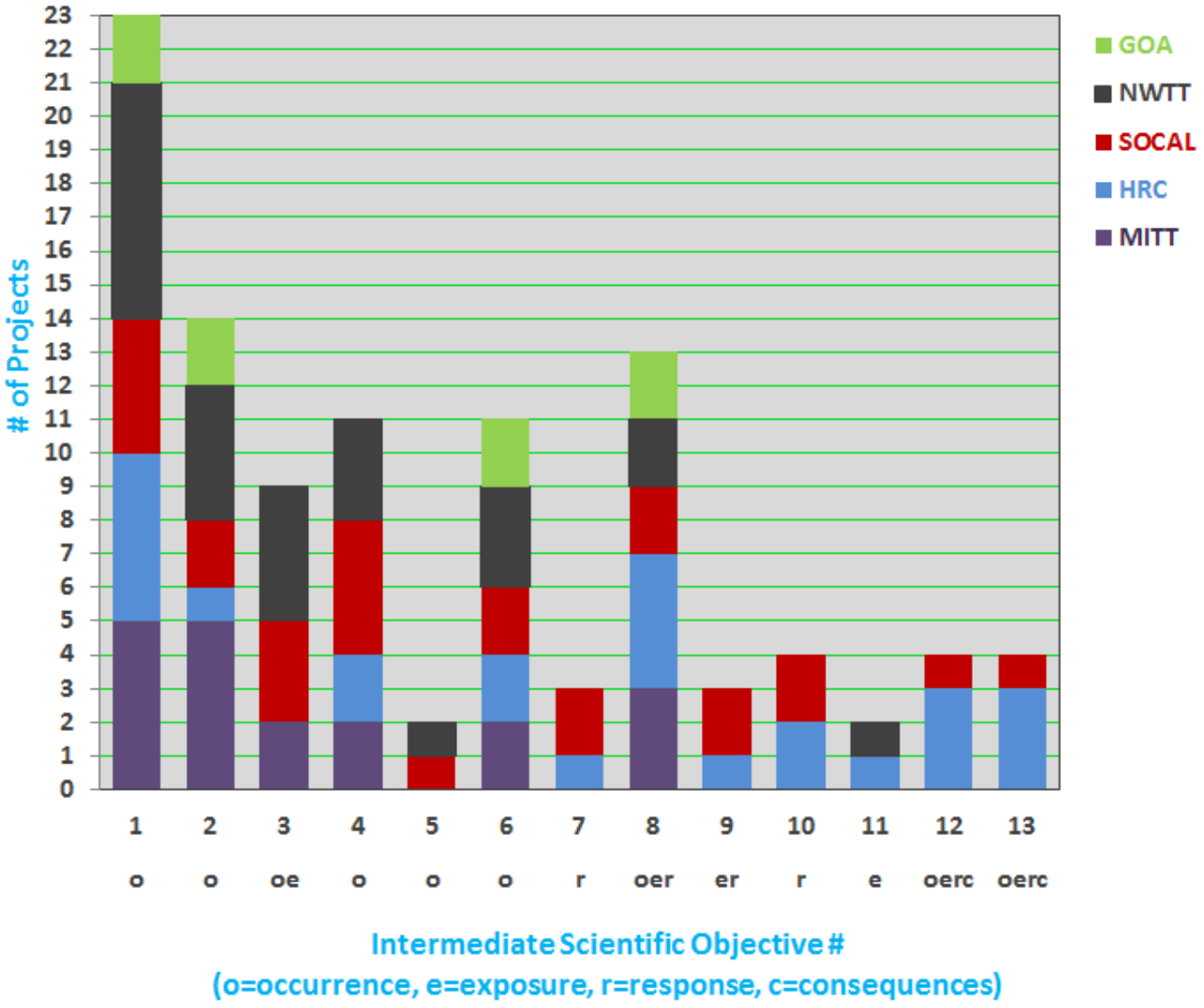

Figure 11. Number of monitoring projects that address the 13 Intermediate Scientific Objectives (see Figure 10) and four Conceptual Framework categories. (*Note*: In some cases, project results did not address all associated Conceptual Framework categories at the time of this report. For example, "Consequences" is not currently addressed through the marine species monitoring program)

2.1.1 Timeline of Monitoring Efforts

In this section, a graphical timeline of monitoring projects is presented for each range, covering the 2015 monitoring year. The ranges that transitioned during 2015 to the second cycle of five (5)-year authorizations begin their timelines mid-year, as described in **Section 1**. The timeline includes monitoring projects as well as notable items. The timeline graphic is followed by a description of each monitoring project; the corresponding monitoring project in the timeline can be identified by the numbered code at the beginning of the project title, which is composed of a one-letter abbreviation of the range (e.g., M=MITT; H=HRC; S=SOCAL; N=NWTT; G=GOA TMAA).

MITT

The MITT Study Area is depicted in **Figure 6**. A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the MITT in 2015 is illustrated in **Figure 12**. It should be noted that for three of these projects, field work and data collection occurred prior to 2015, but data analysis occurred within the 2015 reporting period. Detailed project summaries are provided following **Figure 12**. In addition, on 30 November 2015, a technical program review meeting was held with all organizations performing monitoring in the MITT to jointly discuss current work and future priorities.

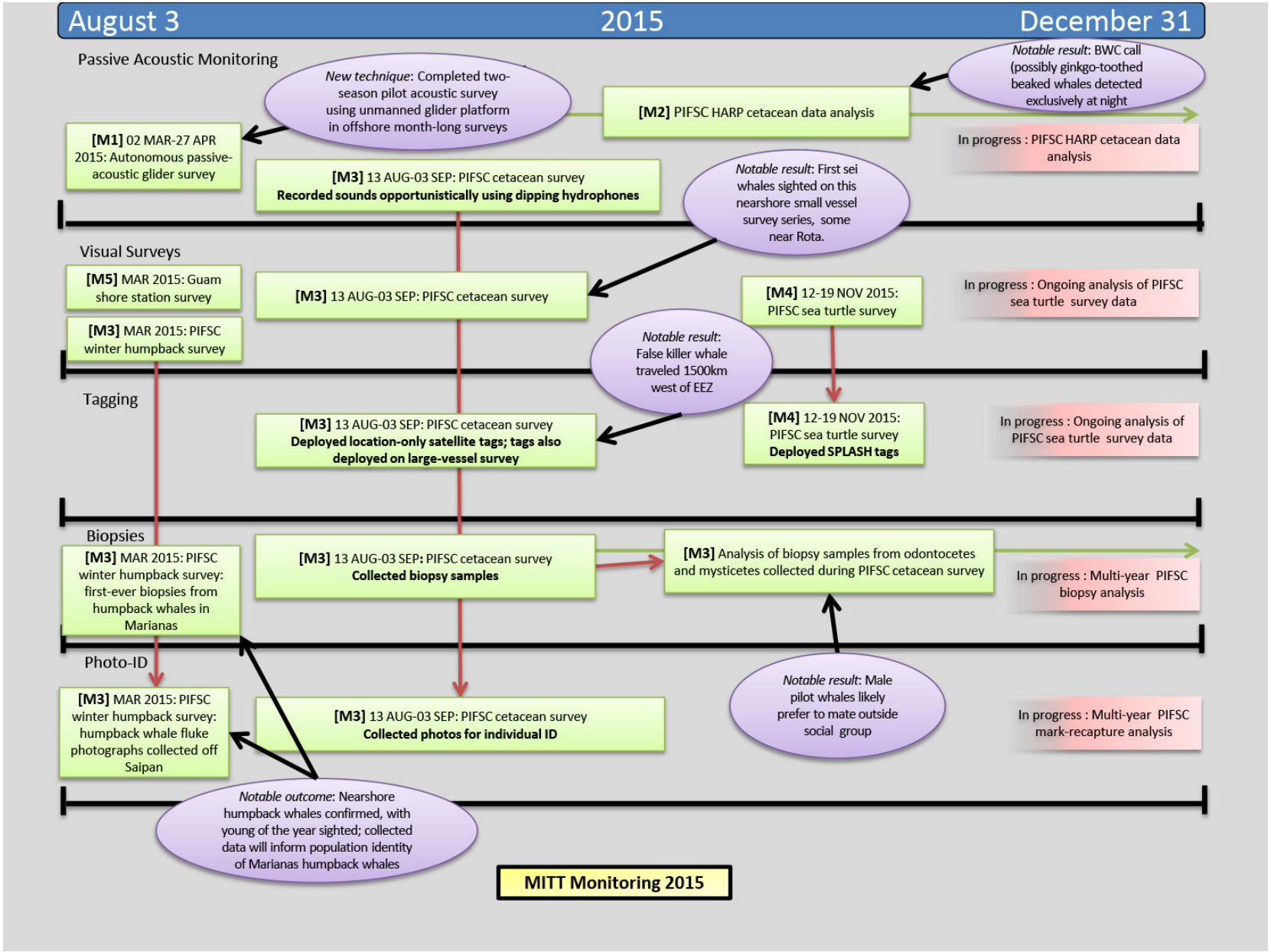

Figure 12. Timeline of 2015 projects in the Mariana Islands Training and Testing Study Area.

[M1] Cetacean Studies on the Mariana Islands Range Complex in March-April 2015: Passive Acoustic Monitoring of Marine Mammals Using Gliders [Klinck et al. 2016a]

A winter season passive acoustic glider survey was conducted by Oregon State University and University of Washington off Guam between 2 March and 27 April 2015 to investigate the spatial and temporal distribution of odontocetes and mysticetes in offshore areas east of the Mariana Islands that are difficult to access and survey. This is the second survey in this study area; the previous survey was performed in Fall 2014. Environmental data for sound speed profiles will be used in an ongoing project funded by the Office of Naval Research to develop and evaluate a framework for density estimation of cetacean species using slow-moving underwater vehicles including gliders and floats.

[M2] Cetacean Monitoring in the Mariana Islands Range Complex, 2015 [Hill et al. 2016]

HARPs were deployed off Tinian and Saipan by NMFS Pacific Islands Fisheries Science Center (PIFSC) (under their independent funding source) to characterize cetacean occurrence and temporal trends in the Mariana Islands. Through funding under MITT monitoring, existing acoustic data collected from the Saipan site for July 2013 through May 2015 and at the Tinian site for June through November 2014 were analyzed for beaked whale signals. Tinian data for 2013 to 2014 were analyzed and detection details were reported previously (refer to Hill et al. 2015).

[M3] Cetacean Monitoring in the Mariana Islands Range Complex, 2015 [Hill et al. 2016]

On 24, 25, and 27 February and 5 March 2015, PIFSC conducted shore-based visual surveys from an elevated station that overlooked the central-west side of Saipan to look for humpback whales. In the event of sightings, there was a small vessel survey team positioned to be ready attempt photography, biopsy, and satellite tagging.

Summer season visual surveys were conducted on small vessels (<12 meters [m] in length) for cetaceans during August through September 2015 off Guam and Rota. Survey effort was designed to cover representative habitat within the study area, and did not conform to systematic (i.e., line-transect) methods. 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, and Smart Position and Temperature (SPOT)-5 satellite tags were deployed on individuals of certain species to investigate their movements. Opportunistic acoustic recordings were collected using a dipping hydrophone. Multi-year mark-recapture photo-ID and biopsy analyses are ongoing.

In addition, satellite tags funded through the MITT monitoring program were deployed during an independently-funded PIFSC large-vessel survey, the Mariana Archipelago Cetacean Survey, during 8 May through 6 June 2015 aboard the National Oceanic and Atmospheric Administration (NOAA) Ship *Oscar Elton Sette*.

Regional and local genetic structure in Pacific short-finned pilot whales was studied using a combination of mitochondrial DNA (mtDNA) haplotypes and genotypes of samples from the Mariana Islands, Hawaiian Islands, and the Eastern Tropical Pacific (Van Cise et al. 2016).

[M4] Sea Turtle Tagging in the Mariana Islands Training and Testing (MITT): Update on Field Research [Jones and Martin 2016]

In November 2015, dedicated sea turtle surveys were conducted from small vessels in the nearshore and coastal waters of Guam, Saipan, and Tinian by Pacific Islands Fisheries Science Center. Survey locations included new areas not previously surveyed by this team—the southwest corner of Tinian, Lao Lao Bay in southeast Saipan, and Agat Bay in Guam. When green (*Chelonia mydas)* and hawksbill (*Eretmochelys imbricata*) turtles were encountered, they were captured by hand while snorkeling or diving, and instrumented with either a temperature-depth tag or an Argos temperature-only Platform Transmitter Terminal (PTT) tag in order to characterize sea turtle movements and habitat use in the MITT. As of the writing of this report, many of the tags are still transmitting and results will be documented in subsequent reports.

[M5] Guam Marine Species Monitoring Survey, Shore Station Study, May 2013 and March 2015 [Deakos et al. 2016]

During May 2013, a pilot study was conducted on Guam by HDR and NAVFAC Pacific to determine the effectiveness and feasibility of a shore-based observation platform (incorporating high-powered 25 X 150-millimeter binoculars ("Big Eyes") for visually surveying marine mammals and sea turtles (HDR 2014) in areas difficult to survey by small vessels due to prevailing environmental conditions. To compare the accuracy of fixing sightings by Big Eyes to using a theodolite, and to quantify the maximum detection range of Big Eyes for sighting large whales, Big Eyes were set-up on two different shore-based platforms in Hawaii (2 days in Maui and 1 day in Oahu) during the peak of humpback whale season. Following the Hawaii calibration work, the planned second part of this pilot survey series, a second 10-day shore station survey using two pairs of Big Eyes, was conducted on Guam in March 2015.

HSTT

The HSTT Study Area is depicted in **Figure 1**. Monitoring in HRC and SOCAL is presented individually in the immediately following sections.

HRC

The HRC is shown in **Figure 2.** A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the HRC in 2015 is illustrated in **Figure 13**. It should be noted that for three of these HRC tasks, field work and data collection occurred prior to 2015, but data analysis occurred within the 2015 reporting period. Detailed project summaries are provided following **Figure 13**.

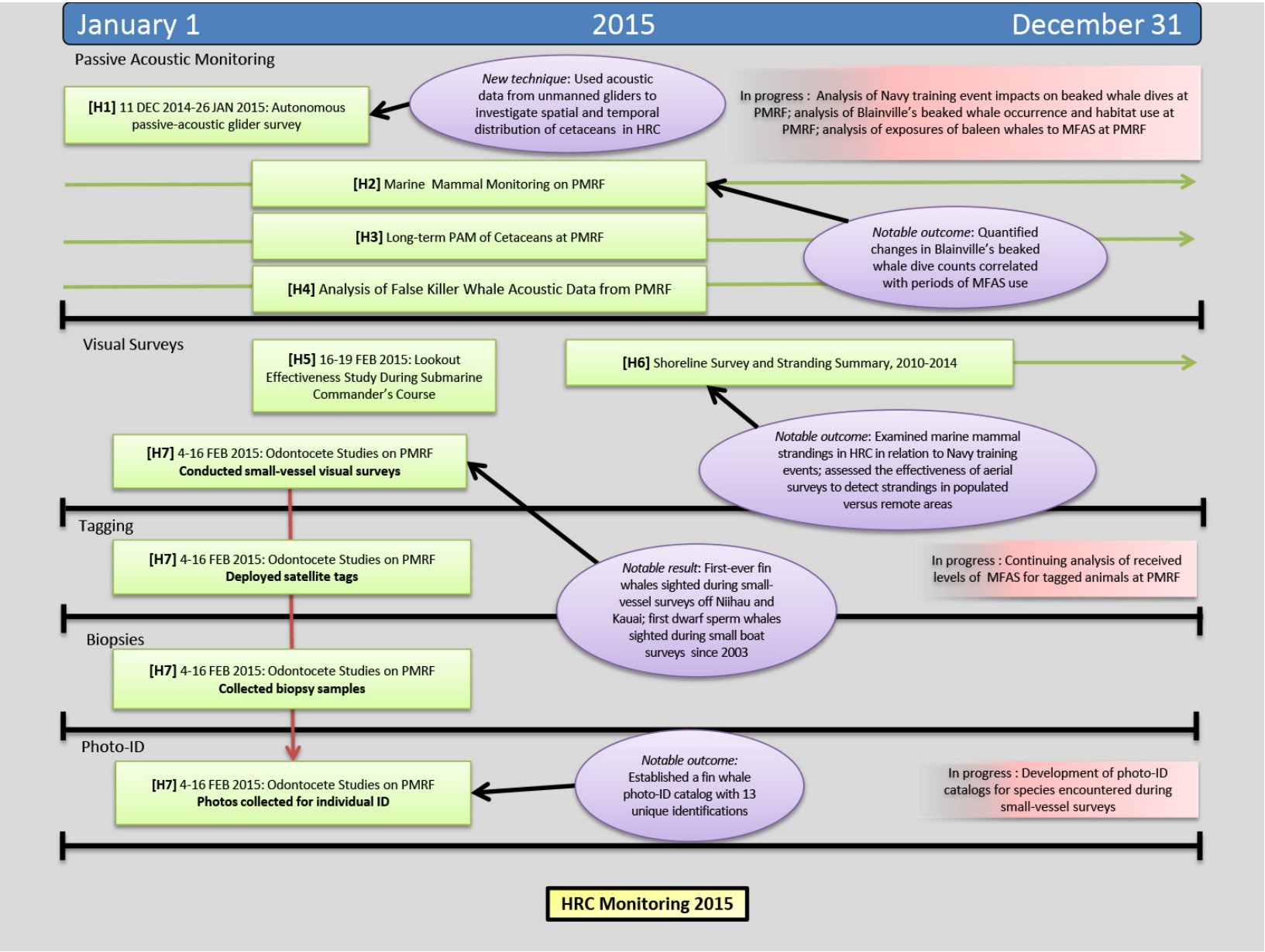

Figure 13. Timeline of 2015 projects in the Hawaii Range Complex.

[H1] Cetacean Studies in the Hawaii Range Complex in December 2014–January 2015: Passive Acoustic Monitoring of Marine Mammals Using Gliders [Klinck et al. 2015a]

A passive acoustic glider survey was conducted in the HRC by Oregon State University and University of Washington between 11 December 2014 and 26 January 2015. The goal of the project was to investigate the spatial and temporal distribution of cetaceans south of the Main Hawaiian Islands during the winter season, and to demonstrate the ability of the acoustic platform to survey remote areas for up to 30 days. This region contains offshore seamounts, including Cross Seamount, and adjacent abyssal areas that are difficult to access, and thus little is known about the abundance and distribution of cetaceans in these offshore areas. Additionally, offshore areas are particularly limited for surveying during the winter months due to the increased swell height.

[H2] SPAWAR Systems Center Pacific FY15 Annual Report on PMRF Marine Mammal Monitoring [Martin et al. 2015a]

Space and Naval Warfare Systems Command (SPAWAR) Systems Center Pacific marine mammal monitoring efforts in Fiscal Year (FY)15 at the PMRF during U.S. Navy MFAS training are detailed by Martin et al. (2015). Automatic processing was conducted of both hydrophone data and standard PMRF range products for presence, occurrence and relative abundance of baleen whales and beaked whales. Using archived acoustic data obtained from 31 seafloor-mounted hydrophones from the PMRF range before, during, and after training events during 2011 through 2013, changes in Blainville's beaked whale dive counts were correlated with periods of MFAS to assess the impact of MFAS on the animals' dive behavior. An automated beaked whale click detector was developed and validation of automated beaked whale click detections was performed to ensure they fit characteristics of foraging echolocation clicks (Manzano-Roth et al. 2015). This project builds upon the analysis conducted for 2011 through 2013 training events reported in Manzano-Roth et al. (2013) and Henderson et al. (2015a). A complementary study by Henderson et al. (2015b) describes foraging dives and habitat usage by Blainville's beaked whales.

[H3] Long-term PAM of Cetaceans at PMRF and Preliminary Abundance of Beaked Whales [Moretti 2016]

Naval Undersea Warfare Center (NUWC) Division Newport is trying to better our understanding the effects of military training events and exercises on local cetacean populations. For each of the major Navy instrumented ranges in the Pacific (PMRF, Southern California Offshore Antisubmarine Warfare Range [SOAR]), the initial goal is to provide a M3R system that can be run with minimal operator intervention to collect passive acoustic detection archives on a nearly continuous basis (see also project [S2]). These archive files provide an electronic record of marine mammal acoustic activity, and sonar activity, as well as marine mammal localization data from multiple algorithms. As algorithms become available and are incorporated into the system, algorithm-specific reports can be seamlessly integrated into the archives to provide a time-synchronous history of events.

When these data are provided with coincident ship track data, NUWC will extract from the archives, in semi-automated fashion, the following data products, with the mid-term goal of moving to a fully automated process to minimize analyst labor:

1. Beaked whale abundance and density values on a near continuous basis
2. Beaked whale distribution with and without sonar
3. Institution of a software source control within the Navy range signal processor software repository.

When combined with group size and dive rate (using echolocation clicks produced by beaked whales during foraging dives), the seasonal and monthly abundance of Blainville's beaked whale can be estimated, as can interannual trends. Group size is being derived from visual sighting data from Cascadia Research Collective (CRC) and Marine Ecology and Telemetry Research; dive rate is being measured via depth-recording satellite tags. In addition, using a different methodology than project *[H2]* (Henderson et al. 2015b), the number of dives immediately before Navy training is being compared to those detected during. Beginning in February 2016, system operation is being monitored by range personnel; this should result in near-continuous data records at PMRF.

[H4] Annotation and Classification of Odontocete Recordings Made in the Vicinity of Tagged False Killer Whales at PMRF [Oswald and Hom-Weaver 2016]

Continued development of methods for detection and classification of marine mammal sounds requires extensive datasets for training classifiers and ground-truthing detection algorithms. Researchers from Biowaves examined recordings collected by the cabled, seafloor-mounted hydrophones at the PMRF range coincident with the presence of false killer whales (*Pseudorca crassidens*) equipped with satellite tags. The Real-time Odontocete Call Classification Algorithm (ROCCA) was used to classify whistles recorded in the presence of satellite-tagged false killer whales at the PMRF range.

[H5] Final Cruise Report, Marine Species Monitoring & Lookout Effectiveness Study, Submarine Commanders Course, February 2015, Hawaii Range Complex [Watwood et al. 2016]

Marine mammal observers (MMOs) embarked on a U.S. Navy vessel during a Submarine Commanders Course (SCC) held in February 2015. MMOs followed a prescribed protocol to collect data that will be pooled with other embarks for future analysis of the effectiveness of U.S. Navy lookouts. In addition, MMOs recorded marine mammal and sea turtle sightings in order help determine the species and populations relative to U.S. Navy training events in the HRC.

[H6] Aerial Shoreline Surveys for Marine Mammals and Sea Turtles in the Hawaii Range Complex, Conducted after Navy Training Events. Five-Year Summary Report 2010 – 2014

Strandings and aerial survey data relative to U.S. Navy training events in the HRC were summarized by HDR, Marine Mammal Research Consultants, and Hawaii Pacific University in order to investigate whether any marine mammal strandings coincide in space and time with U.S. Navy training events. All aerial shoreline surveys (16 days total) conducted before and after seven (7) training events from 2010 through 2014 in the HRC were compiled. Stranding events during the past five (5) years were analyzed to evaluate how long after initial stranding an animal is likely to be detected using aerial monitoring surveys. Findings will provide insight as to the time frame that aerial surveys are most likely to be effective in detecting strandings

following an initial stranding event. Additionally, the effectiveness of aerial surveys to detect strandings in populated versus remote areas across the Hawaiian Islands will be investigated.

[H7] Odontocete Studies on the Pacific Missile Range Facility in February 2015: Satellite-tagging, Photo-identification, and Passive Acoustic Monitoring [Baird et al. 2016]

A joint project by CRC and NUWC Division Newport in February 2015 on and around PMRF was carried out utilizing combined vessel-based field efforts and PAM. Surveys were conducted in conjunction with the M3R real-time PAM system located at the PMRF range (Moretti and Baird 2015). M3R detections helped to locate animals for satellite-tag deployment, and visual observations provided validation of acoustic detections. The goal was to obtain information on cetacean movement and habitat-use on and around PMRF before, during, and after a U.S. Navy training exercise, using data obtained from satellite tags (see Baird et al. 2014). (Note: although tags are deployed prior to the training event, the tags have the potential to remain attached to the animal for several weeks; therefore, recovered data may overlap in space and time with training events.)

SOCAL

The SOCAL Range Complex is depicted in **Figure 3**. A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the SOCAL in 2015 is illustrated in **Figure 14**. It should be noted that for these SOCAL projects, field work and data collection occurred prior to 2015, but data analysis occurred within the 2015 reporting period. Detailed project summaries are provided following **Figure 14**.

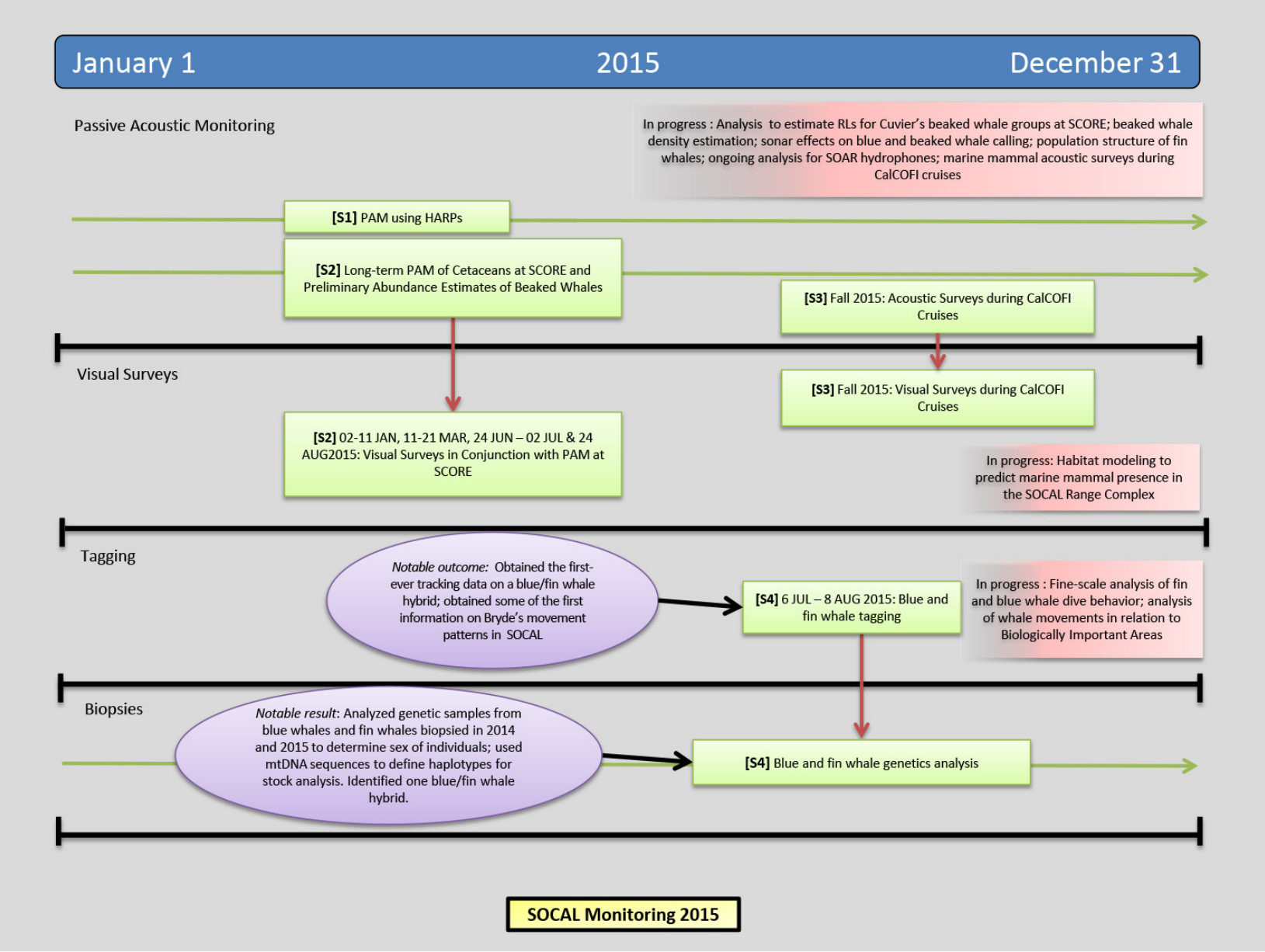

Figure 14. Timeline of 2015 projects in the Southern California Range Complex.

[S1] Passive Acoustic Monitoring and Data Analysis in SOCAL

The University of California San Diego's Scripps Institution of Oceanography (SIO) in La Jolla, California, and SPAWAR are collaborating to study potential impacts of sonar exposure on marine mammal presence and behavior near naval training areas in SOCAL (see **Figure 15**). The range of work conducted under this effort includes analyses of whale calls and echolocation clicks (blue whales, fin whales, and Cuvier's beaked whales), sonar impacts, beaked whale population density, and fin whale population structure. Initial reporting includes Baumann-Pickering et al. (2016), Hildebrand et al. (2016), and Širović et al. (2016).

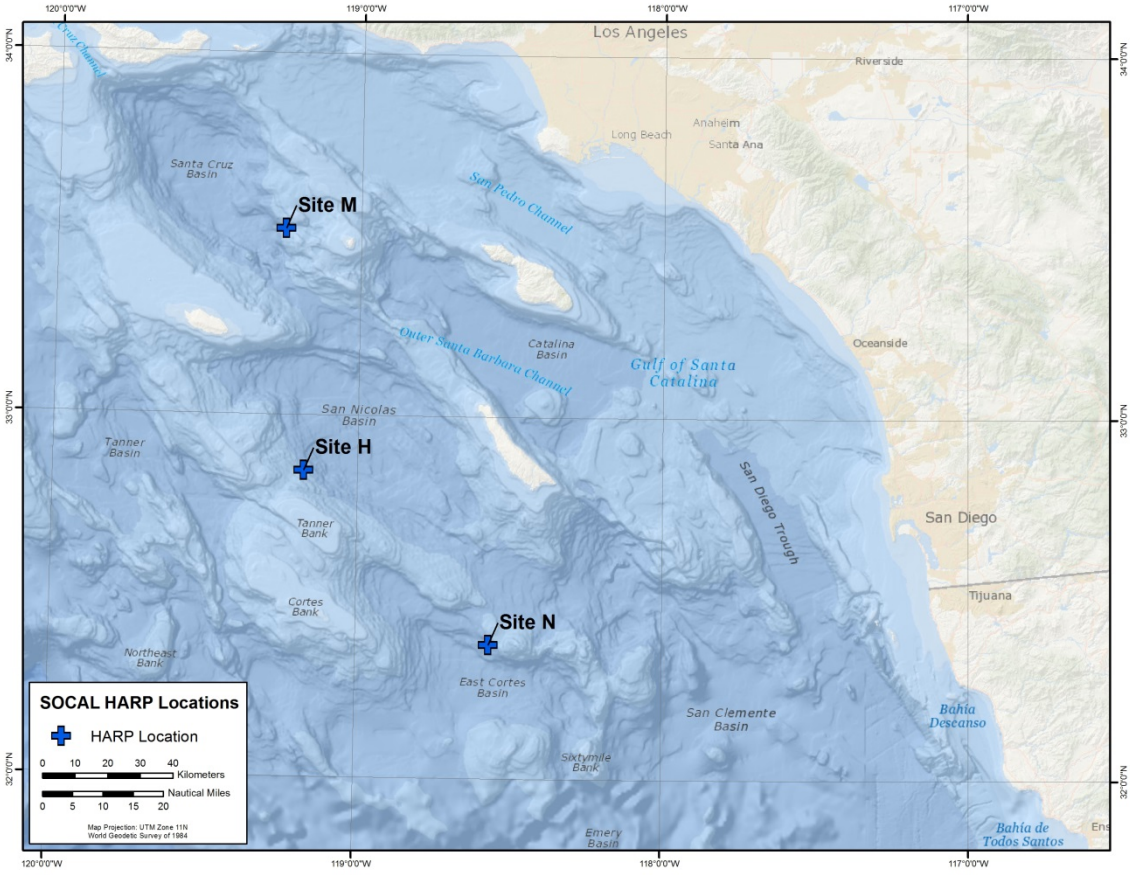

Figure 15. Locations of passive acoustic monitoring sites in the Southern California Range Complex. [Project S1]

[S2] Cuvier's Beaked Whale Impact Assessment at the Southern California Offshore Antisubmarine Warfare Range (SOAR) [Moretti 2016]

NUWC Division Newport is trying to better our understanding the effects of military training events and exercises on local cetacean populations, with an emphasis on Cuvier's beaked whales. For each of the major Navy instrumented ranges in the Pacific (PMRF, SOAR), the initial goal is to provide a M3R system that can be run with minimal operator intervention to collect passive acoustic detection archives on a nearly continuous basis (see also project H3). These archive files provide an electronic record of marine mammal acoustic activity, and sonar activity, as well as marine mammal localization data from multiple algorithms with a focus on Cuvier's beaked whales. As algorithms become available and are incorporated into the system,

algorithm-specific reports can be seamlessly integrated into the archives to provide a time-synchronous history of events.

When these data are provided with coincident ship track data NUWC will extract from the archives, in semi-automated fashion, the following data products, with the mid-term goal of moving to a fully automated process to minimize analyst labor:

1. Beaked whale abundance and density values on a near continuous basis
2. Beaked whale distribution with and without sonar
3. Institution of a software source control within the Navy range signal processor software repository.

Cuvier's beaked whale abundance will be estimated on a monthly and seasonal basis using the dive start method developed previously for Blainville's beaked whales at the U.S. Navy's Atlantic Undersea Test and Evaluation Center (AUTEC). Archived data are being analyzed in a semi-automated fashion to produce the required data products.

These data will then be provided as input to the Office of Naval Research-funded Population Consequences of Acoustic Disturbance model and used to investigate the cumulative impact of sonar exposure in future analyses.

Marine Ecology and Telemetry Research is also a collaborator on this project's field survey component for satellite tagging and population demographics. On-range (i.e., SOAR) and off-range surveys largely targeting Cuvier's beaked whales will be ongoing in 2016, as they are a focal species with a range that extends beyond the waters immediately adjacent to the Southern California Offshore Range (SCORE). Given suitable weather and waters clear from military training, surveys extend to the SOAR, west of SCI, throughout daylight hours (hr) with the acoustic support of the M3R system to assist in locating focal species.

[S3] Marine Mammal Surveys on CalCOFI Cruises

The California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises, a joint agency field effort, have been conducted in Southern California for over 62 years, and represent the only continuous, seasonal marine mammal information available for Southern California. More information on the overall history of the CalCOFI program is available at: http://www.calcofi.net/. Beginning in 2004, the Chief of Naval Operations Environmental Readiness Division funded the collection of marine mammal visual and passive acoustic data during regularly scheduled CalCOFI cruises, which occur four times per year. U.S. Pacific Fleet specifically funded marine mammal data collection in 2013, 2014, 2015, and continuing from 2016 through 2018. The CalCOFI marine mammal efforts represent one of the few cool-water (i.e., winter, spring) vessel surveys in the region, with the exception of the U.S. Pacific Fleet's aerial surveys that have also sampled during cool-water periods (e.g., Smultea and Bacon 2012, 2013). Each CalCOFI cruise consists of sampling the same survey tracklines including coverage offshore (>100 nm). Visual and acoustic data will be used to characterize spatial and temporal distribution patterns, density, and abundance of cetaceans in the Southern California Bight. Through collaboration with SIO and NMFS, these data will also be used to develop predictive marine mammal habitat models

for Southern California, including the SOCAL Range Complex. Final reporting for 2015 CalCOFI survey efforts will be available by September 2016.

[S4] Blue & Fin Whale Tagging and Analysis in Support of Marine Mammal Monitoring Across Multiple Navy Training Areas [Mate et al. 2016]

Oregon State University's Marine Mammal Institute continued the previous year's efforts (see Mate et al. 2015) to tag blue and fin whales within Southern California. The objectives were to collect long-range movement and distribution information as well details on individual animal use of Navy training areas and subareas in terms of residence time. This includes movements in and through SOCAL, NWTT, and Naval Air Systems Command's Point Mugu Sea Range. No animals tagged in 2015 entered the GOA TMAA. In addition, additional scientific information of foraging and dive behaviors for blue and fin whales was obtained (Mate et al. 2016). Two types of satellite-monitored radio tags were deployed on blue and fin whales off the coast of southern California—location-only and Advanced Dive Behavior (ADB) tags—to provide both long-term tracking information and shorter-term, fine-scale dive profile information, respectively. Genetic analyses are in progress on tissue samples collected from blue whale and fin whales during U.S. Navy-funded monitoring efforts in 2014 and 2015.

NWTT

The NWTT Study Area including offshore areas is depicted in **Figures 7 and 8**. A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the NWTT in 2015 is illustrated in **Figure 16**. For three of these NWTT projects, field work and data collection occurred prior to 2015, but data analysis occurred within the 2015 reporting period. Detailed project summaries are provided following **Figure 16**.

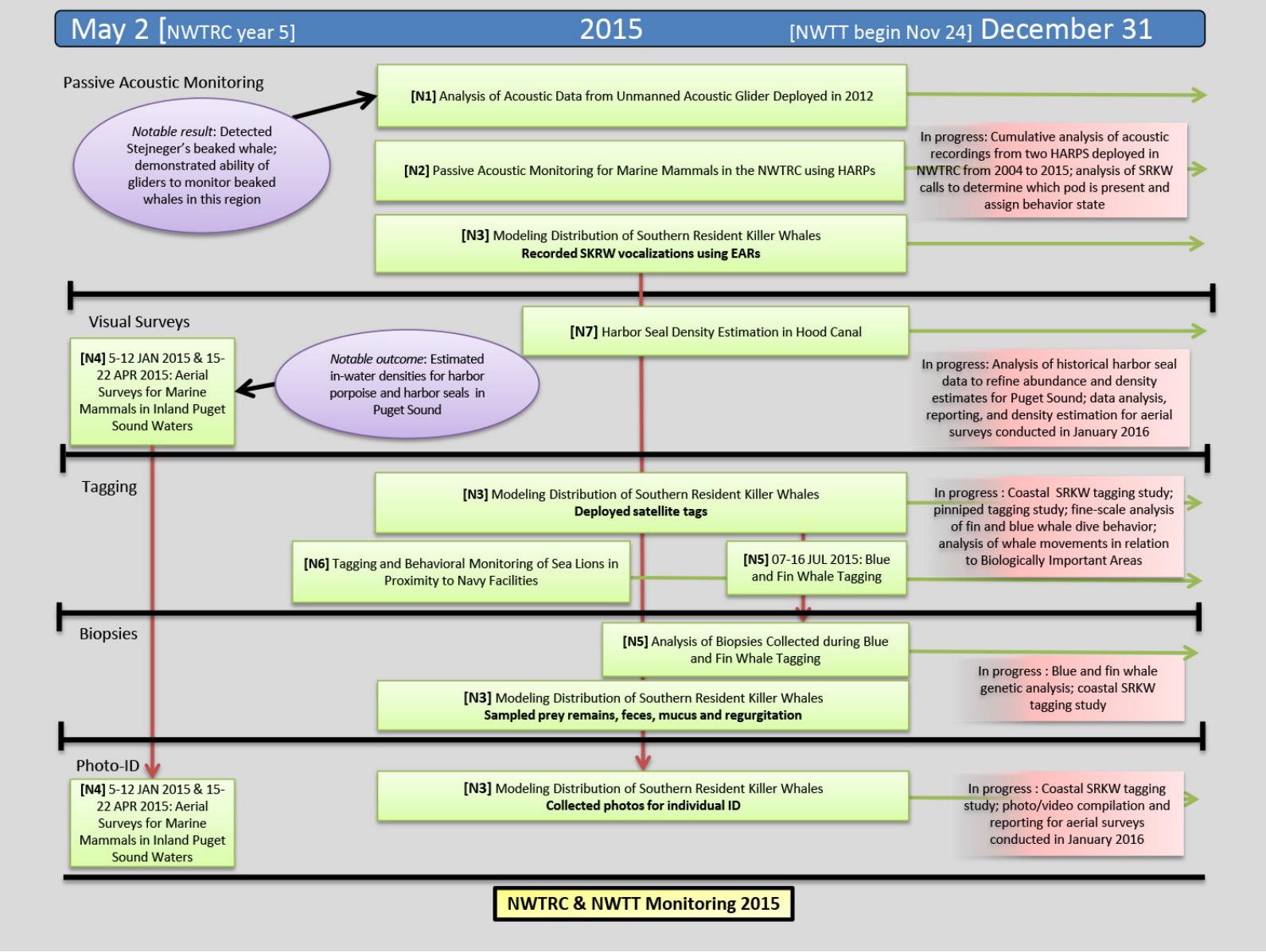

Figure 16. Timeline of 2015 projects in the Northwest Training and Testing Study Area.

[N1] Cetacean Studies on the Quinault Range Site in June 2012: Passive Acoustic Monitoring of Marine Mammals Using Gliders—Results from an Engineering Test [Klinck et al. 2015b]

A passive acoustic glider survey was conducted by Oregon State University and University of Washington in deep waters (>1,000 m) of the Quinault Range Site (QRS) off the Washington coast between 11 June and 12 July 2012. The QRS survey was an engineering trial that focused on testing the proper functionality and robustness of the PAM system. In 2015, a subsequent project funded by U.S. Pacific Fleet enabled a thorough manual analysis of this previously collected dataset for marine mammal detections, as well as processing of collected environmental data.

[N2] Passive Acoustic Monitoring for Marine Mammals in the Northwest Training Range Complex

PAM using HARPs has been conducted in the NWTRC since 2004 by SIO. From 2004 to spring 2014, HARPS were deployed at two sites in the NWTRC - one offshore in the deep waters of Quinault Canyon (site QC) and the other closer inshore near Cape Elizabeth (site CE) (**Figure 17).** Researchers are conducting a cumulative analysis of the acoustic recordings collected in the NWTRC over the past decade, with particular focus on endangered species, including the North Pacific right whale (*Eubalaena japonica*) and SRKW. This work builds on previous similar analyses, from July 2013 to April 2014 (see Trickey et al. 2015).

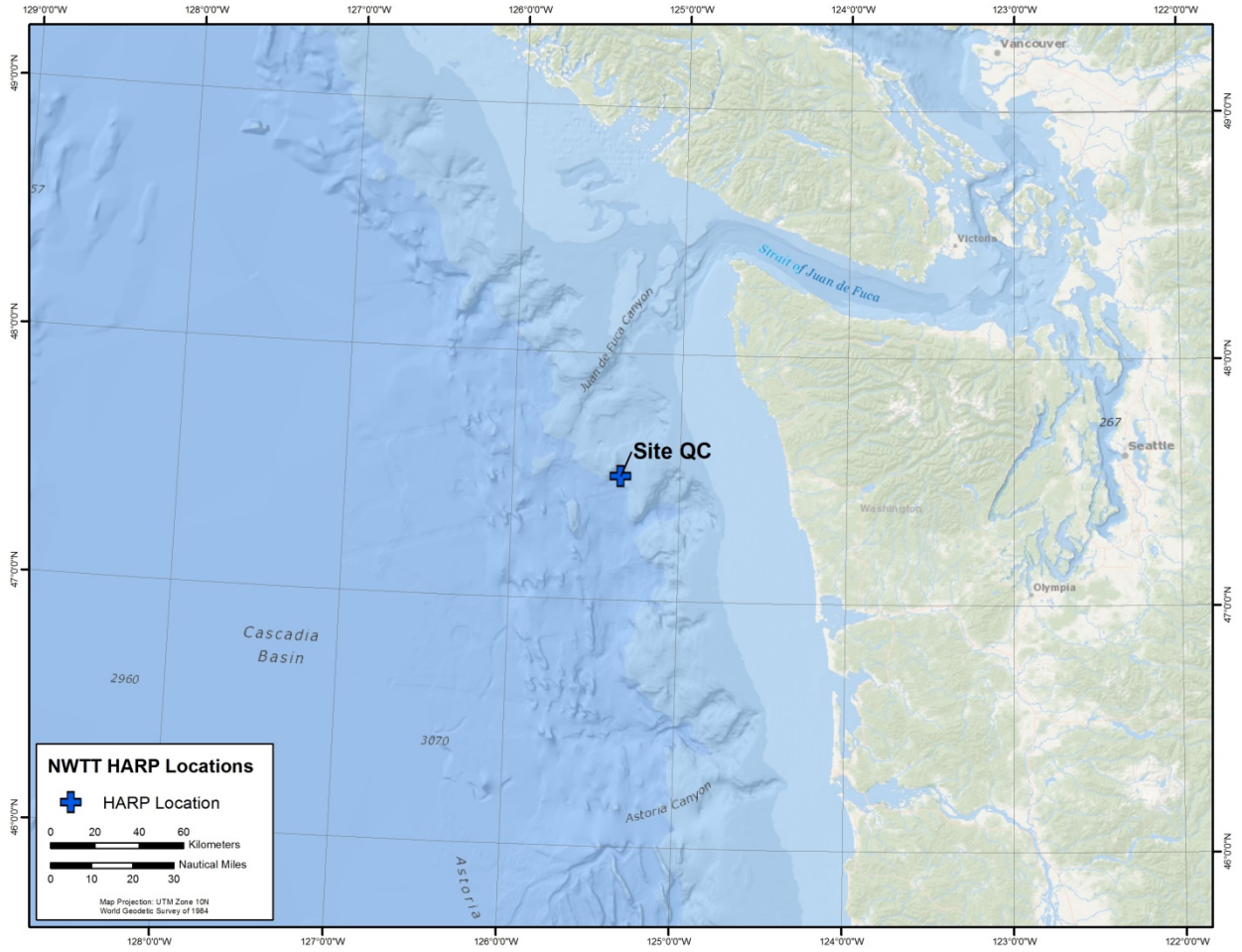

Figure 17. High-frequency Acoustic Recording Package locations in the Northwest Training and Testing study area. [Project N2]

[N3] Modeling Offshore Distribution of Southern Resident Killer Whales

This project leverages existing work funded by the U.S. Navy and NMFS (specifically, the Northwest Fisheries Science Center [NWFSC]). The spatial distribution of endangered SRKW is being studied using deployed passive acoustic devices (Ecological Acoustic Recorders [EARs]), satellite-tracked tags, and spatial habitat modeling. Efforts include analysis of data collected by EARs during the 2012–2013, 2014–2015, and 2015-2016 field seasons. CRC, in cooperation with NWFSC, is conducting small-vessel operations to determine where along the outer coast of Washington and Oregon SRKWs are occurring and/or foraging and conduct tagging and biopsy sampling. Additionally, prey remains and fecal, mucus, and regurgitation samples are collected from killer whales to determine the prey selected by SRKWs throughout their range, but particularly the coastal waters of the U.S., mainly from Cape Flattery to the Columbia River.

The probability of detection and identification are being estimated based on a review of vocalization activity and from a state-space model comparing satellite-linked locations with acoustic recorder detections. State-space models of seasonal and annual probability of occurrence for SRKWs off the Washington coast are being developed. Preliminary results from the EARs were published by Hanson et al. (2013, 2015). The current effort adds additional data and analysis. Data are being collected through 2016, and results of further analyses will be provided in a future report.

[N4] Marine Mammal Aerial Surveys Conducted in the Inland Puget Sound Waters of Washington, Summer 2013–Spring 2015 [Smultea et al. 2015]

The U.S. Navy has funded systematic line-transect aerial surveys over eight sub-regions of inland Puget Sound waters since 2013. From 2013 through 2015, surveys were flown by Smultea Environmental Sciences and Clymene Enterprises during five separate survey periods spanning four seasons, using fixed-wing aircraft to collect data to estimate densities and abundance of marine mammals in inland Puget Sound waters. Distribution, habitat use, and behavior of each observed species was documented. Density and abundance estimates were calculated following conventional distance-sampling methods using DISTANCE 6.2 software. Surveys were divided into eight survey blocks (i.e., sub-regions) developed by the U.S. Navy and NMFS. Occurrence and distribution data were recorded for each of these sub-regions, and when possible, density and abundance estimates were derived for these areas as well.

Inclement weather conditions prevented aerial surveys from being conducted in winter months in 2015. In order to address this data deficiency, an aerial survey was conducted during 16 to 25 January 2016 in order to collect information in this typically data-poor seasonal period. These data are being incorporated with the previous results, and analysis is in progress, with final results expected in 2016.

[N5] Baleen (Blue & Fin) Whale Tagging and Analysis in Support of Marine Mammal Monitoring Across Multiple Navy Training Areas [Mate et al. 2016]

This is the same project noted earlier in SOCAL project descriptions: Oregon State University's Marine Mammal Institute continued the previous year's efforts (see Mate et al. 2015) to tag blue and

fin whales. In cases where tagged animals traveled to the NWTT study area, the results are applied to NWTT monitoring.

[N6] Tagging and Behavioral Monitoring of Sea Lions in the Pacific Northwest in Proximity to Navy Facilities

NMFS-Alaska Fisheries Science Center (National Marine Mammal Laboratory), with funding from the U.S. Navy, is collecting sea lion behavioral data, including the percentage of time animals haul-out each month on structures and assets near Puget Sound naval facilities at Everett, Bremerton, and Bangor. Two floats have been anchored in place since spring/summer 2014; traps were installed on the floats to allow the agencies to capture adult male California sea lions and instrument some of these individuals with satellite-linked time-depth recorders to assess the proportion of time animals are hauled out of the water; the location of their foraging grounds within Puget Sound; and foraging behavior of adult male sea lions. Preliminary results were presented in last year's NWTRC Annual Monitoring Report (DoN 2015d). Tag deployment, data collection, and analyses are still underway; results will be presented in a future report.

[N7] Harbor Seal Density Estimation

Analyses to estimate abundance and densities for the harbor seal in Hood Canal (including Dabob Bay) are currently underway, using existing aerial and vessel-based monitoring survey data to produce and refine estimates of abundance, distribution, and density (by month) with variances. This project is a collaboration between Clymene Enterprises, HDR, NMFS-Alaska Fisheries Science Center (National Marine Mammal Laboratory), and Washington Department of Fish and Wildlife. The analysis will result in a non-uniform density estimate, taking into account known haulouts in the area, seasonal haulout variations, foraging range distribution, and other factors. A workshop was convened in October 2015, and was attended by the U.S. Navy, NMFS, Clymene Enterprises, Washington Department of Fish and Wildlife, and HDR, in order to review existing harbor seal data and agree upon a way forward for revising harbor seal density estimates in Puget Sound. A report summarizing the workshop discussions and description of the density analysis will be provided to the U.S. Navy later this year.

GOA TMAA

The GOA TMAA is depicted in **Figure 9**. A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the GOA TMAA in 2015 is illustrated in **Figure 18**. It should be noted that for the GOA TMAA projects, field work and data collection occurred prior to 2015, but data analysis occurred within the 2015 reporting period. Detailed project summaries are provided following **Figure 18**.

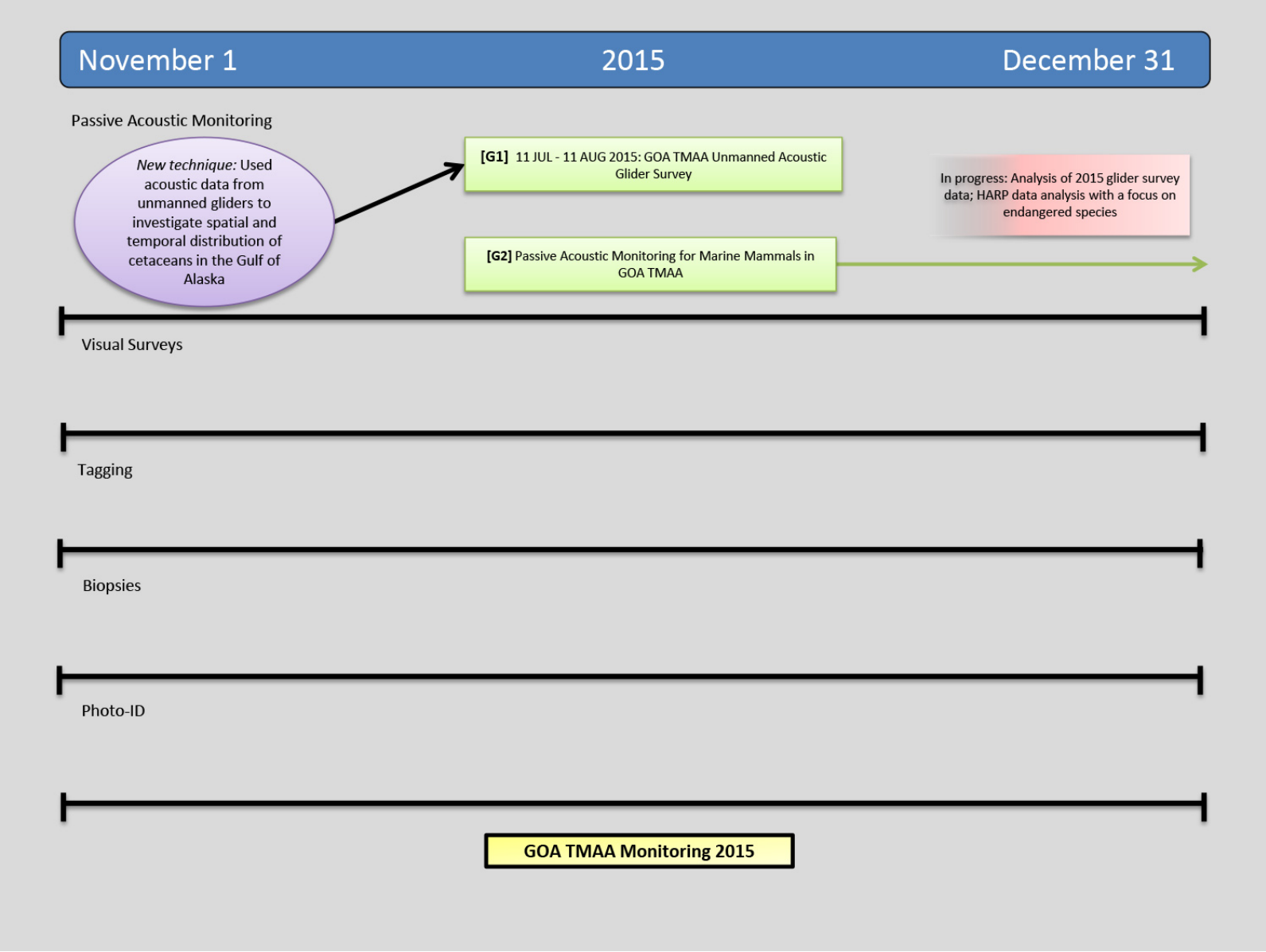

Figure 18. Timeline of 2015 Gulf of Alaska Temporary Maritime Activities Area monitoring projects.

[G1] Cetacean Studies in the Gulf of Alaska Temporary Maritime Activities Area in July-August 2015: Passive Acoustic Monitoring of Marine Mammals Using Gliders [Klinck et al. 2016b]

A passive acoustic glider was deployed by Oregon State University and University of Washington on 11 July 2015, 200 km east-southeast of Homer, Alaska. The acoustic survey was completed on 11 August 2015, and the instrument was recovered on 21 August 2015. The goal of the project was to investigate the spatial distribution and temporal occurrence of odontocetes and mysticetes in the northern Gulf of Alaska. The survey focused primarily on the shelf break area between Middleton Island and Kodiak Island. The Gulf of Alaska is generally difficult to survey, and thus this survey contributes to the body of science for this region.

[G2] Passive Acoustic Monitoring of Marine Mammals in GOA TMAA using Bottom-Mounted Devices

U.S. Navy-funded HARP deployments by SIO have been taking place since 2011 in the GOA TMAA, using two to five HARPs (Baumann-Pickering et al. 2012; Debich et al. 2013, 2014; Rice et al. 2015). Passive acoustic data were collected from the two deployment locations, one on the slope (Slope HARP) and one on Pratt Seamount (**Figure 19**). The Slope HARP was configured with four-channel HARPs to enable tracking and source-level estimation for calling animals including Stejneger's beaked whale; these parameters are needed for density estimation from acoustic data. Data analysis consisted of detecting marine mammal and anthropogenic sounds by analyst scans of long-term spectral averages and spectrograms, and by automated computer algorithm detection when possible. Data from the June through October 2015 deployment will be discussed in a future report.

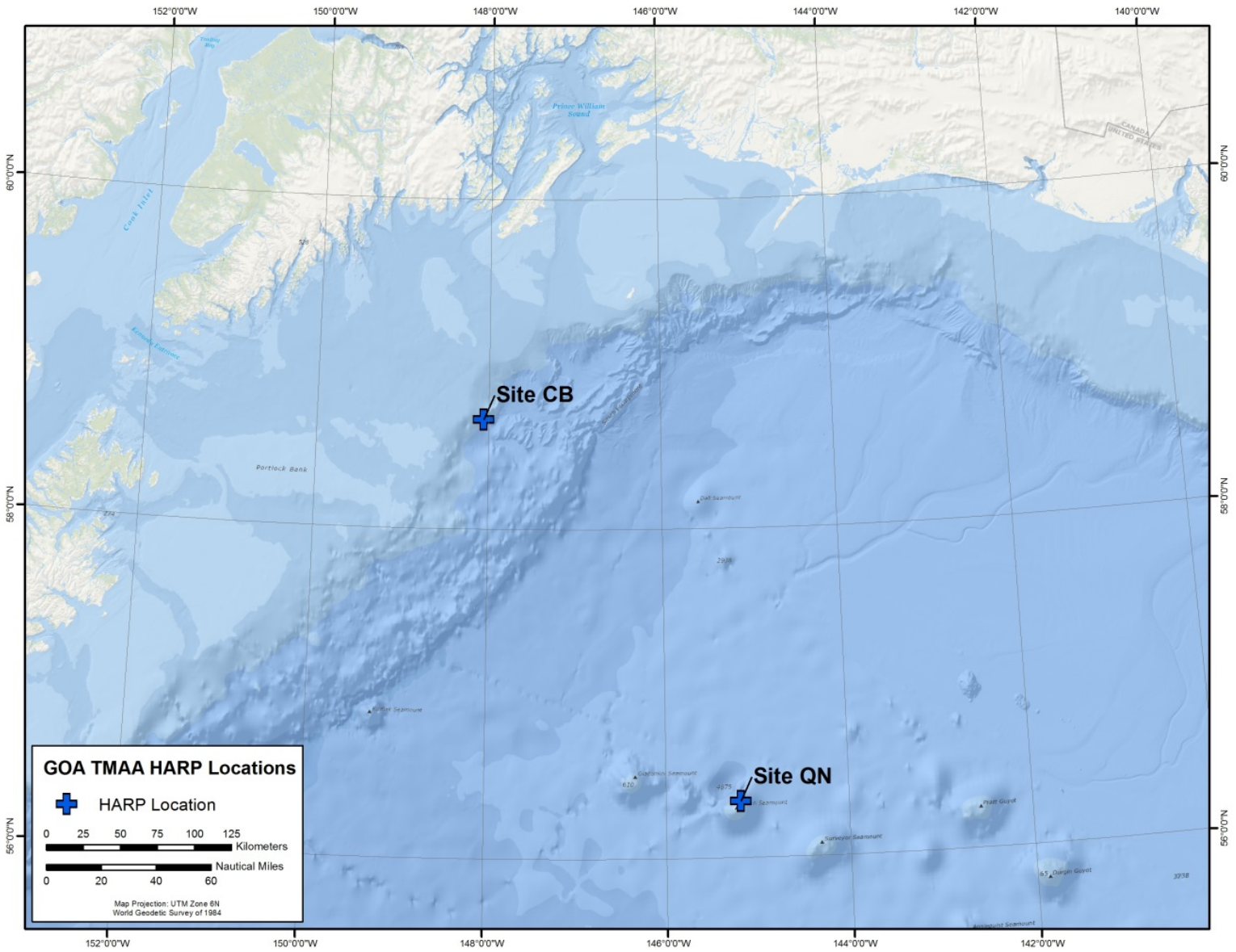

Figure 19. High-frequency Acoustic Recording Package locations in the Gulf of Alaska Temporary Maritime Activities Area. [Project G2] Site CB is on the slope, and site QN is at Quinn Seamount.

2.2 Results

Results and key conclusions from 14 Pacific monitoring projects are summarized below. Cumulative results for HSTT (2014-2015) are included because the monitoring program for these ranges is in Year 2 of their second cycle of five (year) authorizations. Only 2015 results are presented for the other ranges, for which their monitoring programs are either associated with their first cycle of five (5) year authorizations (GOA TMAA), transitioning from their first to second (NWTT), or in Year 1 of their second (MITT).

Project results are organized by Conceptual Framework category (Occurrence, Exposure, and Response); then by monitoring questions or objectives and the projects that address these. Within each conceptual framework category, the regions are generally presented sequentially, as MITT, HSTT, NWTT, and GOA TMAA. If a particular ISO that was addressed by a project fell outside the monitoring questions or objectives, it is treated separately; this occurred only under the Occurrence category. In this monitoring year, no project results specifically addressed the issue of population consequences; therefore, that Conceptual Framework category is not discussed here.

2.2.1 Conceptual Framework Category 1. Occurrence

The following sections summarize progress made this monitoring year on addressing the conceptual framework category of occurrence of protected marine species in the four Pacific training and testing study areas: MITT, HSTT (HRC and SOCAL), NWTT, and GOA TMAA. Progress is treated by monitoring questions and objectives related to Occurrence, and within this grouping will be ordered by range complex.

2.2.1.1 MONITORING QUESTIONS: What species of marine mammals occur in the nearshore and offshore areas of the MITT Study Area?; and

What is the habitat use of cetaceans in the nearshore and offshore areas of the MITT study area?; and

What is the seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area [Projects M1, M2, M3, M5]

The above three monitoring questions are here treated together because these all apply to the same four monitoring projects.

A 10-day shore-station survey was conducted on Guam in March 2015 to investigate the use of a shore-station survey as an alternative approach for surveying marine areas for marine mammals and sea turtles (Deakos et al. 2016). The survey scanned from a north-facing (193-m elevation) and a northeast-facing (143-m elevation) shore station, chosen for mostly unobstructed views of the ocean in areas that are difficult to access by small vessel due to strong winds and large waves. The horizon distance calculated from each elevation was 50 and 42 km, respectively. This survey was the second part of a two-season pilot survey, with the first part conducted in May 2013. A total of 63.5 hr of shore-based observation on-effort was conducted from 3 to 12 March 2015 over 10 days. Of the on-effort time in 2015, 54 percent was spent surveying in Beaufort sea state (BSS) 6 and 92 percent of the time was spent observing

in BSS 5 or greater. A particular goal of the winter-season survey in 2015 was to search for baleen whales, but no sightings were made, even though the survey period overlapped with a small vessel visual survey on Saipan which did encounter humpback whales on multiple days (Hill et al. 2016).

Sightability of baleen whale cues was examined in Hawaii at two different high-elevation shore station sites during the humpback whale wintering season. The Hawaii effort quantified the detection range capability for large whales using Big Eyes and demonstrated that they can be detected as far as 38 km from a shore platform that is 278 m in elevation and 22.6 km from a platform that is 65 m in elevation. Given that the Guam shore platforms are 193 and 143 m in elevation, somewhere in between the Hawaii stations, the furthest a large whale should be visible would be expected to be somewhere between 22 and 38 km, though the calmer sea states encountered during the Hawaii effort must be considered. Furthermore, the long distance at which unidentified small dolphins (15 km away in BSS 3) and melon-headed whales (13 km away in BSS 5) were observed in Guam suggests that visual cues from large whales are likely to have been sighted, if these had been present within the viewshed of either the May 2013 or March 2015 Guam surveys.

In 2015, odontocete sightings included spinner dolphins, bottlenose dolphins, and melon-headed whales (**Figure 20**).

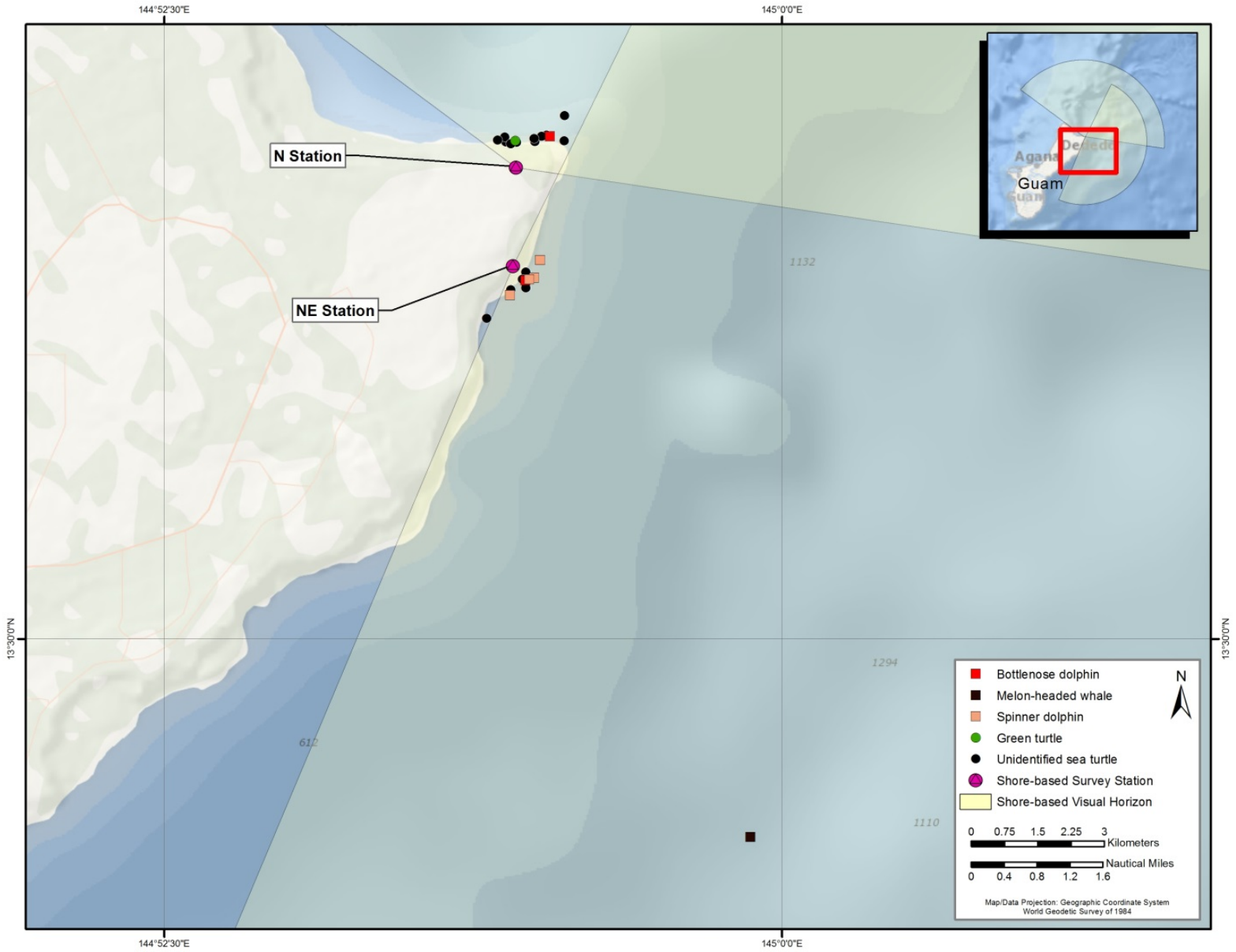

Figure 20. Sightings from two shore survey stations on Guam in March 2015. [Project M5]

PIFSC conducted visual and acoustic surveys in the MIRC to investigate cetacean occurrence in the CNMI region (Hill et al. 2016) (**Figures 21 and 22**).

PIFSC researchers surveyed 2,092 km in the MIRC during summer and recorded cetaceans in the region. The most frequently sighted species was the pantropical spotted dolphin (*Stenella attenuata*), individuals were observed most frequently off Guam (**Table 4**, **Figure 21**). The second most frequently sighted species was the spinner dolphin. Juvenile Bryde's whales, pygmy killer whales (*Feresa attenuata*), and false killer whales were sighted off Guam. Off Rota, PIFSC researchers observed four bottlenose dolphin sightings, two Bryde's whale, unidentified sei/Bryde's whales, Blainville's beaked whales, and unidentified whale blows (**Table 4**, **Figure 21**).

Table 4. Species encounter summary including encounter rate (No. encounters/100 kilometers [km] effort), depth (m) and distance from shore (km) for 2015 PIFSC summer (August–September) small-vessel cetacean surveys. Includes total encounters and overall encounter rates across all survey years (2010–2015) for species encountered during summer 2015 (17,093.2 km total survey distance).

Species	No. Species Encounters (Total 2010-2015*)	Encounters/100km Effort (Overall 2010-2015*)	Median Depth (m) (min-max)	Median Shore Distance (km) (min-max)
Pantropical spotted dolphin	10 (37)	0.48 (0.22)	909 (433-1906)	6.5 (1.7-15.7)
Spinner dolphin	6 (108)	0.29 (0.63)	64 (28-99)	0.7 (0.4-0.9)
Bottlenose dolphin	4 (24)	0.19 (0.14)	457 (18-1048)	4.4 (0.3-10.1)
Bryde's whale	3 (3)	0.14 (0.02)	687 (487-859)	13.8 (12.4-23.9)
Blainville's beaked whale	1 (2)	0.05 (0.01)	678	15.2
False killer whale	1 (6)	0.05 (0.04)	389	4.4
Pygmy killer whale	1 (4)	0.05 (0.02)	1978	9.4
Sei/Bryde's whale	1 (1)	0.05 (0.01)	1918	21.9
Unidentified whale	1 (1)	0.05 (0.01)	447	1.3
Total:	**28**	**1.34**		

*2015 winter effort not included in calculations because the effort targeted humpback whales. From: Hill et al. (2016).
Key: km = kilometer(s); m = meter(s); min = minimum; max = maximum.

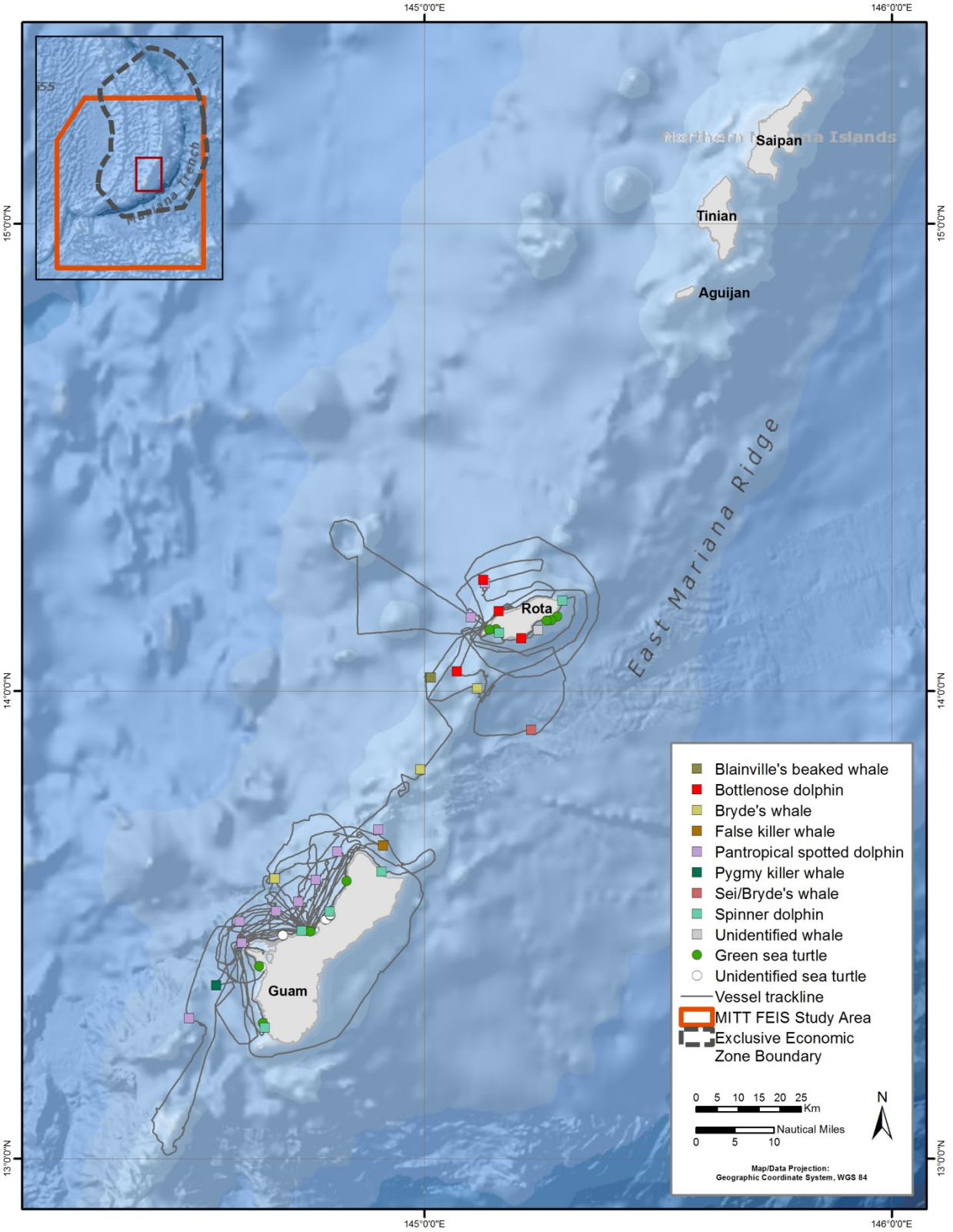

Figure 21. Pacific Islands Fisheries Science Center sightings and survey effort in summer 2015 off Guam and Rota. [Project M3]

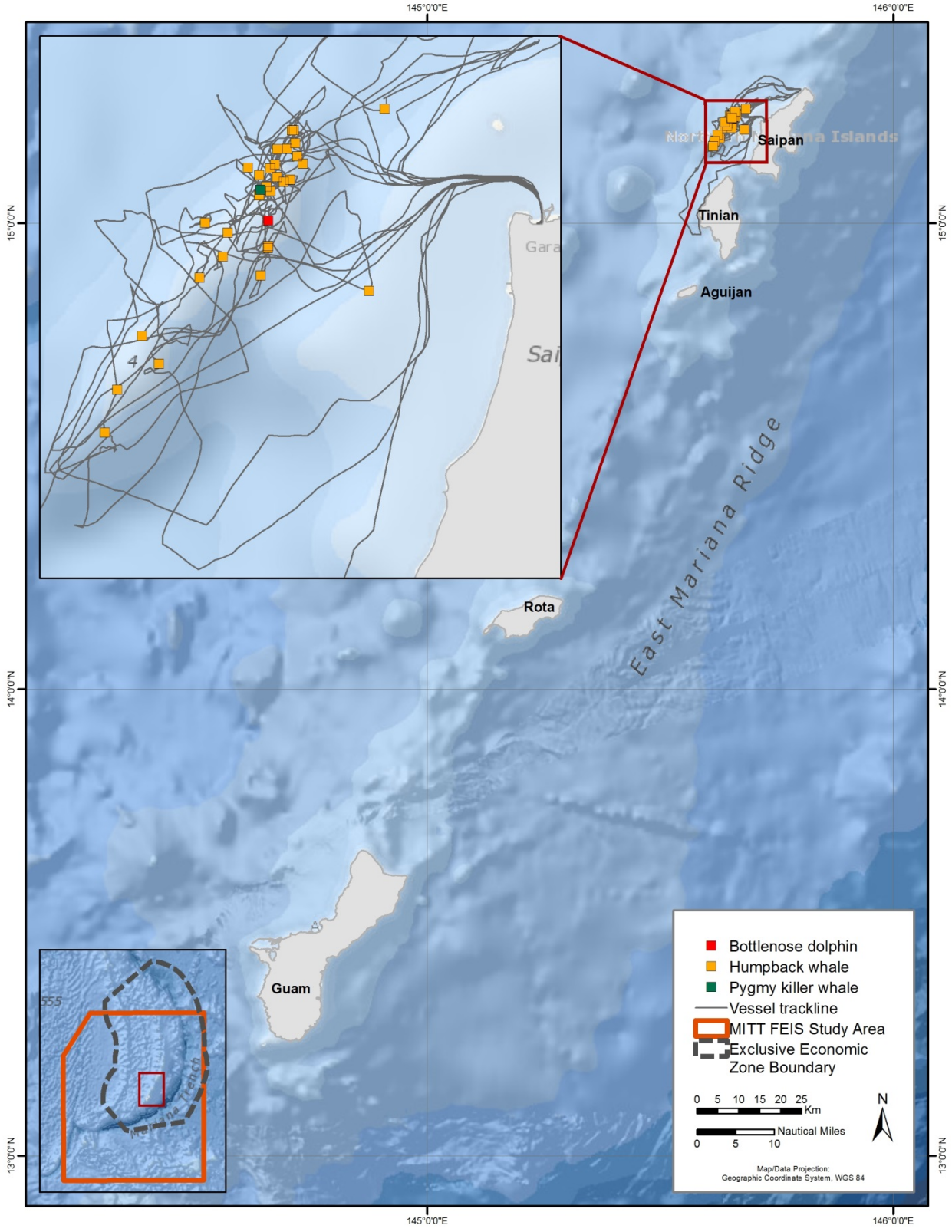

Figure 22. Pacific Islands Fisheries Science Center sightings and survey effort in winter 2015 off Tinian and Saipan. [Project M3]

PIFSC also conducted a winter season survey in March 2015 (Hill et al. 2016), visually confirming the presence of humpback whales off Saipan, the first sighting of this species during this PIFSC survey series, including the only other winter season survey of 9 February through 3 March 2010 off Guam and Saipan (Ligon et al. 2011). During the 2015 winter survey, the team documented 29 encounters with three cetacean species: humpback whale, bottlenose dolphin, and pygmy killer whale (**Figure 22**). The primary purpose of this winter survey mobilization was to search for and investigate humpback whales.

During the summer small-boat surveys off Rota the PIFSC team deployed a SPLASH10 (location-dive) satellite tag on a male bottlenose dolphin known from the photo-ID catalog. During the 10 days of tag transmission, the animal moved back and forth between Rota and Guam, and the tag recorded a maximum dive depth of 768 m and multiple other dives between 560 m and 750 m. During an independently-funded PIFSC May-June 2015 shipboard survey of the entire Mariana Archipelago the tagging team deployed a Navy-funded SPOT5 satellite tag on a false killer whale off the island of Asuncion. The tag transmitted for 30 days during which the false killer whale moved more than 4,600 km, and at its furthest location was well outside the MITT Study Area, 1,962 km west of the tag deployment location and 1,500 km outside of the CNMI Exclusive Economic Zone.

PIFSC maintains long-term acoustic datasets collected using bottom-mounted HARPs near Saipan and Tinian in the southern Mariana Archipelago. Under the Navy-funded monitoring effort, the analysis of three data sets for beaked whale detection and classification is in progress since the last update associated with the 2015 Year 5 MIRC Annual Monitoring Report (DoN 2015c). The locations, depths, and recording dates of the HARP deployments associated with these data sets are: 1) off Saipan (15° 19.0'N 145° 27.5'E; depth of 689 m; 23 July 2013 to 13 January 2014); 2) off Saipan (15° 19.0'N 145° 27.5'E; depth of 696 m; 8 June 2014 to 5 May 2015); and 3) off Tinian (15° 2.3'N 145° 45.1'E; depth of 995 m; 6 June 2014 to 25 November 2014). Three different beaked whale frequency-modulated pulse types were detected at Saipan, with classifications indicating pulses from Blainville's beaked whales, Cuvier's beaked whales, and the "CSBW" (Cross Seamount beaked whale) signal type, possibly belonging to gingko-toothed beaked whales (*Mesoplodon ginkgodens*) (Oleson et al. 2015). All three signal types were regularly detected throughout the monitoring period at Saipan, although encounters with the CSBW type generally occurred at lower numbers. Beaked whale encounters at Tinian were dominated by the frequency-modulated pulse type produced by Blainville's beaked whales, with only a single detection of the CSBW signal at this site. There were no detections of Cuvier's beaked whales in the Tinian deployment. Diel variability in beaked whale detection was examined across all deployments. The CSBW signal type occurred almost exclusively overnight at both sites, while no discernible diel trends were apparent for Blainville's or Cuvier's beaked whale encounters.

Whereas the monitoring projects of Deakos et al. (2016) and Hill et al. (2016) investigated nearshore waters, the acoustic glider project of Klinck et al. (2016a) was dedicated to deep offshore waters of the MITT. A passive acoustic glider survey was conducted between 2 March and 27 April 2015 in offshore waters east of the Mariana Islands, specifically in offshore areas adjacent to Guam, Rota, Tinian, and Saipan, abyssal waters adjacent to and crossing the Mariana Trench (**Figure 23**). Two gliders, referred to as SG178 and SG204, conducted acoustic

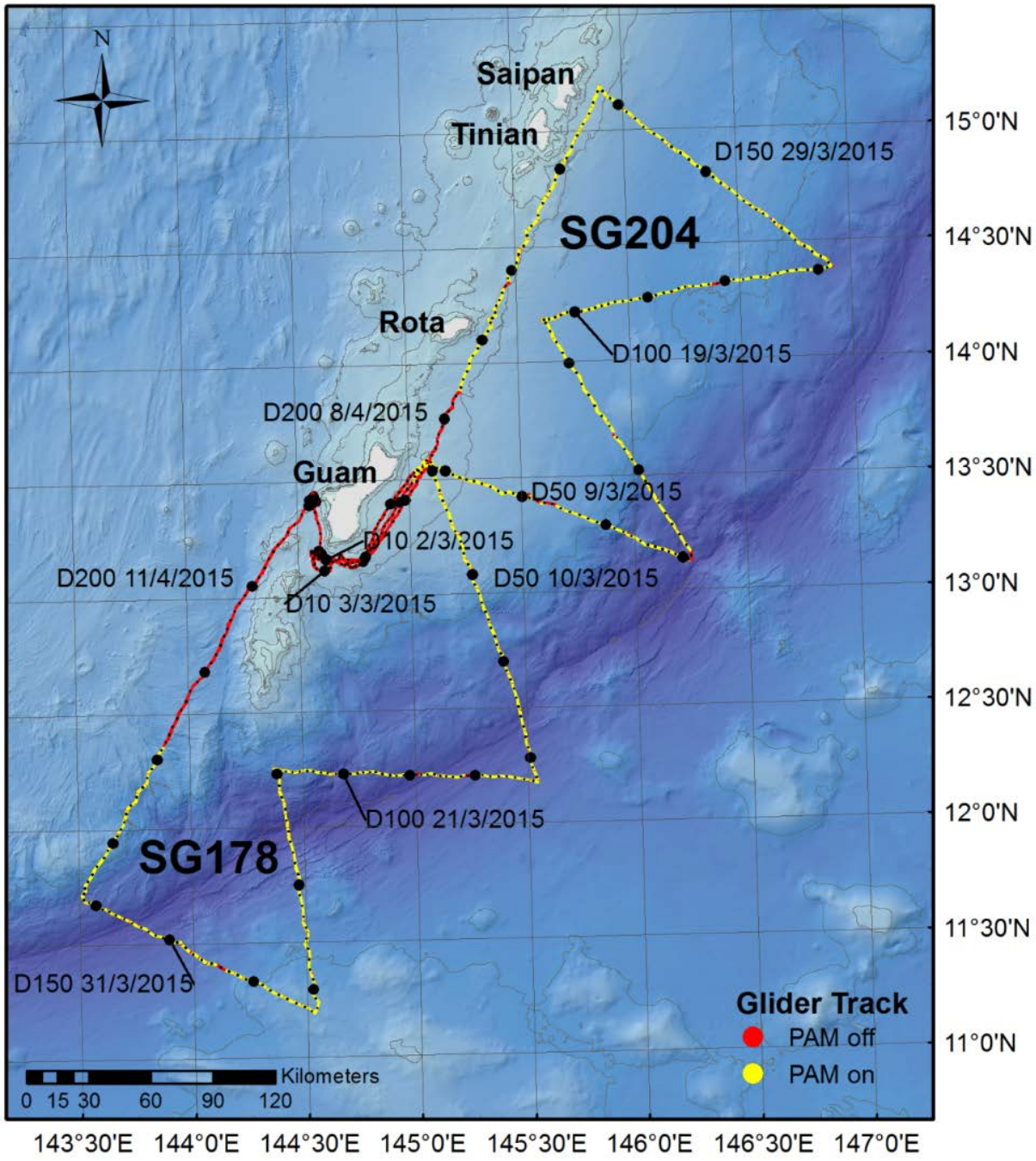

Figure 23. MIRC glider survey track line for the period 2 March–27 April 2015. Two gliders were deployed, SG178 to the south) and SG204 to the north. Each black dot (with every tenth one larger) on the track line indicates the midpoint location of a glider dive. Labels indicate dive number (e.g., D10 for dive no. 10) and date (format: dd/mm/yyyy Coordinated Universal Time). Red sections indicate that the PAM system was switched off. The yellow segments indicate that the PAM system was active. From: Klinck et al. 2016a. [Project M1]

surveys that covered a total distance of approximately 1,400 km over ground (straight-line distance) and 1,340 km through the water (straight-line distance plus depth-change distance) during on-effort survey with passive acoustic monitoring systems (effective frequency range 15 Hertz [Hz] to 90 kilohertz [kHz]) enabled and collected a total of 1,388 hr of acoustic data over a 33-day period from 6 March through 7 April 2015. The gliders recorded odontocetes and mysticetes in the study area. There were numerous sounds made by Blainville's beaked whales, sperm whales, Risso's dolphins (*Grampus griseus*), the CSBW call (possibly ginkgo-toothed beaked whale), and various delphinid species. Although propagation modeling was not included as part of this effort, Klinck et al. (2016a) described glider location when calls by these species were detected, giving some information on habitat use within the MITT.

Calls made by humpback, fin, and minke (*Balaenoptera acutorostrata*) whales were also recorded. Very few fin whale calls were detected during the March-April season, a result differing from those reported by Hill et al. (2015), who recorded fin whale songs from February to April. However, their moored hydrophone was much closer to shore, which could account for the different results.

Humpback whales were the most abundant mysticete detected during this March–April 2015 survey. A previous survey by the same researchers along the same track as the southern glider (SG178) (Klinck et al. 2015) was conducted during fall (September through November) 2014. On that survey, humpback whales were recorded on only 1 day, 22 October, in waters south of the Mariana Trench; fin and minke whales were not detected. The only other mysticete detected during Fall 2014 was an unidentified call which were detected more frequently and was characterized as more complex as compared to the March–April 2015 survey.

The survey demonstrated the platform's utility in surveying remote offshore waters for durations on the order of one month. This glider survey was part of a larger pilot survey investigating the utility of this platform in marine species monitoring in similar surveys at multiple range complexes, with surveys in HRC and GOA TMAA, as well as an analysis of archived data collected by this platform in NWTT. In common with all of these is that the primary monitoring goals of these surveys falls within the Conceptual Framework category of Occurrence; therefore, the results of these surveys may all be found within **Section 2.2.1.**

2.2.1.2 MONITORING QUESTION: What is the baseline vocalization behavior of marine mammals in the MITT Study Area? [Projects M1, M2]

In the MIRC, the baseline vocalization behavior of marine mammals in this study area is still in the progress of being developed. The analysis of available HARP datasets (Hill et al. 2016) and the glider pilot survey (Klinck et al. 2016a) described above in **Section 2.2.1.1** have added to this body of knowledge for the species described, and other existing literature is relatively sparse.

The past work includes towed array on a large-vessel survey, deployment of EARs, and more analyses of available HARP datasets, and these past monitoring projects are summarized by the MIRC Year 5 Annual Monitoring Report (DoN 2015c) and the MIRC 2010-2014 Comprehensive Monitoring Report (DoN 2014); unidentified and tentatively identified mysticete vocalizations have been described by all of these past monitoring projects.

2.2.1.3 MONITORING QUESTION: What is the abundance and population structure of marine mammals in the MITT study area? [Project M3]

PIFSC conducted a nearshore survey targeted at humpbacks for the first time (Hill et al. 2016). Four humpback whale mother/calf pairs and four other humpback whale individuals were observed during this four-day effort. The researchers collected biopsy samples from three of the mothers in the pairs and one biopsy from a humpback whale individual. Analyses of flukes and biopsy samples are underway and results may inform the question of the population identity of humpback whales in the MITT Study Area.

During PIFSC's summer survey in the MIRC (Hill et al. 2016), the field component of photo-identification and genetics work was performed. The team collected over 8,000 photos and 20 biopsy samples, including a biopsy to confirm species of a whale that was identified as either a sei whale (*Balaenoptera borealis*) or Bryde's whale. Other species biopsied include Bryde's whale, bottlenose dolphin, pantropical spotted dolphin, Blainville's beaked whale, pygmy killer whale, and false killer whale.

Photography for individual identification is part of the ongoing maintenance of six odontocete photo-ID catalogs were established during previous years of this survey series, for eventual use in mark-recapture analysis. These catalogs are for the following species: bottlenose dolphin, false killer whale, short-finned pilot whale, pygmy killer whale, rough-toothed dolphin, and spinner dolphin. In addition to mark-recapture analysis, re-sightings of individuals indicate movement patterns, and for some species these results may be compared to conclusions resulting from genetics analyses. Photographic processing also included ongoing work to establish a photo-ID catalog for melon-headed whales. The researchers also analyzed pantropical spotted dolphin photos collected off Guam (2010-2014) to assess whether it would be worthwhile to undertake the creation of photo-identification catalogs for the ultimate purpose of mark-recapture analysis and abundance estimation. The photo analysts found that both the quality of the photographs and the lack of distinctiveness of the dorsal fins would hinder a robust mark-recapture analysis for this species.

Regional and local genetic structure in Pacific short-finned pilot whales was studied using a combination of mtDNA haplotypes and genotypes of samples from the Mariana Islands, Hawaiian Islands, and the Eastern Tropical Pacific (Van Cise et al. 2016). The results have shown that the Mariana and Hawaiian Islands are inhabited by one type of pilot whale that is mitochondrially distinct from those that inhabit the Eastern Tropical Pacific, further showing that all three of these regions are significantly differentiated, indicating a lack of female gene flow between the regions. These results show that short-finned pilot whales from the three regions are also significantly differentiated in their nuclear DNA, indicating a lack of male gene flow between regions as well. Within the Mariana Islands, Martien et al. (2014) previously showed mitochondrial differentiation between the three-island group (Saipan, Tinian, Aguijan) and Guam. These results corroborate those findings with additional samples from each area within the Mariana Islands, but did not find any significant differentiation in nuclear DNA, indicating male-mediated gene flow between Guam and the 3-island area.

With regard to the acoustic glider surveys by Klinck et al. (2016a), there also exists a related long-term project relevant to this monitoring question. In addition to high frequency acoustic

recordings to investigate for detections of marine mammals, other environmental data also collected by the glider surveys (including this one in the MITT) include sound speed profiles and oceanographic data. These environmental data and the marine mammal detections will be used in an ongoing project funded by the Office of Naval Research to develop and evaluate a framework for density estimation of cetacean species using slow moving underwater vehicles including gliders and floats.

2.2.1.4 MONITORING QUESTION: What is the occurrence, habitat use, abundance and population structure of sea turtles in the MITT Study Area? [Project M4]

During November 2015, PIFSC conducted sea turtle surveys from small vessels and in-water (i.e., snorkel) in the nearshore and coastal waters off Guam, Saipan, and Tinian (Jones and Martin 2016). Survey locations included new areas not previously surveyed during dedicated sea turtle surveys by PIFSC, including southwest corner of Tinian, Lao Lao Bay in southeast Saipan, and Agat Bay in Guam.

A total of 68 turtles was observed, 21 were captured and brought to the boat, and 16 were released with Wildlife Computers SPLASH satellite tags (**Table 5**). The majority of observations and captures were of green turtles, and all satellite tag deployments were on green turtles. One hawksbill turtle was observed on Tinian, one was observed on Saipan, and one was captured on Guam **(Figure 24)** but was too small for a satellite tag. Of the 21 total captures, eight occurred on Tinian, nine on Saipan, and four on Guam (**Table 5**).

Table 5. Summary of field research survey effort, turtle observations, turtle captures, and satellite tag deployments from November 2015.

Date	Island	Location	Boat Hours	Dive Hours	Observed			Captured		Sat. tagged	
					Cm	*Ei*	Unid	*Cm*	*Ei*	*Cm*	*Ei*
11/12/15	Tinian	Red Wall (SW)	8.2	1.4	12	1	2	8	0	6	0
11/13/15	Saipan	Lao Lao Bay (SE)	7.0	1.5	7	1	8	6	0	5	0
11/14/15	Saipan	Chalan Kanoa (SW)	4.3	0.9	3	0	7	3	0	2	0
11/17/15	Guam	Agat Bay, Dadi (SW)	6.0	3.5	4	1	10	1	1	1	0
11/18/15	Guam	Dadi Beach (SW)	3.0	1.9	5	0	7	2	0	2	0
11/19/15	Guam	Agat Bay (SW)	1.3	0.8	0	0	0	0	0	0	0
6 Days	***3 Islands***	***5 Locations***	***29.8***	***10***	***31***	***3***	***34***	***20***	***1***	***16***	***0***
				Total:	***68***			***21***		***16***	

Cm = *Chelonia mydas* (green turtle). *Ei* = *Eretmochelys imbricata* (hawksbill turtle). Unid. = unidentified species of turtle (green or hawksbill). SW = southwest part of the island, SE = southeast part of the island.

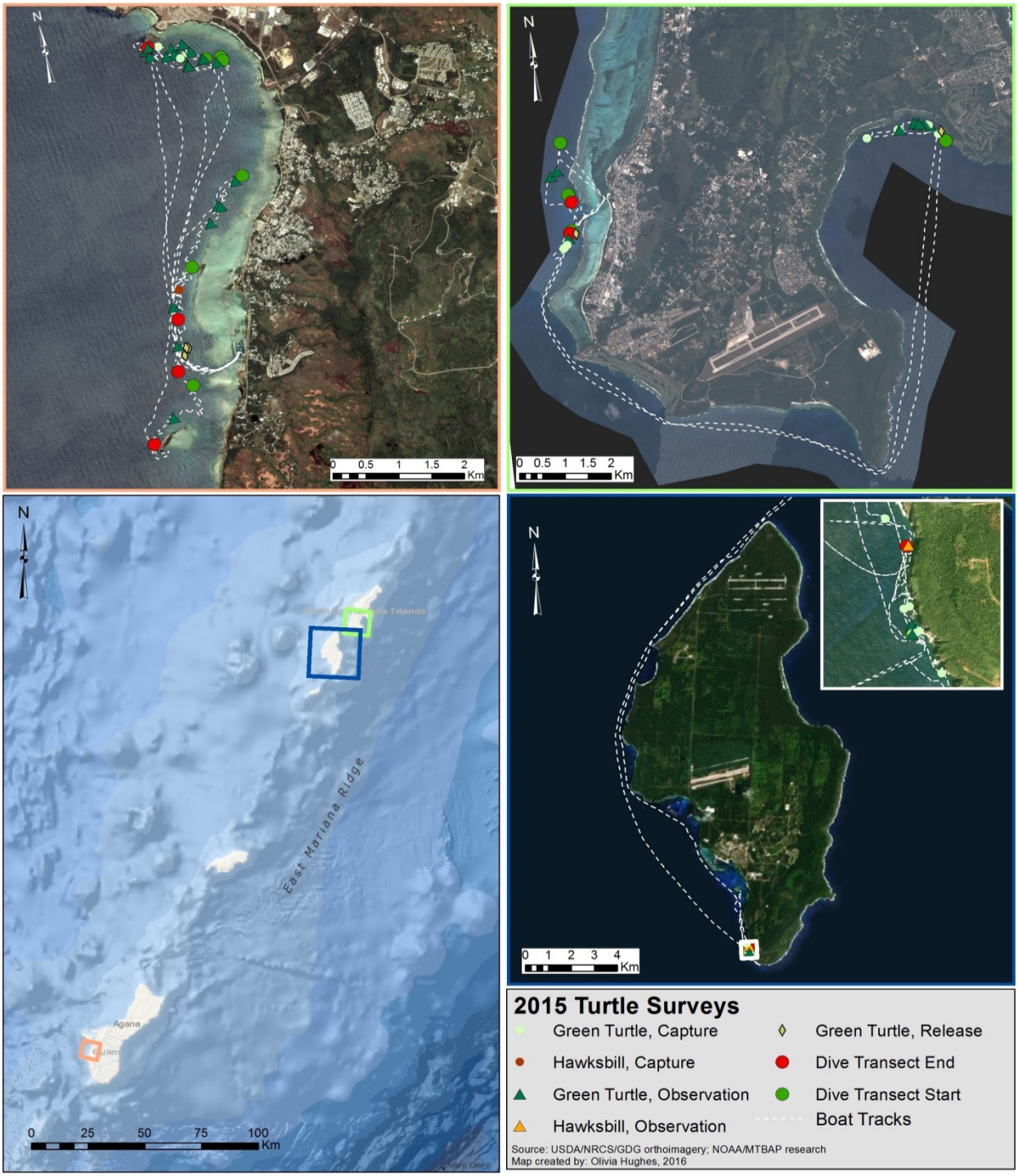

Figure 24. Maps of survey effort, turtle observations, and turtle captures in November 2015. *Bottom left:* southern Mariana Islands with survey areas highlighted (orange = Guam, blue = Tinian, green = Saipan). *Top left:* Guam – Agat Bay. *Top right:* Saipan – Chalan Kanoa (west) and Lao Lao Bay (east). *Bottom right:* Tinian – Red Wall (southwest). From: Jones and Martin 2016. [Project M4]

On Guam in November 2015, Agat Bay (south of Orote Peninsula) was surveyed, with 9 green turtles, 1 hawksbill turtle, and 17 unidentified turtles found within Agat Bay and off Dadi Beach. Sightings were in nearshore waters along the perimeter of the reef flat, likely using the reef as foraging and resting habitat.

On Saipan, the southwestern and southeastern sides of the island were surveyed, with 10 green turtles, one hawksbill turtle, and 15 unidentified sea turtles seen in nearshore waters, along with captures made of turtles at Chalan Kanoa (west) and Lao Lao Bay (east). Kolinski et al. (2001) remarked that is likely that a combination of factors, including access to food, preferred resting habitat, and exposure to disturbance by humans, is responsible for present turtle distributions around the island. Kolinski et al. (2001) also commented that a variety of potential green turtle food resources exists along the east coast within the vicinity of presumed turtle resting habitats. On Tinian, surveys were conducted along the western coast; 12 green turtles, one hawksbill turtle, and two unidentified sea turtles were sighted in nearshore waters, with captures at Red Wall, on the southwest coast of the island (Jones and Martin 2016). Kolinski (2001) noted that the presence of a small barrier and patch reef and limited port and human development along the west coast of the island.

The deployed satellite tags are currently still transmitting. Analysis of the location data for habitat use analysis is in progress and includes a cumulative analysis from the 2013, 2014, and 2015 monitoring field efforts. Tissue sample analyses from past-season surveys are also ongoing, and will inform population structure of sea turtles in the MITT.

2.2.1.5 MONITORING QUESTION: Which species of toothed whales (and especially beaked whales) occur in offshore areas of the HRC and what is their spatial distribution? [Project H1]

A passive acoustic glider survey was conducted in the HRC between 11 December 2014 and 26 January 2015 to investigate spatial and temporal distribution of odontocetes in offshore areas south of the Main Hawaiian Islands (Klinck et al. 2015a).

The survey track was essentially an exploration of the remote offshore seamounts south of the main Hawaiian Islands, including Dutton, Brigham, Bishop, Cross, McCall, and Bishop seamounts, and adjacent abyssal areas, where relatively few dedicated marine mammal surveys have been conducted (**Figure 25**). Researchers recorded 712 hr (approximately 30 days) of acoustic data over a 33-day period and covered 1,072 km through the water. Of the area covered, 794 km were with the PAM system enabled.

Beaked whale echolocation clicks were encountered 12 times on 11 different glider dives (Klinck et al. 2015a). Five of the encounters were identified as Blainville's beaked whales. The remaining seven encounters were identified as the CSBW (which may be the ginkgo-toothed beaked whale). One dive contained both click types.

The first Blainville's beaked whale detection occurred during the testing of the PAM systems immediately after the deployment of the instrument on 11 December 2014. The remaining Blainville's clicks were dispersed across the entire survey. The majority of CSBW clicks were recorded in the vicinity of Cross Seamount. Additional detections occurred in the vicinity of McCall Seamount farther to the east. One encounter was registered close to the start/end point of the acoustic survey approximately 60 nm south of the island of Oahu.

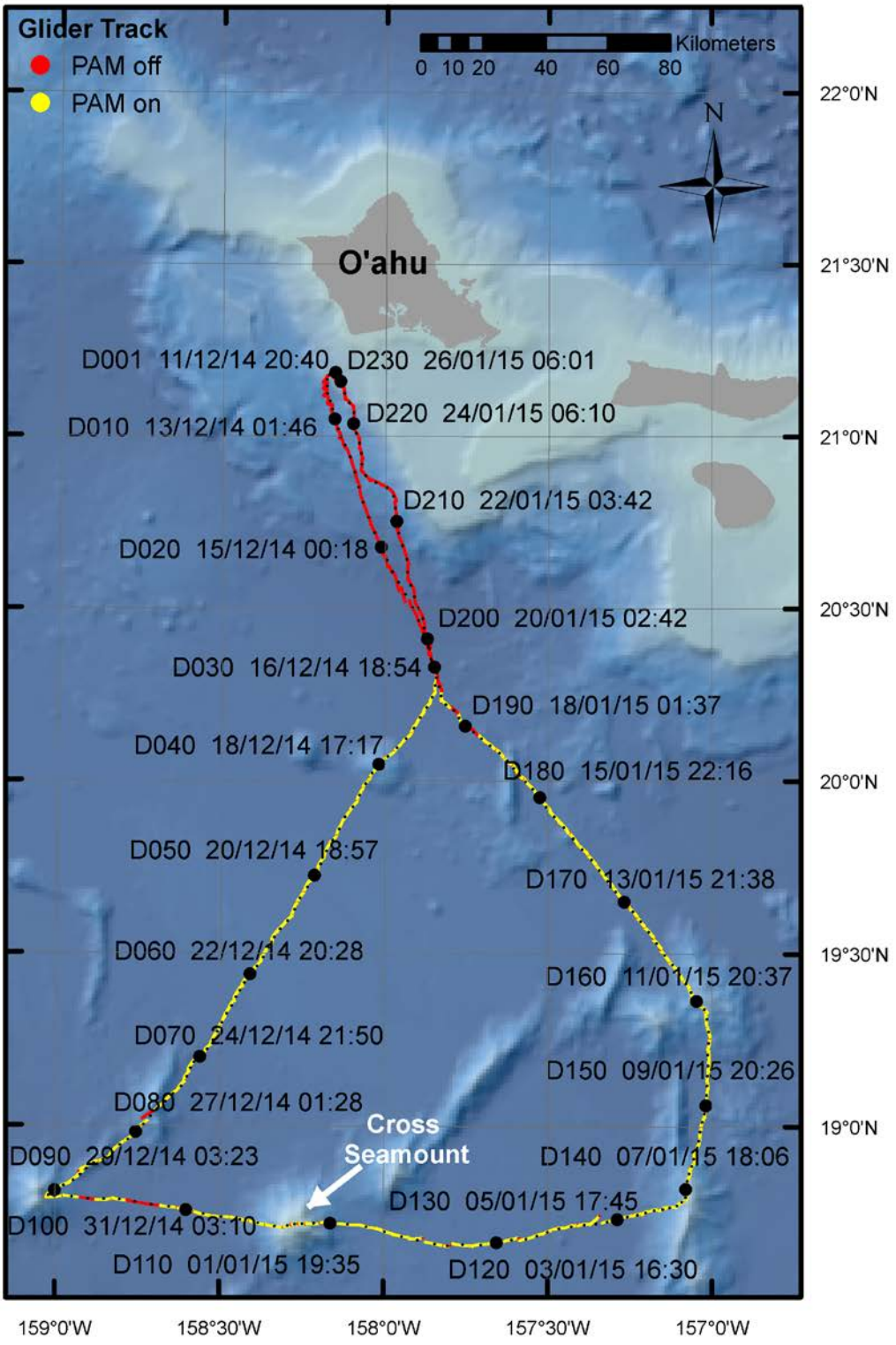

Figure 25. HRC glider survey track line for the period 11 December 2014 - 26 January 2015. Each black dot on the track line indicates the midpoint location of a glider dive. Labels indicate dive number (e.g., D001 for dive no. 1) and date/time (format: dd/mm/yy hh:mm UTC). Red sections indicate that the PAM system was OFF. The yellow marks indicate that the PAM system was active. From Klinck et al. (2015a).

Sperm whale echolocation clicks were detected on 30 different glider dives. No sperm whale clicks were detected when the glider was in the southeastern corner of the survey area. The majority of sperm whale encounters occurred over the abyssal plain. Sperm whale occurrence did not seem to be related to bathymetric features such as seamounts.

Recordings of Risso's dolphin echolocation clicks were made on 11 different dives. Encounters were, on average, of 1 hr (standard deviation [SD] =0.49 hr) duration. Risso's dolphin encounters were registered throughout the entire survey area except for the southernmost part between Bishop Seamount and McCall Seamount.

Recordings of odontocetes that contained whistles were classified according to the maximum frequency of the whistles, but often also included echolocation clicks and sometimes pulses. Acoustic encounters that contained whistles with maximum frequencies below 10 kHz were recorded on 18 glider dives. These low-frequency whistles were detected throughout the survey, aside from two single-week periods without any low-frequency whistle recordings: 17 to 24 December 2014 and 30 December 2014 to 5 January 2015. Detections were most often found in association with bathymetric features. These whistles are likely associated with one of the following species based on the maximum frequency and frequency range spanned by the whistle: false killer whale, short-finned pilot whale, melon-headed whale, or rough-toothed dolphin.

Acoustic recordings containing whistles with energy predominantly above 10 kHz were recorded on only five glider dives. Such bouts containing high-frequency whistles ranged in duration from 4 seconds to 1.39 hr and appear to be associated with bathymetric features. These whistles are likely associated with one of the following species, based on maximum frequency and range of frequencies within a whistle: bottlenose dolphin, pantropical spotted dolphin, spinner dolphin, striped dolphin (*Stenella coeruleoalba*), or Fraser's dolphin (*Lagenodelphis hosei*).

Twenty-two dives contained recordings of both low- and high-frequency whistles, classified as such because either both types of whistles or individual whistles that spanned a frequency range above and below 10 kHz were present. These whistles were spatially distributed throughout the deployment, over the abyssal plain and bathymetric features, aside from a one-week break in detections from 27 December 2014 to 2 January 2015 in the south/southwest part of the survey area.

Acoustic encounters that did not contain whistles, or signals that could not be identified to species level, were classified as echolocation clicks and burst pulses. Such encounters occurred on 29 individual glider dives, totaling 31.6 hr of acoustic data (Klinck et al. 2015a). These recordings occurred in all areas of the survey, with the largest gap between encounters of just under 4 days, or 18 dives (27 to 31 December 2014). More recordings occurred over abyssal plains than over seamounts and ridges, but detections were made over both.

Occurrence of mysticetes: Additionally, mysticetes were also detected during this survey. Although mysticetes lie outside this monitoring question which is specific to odontocetes, they are covered within the Conceptual Framework category of "Occurrence," as well as the ISO *"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."* Blue whales and

sei whales were occasionally detected along the survey track of the glider, whereas humpback whales, minke whales, and fin whales were detected nearly continuously throughout the entire survey. Although propagation modeling was not included as part of this effort, the detection of humpback whales in these deep offshore waters is notable as it is unlikely these were long-range detections of animals in nearshore waters.

2.2.1.6 What are the long-term trends in occurrence of marine mammals on the PMRF range? [Project H3]

In 2015, several improvements were made to M3R monitoring systems on PMRF by NUWC Division Newport (See also project [S2] for a parallel project for SOAR). The following tasks were undertaken: (1) hardware/software upgrade of M3R which includes a full range of broadband recording and integrated data archives; (2) submission of an Information Assurance accreditation and (3) initial analysis of beaked whale detection archives from 2011 to 2014 to establish methods and baseline abundance of Blainville's beaked whales on the PMRF range. Initial abundance values were derived for PMRF by examining 4 years (2011 through 2014) of data archives.

Moretti (2016) presents initial abundance estimates of Blainville's beaked whales at PMRF. Four years of data archives from 2011 to 2014 were examined. The archives included nine periods ranging from less than a day to just under 20 days. The dive counting method developed at AUTEC was applied to estimate overall abundance. These preliminary results from these limited data archives suggest a stable but low population of Blainville's beaked whales at PMRF. Beginning in February 2016, system operation by range personnel is planned that should result in near-continuous data records at PMRF.

2.2.1.7 MONITORING QUESTION: Does exposure to sonar or explosives impact the long-term fitness and survival of individuals or the population, species, or stock? [Project S2]

In 2015, several improvements were made to M3R monitoring systems on the SCORE by NUWC Division Newport. To realize this capability the following tasks were undertaken: (1) hardware/software upgrade of M3R Linux-based cluster signal processor at SCORE, which includes a full range of broadband recording and integrated data archives; (2) completion of requisite internal Navy accreditation (operation of all computer-based hardware within Navy facilities requires this) designed to readily accept security patches at intervals as specified in the accreditation; and (3) initial analysis of beaked whale detection archives from 2010 to 2014 to establish methods and baselines abundance of Cuvier's beaked whales at SCORE.

Moretti (2016) presents initial estimates of monthly, seasonal, and interannual relative abundance for Cuvier's beaked whales using the dive counting method at SOAR based on analysis of 845 days of M3R data recordings from 2010 to 2014. Analysis of 5 years of SCORE data suggest a reduction in the abundance of Cuvier's beaked whales beginning in late spring, extending to early fall with a low in September. A comparison of abundance for the period of 2010-2014 for the month of December does not suggest an interannual decline of this species on the range.

In addition, the number of dives immediately before Navy training is being compared to those detected during training. These data will then be provided as input to the Population Consequences of Acoustic Disturbance model funded by the Office of Naval Research, and used to investigate the cumulative impact of sonar exposure.

Combined visual-acoustic surveys for marine mammals were conducted during three dedicated efforts in 2015 (January, March, and June-August) around the SCORE. These surveys represented the continuation of a collaborative effort between the NUWC M3R program, CRC, and Marine Ecology and Telemetry Research (see Falcone and Schorr 2014). Field surveys in 2015 were funded by the U.S. Navy's Living Marine Resources program, with the primary objective being to better understand the effects of military training events and exercises on local cetacean populations, with an emphasis on Cuvier's beaked whales and fin whales. Surveys also provided visual verification of acoustic species classifications made by M3R, as well as group size data and dive rate as being measured via depth-recording satellite tags. Off-range surveys largely targeted fin whales, as they are a focal species with a range that extends beyond the waters immediately adjacent to SCORE. If weather was suitable and there were no conflicting military operations, the vessel operated on the SOAR, west of SCI, throughout daylight hours (hr) with the acoustic support of M3R to assist in locating focal species. Satellite tags were deployed on four Cuvier's beaked whales and six fin whales in 2015. Data from these surveys are being combined with those from earlier years in a variety of collaborative analyses related to behavioral response to sonar and demographic consequences of these responses as part of several efforts supported by both Living Marine Resources and Office of Naval Research.

Surveys will continue in 2016 for Cuvier's beaked whales with the support of U.S. Pacific Fleet, and will focus on continued satellite tagging, photo-ID, and biopsy sampling to improve demographic assessments of this population.

2.2.1.8 MONITORING QUESTION: What is the seasonal occurrence and density of cetaceans within the Navy's Southern California Range Complex? [Project S3]

U.S. Pacific Fleet has funded marine mammal data collection on the California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises in 2013, 2014, and 2015. This funding will continue into 2016. Through collaboration with SIO and NMFS, these data will also be used to develop predictive marine mammal habitat models for Southern California, including the SOCAL Range Complex. Final reporting for 2015 and early 2016 surveys will be done by the end of September 2016.

2.2.1.9 MONITORING QUESTION: What are the occurrence, movement patterns, and residency patterns of blue and fin whales within Navy U.S West Coast at-sea ranges as compared to the rest of their distribution throughout the Pacific Ocean? [Project S4/N5];

Twenty-two location-only tags were deployed on blue whales in July 2015. As of 15 November 2015, locations were received from all of these tags, providing tracking periods ranging from

4.2 to 128.3 days (Mate et al. 2016). Blue whales tagged in 2015 ranged widely along the California coast and included distribution and habitat use in SOCAL (**Figure 26**). Locations extended into SOCAL in all five active tag months, July through November 2015, and from near shore to 350 km offshore. By mid-November, all five blue whales with tags still transmitting were south of the U.S./Mexico border. SOCAL was the second most heavily used area for blue whales in terms of number of animals. There were 14 whales with locations in the range; individual percentages of locations ranged from 1 to 41 percent (mean = 11 percent; SD = 12.2 percent).

Only two blue whales had locations in the NWTRC (**Figure 27)**. For one whale, only one percent of its locations fell within the range, and for the other, 29 percent of its locations fell within the range. These locations occurred in the NWTRC in August, September, and October 2015.

Nine SPOT5 location-only tags were deployed on fin whales and one on a fin/blue whale hybrid in July 2015. Locations were received from nine of these 10 tags, providing tracking periods ranging from 6.2 to 115.1 days (as of 15 November 2015). Eight whales were spread out between the Southern California Bight and Monterey Bay (California), with locations ranging from near the shore to 300 km out (**Figure 26**). During August, two of the whales had ventured south into Mexican waters, but by the end of the month they were back in southern California waters. The other four whales still being tracked, as of November 2015, ranged from San Nicolas Island (California) (**Figure 26**) to the Olympic Peninsula (Washington) (**Figure 27**). Most of the fin whale locations (including the fin/blue whale hybrid) were farther from shore than the blue whales being tracked at the same time, occurring mostly in waters over the continental slope.

Only three fin whales had locations in SOCAL, with the majority of these occurring in August. Individual percentage of locations for these fin whales ranged from 3 to 29 percent ($\bar{x}$ = 17 $\pm$ SD = 13.1 percent).

Four fin whales had locations in the NWTRC (**Figure 27**), and individual percentage of locations ranged from 5 to 75 percent ($\bar{x}$ = 39 $\pm$ SD = 30.7 percent). One of these fin whales also had 2 percent of its locations occur in W-237 of the NWTRC. Locations in the NWTRC occurred during the months of July through October 2015.

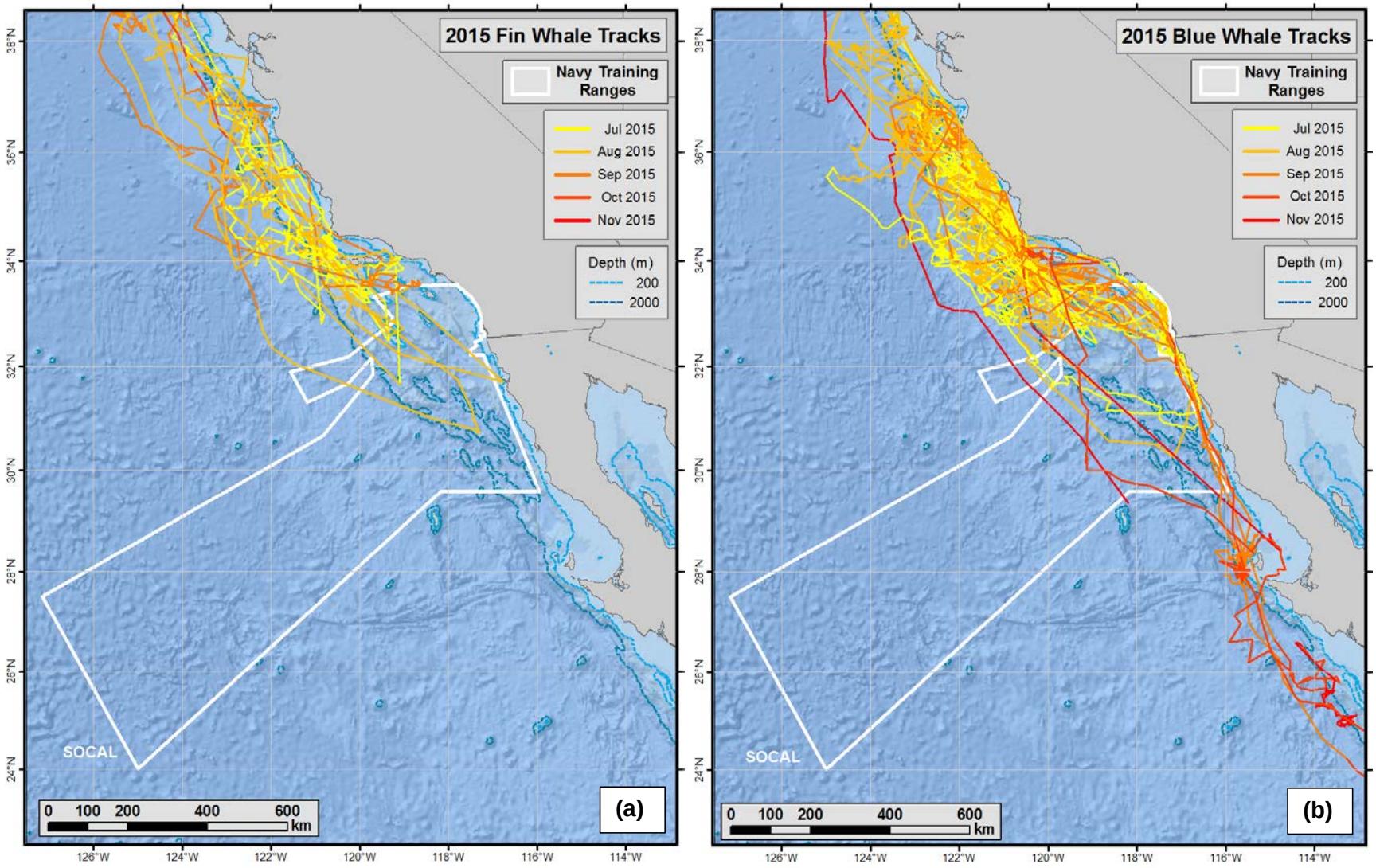

Figure 26. Satellite-monitored radio tracks in the Southern California Range Complex for (a) three fin whales tagged with SPOT5 Argos transmitters off southern California, 2015 (b) fourteen blue whales tagged off southern California, 2015 (12 SPOT5 and 2 ADB tags). From: Mate et al. 2016. [Project S4]

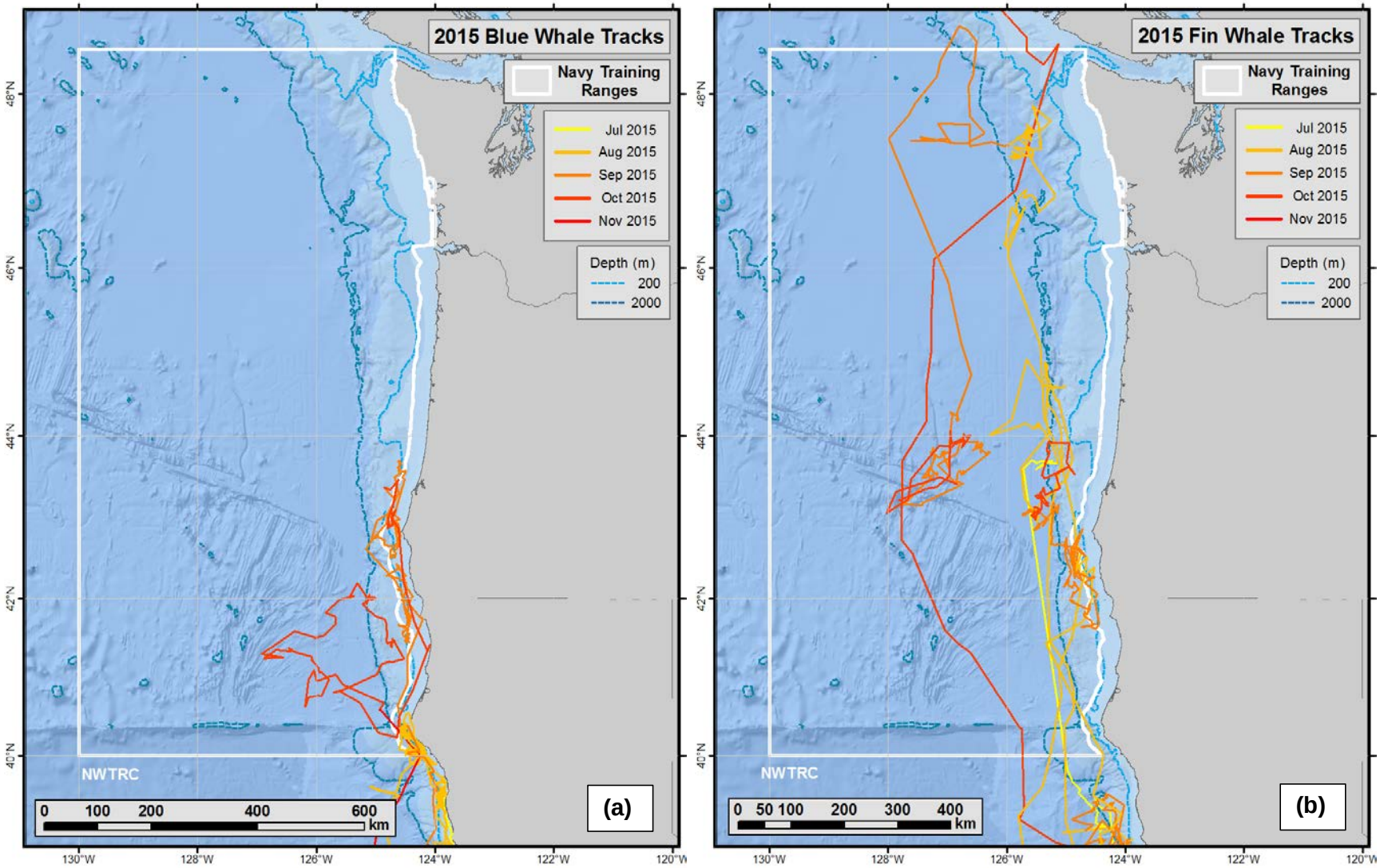

Figure 27. Satellite-monitored radio tracks in the Northwest Training Range Complex for (a) two blue whales tagged with SPOT5 tags off southern California, 2015 and (b) four fin whales tagged with SPOT5 Argos transmitters off southern California, 2015. From: Mate et al. 2016. [Project N5]

Four blue whales were tagged with ADB tags and tracked for a median of 26.7 days. One of the four ADB-tagged blue whales spent the majority of the tracking period near the Southern California coast, ranging from the tagging location at Point Mugu, California to Ensenada, Mexico. The other three ADB-tagged blue whales used waters farther offshore after leaving the tagging area, with two of the three whales leaving Southern California waters and travelling north. The ADB tags each recorded more than 2,000 dives, with a median of 86 dives per day by each tagged whale. The number of FastLoc® geographic positioning system (GPS) locations recorded by the three recovered tags ranged from approximately 1,500 to 2,300 locations (median = 63 locations/day/whale). A total of 69 FastLoc® GPS locations was received through Service Argos, Inc. from the tag that was not recovered (three locations per day). The location, duration, and intensity (i.e., number of lunges per dive) of foraging effort varied by individual. Foraging dives were generally located near areas of steep bottom slope (**Figure 28**). Foraging bouts identified from the tracks were temporally distinct (median = 2.2 hr apart) and generally small in area (median = 1.7 km^2), with a median foraging bout containing 11 dives over 2.2 hr. Foraging bout duration was generally short (<2 hr) with a smaller number of long-duration bouts. Average number of foraging lunges per dive within bouts varied substantially and was correlated to the duration of a foraging bout ($p<0.001$, $R^2 = 0.37$ from linear regression). Dive depths during foraging bouts varied widely; however, median values for individuals were generally close to 95 or 135 m.

Two fin whales were tagged with ADB tags and tracked for a median of 15.7 days. One tag was recovered (Tag #5654) and recorded 1,591 FastLoc® GPS locations (99 locations per day) while 12 locations were received through Service Argos, Inc. from the tag that was not recovered (Tag #5644). While both ADB tagged fin whales left Southern California waters after tagging, Tag #5654 foraged extensively in the area before doing so; however, it remained well offshore, staying to the west of San Nicolas and San Miguel Islands (**Figure 28**). As with ADB-tagged blue whales, foraging bouts appear to have been located near areas of steep bottom topography, which have been shown to both increase and concentrate prey (Genin 2004, Croll et al. 2005). The two ADB tags recorded 406 and 910 dives >2 min in duration and >10 m in depth, respectively.

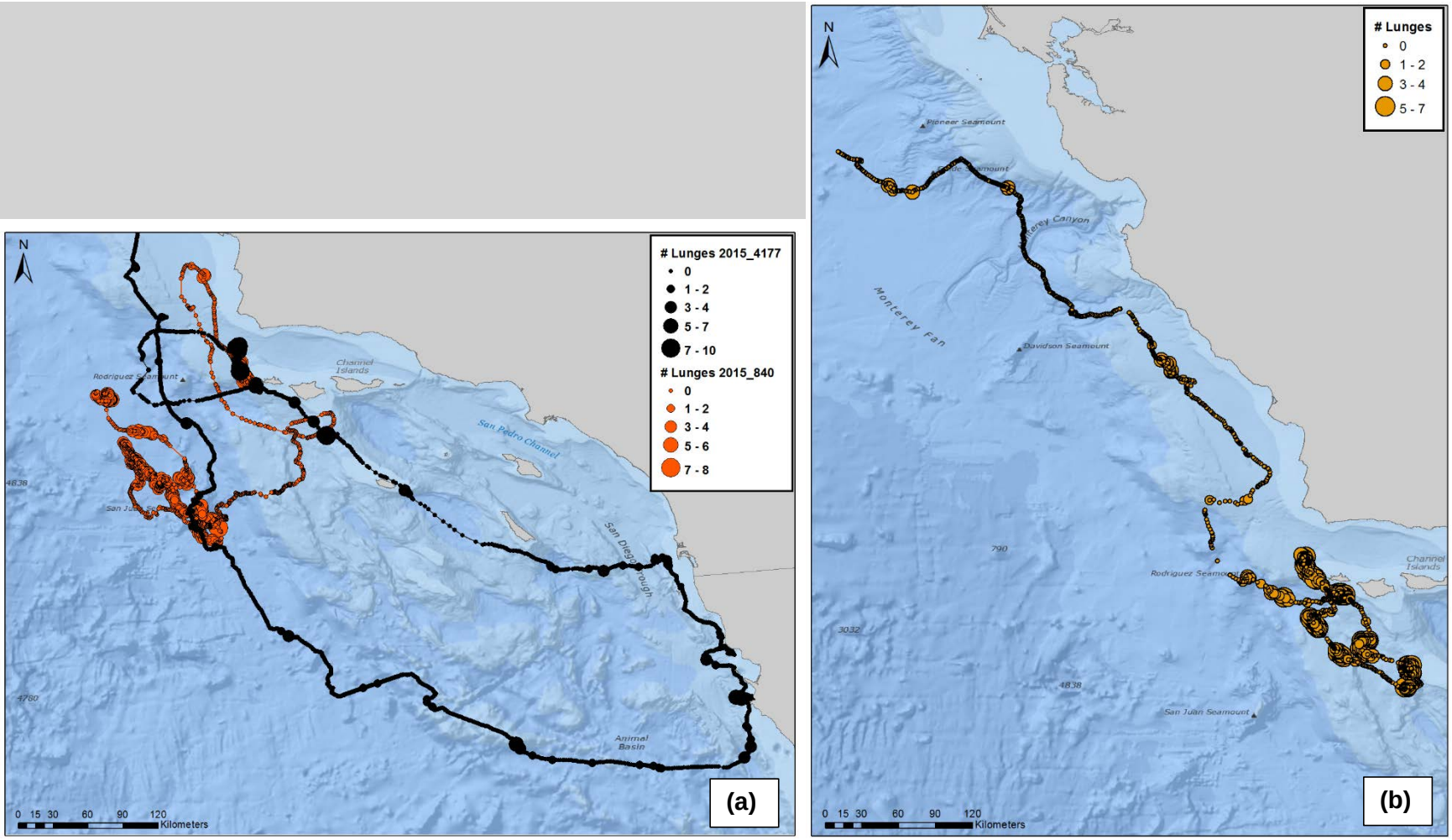

Figure 28. FASTLOC tracks of (a) two ADB-tagged blue whales off southern California in July 2015 (Tag #s 840 and 4177) and (b) of an ADB-tagged fin whale (Tag #5654) tagged off southern California in July 2015. Sizes of the circles represent the number of foraging lunges that occurred during a dive at that location. From: Mate et al. 2016. [Project S4]For the one fin whale that had the ADB tag recovered (Tag #5654), most of the foraging occurred in the offshore portions of the Southern California Bight, from the tagging area west of San Miguel Island, California, south to San Nicolas Island, California (**Figure 26b**). The duration of foraging bouts made by the tagged fin whale was almost twice the median duration of foraging bouts made by ADB-tagged blue whales; however, other

aspects of the bouts (e.g., average depth, number of lunges) were very similar, suggesting that the greater duration may have reflected the fin whale finding more profitable foraging areas than the tagged blue whales. The fin whale also showed the same correlation between the number of lunges made per dive within a foraging bout and the duration of a foraging bout, suggesting it also left poor-quality prey patches quickly and stayed to forage longer in good-quality patches.

A tagged Bryde's whale traveled extensively throughout the Southern California Bight during its 89-day tracking period (**Figure 29**). Most of this animal's movements were in waters over the continental slope, ranging from Point Conception to San Clemente Island (SCI), with occasional forays out over deeper ocean basin waters (maximum distance from shore of 268 km). The Bryde's whale had 18 percent of its locations in SOCAL. This animal was located in the SOCAL area predominantly in October 2015.

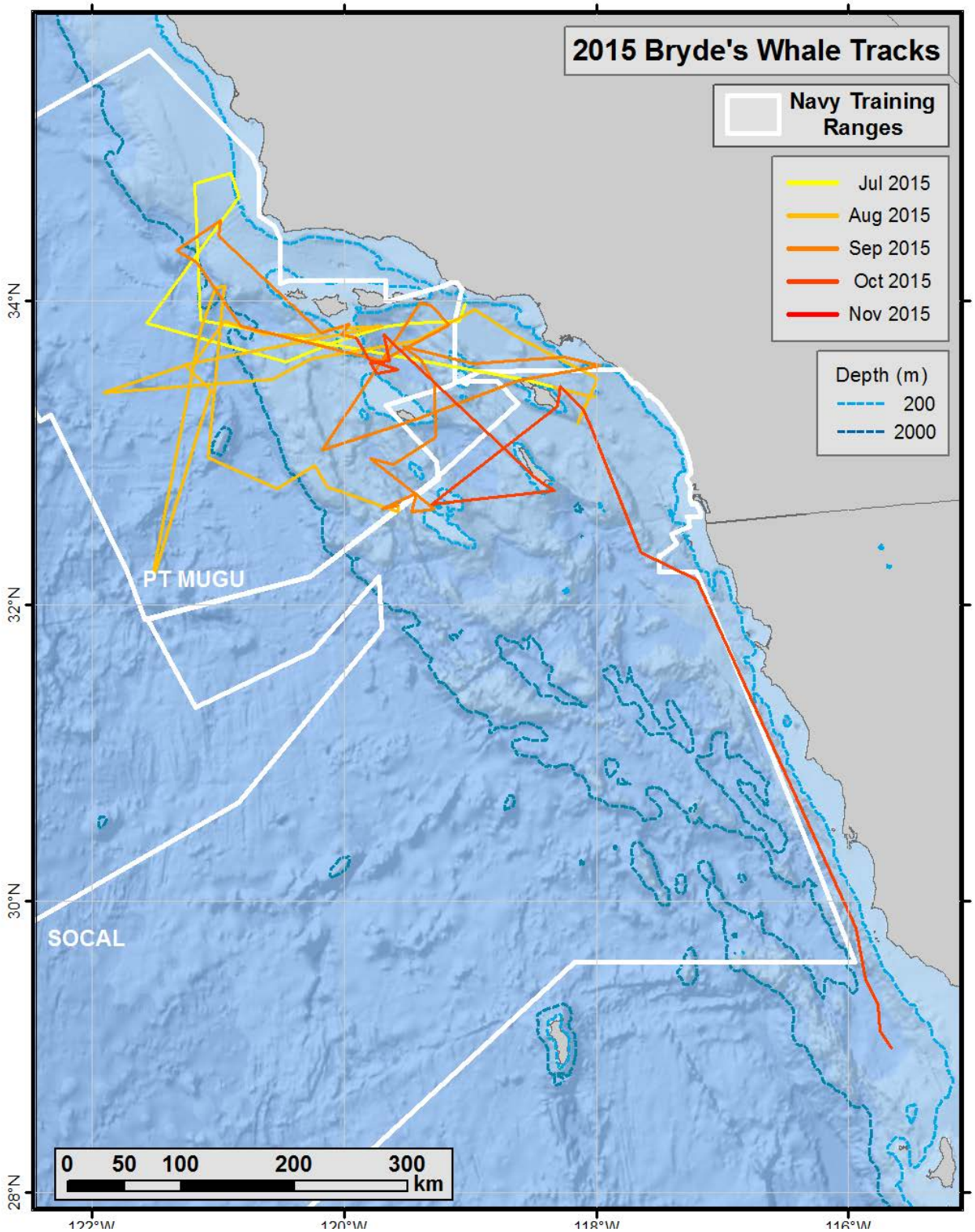

Figure 29. Satellite-monitored radio tracks for a Bryde's whale tagged with a SPOT5 Argos transmitter off southern California, 2015. From: Mate et al. 2016. [Project S4]

Tracking data from 2015 add to sample sizes from 2014. Totals of 40 blue whales (24 in 2014 and 26 in 2015), 15 fin whales (6 in 2014 and 9 in 2015), one blue/fin whale hybrid, and one Bryde's whale were tagged over the 2-year period. The increase in sample sizes provides a richer data set regarding long-term movements of whales in the eastern North Pacific, including expanding knowledge regarding blue and fin whale occurrence within and use of U.S. Navy training and testing ranges. In both 2014 and 2015, blue whales occurred in all months of active transmission for tag locations in SOCAL. The tagging study also provides the first-ever tracking information from a blue/fin whale hybrid as well as some of the first information on movements of a Bryde's whale in Southern California. Although the sample size is too limited, the study suggests a possible trend that different blue whale individuals may preferentially use different portions of the southern California waters.

2.2.1.10 MONITORING OBJECTIVE: Analyze data collected during a 2012 glider deployment off the Washington coast [Project N1]

In 2015, a data analysis was performed to examine marine mammal detections on a historical 2012 acoustic recording made during a 2012 passive acoustic glider survey conducted in the QRS off Washington in waters with a bottom depth more than 1,000 m (Klinck et al. 2015b). The glider surveys included 155 dives; however, the PAM system was only active for 56 of the dives intermittently between 12 June and 2 July; this field effort was one of the surveys made during the original development of this survey platform. Marine mammal species frequently detected included Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and northern right whale dolphins (*Lissodelphis borealis*). Also, sperm whale clicks were recorded throughout the deployment, and six dives contained vocalizations of Risso's dolphins. The only beaked whale detections were of Stejneger's beaked whales during a single glider dive. The results of the data analysis also revealed no baleen whale activity in the area at the time of the survey (June/July), which is consistent with other passive acoustic efforts in the area.

2.2.1.11 MONITORING OBJECTIVE: Analyze passive acoustic data in NWTRC for the presence of dolphin echolocation clicks, whale vocalizations, and anthropogenic sounds [Project N2]

PAM using HARPs has been conducted in the Northwest Training Range Complex (NWTRC) since 2004 by SIO. From 2004 to spring 2014, HARPS were deployed at two sites in the NWTRC; one offshore in the deep waters of Quinault Canyon (site QC) and the other closer inshore near Cape Elizabeth (site CE) (**Figure 17**). In spring of 2014, HARP-CE was removed so that only one HARP was deployed for continued new data collection through May 2015 (DoN 2015d). This HARP was recovered on 18 May 2014, however experienced data disk storage failure such that only the first day of data was recorded. For 2015, the cumulative analysis continued and final report is expected by the end of June 2016.

2.2.1.12 MONITORING OBJECTIVE: Identify and classify Southern Resident killer whale detections from acoustic recorders and satellite tag tracking; develop a model to estimate the seasonal and annual occurrence patterns of southern resident killer whales relative to offshore Navy training ranges. [Project N3]

NMFS NWFSC is studying spatial distribution of endangered SRKW using deployed passive acoustic devices (Ecological Acoustic Recorders [EARs]), satellite-tracked tags, and spatial

habitat modeling for inland and offshore waters. Efforts include the ongoing analysis of data collected by EARs during the 2012–2013, 2014–2015, and 2015–2016 field seasons. CRC, in cooperation with NWFSC, is conducting small-vessel operations to determine where along the outer coast of Washington and Oregon SRKWs are occurring and/or foraging and to conduct tagging and biopsy sampling. On 31 December 2015, a satellite tag was deployed on one SRKW adult male, a member of K pod (K33, popularly known as "Tika"). Field work, analysis including state-based spatial habitat modeling, and reporting will be ongoing through 2016.

2.2.1.13 MONITORING OBJECTIVE: Determine abundance, distribution, and densities of marine mammals in inland waters of Puget Sound via aerial surveys [Project N4]

In 2015, researchers conducted survey flights over eight pre-defined sub-regions of inland Puget Sound waters (Smultea et al. 2015) (**Figure 30**). Surveys focused on estimating in-water density and abundance estimation of cetaceans. Observers completed 48 survey flights on 28 days for a total of 148 hr and 28,625 km during five survey periods across four seasons, although only one winter flight occurred (Smultea et al. 2015). Surveys were completed in BSS 1 to 3. Observers recorded a total of 5,005 sightings of an estimated 9,645 individual marine mammals. Of these sightings, 4,909 sightings with 9,528 individuals were identified to species, while 96 sightings with 117 individuals were unidentified (i.e., not identified to species). The Puget Sound surveys documented 10 species, including (ordered from most to least frequently sighted): harbor seal, harbor porpoise (*Phocoena phocoena*), California sea lion, Steller sea lion (*Eumetopias jubatus*), gray whale (*Eschrichtius robustus*), killer whale, minke whale, Risso's dolphin, Dall's porpoise (*Phocoenoides dalli*), and sea or river otter (*Enhydra lutris* and *Lontra canadensis*, respectively).

The largest mean group sizes in winter were of harbor seals and in spring were of killer whales. Only harbor porpoise, killer whale, and harbor seal sightings contained calves/pups (**Table 6**). The highest percentages of harbor porpoise calves sighted occurred in summer and fall and highest percentages of harbor seal pups sighted occurred in summer.

Harbor porpoise were most frequently sighted in the South Whidbey and Strait of Juan de Fuca sub-regions. Non-harbor porpoise cetacean species were uncommon and/or seasonally sighted. All four gray whales were sighted in the East Whidbey sub-region in spring, three to the northwest of Naval Station Everett. Killer whales were sighted in the East Whidbey and Vashon sub-regions in spring and outside of the survey area near San Juan Island in fall. Minke whales were sighted in the Strait of Juan de Fuca during opportunistic surveys in fall. Risso's dolphins were sighted in the Seattle/Vashon sub-regions in fall. The Dall's porpoise was sighted in Dabob Bay in the Hood Canal sub-region in spring (**Table 6**).

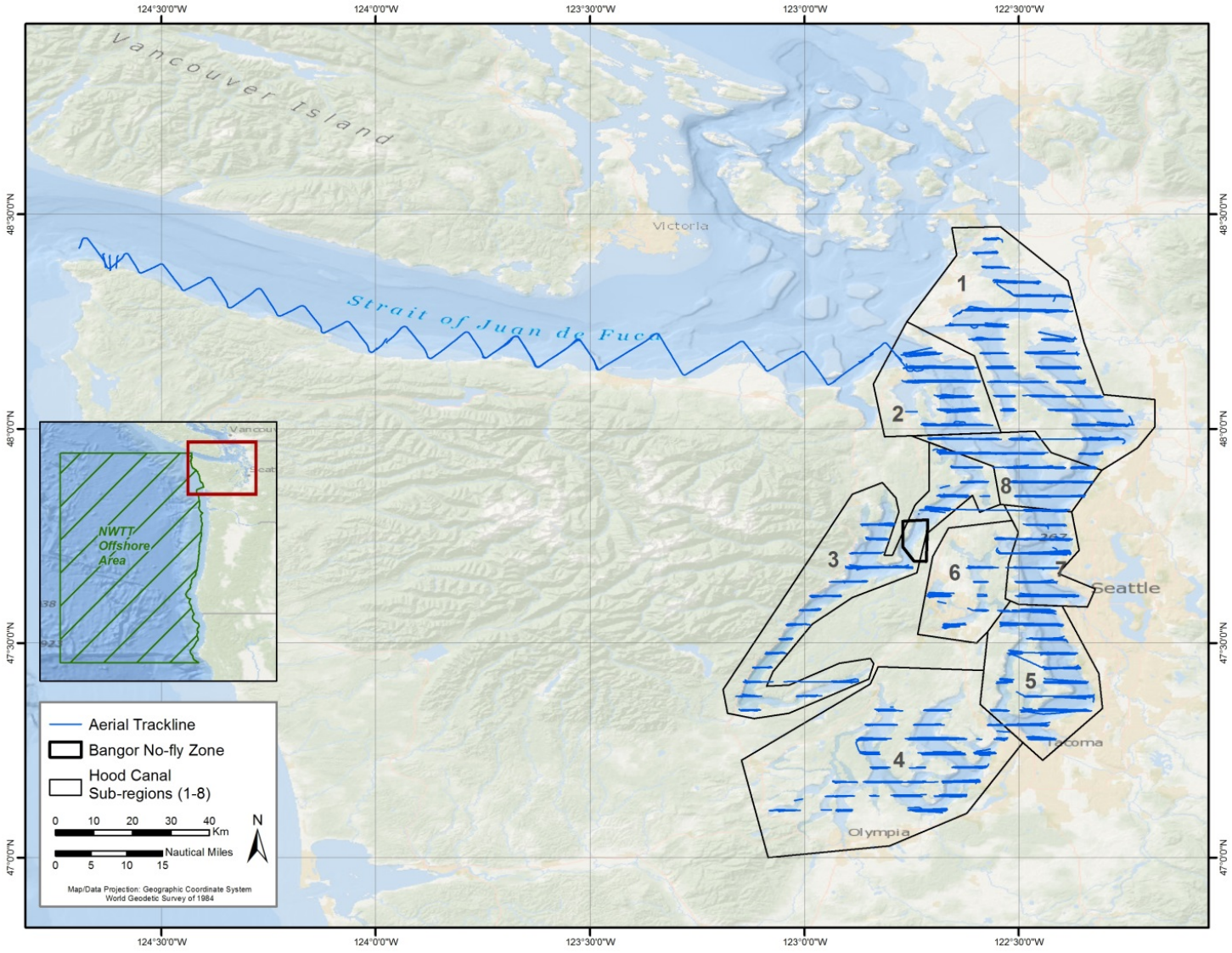

Figure 30. Systematic, on-effort tracklines for Puget Sound aerial surveys 2013–2015, including opportunistic effort in the Strait of Juan de Fuca. Also shown are the eight pre-defined sub-regions of Hood Canal (1=East Whidbey, 2=Admiralty Inlet, 3=Hood Canal, 4=Southern Puget Sound, 5=Vashon, 6=Bainbridge, 7=Seattle, and 8=South Whidbey), and the no-fly zone at Naval Base Kitsap at Bangor. [Project N4]

Table 6. Species sighted (ordered from most to least frequently sighted) during Puget Sound aerial surveys conducted from 2013 through 2015.

Species	# Groups	Total # Individuals	# Calves/ Pups	Mean Group Size	Standard Error	Sub-region(s) Where Species Most Frequently Sighted
Harbor seal	3,803	7,292	24	1.9	0.1	Southern Puget Sound East Whidbey
Harbor porpoise	909	1,971	98	2.2	0.1	South Whidbey
California sea lion	115	157	0	1.3	0.1	Vashon
Steller sea lion	69	76	0	1.1	<0.1	Admiralty Inlet
Unidentified small marine mammal	46	53	0	1.2	0.1	*
Unidentified pinniped	26	35	0	1.3	0.2	*
Unidentified marine mammal	18	20	0	1.1	0.1	*
Gray whale	5	7	0	1.4	0.2	East Whidbey
Killer whale	3	18	1	6.0	1.7	
Unidentified dolphin	3	5	0	1.6	0.3	
Minke whale	2	2	0	1.0	<0.1	Strait of Juan de Fuca[1]
Risso's dolphin	2	4	0	2.0	<0.1	Seattle Vashon
Unidentified porpoise	2	3	0	1.5	0.5	
Dall's porpoise	1	1	0	1.0	N/A	Hood Canal
Unidentified otter	1	1	0	1.0	N/A	Southern Puget Sound
Total	**5,005**	**9,645**	**123**			

*****Report does not provide tally for category.
[1] Opportunistic surveys also were flown over the Strait of Juan de Fuca during two survey periods in 2014

The majority of pinnipeds (i.e., harbor seal, California sea lion, and Steller sea lion) were sighted in the water. This trend arose because the surveys were designed to detect cetaceans in water. Harbor seals were most frequently sighted in the Southern Puget Sound and East Whidbey sub-regions. For pinnipeds other than harbor seals, observations were made of California sea lions and Steller sea lions in all eight of the sub-regions. The only mustelid observed, an otter (river or sea otter), was sighted in the Southern Puget Sound sub-region in the spring (**Table 6**).

Sightings data were used to estimate density and abundance of harbor seals and harbor porpoise. Sample size was sufficient for only these two species to estimate density and

abundance. Harbor porpoise estimates in various survey sub-regions ranged between 21 and 661 individuals (**Table 7**). The highest estimate was recorded in the South Whidbey sub-region at 661 harbor porpoise and a density of 2.47 porpoise/km^2. Highest harbor porpoise numbers were recorded in spring (4,349) and the lowest were observed in fall (2,253). Overall the pooled estimate of abundance across the three seasons in the entire survey area was 2,387 porpoise (coefficient of variation = 11 percent). Harbor seal estimates in various survey sub-regions ranged between 59 and 838 individuals. The highest densities were recorded in the Southern Puget Sound sub-region, which encompassed 838 seals and a density of 1.84 seals/km^2. Highest harbor seal numbers were in spring (3,049) and the lowest were in fall (1,961) (**Table 7**). Overall, the pooled estimate of abundance across three seasons in the entire survey area was 2,659 seals (coefficient of variation = 8 percent). With regard to naval installations in the region, the greatest densities of harbor seals and harbor porpoise were seen in waters surrounding NAVBASE Kitsap at Bangor and Dabob Bay and the least number of individuals was observed in waters surrounding Manchester Fuel Depot. Abundance within 3.7 km (2 nautical miles) of installations was greatest at Dabob Bay followed by NAVBASE Kitsap at Bangor and Naval Air Station Whidbey.

Table 7. Harbor seal and harbor porpoise density and abundance.

Species	Highest Estimate in a Sub-region (# Animals)	Lowest Estimate in a Sub-region (# Animals)	Highest Individual Numbers (# Animals)	Lowest Individual Numbers (# Animals)	Highest Density Estimate (Animals/km^2)	Pooled Estimate of Abundance Across Three Seasons (#)
Harbor porpoise	661	21	4,349	2,253	2.47	2,387
Harbor seal	838	59	3,049	1,961	1.84	2,659

A number of notable findings emerged from this study, especially for the harbor porpoise and harbor seal. The study provided an updated population estimate for harbor porpoise, which is critically needed to update the NOAA Marine Mammal Stock Assessment Report for inland Puget Sound waters. Scientists confirmed an increase in harbor porpoise use of Puget Sound in recent years and show that the population in Puget Sound is rebuilding. The study also documented that harbor porpoise currently occur in all major regions of Puget Sound throughout the year, but that their group sizes may be higher in winter. The findings from this effort will also contribute to a new abundance estimate for the Inland Washington stock of harbor porpoise. Additionally, the study contributes to the current knowledge base on harbor seal stocks in inland waters of Washington State. This effort may help develop or ground-truth correction factors for harbor seals in-water during shore-based survey. The data collected indicate that group size for harbor seals may remain stable across seasons and dispersal distances may be lower in winter; however, more data are needed to confirm this potential trend.

In January 2016, an additional winter season aerial survey was conducted under this project. A total of 13 survey flights were completed on 7 days with over 19 hr of observation. Analysis and reporting are in progress. Preliminary review of the data suggests that there may be sufficient sightings for density analyses for three species: harbor seal, California sea lion, and harbor porpoise.

2.2.1.14 MONITORING OBJECTIVE: Deploy satellite tags; Estimate the number of California sea lions and Steller sea lions that haul out at Navy facilities in Puget Sound; Develop population estimates; Describe regional marine habitat usage by pinnipeds relative to Navy training, testing, and pile driving activities. [Project N6]

NMFS-Alaska Fisheries Science Center (National Marine Mammal Laboratory) is collecting sea lion behavioral data to describe the hauling behavior, diving behavior, proportion of time hauled out on Navy facilities and regional marine habitat usage by pinnipeds relative to U.S. Navy activities and Puget Sound naval facilities at Everett, Bremerton, and Bangor. Some preliminary results were previously presented in last year's NWTRC Annual Monitoring Report (DoN 2015d). Traps on dedicated floats were utilized to capture animals for tagging. Satellite tags could not be attached to the pelage of adult male sea lions that were molting in November 2014 and tag deployments were delayed until mid-December 2014 and January 2015. Most males departed Bremerton shortly after the tags were deployed. In November 2015 as soon as animals began hauling out on the trap at Bremerton, very-high-frequency (VHF) tags were deployed on the rear flippers of 30 sea lions. A radio scanner, receiver and data logger monitored their hauling behavior over the following weeks. Most of these animals departed Bremerton by mid December 2015. On 22 December 2015, satellite-linked dive recorders were deployed on six adult males at Bremerton. Animal abundance then declined precipitously at Bremerton in late December, and many of the animals appeared to move to hauling areas at Manchester. Trap relocation and satellite tag deployment continued into early 2016. Tag deployment, data collection, and analyses are still underway in 2016; results will be presented in a future report.

2.2.1.15 MONITORING METRIC: Determine spatial distribution and occurrence of beaked whales, other odontocetes, and baleen whales in offshore areas using a deep-diving autonomous glider [Project G1]

A passive acoustic glider survey was conducted between 11 July and 21 August 2015 in the GOA TMAA. The goal of the project was to investigate the spatial distribution and temporal occurrence of odontocetes and mysticetes in the northern Gulf of Alaska. The survey focused primarily on the shelf break area between Middleton Island and Kodiak Island (**Figure 31**). The Gulf of Alaska is generally difficult to survey, and thus the knowledge about the abundance and distribution of cetaceans in this area is limited. Any additional effort improves the understanding and awareness of marine mammal occurrence in the GOA TMAA.

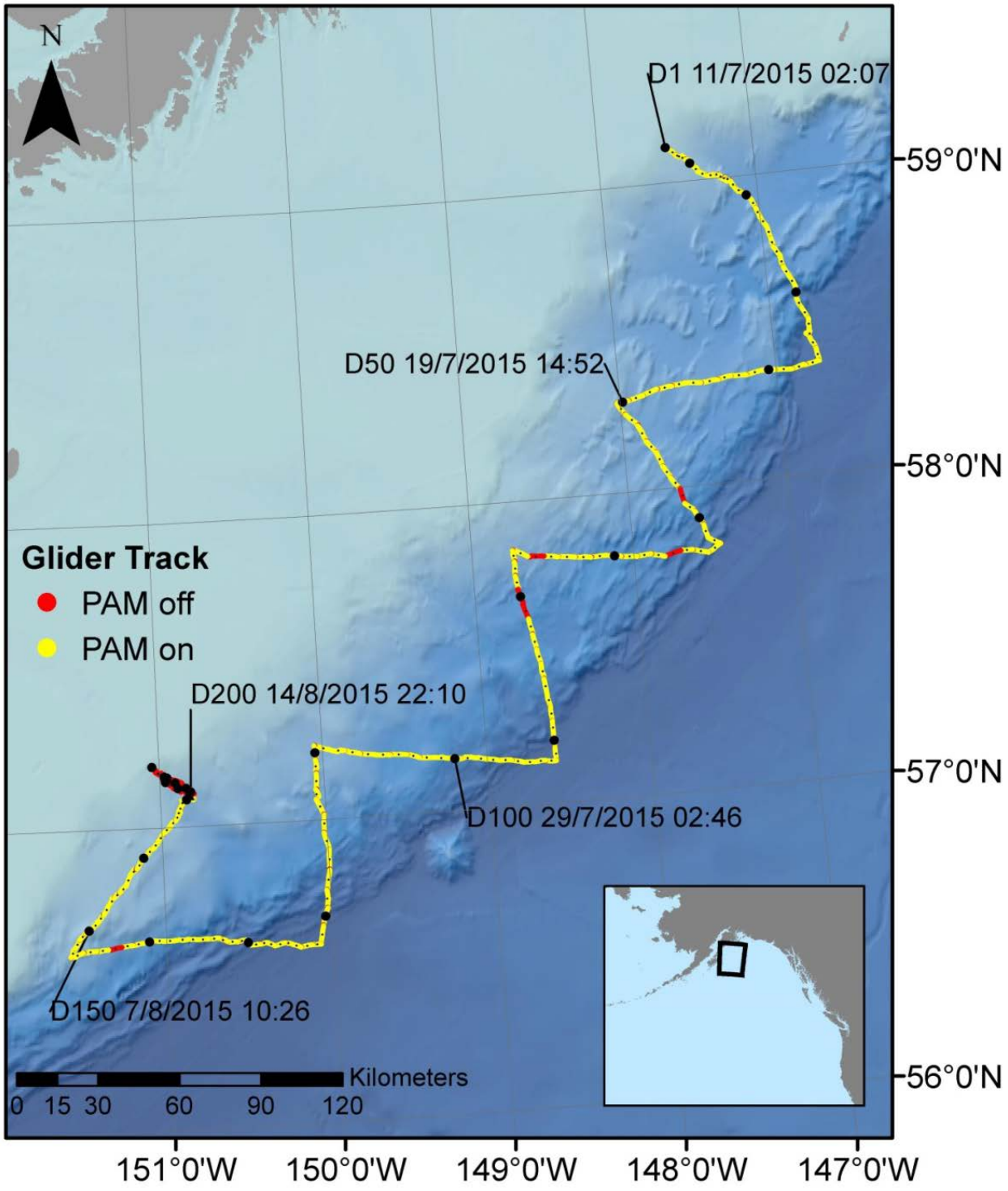

Figure 31. Track of unmanned acoustic glider deployed in the GOA TMAA from 11 July through 21 August 2015 (data collection period was 11 July to 11 August). Each black dot (with every tenth one larger) on the track line indicates the midpoint location of a glider dive. Labels indicate dive number (e.g., D10 for dive no. 10) and date (format: dd/mm/yyyy Coordinated Universal Time). [Project G1]

The glider, referred to as SG203, conducted an acoustic survey that covered a distance of 744 km over ground with the PAM systems (effective frequency range 15 Hz to 90 kHz) active and collected 680 hr of acoustic recordings. This survey further demonstrated that autonomous underwater vehicles are useful for acoustic monitoring in remote areas. These long-duration trials are invaluable for improving these glider systems and are crucial for further development efforts. A primary long-term technical goal is to extend the deployment duration to allow for 2–3 months of continuous acoustic data collection.

A total of 315 cetacean encounters was recorded during 170 dives with the PAM system active. The data analysis revealed the presence of a wide variety of acoustically active cetaceans, including the infrasonic song notes produced by blue whales and the ultrasonic echolocation clicks of Pacific white-sided dolphins. Odontocete acoustic encounters were abundant. Most encounters were associated with the acoustic presence of sperm and killer whales. Other species detected included Pacific white-sided dolphins and a few unidentified odontocetes including a high frequency click signal. Beaked whale species were not recorded during this survey.

Blue whale D calls as well as fin whale 40-Hz calls were the most abundant mysticete sound. The glider also recorded a variety of downsweeps throughout the survey, which potentially indicate the presence of sei whales in the study area. The glider did not record known vocalizations produced by humpback whales, North Pacific right whales, minke whales, or gray whales. Porpoise species' clicks were above the upper frequency limit of the glider's PAM system.

2.2.1.16 MONITORING METRIC: Maintain passive acoustic data collection from two HARPs [Project G2]

U.S. Navy-funded HARP deployments have been taking place since 2011 in the GOA TMAA, using two to five HARPs (Baumann-Pickering et al. 2012; Debich et al. 2013, 2014; Rice et al. 2015). Passive acoustic data were collected from the two deployment locations, one on the slope (Slope HARP, aka "Site CB") and one on Pratt Seamount (aka "Site QN") (**Figure 19**). The Slope HARP was configured with four-channel HARPs to enable tracking and source-level estimation. Analysis and reporting are in progress. In 2015, both HARPs were serviced twice. The Slope HARP at Site QB had been deployed on 10 September 2014, and was recovered on 2 May 2015. A HARP was redeployed at the same location on that day, and subsequently recovered on 10 September 2015. The Seamount HARP at Site QN had been deployed on 9 September 2014, and was recovered on 1 May 2015. A HARP was redeployed at the same loction on that day, and was subsequently recovered on 6 September 2015. All deployments were recovered with the full acoustic data set, with the exception of the second deployment at QN, which recorded through 18 August 2015. No redeployment was made in the GOA TMAA after the final recovery in September 2015. Cumulatively, from July 2011 through May 2015, approximately 51,000 hours of passive acoustic data has been collected and analyzed from these HARP deployments (Rice et al. 2015). Data from the June through October 2015 deployment will be discussed in a future report.

2.2.1.17 MONITORING QUESTION: What are the spatial-movement and habitat-use patterns (e.g., island-associated or open-ocean, restricted ranges vs. large ranges) of species that are exposed to MFAS, and how do these patterns influence exposure and potential responses? [Project H7]

The results for this project related to the conceptual framework of Occurrence are described in this section. Results related to Exposure are described within **Section 2.2.2.**

Studies using satellite tags to assess movements and behavior of individual toothed whales on and around the PMRF were first begun in June 2008 in association with the Rim of the Pacific U.S. Navy training event (Baird et al. 2016). Since 2008 and prior to February 2015, there have been eight additional vessel-based field projects off Kauai (seven in conjunction with PAM through the M3R program) during which satellite tags were deployed. During these nine efforts, 49 satellite tags were deployed on seven different species (short-finned pilot whale [*n*=15], melon-headed whale [*n*=3], bottlenose dolphin [*n*=10], rough-toothed dolphin [*n*=12], sperm whale [*n*=1], false killer whale [*n*=6], Blainville's beaked whale [*n*=2]) (Baird et al. 2016). Nine satellite tags were deployed during February 2015 on three species of cetaceans: short-finned pilot whale (individuals from both the insular and pelagic populations), bottlenose dolphin, and rough-toothed dolphin. These additional deployments increased our understanding of the movement patterns of these three species. The addition of tags deployed on two rough-toothed dolphins and a bottlenose dolphin off the east side of Kauai help reduce potential spatial biases resulting from tag deployment locations. The 2015 data were added to those from previous years' efforts, and kernel density estimates of short-finned pilot whale, bottlenose dolphin, and rough-toothed dolphin space use were computed from the filtered and interpolated tag position data.

The kernel density estimation results showed the following:

- Core ranges for the pelagic population of short-finned pilot whales were more than 20 times larger than for the resident island-associated population of short-finned pilot whales.
- Core ranges for individuals from pelagic population of short-finned pilot whales were larger in comparison with the resident island-associated population.
- The bottlenose dolphin off Kauai has the smallest range of any of the three species examined.

Both of the rough-toothed dolphins (with tags that functioned properly) and both of the bottlenose dolphins remained associated with the island of Kauai, with bottlenose dolphins remaining in shallow depths (medians of 80 and 275 m) and rough-toothed dolphins using slope waters (median depths of 1,450 and 1,680 m). One of the tagged groups of short-finned pilot whales included re-sighted individuals known to be from the resident island-associated population. The other group had no re-sightings (of 21 distinctive individuals), and satellite-tag data suggest that they are part of the pelagic population. Probability density analyses of all tag-location data obtained for bottlenose dolphins and rough-toothed dolphins tagged off Kauai since 2011 indicate that core ranges (i.e., the 50 percent kernel density polygons) are relatively small (1,200 and 1,656 square kilometers [km^2]). Probability density analyses were undertaken separately for 13 resident short-finned pilot whales tagged off Kauai since 2008, and for five pilot whales tagged off Kauai and Oahu thought to be from the pelagic population (**Figure 32**).

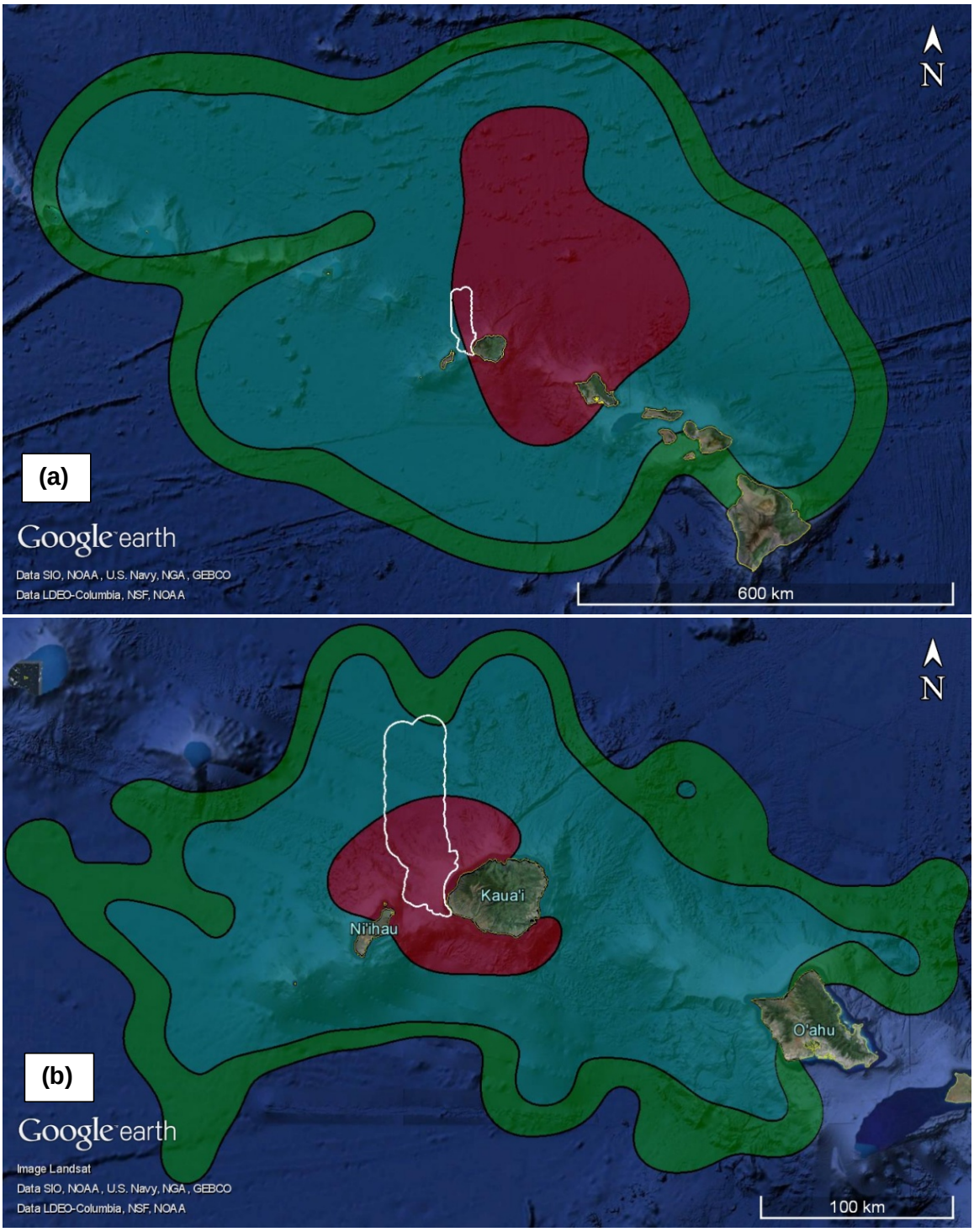

Figure 32. Probability density representation of short-finned pilot whale location data from satellite tag deployments off Kauai. Location data from the first 24 hours of each deployment were omitted to reduce tagging area bias, and only one of each pair of individuals with overlapping tag data that were acting in concert were used. (top) Individuals known to be part of the open-ocean population (n=5), including three individuals tagged off Oahu in 2010. (bottom) Individuals known to be part of the resident island-associated population (n=13). The red area indicates the 50 percent density polygon (the "core range"), the light blue represents the 95 percent polygon, and the green represents the 99 percent polygon. The Pacific Missile Range Facility boundary is shown as a solid white line. From: Baird et al. 2016. [Project H7]

Core range for the pelagic population was more than 20 times larger (122,119 km^2) than for the resident population (6,157 km^2), and the overall range (using the 99 percent kernel density isopleth) was an order of magnitude larger for the pelagic population (755,166 km^2). This suggests that the likelihood of exposure to MFAS on the PMRF range varies substantially between the two populations. For rough-toothed dolphins, bottlenose dolphins, and short-finned pilot whales, the core areas (represented by the 50 percent kernel polygons) overlap with the PMRF range to varying degrees, reflecting the importance of the channel between Kauai and Niihau to these species, and also having implications for exposure to MFAS.

The tag deployments to date on bottlenose and rough-toothed dolphins appear to be from the known resident populations. Given the overlap in core areas with the PMRF range, it is likely that individuals within these resident populations are repeatedly exposed to MFAS. However, the deployments of satellite tags on pilot whales occurred from three social groups with varying re-sighting histories among the islands. Two of the groups from the resident population may receive more frequent exposure to MFAS when compared to the one group from the pelagic population (**Figure 32**), illustrating that the amount of exposure to MFAS will likely vary by social cluster. Reactions to MFAS are likely to be influenced by prior exposure history, thus understanding potential consequences of exposure, both to the social group and to the population, will benefit from an increased understanding of the social organization of the population. For example, repeated exposure might lead to different responses compared to that of populations naïve to exposure.

2.2.1.18 OTHER RESULTS: ISOs beyond given monitoring questions

There exist several conceptual levels above an individual monitoring project. The range or study area may be associated with monitoring questions or monitoring objectives. At a broader level there exists the Navy-wide intermediate scientific objectives (ISOs), and above that are the four conceptual framework levels of Occurrence, Exposure, Response, and Consequences.

These levels exist as a frame of reference to conceptually parse the goals and implementation of the monitoring program. However, the monitoring projects, questions, and ISOs are not linearly derived from the top down. For example, ISOs are related to multiple conceptual framework categories. Similarly, multiple ISOs may be associated with each range-specific monitoring question. Finally, individual monitoring projects may also span multiple questions, as well as multiple ISOs beyond those questions. As a result, the entire set of ISOs associated with a given project may not all map to the ISOs associated with the higher-level parent monitoring question(s) for that project.

Therefore, some 2015 monitoring projects have made progress on ISOs related to Occurrence, but is not covered by the progress on monitoring questions described above. Progress on such ISOs is described in this section.

2.2.1.18.1 ISO #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals [Projects H2, H4, M5]

In HRC, using archived raw data collected from the PMRF hydrophone range, researchers applied newly modified methods for automated analysis to track humpback whales using song units (Martin et al. 2015a; Helble et al. 2015a). Results provided information on the seasonal presence and relative abundance of vocally-active humpback whales at or near the PMRF

instrumented range. Researchers are currently modifying PAM analysis methods to establish the feasibility of using three-dimensional localization to analyze the water depths of transiting humpback whales (d et al. 2015).

In 2015, researchers continued developing methods to detect and classify marine mammal sounds using PAM data collected by seafloor-mounted hydrophones at PMRF. Whistles recorded on the PMRF range in the presence of satellite-tagged false killer whales were classified using ROCCA (Oswald and Hom-Weaver 2016). The vocalizations were confirmed as false killer whales by ROCCA's random-forest classifier that automatically identifies 'acoustic encounters' to species.

The classification of recordings made from cabled, seafloor-mounted hydrophones on the PMRF range off the northwest side of the island of Kauai builds upon satellite-tagging work conducted in a 2014 study of false killer whales on the range. These classification results of the acoustic recordings made by the hydrophones on the PMRF range match the species tagged in the area the previous year and, therefore, provide a higher level of confidence for species identification of the acoustic recordings. As a result of this confidence in species identification, these recordings could be used to train and test other classifiers. In addition, the annotated dataset provides much-needed data for ground-truthing automated detectors (Oswald and Hom-Weaver 2016). Annotated datasets are time- and cost-intensive to produce, so these data are a valuable addition to existing annotated datasets.

In the MITT, Deakos et al. (2016) demonstrated that shore-based visual survey is a viable alternative for conducting marine mammal visual surveys for basic occurrence in areas where small vessel surveys are difficult to perform. With regard to visual localization, the team compared the accuracy of sighting fixes made by Big Eyes to those made by theodolite, and found that both methods were accurate and comparable to one another. The range of sightability of large whale species was also measured as part of this project, helping to validate the use of this methodology for visual localization of some species of marine mammals within this range of sightability. In the future, the visual localization of such sightings from a shore station could be combined with other data products to produce received level estimates in waters where passive acoustic localization is not possible or practical. Additionally, the team developed a customized Filemaker Pro relational database with a modifiable front-end interface to collect shore-based data on marine mammal species. Several custom calculators were incorporated into the database to allow for rapid conversion of horizontal and vertical information that could be relayed to Big Eyes, handheld binocular, super-telephoto photography, or theodolite operators so they could quickly locate the sighting between visual instruments.

2.2.1.18.2 ISO #13: Assess existing data sets which could be utilized to address the current objectives [Project H4]

The seafloor-mounted hydrophones at PMRF off the northwest side of the island of Kauai collect vast amounts of acoustic data throughout the year. Archived data from PMRF hydrophones were used to confirm the presence of false killer whales on the range and refine the classifier for this species.

Recordings were made on different hydrophones as false killer whales equipped with satellite tags moved throughout the range. Recordings from the five hydrophones closest to the tagged

animals during tag updates (animal location readings obtained from the tags) were provided by SPAWAR Systems Center, Pacific for eight tag update periods (Martin et al. 2015a). Tag updates included the depth and location of the tagged animal, so it was possible to determine the horizontal distance between the tagged animal and the PMRF hydrophone. A total of 2 hr and 10 min of recordings was provided by SPAWAR for the analysis. All encounters in the dataset were classified as false killer whales (Oswald and Hom-Weaver 2016). Because the recordings were made when tagged false killer whales were less than 2 nm from the PMRF hydrophones, it was assumed that the vocalizations recorded were produced by false killer whales. However, there were no visual observations associated with the recordings, so it is possible that other species were also present within acoustic range of the hydrophones. The fact that all encounters were classified as false killer whales (based on the recorded whistles) provides a second source of evidence to support the hypothesis that the recorded sounds were produced by false killer whales.

2.2.1.18.3 ISO #12: Evaluate trends in distribution and abundance for populations of protected species regularly exposed to sonar and underwater explosives [Project H7]

Marine species monitoring was conducted before and during an SCC training event in mid-February 2015. The effort included photo-ID and satellite-tagging of marine mammal species off Kauai. There were 17,740 photographs captured for photo-ID. Photo matching showed the following:

- Seven of 35 distinctive short-finned pilot whales had been photo-IDed in previous years.
- 33 of 81 rough-toothed dolphins had been previously photo-IDed off Kauai. One of the 81 rough-toothed dolphins was previously photographed off Oahu.
- 33 of 39 bottlenose dolphins were previously seen off Kauai and/or Niihau.

In addition to progress on these photo-ID catalogs, fin whale photographs helped researchers establish a new fin whale catalog and included 13 unique identifications. They included individuals from the January 2015 U.S. Navy effort and past NMFS and CRC surveys; however, no matches were found. The establishment of a photo-identification catalog for fin whales is a step toward estimating species abundance using mark-recapture methods. The catalog will also be useful in the future for researchers to examine movement of fin whales across PMRF and across the entire archipelago. This study documented the first fin whales sighted by CRC off Kauai and Niihau and the first dwarf sperm whales identified in CRC small-vessel surveys off Kauai and Niihau since 2003 (Baird et al. 2015).

2.2.2 Conceptual Framework Category 2. Exposure

The following sections summarize progress made this monitoring year on addressing the issue of exposure of protected marine species to anthropogenic noise generated by U.S. Navy training activities. Only projects conducted in HSTT address this topic.

2.2.2.1 MONITORING QUESTION: What are the occurrence and estimated received levels of MFAS on 'blackfish' and humpback, minke, sperm, and Blainville's beaked whales within the PMRF instrumented range? [Project H2]

The results related to the conceptual framework of Exposure are described in this section. Results related to Response are described within **Section 2.2.3.**

Developing the capability to detect and localize cetaceans at the PMRF range is a step towards combining these data with Navy exercise products to estimate received level at the animals. PAM data recorded on bottom-mounted hydrophones at the PMRF range were analyzed to determine the presence, occurrence, and qualitative relative abundance of vocalizing marine mammals (Martin et al. 2015a). Data analyzed included standard baseline recordings made during 1 October 2014 to 27 August 2015 and recordings collected before, during, and after the SCC training event conducted in February 2015. By using established automated algorithms for detecting and localizing marine mammal calls, researchers conducted a 'quick look' analysis to determine un-validated relative species abundance. Abundance was calculated as the number of automatically-localized calls per hour for individual baleen whales and automatically recorded foraging dives per hour for beaked whale groups. Results of this study are described below for each species or group analyzed.

Ongoing efforts are utilizing the instrumented range to determine the baseline occurrence and habitat-use patterns of humpback whales at PMRF to assess potential behavioral impacts during U.S. Navy training events. Researchers tracked humpback whales at PMRF using song units (see Helble et al. 2015a). According to preliminary results from analysis of the FY15 baseline data, the presence and relative abundance of vocally active humpback whales on the PMRF range from December through June corresponded to the expected seasonal migratory trends for this species. The few data points collected outside of the PMRF range are likely due to false positives and may also encompass other sources of sound in the humpback whale vocalization band. Based on the 81 individual tracks identified from the 2011 through 2014 baseline data, humpback whales change their headings throughout the spring breeding season; they head mostly south in December and January, southwest in February and March, and east-southeast in April and May. Results also indicated that vocally active humpback whales exhibit deep diving behavior across the PMRF range; maximum depths recorded were approximately 300 m.

Based on the preliminary analysis of automatically localized minke whale boing calls per hour from the FY15 baseline data, the presence and relative abundance of minke whales on the PMRF range corresponded to expected seasonal migratory trends for this species. Peak minke whale boing detections were recorded between December and May.

The current version of the custom algorithm for species detections (as of February 2015) includes sperm whale processing. The localization algorithm, implemented in 2013, localizes sperm whale clicks by utilizing automatic detector start times across multiple hydrophones. However, these detection and localization capabilities are not yet fully automated.

Beaked whale clicks were automatically detected at PMRF throughout FY15. However, these fully automated results were not validated and could include false positive detections of

individuals, combinations of all beaked whale species' dives together, or incorrect automatic aggregations of clicks. These issues will be corrected during the manual validation process. Detections have mostly been attributed to Blainville's beaked whales based on click characteristics. Researchers completed the baseline analysis of Blainville's beaked whale group foraging dive activity in the range from 2011 through 2013 (see Henderson et al. 2015b). The density of Blainville's beaked whales at the PMRF range was estimated to be 11.7 whales/440 km^2 (± 0.26) during calendar year 2013. Although foraging dives occurred throughout the PMRF range, the majority of dives were within 32 km off Kauai, and results indicated a strong association with steep slopes and depths around 2,000 m. Most dives occurred in waters between 1,500 and 3,000 m in bottom depth. No clear seasonal trends in the number of dives were detected. Ongoing analyses will examine long-term trends in dive rates and habitat-use patterns of Blainville's beaked whales at the PMRF range.

Preliminary results of the analysis of automatically localized low-frequency baleen whale (fin, sei [*Balaenoptera borealis*], Bryde's [*B. edeni*], and potentially blue whale) calls from FY15 baseline data corresponded to expected seasonal migratory trends of these species. Some of the peaks in localizations that were documented outside of the expected seasonal period for migratory baleen whales correspond to year-round presence of Bryde's whales (Martin and Matsuyama 2014, Helble et al. 2015b).

A case study was conducted to estimate exposures to baleen whales from surface ship MFAS training conducted at PMRF. This study tested the use of the Peregrine parabolic equation acoustic propagation model to improve the process for reporting estimated exposures with better-defined estimates. The goal was to identify modifications to the automated processes that would reduce manual steps during the steps involved in estimation of received level. More complete automation and the ability to batch multiple such estimates would enable the estimation of large numbers of ship-animal exposures to reach sample sizes necessary for investigating potential behavioral responses. PAM data were recorded before, during, and after the SCC training event in February 2015. Analysis of three whales exposed to MFAS during an anti-submarine warfare (ASW) surface tracking training event was conducted; two of the whales were presumed to be fin whales, and the third was confirmed as a minke whale. This minke whale also was exposed to MFAS activity during the SCC training event one day after the end of the ASW event. Estimated received levels to the three whales varied between 156 and 167 dB re 1 µPa.

Monitoring efforts in 2015 continued to provide baseline information on the occurrence and behavior of baleen and beaked whales at PMRF using comprehensive analyses of acoustic data. During the 2014 monitoring efforts, the analysis of PMRF data recorded between 2011 and 2013 revealed information on Bryde's whale use of PMRF and this species' general distribution and acoustic behavior (Martin and Matsuyama 2015). Data recorded during 2014 provided information on swim speeds, bearing, and duration of several Bryde's whales acoustically tracked at PMRF; new cue rate information provided for this species may be used in future density studies involving PAM data (Helble et al. 2015b). In addition, 2014 efforts included the development of an automated method to track humpback whales at PMRF.

During 2015, new modifications were used to detect, classify, and track Bryde's whales at PMRF; these methods may also be used to obtain depth information for this species.

2.2.2.2 MONITORING QUESTION: What is the effectiveness of Navy lookouts on Navy surface ships and what species are sighted during sonar training events? [Project H5]

In February 2015, MMOs embarked on a U.S. Navy warship for 2 days during an SCC training event (Watwood et al. 2016). The objectives were to evaluate the effectiveness of the Navy watchstanders (lookouts) on the ship and to collect sighting information that could be used to determine level of exposure a marine mammal may experience during MFAS events. The observers spent 16 hr and 10 min (8.1 hr per day) searching for marine species. The majority of the observation time was spent in BSS of 2, 3, or 4; sightings were mostly during BSS 1 to 4. During 2 days of observation, MMOs recorded 36 sightings with at least 61 individual marine mammals. The only taxon identified to species was the humpback whale which accounted for 31 percent of sightings. For each individual sighting, MMOs recorded the estimated distance of the sighting from the ship, the bearing of the sighting to the ship, and observer position. This information, along with the ship's heading, was used to calculate actual sighting positions (**Figure 33**). Animal position data, along with ship position, type of sonar, sonar direction, and other information, will be provided to SPAWAR to estimate the received level of sonar a marine mammal may experience during an MFAS event.

MMOs made 26 sightings independent of the ship's watchstander team. Seven sightings were made concurrently by both the MMO team and the watchstander team. Watchstanders made three sightings independent of the MMOs.

This event is the twelfth aboard a Navy warship during which data were collected to determine effectiveness. The data will be combined with past and future monitoring efforts to better quantify the effectiveness of U.S. Navy lookouts.

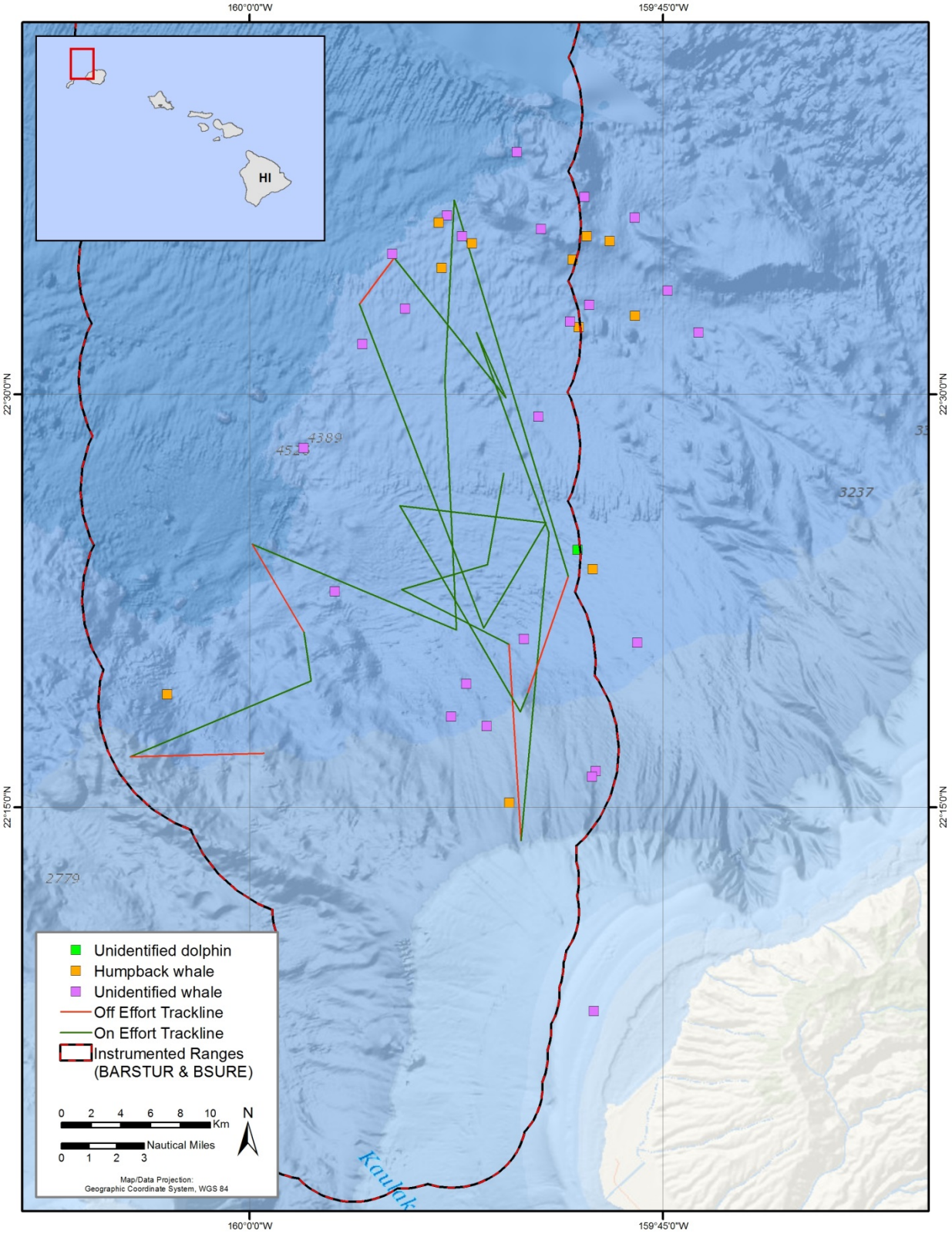

Figure 33. Sightings and generalized trackline (effort) from a February 2015 lookout effectiveness study. Sighting locations were reconstructed from observer position, distance to sighting, and bearing to sighting. [Project H5]

2.2.2.3 MONITORING QUESTION: What are the spatial-movement and habitat-use patterns (e.g., island-associated or open-ocean, restricted ranges vs. large ranges) of species that are exposed to MFAS, and how do these patterns influence exposure and potential responses? [Project H7]

Small-vessel surveys and passive acoustic monitoring were conducted in conjunction with the M3R PAM system located at the PMRF range (Moretti and Baird 2015). This effort was conducted in order to address specific U.S. Navy monitoring questions in the HRC concerning exposure of marine mammals to sonar (Baird et al. 2016). Analysts provided localizations of animals vocalizing on the range to the tagging team with the goal of assisting the tagging team in finding animals as well as obtaining visual species verification. The tagging before the event may provide animal movements before, during, and after an SCC training event. Researchers found that the channel between Kauai and Niihau represents a core area for rough-toothed dolphins and that a portion of this core area overlaps with PMRF. Bottlenose dolphin tag data off Kauai indicates that much of the 50 percent core area (i.e., kernel density estimation) overlaps with the PMRF range. The likelihood of exposure to MFAS on the PMRF range varies between the pelagic population of short-finned pilot whales and the resident population. Individuals from all three insular populations likely are repeatedly exposed to audible levels of MFAS at the PMRF range throughout the year; given the areas with high densities overlap the range.

2.2.3 Conceptual Framework 3. Response

The following sections summarize progress made this monitoring year on addressing the issue of response of protected marine species to anthropogenic noise generated by U.S. Navy training activities. Only projects conducted in HSTT address this topic.

2.2.3.1 MONITORING QUESTION: What, if any, are the short-term behavioral responses of 'blackfish' and humpback, minke, sperm, and Blainville's beaked whales when exposed to MFAS/explosions at different levels/conditions at PMRF? [Project H2]

The results for this project related to the conceptual framework of Response are described in this section. Results related to Exposure are described within **Section 2.2.2.**

A case study at PMRF was conducted to estimate exposures and behavioral responses of baleen whales to MFAS during SCC training events in February 2015 (Martin et al. 2015a). The study will enable the Navy to estimate large numbers of ship-animal exposures and potential behavioral responses. During the PMRF case study in February 2015, two presumed fin whales and one confirmed minke whale exhibited short-term responses to MFAS. Both of the presumed fin whales ceased calling during MFAS exposures. One whale called for 60 min prior to exposure and went silent after the first MFAS transmission occurred at an estimated received level of 156 dB re 1 µPa. The other whale began calling during MFAS activity but ceased calling after prolonged MFAS exposure (106 min) and during the close (i.e., 3 km) approach of the transmitting ship, when estimated received levels reached 167 dB re 1 µPa. During this SCC training event, a minke whale vocalized during MFAS exposures at received levels of 156 dB re 1 µPa and continued to vocalize for over 33 hr between MFAS activities. However, this same minke whale ceased calling almost immediately after the onset of MFAS activity with an estimated received level of 166 dB re 1 µPa during phase B of the training event. The whale

resumed calling after this MFAS activity but went silent again when the second block of MFAS activity with estimated received levels of 160 dB re 1 µPa began. The inter-call-interval between these minke whale boing calls was 904 seconds, which may indicate a change in call intervals after one exposure. However, more ship-whale encounters need to be analyzed to determine if there is a statistical correlation between increases in inter-call-intervals and exposures to MFAS.

Results also indicated that minke whales respond to MFAS with a reduction in number of calling individuals in the area (Martin et al. 2014, 2015a, 2015b). The minimum densities of minke whales were significantly lower during the phase B period within each year, suggesting a clear response to the phase B training (Martin et al. 2015b). For example, based on the number of minke whales acoustically localized in 2011 within the 3,780-km^2 study area, the minimum estimated densities that year were 3.64 whales before the training activity, 2.81 whales during phase A, 0.69 whales during phase B (e.g., frigate and destroyer maneuvers including the use of MFAS), and 4.44 whales after the naval training activity (Martin et al. 2015b). This work also demonstrated that minke whales change inter-call-intervals in response to phase B training (Martin et al. 2015a).

Additional efforts to evaluate behavioral responses of marine mammals, relative to U.S. Navy training and testing activities, included ongoing analysis of satellite-tag data. Previous analyses of tag data from 2011 to 2013 identified the movement patterns of bottlenose dolphins, rough-toothed dolphins, and short-finned pilot whales exposed to MFAS (Baird et al. 2014). In FY15, the analysis of additional satellite-tagged odontocete data from late 2013 through February 2015 was initiated and is still ongoing; therefore, no results are available at this time, but will be available in a future report.

Monitoring projects at PMRF in 2015 included additional recording and analysis of data collected during previous years during training events using MFAS. Previous analyses of data recorded during MFAS events in 2011, 2012, and 2013 documented short-term behavioral responses of marine mammals to MFAS exposure (Manzano-Roth et al. 2015; Henderson et al. 2015a,b—appendices in Martin et al. 2015a). This year, SPAWAR focused in part on refining information presented in last year's HSTT Annual Monitoring Report, readying it for submission for publication in scientific journals.

Beaked whale foraging dives during 2011 through 2013 were found to continue during use of MFAS, but at reduced rates. Blainville's beaked whale dives were detected across the range before training events, predominantly in the south-central portion of the PMRF range. During events, the overall number of dives decreased, and the dives occurred more in the southern portion of the range. An increase in detections on the edge hydrophones at PMRF occurred as well. Therefore, beaked whales may be concentrating in an area of preferred foraging habitat during training events using MFAS, as well as moving away from the ship traffic and sonar noise (Manzano-Roth et al. 2015). There are interannual differences in dive counts across periods, indicating that baseline periodicity in beaked whale dives must be distinguished from reduced dive activity due to sonar to understand the true impact of sonar.

2.2.3.2 MONITORING QUESTION: Do marine mammals strand along shorelines of the main Hawaiian islands within one week following U.S. Navy training? [Project H6]

Two datasets were analyzed for this project: 1) shoreline aerial survey data collected following some U.S. Navy training events in HRC from 2010 to 2014; and 2) the Hawaii Pacific University (HPU) stranding database maintained by HPU and NMFS. Analysis and reporting are in progress.

2.2.3.3 MONITORING QUESTION: What, if any, are the short-term behavioral and/or vocal responses when exposed to sonar or explosions at different levels or conditions? [Project S1]

The University of California San Diego's Scripps Institution of Oceanography (SIO) in La Jolla, California, and SPAWAR are collaborating to study potential impacts of sonar exposure on marine mammal presence and behavior near U.S. Navy training areas.

In 2015, PAM utilizing HARPs was conducted in SOCAL to detect marine mammal and anthropogenic sounds at four locations (**Figure 15**; sites M, H, N, P): near La Jolla, CA, west of SCI, and southwest of SCI. Deployment of two 4-channel HARPs at one site allowed three-dimensional tracking of vocalizing baleen whales (i.e., blue and fin whales) and beaked whales. At site M, a HARP recovery from a November 2014 deployment occurred on 4 February 2015. At site N, recoveries and immediate re-deployments occurred on 5 November 2014, 4 February 2015, 1 June 2015, and 3 October 2015, with the final HARP still deployed. At site H, recoveries and immediate deployments occurred on 4 February 2015, 1 June 2015, 2 October 2015, and 21 November 2015, with the final device still deployed. At site P, recoveries and immediate deployments occurred on 2 June 2015, 25 September 2015, 19 October 2015, and 20 November 2015, with the final device still deployed (Širović et al. 2016).

Ongoing analysis of these data includes presence of species of interest and calculations of movement tracks for calling animals. A related project investigates these data for population density and potential impact of MFAS on marine mammals (Baumann-Pickering et al. 2016, Širović et al. 2016). 2006–2014 PAM data were used to estimate densities of beaked whales at three specific SOCAL sites with persistent acoustic detections of beaked whales. Group- and click-counting techniques were used for density estimates over temporal and spatial scales (Hildebrand et al. 2016). The impact of sonar on calling behavior of blue whales and beaked whales was investigated by comparing these data with call presence to investigate the potential impacts of sonar and other anthropogenic activities on calling animals. Researchers conducted statistical analyses and developed dose response curves (Baumann-Pickering et al. 2016). Based on the analysis of fin whale song patterns at one location, songs from resident and "transient" or pan-Pacific populations of fin whales (Oleson et al. 2014) have been described and their presence investigated. Analyses are being extended into 2016 to additional sites in southern California to obtain a more complete picture of spatial variability in resident and pan-Pacific populations of fin whales (Širović et al. 2015). A report on Southern California fin whale population structure is continuing with additional reporting after September 2016.

3. Adaptive Management and Yearly Monitoring Goals

The Strategic Planning process is used to set intermediate scientific objectives, identify potential species of interest at a regional scale, and evaluate and select specific monitoring projects to fund or continue supporting for a given fiscal year. Continuing or new monitoring for calendar year 2016 are listed below in **Table 8** and is also listed on the U.S. Navy's Marine Species Monitoring web site:

http://www.navymarinespeciesmonitoring.us/regions/pacific/current-projects/

Table 8. 2016 Monitoring projects for Pacific Navy Ranges: HRC, SOCAL, MITT, NWTT, and GOA TMAA

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Hawaii Range Complex (HSTT)			
Title: Long-term Trends in Abundance of Marine Mammals at PMRF **Methods:** Analysis of archived PMRF hydrophone recordings **Performer:** SPAWAR Systems Center Pacific	***Further our understanding of the long term trends in occurrence of marine mammals (e.g., minke, humpback, fin, Bryde's, Blainville's beaked whales) on the PMRF range***	#3: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals #9: Develop and validate analytic methods to evaluate exposure and/or behavioral responses based on passive acoustic monitoring techniques #12: Evaluate trends in distribution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives #13: Assess existing data sets which could be utilized to address the current objectives	Continuing from FY15
Title: Estimation of Received Levels of MFAS on Marine Mammals at PMRF **Methods:** PAM, tagging, photo-ID, biopsy, visual survey **Performer:** SPAWAR Systems Center Pacific; Naval Undersea Warfare Center Newport; and Cascadia Research Collective	***Further our understanding of the occurrence and estimated received levels of MFAS on 'blackfish', humpback, minke, sperm and Blainville's beaked whales within the PMRF range***	#3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur #8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals #9: Develop and validate analytic methods to evaluate exposure and/or behavioral responses based on passive acoustic monitoring techniques #12: Evaluate trends in distribution and abundance for populations of protected species that are regularly exposed to sonar and underwater explosives #13: Assess existing data sets which could be utilized to address the current objectives	Continuing from FY15

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Hawaii Range Complex (HSTT) (continued)			
Title: Behavioral Response of Marine Mammals to Navy Training and Testing at PMRF **Methods:** PAM, tagging, photo-ID, biopsy, visual survey **Performer:** SPAWAR Systems Center Pacific; Naval Undersea Warfare Center Newport; and Cascadia Research Collective	***Further our understanding of any short term behavioral responses of 'blackfish,' humpback, minke, sperm and Blainville's beaked whales when exposed to MFAS/explosions at different levels/conditions at the PMRF range***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities #8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals #9: Develop and validate analytic methods to evaluate exposure and/or behavioral responses based on passive acoustic monitoring techniques #10: Evaluate behavioral responses by marine mammals exposed to Navy training and testing activities #13: Assess existing data sets which could be utilized to address the current objectives	Continuing from FY15
Title: Historical analysis of autonomous glider passive acoustic monitoring survey off Hawaii Island **Methods:** PAM on autonomous platform **Performer:** Oregon State University	***Further our understanding of the spatial distribution and occurrence of beaked whales, other odontocetes, and baleen whales using deep-diving autonomous gliders.***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur	Continuing from FY15, concluding FY16.
Title: Shoreline Aerial Survey and Stranding Summary **Methods:** Statistical analysis from archived aerial survey and stranding data **Performer:** HDR, Inc.; Marine Mammal Research Consultants; Hawaii Pacific University.	***Further our understanding of any association of marine mammal strandings to Navy training events in HRC, and the effectiveness of aerial surveys to detect strandings***	#1: Determine what species and populations of marine mammals and sea turtles are present in Navy range complexes. #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities.	Continuing from FY15, expected completion in 2016.

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Hawaii Range Complex (HSTT) (continued)			
Title: Navy Civilian Marine Mammal Observers On DDGs **Methods:** Visual survey embarked on DDG during training exercise **Performer:** U.S. Navy and HDR, Inc.	***Further our understanding of:*** ***1) effectiveness of Navy lookouts on Navy surface ships for mitigation and*** ***2) cetacean species sighted during sonar training events***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur #11: Collect data to support impact and effects analyses	Continuing from FY10
Location: Southern California Range Complex (HSTT)			
Title: Blue and Fin Whale Satellite Tagging **Methods:** Satellite tagging, photo-ID, biopsy, visual survey **Performer:** Oregon State University	***Further our understanding of:*** ***1) occurrence, movement patterns, and residency patterns of blue and fin whales within Navy U.S West Coast at-sea ranges (SOCAL, NWTT, GOA) as compared to the rest of their distribution throughout the Pacific Ocean;*** ***2) seasonal occurrence and density of cetaceans within the Southern California Range Complex***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur	Continuing from 2014
Title: Marine mammal sightings during CalCOFI cruises **Methods:** Visual and passive acoustic surveys during quarterly CalCOFI cruises **Performer:** Scripps Institution of Oceanography, University of California San Diego	***Further our understanding of the seasonal occurrence and density of cetaceans within the Southern California Range Complex***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur	Continuing from 2004

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Southern California Range Complex (HSTT) (continued)			
Title: Cuvier's Beaked Whale Impact Assessment at the Southern California Offshore Antisubmarine Warfare Range (SOAR) **Methods:** PAM, satellite tagging, Photo-ID, visual survey **Performer:** Naval Undersea Warfare Center Newport	***Further our understanding of:*** ***1) Baseline population demographics, vital rates, and movement patterns for a designated key species;*** ***2) Any short term behavioral and/or vocal responses when exposed to sonar or explosions at different levels or conditions;*** ***3) Any impacts from sonar or explosives to the long term fitness and survival of individuals or the population, species or stock? (with initial focus on Cuvier's beaked whales)***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where U.S. Navy training and testing activities occur #7: Determine what behaviors can most effectively be assessed for potential response to U.S. Navy training and testing activities #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals #9: Develop and validate analytic methods to evaluate exposure and/or behavioral responses based on passive acoustic monitoring techniques #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities #13: Assess existing data sets which could be utilized to address the current objectives	Continuing

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Southern California Range Complex (HSTT) (continued)			
Title: Cuvier's Beaked Whale, Blue Whale, and Fin Whale Impact Assessments at Non-Instrumented Range Locations in the SOCAL Range Complex **Methods:** PAM, satellite tagging, Photo-ID, visual survey **Performer:** Scripps Institution of Oceanography, University of California San Diego	***Further our understanding of:*** ***1) any short term behavioral and/or vocal responses when exposed to sonar or explosions at different levels or conditions*** ***2) impact for sonar/explosives to the long term fitness and survival of individuals or the population, species or stock (with focus on blue whale, fin whale, humpback whale, Cuvier's beaked whale, and other regional beaked whale species)***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in U.S. Navy range complexes #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where U.S. Navy training and testing activities occur #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where U.S. Navy training and testing activities occur #7: Determine what behaviors can most effectively be assessed for potential response to U.S. Navy training and testing activities #8: Develop and validate techniques and tools for detecting, classifying, and tracking marine mammals #9: Develop and validate analytic methods to evaluate exposure and/or behavioral responses based on passive acoustic monitoring techniques #10: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities #13: Assess existing data sets which could be utilized to address the current objectives	Continuing
Title: Navy Civilian Marine Mammal Observers On DDGs **Methods:** Visual survey embarked on DDG during training exercise **Performer:** U.S. Navy and HDR, Inc.	***Further our understanding of:*** ***1) effectiveness of Navy lookouts on Navy surface ships for mitigation and*** ***2) cetacean species sighted during sonar training events***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur #11: Collect data to support impact and effects analyses	Continuing from FY10

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Mariana Islands Training and Testing			
Title: Small vessel visual surveys **Methods:** Visual surveys (nearshore small vessel winter and summer season), photo-identification (develop catalogs for multiple cetacean species), biopsy and genetic analysis, satellite tagging, opportunistic acoustic recording during sightings **Performer:** National Marine Fisheries Service Pacific Islands Fisheries Science Center Cetacean Research Program	***Further our understanding of:*** ***1) species of marine mammals that occur in the nearshore and offshore areas of the MITT study area*** ***2) habitat use of cetaceans in the nearshore and offshore areas of the MITT study area*** ***3) abundance and population structure of marine mammals in the MITT study area*** ***4) seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area*** ***5) exposure of cetaceans and sea turtles to explosives and/or sonar in the MITT study area***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #2: 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 #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur	Continuing from FY10
Title: Acoustic analysis of High-frequency Acoustic Recording Package data **Methods:** Analysis of archived acoustic recordings made by moored high frequency passive acoustic monitoring devices **Performer:** National Marine Fisheries Service Pacific Islands Fisheries Science Center Cetacean Research Program	***Further our understanding of*** ***1) species of marine mammals occur in the nearshore and offshore areas of the MITT study area*** ***2) seasonal occurrence and movements of baleen whales in the nearshore and offshore areas of the MITT study area*** ***3) baseline vocalization behavior of marine mammals in the MITT study area?***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur #8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals	Continuing from FY12

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Mariana Islands Training and Testing (continued)			
Title: Sea turtle tagging in the Mariana Islands Range Complex **Methods:** Sea turtle satellite tagging, habitat use analysis of tag data **Performer:** National Marine Fisheries Service Pacific Islands Fisheries Science Center Marine Turtle Biology & Assessment Program	***Further our understanding of:*** ***1) occurrence, habitat use, abundance, and population structure and of sea turtles in the MITT study area*** ***2) exposure of cetaceans and sea turtles to explosives and/or sonar in the MITT study area***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #2: 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 #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur	Continuing from FY14
Location: Northwest Training and Testing			
Title: Modeling the Offshore Distribution of Southern Resident Killer Whales in the Pacific Northwest **Methods:** Passive acoustic monitoring, satellite tagging, modeling **Performer**: National Marine Fisheries Service Northwest Fisheries Science Center, Cascadia Research Collective	***Develop a model to estimate the seasonal and annual occurrence patterns of southern resident killer whales relative to offshore Navy training ranges using acoustic recorders and satellite tag tracking***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #2: 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 #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur	Continuing from 2014

Project Description	Monitoring Goal	Intermediate Scientific Objectives	Continuing or Proposed New Start
Location: Northwest Training and Testing (continued)			
Title: Marine Mammal Density Surveys in the Pacific Northwest (Inland Puget Sound) **Methods:** Aerial surveys & Density Analysis **Performer:** HDR, Inc.; Smultea Environmental Services; National Marine Fisheries Service Alaska Fisheries Science Center; Washington Department of Fish & Wildlife	***Determine abundance, distribution, and densities of marine mammals in inland waters of Puget Sound***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #2: 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 #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #11: Collect data to support impact and effects analyses	Continuing from 2014
Title: Pacific Northwest Sea Lion Satellite Tracking **Methods:** Tagging **Performer:** National Marine Fisheries Service Alaska Fisheries Science Center; Washington Department of Fish and Wildlife	***Estimate the number of California sea lions and Steller sea lions that haul out at Navy facilities; develop population estimates; describe regional marine habitat usage by pinnipeds relative to Navy training, testing, and pile driving activities***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #3: Determine what species and populations of marine mammals and ESA-listed species are exposed to Navy training and testing activities #4: Establish the baseline habitat uses and movement patterns of marine mammals and sea turtles where Navy training and testing activities occur #11: Collect data to support impact and effects analyses	Field work 2013-2016 Final analysis and reporting 2016
Location: Gulf of Alaska Temporary Maritime Activities Area			
Title: Passive Acoustic Monitoring of Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area using Bottom-Mounted Passive Acoustic Devices **Methods:** Passive acoustic monitoring **Performer:** Scripps Institution of Oceanography, University of California San Diego	***Determine temporal occurrence of baleen whales and beaked whales from bottom-mounted passive acoustic devices***	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges #8: Development and validation of techniques and tools for detecting, classifying, and tracking marine mammals #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics) of marine mammals where Navy training and testing activities occur	Field work 2011-15. Final analysis and reporting 2016

Concluding Projects

Several monitoring projects concluded their final year of effort in 2015, and were not continued in 2016:

- Autonomous glider acoustic pilot survey series (various ranges): A pilot study of acoustic survey based on an autonomous glider platform was performed in multiple ranges, and completed their final technical reports: MIRC (Klinck et al. 2015c; Klinck et al. 2016a), HRC (Klinck et al. 2015a), and GOA TMA (Klinck et al. 2016b). These survey reports conclude the planned field deployments for this pilot study series, after which any future use of acoustic surveys mounted on underwater autonomous vehicles will be evaluated through the Strategic Planning Process. Also related to these field efforts are analyses of two historical seaglider deployments. One, from a 2012 deployment in the NWTRC, is presented in this current annual report (Klinck et al. 2015b). The second, from a 2010 deployment off the Big Island of Hawaii, will be completed in 2016.
- Aerial survey series (HRC): 2015 represents the final year of during- and post-training aerial surveys. The post-training survey series examined the possibility of that marine mammals were stranding unobserved subsequent to U.S. Navy training exercises at remote beaches by utilizing aerial survey along shorelines. A summary report evaluating the post-exercise aerial shoreline surveys was initiated in 2015 and is expected to be completed in 2016 (Project H6). The during-exercise aerial survey series involved an orbital survey over a guided missile destroyer (DDG) deploying MFAS during a training exercise, with focal follows of sighted animals for examination of potential behavioral responses. These surveys also assisted in the visual verification of species identification, for comparison to detections by the instrumented range at PMRF. A case study of aerial focal follows was completed in 2012 (Mobley et al. 2012), and at the same time the component of this study conducted using PMRF range products and monitoring by range hydrophones continued to yield interesting results and relatively quicker progress (e.g., Martin et al., 2015a). Therefore, the range component of the during-exercise monitoring has been emphasized, with a corresponding de-emphasis on the aerial survey component.
- Guam shore station survey pilot study (MITT): 2015 represents the final year of a planned two-season pilot study investigating the utility of a shore-based marine mammal survey protocol utilizing Big Eyes, theodolites, and ultra-telephoto photography from a high-elevation survey station. The intent was to survey nearshore waters off Guam that have proven very difficult to access by small boat survey due to prevalent environmental conditions. In particular a study goal of the second survey in 2015 was to utilize the wide viewshed over these waters to confirm whether baleen whales could be detected during the winter season. The completion of this second-season survey represents the end of the planned two-season pilot study, and the resulting technical report is presented with this annual report (Deakos et al. 2016). This pilot study series validated the utility of this novel shore-based survey methodology, and therefore the use of this methodology may be considered for future projects at other ranges through the Strategic Planning Process.

Gulf of Alaska TMAA 2016 monitoring

The closeout year-5 annual monitoring report for GOA TMAA (DoN 2015f) described monitoring results through May 2015, and the current report describes subsequent update on continuing progress through December 2016. The Letter of Authorization (NMFS 2013d) and Final Rule (NMFS 2011b) for GOA are effective through 4 May 2016.

In consultation with the NMFS during a June 2015 adaptive management meeting, the Navy and NMFS agreed that Navy-funded monitoring within the GOA TMAA would be revisited during subsequent adaptive management meetings in 2016 and 2017. Given 4 years of constant 24/7 passive acoustic marine mammal baseline monitoring through the years 2011-2015, scientifically significant ambient background data for a region used infrequently by the Navy has been sufficiently obtained under the current authorization. The latest GOA TMAA passive acoustic monitoring report is Rice et al. (2015) for the April 2014 to May 2015 season, which was included as part of the year-5 annual monitoring report for GOA TMAA (DoN 2015f). Previous year's reports are available on the Navy's public monitoring website.

Therefore, the Navy with NMFS' concurrence will not fund GOA TMAA marine mammal field monitoring in 2016, a year in which no Navy presence is anticipated within the TMAA. The remaining monitoring project, for passive acoustic analysis using HARPs (**Table 8**), will continue its ongoing analysis effort and is expected to conclude with the production of a final technical report in 2016.

A more focused monitoring effort is currently envisioned before, during, and after the Navy's next Northern Edge exercise tentatively scheduled for June or July 2017, which will be subject to future MMPA and ESA authorizations.

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