2022 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 Gulf of Alaska Training (GOA) Areas

Prepared For and Submitted To

National Marine Fisheries Service
Office of Protected Resources

Prepared By

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Cover Photograph Credit:

A Chinook salmon (*Oncorhynchus tshawytscha*) tagged and released with a pop-up satellite archival tag near Chignik Bay, Alaska, photographed by Michael Courtney under the University of Alaska Fairbanks Institutional Animal Care and Use Committee assurance 495247 and State of Alaska Aquatic Resource Permits CF-20-039, CF-21-027, CF-21-085, and CF-22-034.

Short-finned pilot whales (*Globicephala macrorhynchus*) photographed by Robin W. Baird/Cascadia Research Collective on 17 April 2022 under NMFS Permit #20605 to Robin Baird.

Executive Summary

The United States (U.S.) Navy conducts training and testing activities in the Pacific region. These activities are described in the Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) for each area: the Hawaii-Southern California Training and Testing (HSTT) area (Department of the Navy [DoN] 2018a), the Mariana Islands Training and Testing (MITT) area (DoN 2020a), the Northwest Training and Testing (NWTT) area (DoN 2020b), and the Gulf of Alaska Training (GOA) area (DoN 2022a). The U.S. Navy training and testing ranges covered by these EISs/OEISs include the Hawaii Range Complex (HRC) and Southern California Range Complex (SOCAL), which are part of the HSTT Study Area; the Mariana Islands Range Complex (MIRC), which is part of the MITT Study Area; the Northwest Training Range Complex (NWTRC) and the Keyport Range Complex, which are part of the NWTT Study Area.

To authorize these actions, the National Marine Fisheries Service (NMFS) issued Final Rules and Letters of Authorization (LOA) under the Marine Mammal Protection Act (MMPA) to the Commander, U.S. Pacific Fleet, and the Commander, Naval Sea Systems Command, and Biological Opinions under the Endangered Species Act (ESA) for each training and testing area.

This monitoring report was prepared in accordance with the annual monitoring reporting requirements for the 2022 calendar year, and presents results and progress made during the period of 1 January 2022 to 31 December 2022. This is the Navy's 14th annual monitoring report since the program began in 2009. The marine species monitoring (MSM) described was conducted in accordance with objectives listed on the U.S. Navy's MSM Program website:

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

In this report, monitoring goals for the HSTT, MITT, NWTT, and GOA study areas are framed in terms of progress made on question-based scientific objectives and programmatic Intermediate Scientific Objectives (as discussed in **Section 1**). The following list provides brief summaries of key results during 2022 with additional details in **Section 2**. **Section 3** lists the 2023 Monitoring Goals.

Highlights of scientific progress over the course of this reporting period include the following:

- Several projects in the HSTT and NWTT Study Areas resulted in peer-reviewed publications in 2022, including: Passive Acoustic Monitoring (PAM) of Marine Mammals in SOCAL; Cuvier's Beaked Whale (BW) and Fin Whale Population Dynamics and Impact Assessment at Southern California Anti-Submarine Warfare Range (SOAR); Marine Mammal Monitoring on Pacific Missile Range Facility (PMRF); and Odontocete Studies on Pacific Missile Range Facility (PMRF) (see **Appendix A**).

- With regard to the conceptual framework categories, several projects in calendar year 2022 demonstrated progress beyond the category for *occurrence* and estimated the *exposure* of animals to mid-frequency active sonar (MFAS) and explosives, assessed animals' *responses* to underwater noise generated by U.S. Navy training and testing activities, and continued to make strides toward assessing any population *consequences* resulting from these activities by investigating population trends.

U.S. Navy range-specific progress highlights include the following:

MITT

- The U.S. Navy provided funding for the University of Hawaii Health and Stranding Lab to conduct comprehensive stranding response, necropsy, and cause of death investigations for 18 stranding events that occurred in calendar year 2022 in the Pacific Islands Region. Funding also supported detailed analysis of marine debris ingestion, as well as an investigation of historical strandings of BWs in the region.

- Drifting Acoustic Spar Buoy Recorders (DASBRs) were deployed during the 2021 Mariana Archipelago Cetacean Surveys (MACS); in 2022, efforts were initiated to derive density and abundance estimates for Cuvier's BW (*Ziphius cavirostris*) and Blainville's BW (*Mesoplodon densirostris*) from these acoustic data. Results will be applied towards modeling efforts for the next round of MITT compliance documents.

- Conducted PAM off the island of Guam with the goal of detecting, classifying, locating, and deriving abundance and densities of BW species that use the MITT; the spatially explicit nature of the analysis will facilitate a better understanding of BW occurrence within the area, and potentially be used in the future to examine exposure and behavioral responses of these species to naval activities.

HSTT HRC

- Nearly 5,400 hours (hr) of recordings were collected from 63 bottom-mounted PMRF hydrophones between September 2021 and August 2022; data were used to examine the abundance of baleen, beaked, sperm (*Physeter macrocephalus*), and killer (*Orcinus orca*) whales on the range and to perform a disturbance analysis of minke (*Balaenoptera acutorostrata*), fin (*B. physalus*), and humpback (*Megaptera novaeangliae*) whales in relation to MFAS.

- The Marine Mammal Monitoring on U.S. Navy Ranges program conducted a trend analysis abundance of Blainville's and Cuvier's BWs on PMRF. A trend analysis of Blainville's BWs at PMRF indicated that the sample mean number of group vocal periods (GVPs) per hour (GVPs/hr) and sample mean abundance per hr increased significantly between the periods of 2012–2014 and 2019–2021; similarly, the sample mean number of Cuvier's BW GVPs/hr increased significantly between the periods of 2012–2014 and 2019–2021.

- Ten satellite tags were deployed on five odontocete species: Blainville's BW, melon-headed whale (*Peponocephala electra*), short-finned pilot whale (*Globicephala macrorhynchus*), rough-toothed dolphin (*Steno bredanensis*), and bottlenose dolphin (*Tursiops truncatus*), and data will be analyzed for potential exposure and behavioral responses to sonar. Additionally, one fecal sample was collected from a short-finned pilot whale, and two environmental deoxyribonucleic acid (eDNA) samples were collected from Blainville's BW.

- A pilot study was conducted to investigate whether a conservation canine (K9) could be used to detect marine mammal scat in the Hawaiian Islands.

- A project to advance tagging capabilities in Hawaii has begun with development of training courses and tag setup, calibration, diagnostic, data processing, and data storage tools in process.

HSTT SOCAL

- Data recorded by High-frequency Acoustic Recording Packages deployed at four sites within the Southern California Bight between April 2021 and May 2022 were analyzed to characterize the seasonal occurrence and relative abundance of BWs. A total of 31,380 hr of acoustic recordings were obtained. Frequency-modulated (FM) echolocation pulses from Cuvier's BWs were regularly detected at all sites but were detected most frequently at Site E from December through May. Hubbs' BW (*Mesoplodon carlhubbsi*) FM pulses were detected only at Site SN in January and April 2022. BW43 (thought to be Perrin's BW [*Mesoplodon perrini*]) FM pulses were detected in low numbers and only at Site N.

- Results for a trend analysis for abundance of Cuvier's BW on SOAR indicated that the sample mean number of GVPs/hr and sample mean abundance per hr dropped significantly between the periods of 2011–2013 and 2019–2021.

- As part of an ongoing study of the distribution and demographics of BWs and fin whales within SOCAL, 32 days of small vessel surveys were conducted in SOAR from 6 January 2022 to 26 November 2022. Preliminary photo identification of Cuvier's BW sightings in 2022 included 56 unique individuals, bringing the catalog to 298 individuals in the SOCAL area, and included four females with calves. Nine genetic samples were collected in 2022, one each from a Cuvier's and Baird's BW, and seven from fin whales. Eight satellite tags were deployed, including six Cuvier's BWs (one from an ancillary project) as well as one each on a fin whale and short-finned pilot whale.

NWTT

- Acoustic telemetry was used to investigate the anadromous behavior of 17 acoustically tagged bull trout (*Salvelinus confluentus*) along the coast of the Olympic Peninsula. An existing offshore acoustic array, combined with in-river receivers, was used to track the movement of bull trout between the Hoh River and Kalaloch Creek via the coastal ocean waters. Bull trout exhibited repeated use of marine migratory corridors along the coast and spent significant periods in the ocean, suggesting that anadromy is an important aspect of their life history in these systems.

- In order to explore factors limiting post-spawn survival of steelhead trout (*Oncorhynchus mykiss*), 86 individuals (49 wild and 37 hatchery origin) were instrumented with acoustic pinger tags, and 14 individuals were instrumented with Pop-up Satellite Archival Tags (PSATs) in a coastal tributary of Willapa Bay, Washington, and the near-coastal ocean. Twenty-three % of acoustically tagged wild fish and 14% of tagged hatchery fish successfully returned to the ocean after spawning. Of the 14PSATs deployed, nine reported from the Willapa River, Willapa Bay, off the Washington State coast, and in the Salish Sea.

- The spatial and depth distribution of Chinook salmon in the Northern California Current was

examined by capturing salmon at different locations and times and analyzing how environmental variables may influence the probability of capture. Chinook salmon had a wide distribution in nearshore marine waters, with higher capture rates near estuaries and the ocean bottom. The distribution was also influenced by environmental variables such as sea surface temperature.

- Three deployments of gliders with acoustic tag detectors were conducted between August 2019 and June 2020. Twelve distinct tagged individuals, including Chinook salmon, green sturgeon, and steelhead trout, were detected.

- The distribution of Chinook salmon acoustically tagged off Washington was compared to the distribution of Southern Resident killer whales as determined by acoustic detections from five passive acoustic recorders off the coast of Washington. The highest overlap occurred in the winter near the mouth of the Strait of Juan de Fuca. Another area of overlap was the mouth of the Columbia River in winter and spring.

- In order to characterize the distribution of two distinct populations of green sturgeon in and near the NWTT, 110 sturgeon were acoustically tagged, and genetic samples from 188 sturgeon were analyzed in 2020 and 2021. Single nucleotide polymorphism assays indicated that 71% of individuals belonged to the Northern Distinct Population Segment (DPS) and 29% belonged to the Southern (ESA-listed) DPS.

GOA

- PSATs were deployed on 100 Chinook salmon (*Oncorhynchus tshawytscha*) within the GOA to characterize their horizontal and vertical distribution, habitat use, natural mortality of tagged individuals, and occupancy in the GOA. Movement models suggest the majority of tagged fish remained over the continental shelf in relatively close proximity to their tagging locations. Tissue samples were also collected for genetic analysis to determine the stock-of-origin for each tagged fish, which included individuals from all populations south of central Alaska.

- Out of 298 acoustically tagged Chinook salmon from locations around the GOA, to date, 47 have been detected on acoustic detectors deployed from Prince William Sound to the coast of Washington.

- PAM data were collected at seven sites within the GOA from 2011 to 2019 in shelf, slope, abyssal, and seamount habitats. Killer whale signals were analyzed to determine the seasonal occurrence and distribution of various ecotypes detected at these sites. Killer whales (possible resident, transient, offshore, or unknown) were detected at all seven recording locations. Kodiak Shelf and Kenai Shelf had the highest percent of days with killer whale detections, whereas sites near the Quinn and Pratt Seamounts had the lowest.

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Acronyms and Abbreviations

K9	canine
Argos	Advanced Research and Global Observation Satellite
ATN	Animal Tracking Network
BARSTUR	Barking Sands Tactical Underwater Tracking Range
BO	Biological Opinion
BSS	Beaufort sea state
BW	beaked whale
BWB	BW Baja
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CeMV	cetacean morbillivirus
CFC	Conceptual Framework Category
CI	confidence interval
cm	centimeter
CRC	Cascadia Research Collective
CTD	Conductivity, Temperature, and Depth
CY	calendar year
d	day
DASBR	Drifting Acoustic Spar Buoy Recorder
dB re 1µPa	decibel(s) referenced to 1 microPascal
DEMVAL	Demonstration-Validation
DNA	deoxyribonucleic acid
DoN	Department of the Navy
DPS	Distinct Population Segment
eDNA	environmental deoxyribonucleic acid
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FL	fork length
FM	frequency-modulated
FY	fiscal year
GOA	Gulf of Alaska Training
GPS	Global Positioning System
GVP	group vocal period
HARP	High-frequency Acoustic Recording Package
HMM	Hidden Markov Models
hr	hour(s)
HRC	Hawaii Range Complex
HSTT	Hawaii-Southern California Training and Testing
Hz	Hertz
ICMP	Integrated Comprehensive Monitoring Program
ISO	Intermediate Scientific Objective(s)
kHz	kilohertz
km	kilometer(s)
kt	knot(s)
LIMPET	Low Impact Minimally Percutaneous Electronic Transmitter
LO	location-only
LOA	Letters of Authorization
LTSA	Long-Term Spectral Averages
m	meter(s)
M3R	Marine Mammal Monitoring on U.S. Navy Ranges
MACS	Mariana Archipelago Cetacean Survey
MarEcoTel	Marine Ecology and Telemetry Research
MFAS	mid-frequency active sonar
MIRC	Mariana Islands Range Complex
MITT	Mariana Islands Training and Testing
MMPA	Marine Mammal Protection Act
MSM	marine species monitoring
MTBAP	Marine Turtle Biology and Assessment Program
NARWHAL	Navy Acoustic Range Whale Analysis
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NIWC	Naval Information Warfare Center
NUWC	Naval Undersea Warfare Center
NWFSC	Northwest Fisheries Science Center
NWTRC	Northwest Training Range Complex
NWTT	Northwest Training and Testing
OEIS	Overseas Environmental Impact Statement
ONR	Office of Naval Research
PacMAPPS	Pacific Marine Assessment Program for Protected Species
PAM	passive acoustic monitoring
PCoD	Population Consequences of Disturbance
PCR	polymerase chain reactions
photo-ID	photo-identification
PIFSC	Pacific Islands Fisheries Science Center
PIT	Passive Integrated Transponders
PMRF	Pacific Missile Range Facility
PSAT	Pop-up Satellite Archival Tag
RHIB	rigid-hull inflatable boat
RL	received level(s)
s	second(s)
SCB	Southern California Bight
SCC	Submarine Command Course
SEAFAC	Southeast Alaska Acoustic Measurement Facility
SIO	Scripps Institution of Oceanography
SNP	single nucleotide polymorphism
SOAR	Southern California Offshore Anti-Submarine Warfare Range
SOCAL	Southern California Range Complex
SPOT	smart position and temperature
SRKW	Southern Resident Killer Whale
TDOA	time-difference-of-arrival
UH	University of Hawai‘i
U.S.	United States
WARP	Whale Acoustic Reconnaissance Project
WDFW	Washington Department of Fish and Wildlife

1 Introduction

The United States (U.S.) Navy conducts training and testing activities in the Pacific region. These activities are described in the Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) for each area: the Hawaii-Southern California Training and Testing (HSTT) area (Department of the Navy [DoN] 2018a), the Mariana Islands Training and Testing (MITT) area (DoN 2020a), the Northwest Training and Testing (NWTT) area (DoN 2020b), and the Gulf of Alaska Training (GOA) area (DoN 2022a).

The U.S. Navy training and testing ranges covered by these EISs/OEISs include the Hawaii Range Complex (HRC) and Southern California Range Complex (SOCAL), which are part of the HSTT area; the Mariana Islands Range Complex (MIRC), which is part of the MITT area; the Northwest Training Range Complex (NWTRC) and the Keyport Range Complex, which are part of the NWTT area.

To authorize these actions, the National Marine Fisheries Service (NMFS), under the Marine Mammal Protection Act (MMPA), issued (1) Final Rules for HSTT (NMFS 2018a, 2020j, 2022a), MITT (NMFS 2020g), NWTT (NMFS 2020d), and GOA (NMFS 2017b, 2023a); (2) Letters of Authorization (LOA) under the MMPA to Commander, U.S. Pacific Fleet and Commander, Naval Sea Systems Command for HSTT (NMFS 2018c, 2018d, 2020h, 2020i), MITT (NMFS 2020f), NWTT (NMFS 2020b, 2020c), and GOA (NMFS 2017a, 2023b); (3) and Biological Opinions (BOs) under the Endangered Species Act (ESA) for HSTT (NMFS 2018b), MITT (NMFS 2020e), NWTT (NMFS 2020a), and the GOA (NMFS 2017c, 2022b).

The regulations issued with the Final Rules for HSTT, MITT, NWTT, and GOA require the U.S. Navy to submit an annual monitoring report, as specified at 50 Code of Federal Regulations § 218.75(d) (HSTT), § 218.95(d) (MITT), § 218.145(d) (NWTT), and § 218.155(f) (GOA). Monitoring results from all Pacific U.S. Navy area, (i.e., HRC, SOCAL, MIRC, NWTRC, GOA), are treated in this report in an integrated fashion to allow comparison across ranges and a cumulative view of progress made on monitoring goals across ranges. This report is the eighth such “Multi-Range”-Complex Annual Monitoring Report (see DoN 2016, 2017, 2018b, 2019, 2020c, 2021, 2022b). Monitoring at each range complex is coordinated under the U.S. Navy’s Integrated Comprehensive Monitoring Program (ICMP)[1] (DoN 2010). Results from this report are intended to iteratively inform future cycles of the ICMP, Adaptive Management Review, and Strategic Planning Processes as well as provide a comprehensive view of marine species monitoring (MSM) within the Pacific Ocean during the 2022 reporting period. Additional information about the ICMP and Strategic Planning Process is available on the U.S. Navy’s MSM Program website at:

https://www.navymarinespeciesmonitoring.us/reading-room/program-workshop/

[1] The U.S. Navy’s ICMP (DoN 2010) provides the overarching framework for coordination of the U.S. Navy’s MSM efforts and serves as a planning tool to focus U.S. Navy monitoring priorities pursuant to ESA and MMPA requirements. The purpose of the ICMP is to coordinate monitoring efforts across all regions and to allocate the most appropriate level and type of monitoring effort for each range complex based on a set of standardized objectives, regional expertise, and resource availability. Although the ICMP does not identify specific fieldwork or individual projects, it is designed to provide a flexible, scalable, and adaptable framework using adaptive-management and Strategic Planning Processes that periodically assess progress and reevaluate objectives.

Prior-year reports and associated publications are available on the U.S. Navy's MSM Program website at:

https://www.navymarinespeciesmonitoring.us/reporting/pacific/

This monitoring report was prepared in accordance with the annual monitoring reporting requirements, and presents results and progress made during the period from 1 January 2022 to 31 December 2022, with some variation in the reporting period.

MSM was conducted in accordance with project objectives listed on the U.S. Navy's MSM Program website at:

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

Section 2 of this report summarizes monitoring results, with additional data and information, in the bullets below:

- Detailed technical reports for the individual MSM projects are provided as supporting documents to this report (Angliss et al. 2023; Baird et al. 2023; Bejder et al. 2023; Dolan et al. 2023; Harbison et al. 2022; Heironimus et al. 2022; Huff and Smith 2022; Martin et al. 2023; Oleson et al. 2023; Rice et al. 2022a, 2023; Rivers 2023; Schorr et al. 2022; Seitz and Courtney 2023; Smith and Huff 2023a, 2023b, 2023c; Smith et al. 2022; West et al. 2023a, 2023b; Zerbini et al. 2023).

- 2022 publications and conference presentations from U.S. Navy-funded monitoring are listed in **Appendix A** by author's last name.

- Details of 2023 monitoring projects are in **Appendix B**.

2 Marine Species Monitoring in the Pacific Ocean

2.1 2022 Monitoring Goals and Implementation

The U.S. Navy training and testing ranges within the Pacific Ocean are located within the HSTT Study Area, MITT Study Area, NWTT Study Area, and GOA Training Area. The study areas vary in terms of monitoring goals implemented for protected marine species, including marine mammals, sea turtles, and ESA-listed fish, in support of each study area's MMPA and ESA requirements (NMFS 2017a, 2017b, 2017c, 2018a, 2018b, 2018c, 2018d, 2020a, 2020b, 2020c, 2020d, 2020e, 2020f, 2020g, 2020h, 2020i, 2020j, 2022a, 2022b).

Figures 1 and **2** provide an overview of all MSM projects and goals across all the Pacific training and testing areas. **Figure 1** shows the distribution of monitoring questions and study objectives with respect to monitoring projects and Conceptual Framework Categories (CFC) (i.e., *occurrence, exposure, response,* and *consequences*) (DoN 2010), as well as illustrates which Intermediate Scientific Objectives (ISOs) are addressed by each monitoring project. **Figure 2** illustrates the relative number of monitoring questions associated with each CFC, and how this varies by U.S. Navy training and testing area.

Following advancements in methodology made through investments by the Office of Naval Research (ONR) and others, the compliance monitoring programs continue to invest in the CFC consequences. Two monitoring questions for HRC and one for SOCAL projects were related to population trends of marine species at range complexes, as shown in Figure 2 under *consequences*.

Current monitoring goals are framed in terms of progress made on scientific monitoring questions and ISOs and are shown paired with cumulative accomplishments in **Table 1**. Project accomplishments are shown for the current year (2022). Readers may refer to DoN (2016, 2017, 2018b, 2019, 2020c, 2021, 2022b; **Table 1**) for project accomplishments from previous years.

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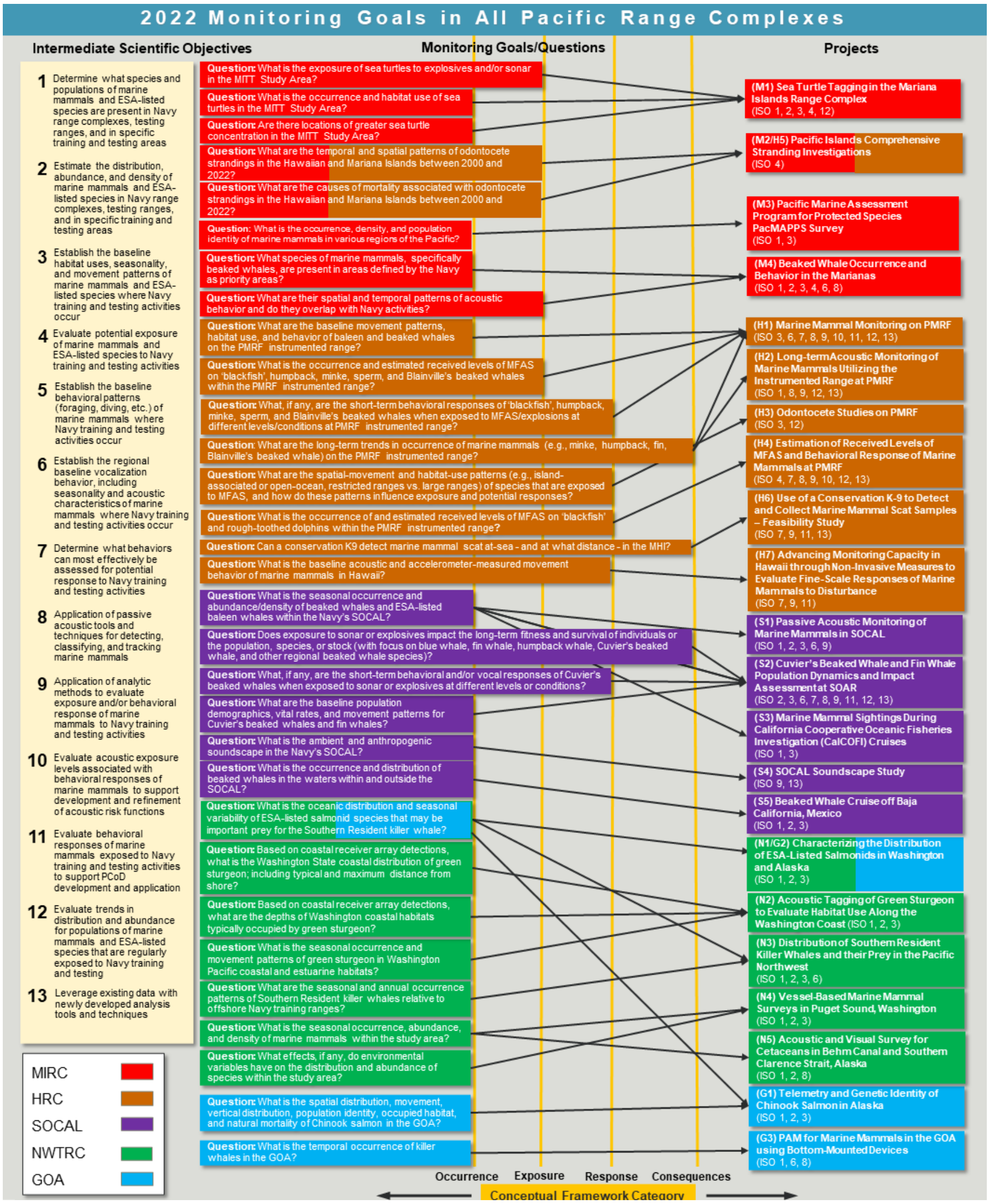

Figure 1. 2022 Monitoring goals in all Pacific range complexes by project. Range color under Projects indicates fieldwork location and under Monitoring Goals/Questions indicates where the questions are being addressed.

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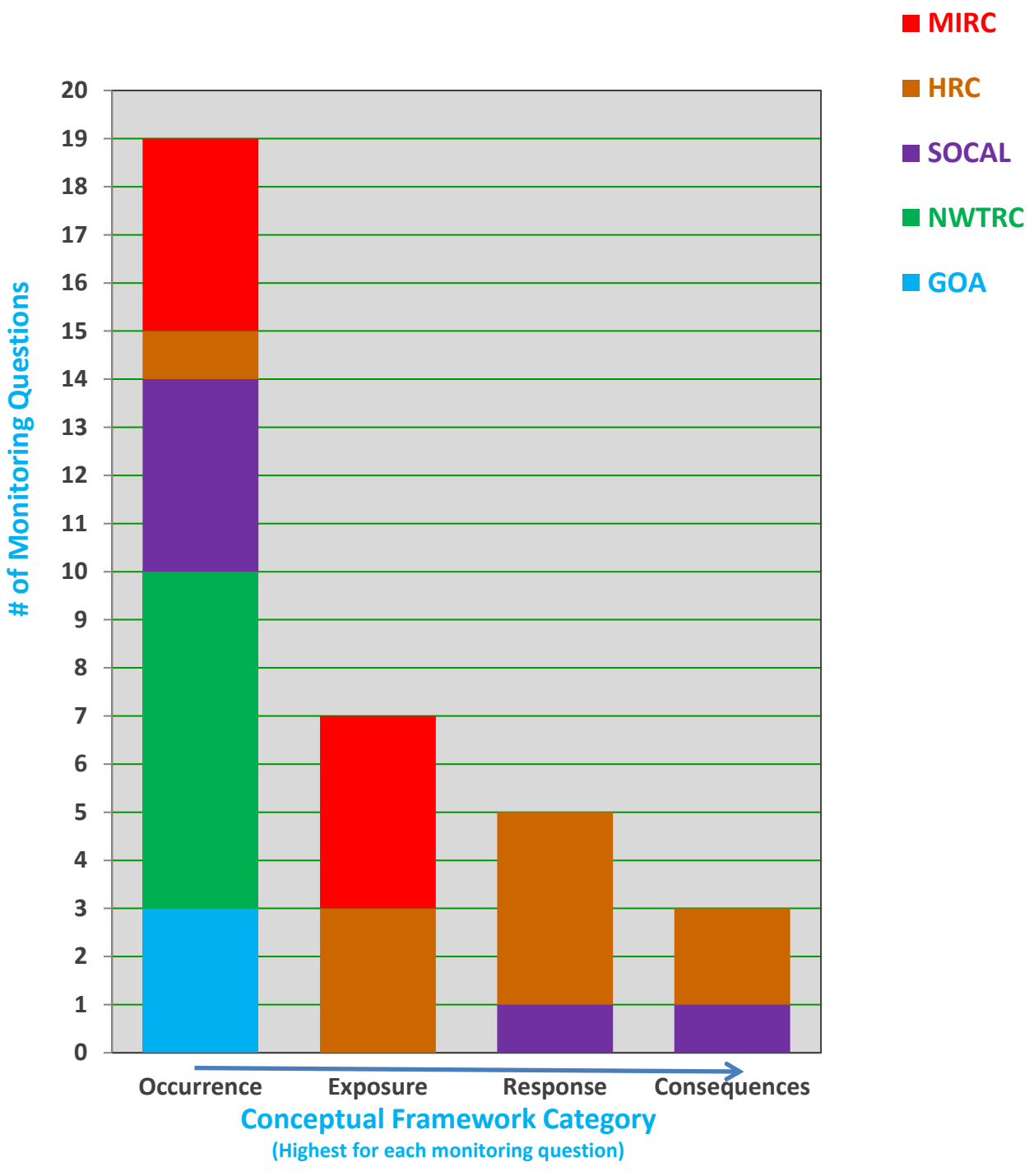

Figure 2. Number of monitoring questions and goals in all U.S. Navy Pacific range complexes that address the four progressive CFCs for monitoring knowledge outlined by the Scientific Advisory Group. Additional U.S. Navy-funded effort under Response (not represented here) has been conducted in HRC and SOCAL under the ONR Marine Mammal and Biology and Living Marine Resources programs.

Table 1. Monitoring goals and accomplishments for U.S. Navy study areas/ranges in 2022.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
MITT				
[M1] Sea Turtle Tagging in the Mariana Islands Range Complex	Occurrence, Exposure	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur. #4: Evaluate potential exposure of marine mammals and ESA-listed species to Navy training and testing activities. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives.	• What is the occurrence and habitat use of sea turtles in the MITT Study Area? • What is the exposure of sea turtles to explosives and/or sonar in the MITT Study Area? • Are there locations of greater sea turtle concentration in the MITT Study Area?	In 2022: • Completing data analysis for this project (ongoing), with a final project report expected in summer 2023.
[M2/H5] Pacific Islands Comprehensive Stranding Investigations (West et al. 2023a, 2023b) This project is also a component of HRC [H5].	Exposure	#4: Evaluate potential exposure of marine mammals and ESA-listed species to Navy training and testing activities.	• What are the temporal and spatial patterns of odontocete strandings in the Hawaiian and Mariana Islands between 2009 and 2022? • What are the causes of mortality associated with odontocete strandings in the Hawaiian and Mariana Islands between 2009 and 2022?	In 2022: • Initiated an analysis of the history and distribution of BW strandings across the Pacific Islands in order to (1) provide context to these strandings, and (2) improve our understanding of the biogeography of BWs in this large but data-poor region. • Summarized stranding response, necropsy, and cause of death investigations on 18 stranding events that occurred during calendar year 2022 (West et al. 2023a). • Coordinated or conducted stranding responses, necropsies, and sample collections over a wide geographical range that includes five of the main Hawaiian Islands (Hawaii, Oahu, Maui, Molokai, and Kauai) as well as the Commonwealth of the Northern Mariana Islands (Tinian), Marshall Islands (Kwajalein Atoll), and American Samoa. • Reported the cause of death examinations by species over the time period of 2006 to 2022 in the Pacific Islands region with major pathological findings in stranded cetaceans (West et al. 2023b). • Conducted analyses of historical stranding patterns and causes of mortality that incorporated quantitative estimates of stranding date, genetic identification of species when necessary, and advanced diagnostic procedures. • Conducted genetic species identification for stranding events where an initial species determination was not possible. Specifically, for *Kogia* species, confirmed species diagnostics using genetic sequencing for 24 of the 27 individuals analyzed. For other previously unconfirmed cases, nine of 13 cases were identified to species through genetic analysis. • Screened for the presence of *Brucella* spp. from 175 tissues from 35 different animals; results indicated that 15 of these individuals (43%) are positive for a marine mammal strain of Brucella in one or more tissues. • Determined that pathological findings from 126 cases had a significant diagnosis or diagnoses; natural disease was significant in 56% of stranded animals across all species, and approximately half of the individuals where significant natural disease was identified were in poor body condition due to chronic illness. • Determined that approximately 14% of stranded individuals across all species examined were in the perinatal/neonatal age group, with three cases of dystocia where the mother and calf died.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
MITT (continued)				
[M3] Pacific Marine Assessment Program for Protected Species (PacMAPPS) Survey (Oleson et al. 2023)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• What is the occurrence, density, and population identity of marine mammals in various regions of the Pacific?	In 2022: • Conducted an ongoing analysis of the density and abundance of Cuvier's and Blainville's BWs using the DASBR acoustic dataset from the 2021 MACS cruise. During this cruise, acoustic data was collected by 21 DASBRs deployed throughout Guam and the Commonwealth of the Northern Marianas. • Processed acoustic data files using PAMGuard software (version 2.01.05) to detect echolocation pulses using the Click Detector module (IIR Butterworth 4 kHz high pass filter) and to classify those pulses based on peak frequencies and the presence of a frequency change (upsweeps). • Estimated vertical bearing angles from the time-difference-of-arrival of the same echolocation click on the upper and lower hydrophones using the cross-correlation algorithm in PAMGuard. • Estimated population density of Cuvier's and Blainville's BWs using a group-based, point-transect survey method. • Estimated density estimates, to be completed by mid-summer, with final report delivered by September 2023.
[M4] Beaked Whale Occurrence and Behavior in the Marianas	Occurrence, Exposure, Response	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur. #4: Evaluate potential exposure of marine mammals and ESA-listed species 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: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[a].	• What species of marine mammals, specifically beaked whales, are present in areas defined by the Navy as priority areas? • What are their spatial and temporal patterns of acoustic behavior?	In 2022: • Conducted PAM off the island of Guam with the goal of detecting, classifying, locating, and deriving abundance and densities of BW in the MITT; data analysis will begin in early 2023. • Deployed six Rockhopper marine recording units off the western side of Guam in May 2022 for six months; retrieved five of these units in December 2022 (several attempts were made to recover the 6th Rockhopper, but the unit did not respond to communications; recovery attempts are still underway). • Deployed an additional six Rockhoppers in December 2022 at the same locations; deployed all instruments in depths greater than 700 m. • Continuously sampled the acoustic data at a frequency range sufficient to record the signals of all BW species that are thought to use the area: Cuvier's BW, Blainville's BW, Longman's BW, Deraniyagala's BW, and 'BWC' BW. • Equipped each mooring with an acoustic pinger to synchronize the recording units in the array and enable collection of accurate TDOA information.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
HRC				
[H1] Marine Mammal Monitoring on PMRF (Martin et al. 2023)	Occurrence, Exposure, Response, Consequences	#3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[b]. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #10: Evaluate acoustic exposure levels associated with behavioral responses of marine mammals to support development and refinement of acoustic risk functions. #11: Evaluate behavioral responses of marine mammals exposed to Navy training and testing activities to support PCoD development and application. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives. #13: Leverage existing data with newly developed analysis tools and techniques[b].	• What is the occurrence and estimated received levels of MFAS on 'blackfish', humpback, minke, sperm, and Blainville's beaked whales within the PMRF instrumented range? • What, if any, are the short-term behavioral responses of 'blackfish,' humpback, minke, sperm, and Blainville's beaked whales when exposed to MFAS/explosions at different levels/conditions at PMRF instrumented range? • What are the baseline movement patterns, habitat use, and behavior of baleen and beaked whales on the PMRF instrumented range? • What are the long-term trends in occurrence of marine mammals (e.g., minke, humpback, fin, Bryde's, Blainville's) on the PMRF instrumented range?	In 2022: • Collected and analyzed (by the NIWC Pacific WARP Laboratory) 5,395.5 hr of new acoustic data from September 2021 to August 2022 (Martin et al. 2023). • Tracked five minke, one fin, and six humpback whales during the February 2022 SCC, and estimated minimum ship distances, minimum MFAS source distances, and cSEL for each track. • Developed a more appropriate metric of baleen whale abundance (mean number of whales present in 10-minute snapshots per hr and for each month); this metric provides a better statistical representation of the numbers of whales present on the range as compared to maximum numbers. • Corrected the number of Blainville's BW GVPs based on sample validation of six FY22 baseline recordings (96% true positive rate and 4% false positive rate); the highest GVP rate of 4.07 GVPs/hr occurred in August 2022. • Validated that Cuvier's and BWC BW GVPs occurred far less frequently than Blainville's BW GVPs, resulting in a maximum of 0.42 GVPs/hr in December 2021 for Cuvier's BWs and 0.18 GVPs/hr for BWC BWs in September 2021. • Added the capability to track non-shipboard MFAS transmissions to expand disturbance analysis processing to include exposures from helicopter dipping sonar and sonobuoys. • Developed HMMs based on the travel speeds and turning angles of smoothed minke whale acoustic tracks for five seasons of all recorded acoustic baseline data between 2012 and 2017. • Used HMMs to quantify the relationship between call rate and the distance to the nearest calling conspecific for minke whales; overall, the probability that a rapid call rate would occur increased as the distance to the nearest conspecific decreased, and the probability of the nominal call rate occurring increased as the distance to the nearest conspecific increased. • Published four manuscripts: in *Marine Mammal Science*, "Quantifying the response of Blainville's beaked whales to US Naval sonar exercises in Hawaii" (Jacobson et al. 2022); in *Frontiers in Marine Science*, "North Pacific minke whales call rapidly when calling conspecifics are nearby" (Martin et al. 2022), and "Dive characteristics of Cross-Seamount beaked whales from long-term passive acoustic monitoring at the Pacific Missile Range Facility" (Manzano-Roth et al. 2022); and in *Marine Ecology Progress Series*, "Behavior and inter-island movements of satellite-tagged humpback whales in Hawai'i, USA" (Henderson et al. 2022b). • Presented findings from this project at the 24th Biennial Conference on the Biology of Marine Mammals; Effects of Noise on Aquatic Life Conference; Navy Marine Species Monitoring Meeting; Effects of Sound on Marine Mammals Conference; ONR Marine Mammals and Biology Program Review; SMART SEED Annual Review; and 9th International Workshop on Detection, Classification, Localization, and Density Estimation of Marine Mammals Using Passive Acoustics (see **Appendix A**).

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
HRC (continued)				
[H2] Long-term Acoustic Monitoring of Marine Mammals Utilizing the Instrumented Range at PMRF and SOAR (Dolan et al. 2023) This is a joint project with [H3] "Odontocete Studies on PMRF" and [S2] "Cuvier's Beaked Whale and Fin Whale Dynamics and Impact Assessment at SOAR."	Consequences	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[b]. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives. #13: Leverage existing data with newly developed analysis tools and techniques[b].	• What are the long-term trends in occurrence of marine mammals (e.g., minke, humpback, fin, Bryde's, Blainville's BW) on the PMRF instrumented range?	In 2022: • Conducted four field tests at SOAR (November 2021 and January, March, and June 2022) in collaboration with MarEcoTel (see **Project [S2]**), and one field test at PMRF (in August 2022) with CRC (see **Project [H4]**). • Analyzed seasonal distribution of BWs using BW GVPs detected on range; converted the GVPs to number of animals to estimate abundance. • Implemented a fix to the call association programs to reduce the processing load on the computer nodes that associate times of call arrival among neighboring hydrophones; modified the LF FFT detector to increase its time resolution by a factor of eight. • Logged at total of 355 acoustic detections, including 236+ of Cuvier's BWs; 46 of fin whales; 15+ of humpback whales; four + of Risso's dolphins; two of sperm whales; and single groups of sei, blue, gray, and killer whales and common dolphins. • Cuvier's BWs exhibit a seasonal pattern on the SOAR range, with the numbers of GVPs detected and abundance peaking in May and in the December/January timeframe; determined that the mean number of Cuvier's BW GVPs/hr varied from 2.93 to 4.98 between 2010 and 2022, while the mean abundance per hr on range in any month, averaged from 2010–2022, is between 33 and 57 animals. • Seasonal distribution of Blainville's BWs at PMRF appears to peak in May through July, and in the December/January timeframe, while it is lowest in April, with another dip in September; determined that the mean number of Blainville's BW GVPs/hr from 2011–2022 varied from 0.04 to 1.48, with a maximum of 14 in 2021; calculated that in 2011, 2012, and 2013 the mean GVPs/hr were 1.33, 0.21, and 0.86, respectively, which average to a mean of 0.74 GVPs/hr. • The number of Cuvier's BW GVPs detected on PMRF fluctuated from 2011 to 2022, with the numbers highest around 2014 and 2021, and lowest in 2015, followed by 2012; determined that the extreme spike seen in 2021 may have skewed due to a data collection error in 2021, where detections were not recorded for the BARSTUR hydrophones for approximately the first 6 months of 2021.
[H3] Odontocete Studies on PMRF **(Baird et al. 2023)** **Tag telemetry data collected was also used in Project [H4]. This project is conducted in conjunction with Project [H2].**	Occurrence, Exposure, Response	#3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed 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 2022: • Encountered a group of approximately 100 striped dolphins, only the second time this species has been seen off Kauai in the 14 different years of CRC field effort off Kauai and Niihau since 2003. • Deployed a total of 10 satellite tags on five different species: 8 depth-transmitting SPLASH10-F2220 (Fastloc®-GPS) tags and two depth-transmitting SPLASH10 tags. • Collected one fecal sample from a short-finned pilot whale and two eDNA samples from Blainville's BWs. • Retrieved location data from all 10 satellite tags and dive data from nine of the 10. • Presented findings from this project at the 24th Biennial Conference on the Biology of Marine Mammals (see **Appendix A**). • Initiated a full photo-ID analysis of priority species encountered during tagging surveys to determine population identity and sighting history for individuals of these species; results will be available in summer 2023.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
HRC (continued)				
[H4] Estimation of Received Levels of MFAS and Behavioral Response of Marine Mammals at PMRF **Data used in this project were collected from projects [H3] and [H1].**	Exposure, Response	#4: Evaluate potential exposure of marine mammals and ESA-listed species to Navy training and testing activities. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #8: Appl passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[b]. #9: Appl analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #10: Evaluate acoustic exposure levels associated with behavioral responses of marine mammals to support development and refinement of acoustic risk functions. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives. #13: Leverage existing data with newly developed analysis tools and techniques[b].	• What is the occurrence of and estimated received levels of MFAS on 'blackfish' and rough-toothed dolphins within the PMRF instrumented range?	In 2022: • Data analysis is ongoing, including on the 10 tags deployed August 2022 in **Project [H3]**; report is expected in summer 2023.
[H5/M2] Pacific Islands Comprehensive Stranding Investigations (West et al. 2023a, 2023b) This project is also a component of MIRC Project [M2].	*See Project M2/H5 (above, in MIRC)*			
[H6] Use of a Conservation K9 for Marine Mammal Scat Collection in Hawaii – Feasibility Study (Rivers 2023)	Occurrence, Exposure, Response, Consequences	#7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #9: Apply analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #11: Evaluate behavioral responses of marine mammals exposed to Navy training and testing activities to support PCoD. #13: Assess existing data sets, which could be used to address the current objectives[a].	• Can a conservation K9 detect marine mammal scat at-sea and at what distance in the MHI?	In 2022: • A conservation K9 was successfully trained on land to detect and direct handlers to scat samples provided from strandings for three species of marine mammals: pilot whale, pygmy sperm whale, and false killer whale. • This was successfully transitioned to detection and direction of scat samples on a small boat at sea. • One sighting of pilot whales occurred and adjustments to the methodology were made in order to improve the chance of success. The K9 was able to indicate detection of scat which was confirmed by a visual observer.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
HRC (continued)				
[H7] Advancing Monitoring Capacity in Hawaii through Non-Invasive Measures to Evaluate Fine-Scale Responses of Marine Mammals to Disturbance (Bejder et al. 2023)	Response	#7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #11: Evaluate behavioral responses of marine mammals exposed to Navy training and testing activities to support PCoD.	• What is the baseline acoustic and accelerometer-measured movement behavior of marine mammals in Hawaii?	In 2022: • Infrastructure for tag set up, calibration, diagnostics, data processing, and data archiving has been or is in the process of being set up. • Tag data collection has begun. • Development of workshops and classes to train the wider community has begun with training University of Hawaii Marine Mammal Research Program students.
SOCAL				
[S1] Passive Acoustic Monitoring of Marine Mammals in SOCAL (Rice et al. 2023) Additional results reported in project [S4].	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and 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. #6: Establish the regional baseline vocalization behavior, including seasonality and acoustic characteristics of marine mammals where Navy training and testing activities occur. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities.	• What is the seasonal occurrence and abundance/density of beaked whales within the Navy's SOCAL?	In 2022: • Analyzed acoustic data recorded by HARPs deployed at four sites (Sites E, SN, H, N) from April 2021 to May 2022. • Detected individual BW echolocation clicks, as well as MFA sonar (2.4–4.5 kHz) and explosion (see **Project [S4]**) occurrence and levels using computer algorithms. • Detected Cuvier's BW FM pulses most at Site E and least at Site N; determined that at Site SN, detections peaked in spring; at Site E, detections were low August through October and highest December to May; at Site H, detections peaked during early summer. • Detected Hubbs' BW FM pulses at Site SN on 2 days in January and on only 1 day in April; determined no detections occurred at Sites E, H, or N; determined all Hubbs' BW detections occurred at night. • Detected BW43 FM pulses in low numbers at Site N; determined no detections at Sites SN, H, or E; determined detections occurred on 1 day each in September, December, and February. • Published a manuscript in *PLoS ONE*, "Update on frequency decline of Northeast Pacific blue whale (*Balaenoptera musculus*) calls" (Rice et al. 2022b), and in *The Journal of the Acoustical Society of America*, "Echolocation click discrimination for three killer whale ecotypes in the Northeastern Pacific" (Leu et al. 2022).

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
SOCAL (continued)				
[S2/H2] Cuvier's Beaked Whale and Fin Whale Population Dynamics and Impact Assessment at the SOAR (Schorr et al. 2022; Dolan et al. 2023) This is a joint project with [H2] "Long-term Passive Acoustic Monitoring of Marine Mammals at PMRF and SOAR".	Occurrence, Exposure, Response, Consequences	#2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[b]. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #11: Evaluate behavioral responses by marine mammals exposed to U.S. Navy training and testing activities to support PCoD development and application. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives. #13: Leverage existing data with newly developed analysis tools and techniques[b].	• What are the baseline population demographics, vital rates, and movement patterns for Cuvier's beaked whales and fin whales? • What, if any, are the short-term behavioral and/or vocal responses of Cuvier's beaked whales when exposed to sonar or explosives at different levels or conditions? • What is the seasonal occurrence and abundance/density of beaked whales and ESA-listed fin whales within the Navy's SOCAL? • Does exposure to sonar or explosives impact the long-term fitness and survival of individuals or the population, species, or stock (with focus fin whale, Cuvier's beaked whale, and other regional beaked whale species)?	In 2022: • Conducted 32 days of survey effort from 6 January 2022 to 26 November 2022 and sighted 15 cetacean species, including 34 sightings totaling 110 Cuvier's BWs and 38 sightings totaling 60 fin whales (Schorr et al. 2022). • Deployed eight satellite tags: six Cuvier's BWs (one from an ancillary project), and one each on a fin whale and short-finned pilot whale. • Collected nine genetic samples: one each from a Cuvier's and Baird's BWs, and seven from fin whales. • Identified 56 unique individuals of Cuvier's BWs, bringing the catalog to 298 individuals in the SOCAL area; determined 28 of these whales (50%) had previous sighting histories at SOAR, with five whales first identified in 2007 seen in 2022. • Processed identification photographs of fin whales from directed and opportunistic data collection in 2021 (n = 295, including a small number of photo-IDs from previous years) were processed; determined this collection brings the U.S. West Coast fin whale catalog to 1,281 individuals, of which 798 have sighting histories in Southern California. • Presented findings from this project at the 24th Biennial Conference on the Biology of Marine Mammals (see **Appendix A**). • Published manuscripts in *Mammalian Biology*," Multi-regional comparison of scarring and pigmentation patterns in Cuvier's beaked whales" (Coomber et al. 2022) and "Movements and residency of fin whales (*Balaenoptera physalus*) in the California Current System" (Falcone et al. 2022), *Ecological Applications,* "Discrete-space continuous-time models of marine mammal exposure to Navy sonar" (Jones-Todd et al. 2022), *Frontiers in Marine Science*, "Movements and diving behavior of Risso's dolphins in the Southern California Bight" (Rone et al. 2022), and in *Marine Ecology Progress Series*, "Cuvier's beaked whale foraging dives identified via machine learning using depth and triaxial acceleration" (Sweeney et al. 2022).
[S3] Marine Mammal Sightings During CalCOFI Cruises [This project was formerly titled "Beaked Whale Occurrence in SOCAL using Towed Array" in 2018 and "Marine Mammal Sightings during CalCOFI Cruises" from 2004–2017].	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• What is the seasonal occurrence and abundance/density of marine mammals and ESA-listed baleen whales within the Navy's SOCAL?	In 2022: • Report expected in summer 2023. • Continued seasonal cruises.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
SOCAL (continued)				
[S4] SOCAL Soundscape Study (Rice et al. 2023) Additional results reported in [S1].	Occurrence	#9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #13: Leverage existing data with newly developed analysis tools and techniques[b].	• What is the ambient and anthropogenic soundscape in the Navy's SOCAL?	In 2022: • Analyzed data recorded by HARPs deployed at Sites E, SN, H, N from April 2021 to May 2022 to characterize ambient noise, the presence of MFAS and underwater explosions, and the LF soundscape. • Detected explosions occurred throughout the monitoring periods at all sites; the highest number of explosions occurred at Site H, with peaks in July and October 2021, and again in January 2022. The majority of explosions are likely associated with fisheries use of seal bombs. • Determined that the underwater ambient soundscape at all sites had higher sound levels at low frequencies owing to the dominance of ship noise and whale calls at frequencies below 100 Hz, and local wind and waves above 100 Hz. Seasonal peaks due to blue whale calls were evident at each location.
[S5] Beaked Whale Cruise off Baja California, Mexico	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• What is the occurrence and distribution of beaked whales in the waters within and outside the SOCAL?	In 2022: • Conducted one short trip in 2022 with no BW sightings. • Logistical issues prevented additional planned trips in 2022 but will be rescheduled for 2023.
NWTT				
[N1/G2] Characterizing the Distribution of ESA-Listed Salmonids in Washington (Harbison et al. 2022; Huff and Smith 2022; Smith and Huff 2023a, 2023b) This project is also linked to projects [G1], [G2], and [N3].	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• What is the oceanic distribution and seasonal variability of ESA-listed salmonid species that may be important prey for the Southern Resident killer whale?	In 2022: • Used acoustic telemetry data collected from an existing offshore acoustic array and in-river receivers to track the movements of bull trout between the Hoh River and Kalaloch Creek via the coastal waters of the Pacific (Huff and Smith 2022). • Detected tagged bull trout 157,408 times at 8 receiver locations: 6 river locations and 2 marine locations. • Captured, sampled, and tagged female steelhead trout intercepted during their upstream spawning migration in Forks Creek, a tributary of the Willapa River, in Pacific County, from 1 January and 30 June 2021 and released near Forks Creek Hatchery upstream on the day of capture (Harbison et al. 2022). • Explored factors limiting post-spawn survival by assessing behavior and movement patterns exhibited by 86 steelhead trout (49 wild and 37 hatchery origin) using acoustic telemetry and 14 hatchery origin steelhead trout using PSATs in a coastal tributary of Willapa Bay, Washington, and the near-coastal ocean. • Three glider deployments with acoustic tag detectors were conducted off the coast of Washington between August 2019 and June 2020. During 51 days of deployments, the glider recorded detections of 10 individual Chinook salmon, one green sturgeon, and one steelhead trout (Smith and Huff 2023a). • Chinook salmon were detected on gliders in relatively higher salinity water, and notably in areas with high-salinity water at the surface even when fresh surface water was nearby. There was also a weak pattern of detection adjacent to or near the margins of relatively cool and warm water masses and high chlorophyll concentrations. • From 2020 to 2022, 298 Chinook salmon were tagged across five locations in the Gulf of Alaska: Chignik, Kodiak, Yakutat, Sitka, and Craig (Smith and Huff 2023b). • Proportion of different genetic stock identities of tagged Chinook varied across tagging locations, with individuals from stocks from Oregon to Alaska represented in the sampled fish. • To date, 53 of the acoustically tagged Chinook salmon have been detected at locations ranging from Prince William Sound to the Washington coast. Detections have occurred between 17- and 433-days post tagging.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
NWTT (Continued)				
[N2] Acoustic Tagging of Green Sturgeon to Evaluate Habitat Use Along the Washington Coast (Heironimus et al. 2022)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• Based on coastal receiver array detections, what is the Washington State coastal distribution of green sturgeon; including typical and maximum distance from shore? • Based on coastal receiver array detections, what are the depths of Washington coastal habitats typically occupied by green sturgeon? • What is the seasonal occurrence and movement patterns of green sturgeon in Washington Pacific coastal and estuarine habitats?	In 2022: • Operated four VEMCO 69-kHz VR2W acoustic receivers at the mouth of Grays Harbor from 7 June to 31 October 2022, and two at the mouth of Willapa Bay from 3 June 2020 to 21 January 2022, to assess survival of tagged green sturgeon and determine the period of migration of tagged individuals from the estuarine to marine environment. • Detected green sturgeon in the offshore acoustic receiver array nearly every month in which data was available between March 2019 and July 2022. • Detected more than 100 green sturgeon in each month between June and September 2022, nearly all occurring within coastal estuaries. • Determined during initial exploratory analysis of the acoustic data that some green sturgeon were also detected on the offshore acoustic receiver array year-round, with peak detections occurring around May. • Detected the majority of individual fish on the offshore acoustic receiver array moving back and forth between the Columbia River estuary, Willapa Bay, and Grays Harbor during this period, although some individuals displayed long migrations up the coast and were detected off the coast of B.C.
[N3] Distribution of Southern Resident Killer Whales and their Prey in the Pacific Northwest (Smith and Huff 2023c; Smith et al. 2022) This project is linked to projects [N1], [G2], and [G1]. [SRKW focus 2014–2018; 2018–2022 focus on killer whale prey (ESA-listed salmonids)].	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #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: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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.	• What are the seasonal and annual occurrence patterns of Southern Resident killer whales relative to offshore Navy training ranges? • What is the oceanic distribution and seasonal variability of ESA-listed salmonid species that may be important prey for the Southern Resident killer whale?	In 2022: • Analyzed depth-specific data from 223 Chinook salmon, ranging in size from 111 to 560 mm in FL, captured from June through August 2018 and May through August 2019 (Smith et al. 2022). • Time-to-capture data indicated that Chinook salmon tend to concentrate near the ocean bottom, particularly in depths between 30 and 50 m. • Determined that sea surface temperature was the most significant predictor of catch rates, and time-to-capture was faster near estuaries such as the mouth of the Chehalis and Columbia Rivers as well as near the ocean bottom. • Some individuals from these ESUs do not migrate long distances from their river of origin during at least the first two years at sea. • Findings highlight the importance of considering the distribution and abundance of different Chinook salmon ESUs to understand their potential impacts on SRKW and other species that rely on them for food. • To examine the overlap in distribution of Chinook salmon and SRKW, 142 Chinook salmon were acoustically tagged, and 115 stationary acoustic receivers were deployed along the Washington coast. Five stationary passive acoustic monitoring stations were deployed (Smith and Huff 2023c). • Genetic stock of the tagged Chinook salmon was determined. Most individuals were of Columbia River origin, and the Lower Columbia River ESU. • Tagged Chinook showed seasonal changes in distribution, generally moving south during fall and winter, north during spring, and east during summer. Chinook were present near the mid-coast of Washington State in spring and summer then moved north near the entrance to the Strait of Juan de Fuca during fall and winter. • SRKW distribution showed seasonal changes, spending time near the mouth of the Strait of Juan de Fuca in the fall and winter, and spent time near the mouth of the Columbia River during winter and spring. • Overlap between tagged Chinook salmon and SRKW acoustic detections were greatest near the entrance to the Strait of Juan de Fuca in the fall and winter. • SRKW near the mouth of the Columbia River in winter and spring could be attributed to their pursuit of spring-run Chinook salmon, which were largely not tagged during the study.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
NWTT (Continued)				
[N4] Vessel-Based Marine Mammal Surveys in Puget Sound, Washington (Zerbini et al. 2023)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• What marine mammals, with a focus on the killer whale (*Orcinus orca*) and the harbor porpoise (*Phocoena phocoena*), are present within the study area? • What are the effects of environmental variables on the distribution and abundance of species within the study area?	In 2022: • Conducted line-transect surveys over a total of 34 days (in all seasons) from 9 February to 13 December 2022 to assess the seasonal distribution and abundance of marine mammals in Hood Canal, with a focus on harbor porpoise and killer whales. • Surveyed more than 2,000 km of on-effort trackline (632 lines) and observed 744 groups (1,293 individuals) of harbor porpoise, and four groups of transient killer whales; had 559 sightings of harbor seals (711 individuals), one of Stellar sea lion, and six of California sea lions (11 individuals). • Computed preliminary estimates of density and abundance of harbor porpoise using data from the primary (upper) observation platform. • Determined that estimates of abundance showed a clear seasonal pattern (more abundant during summer) in the occurrence of harbor porpoise in Hood Canal; determined that density of porpoise was higher in central Hood Canal, north of Hood Point.
[N5] Acoustic and Visual Survey for Cetaceans in Behm Canal and Southern Clarence Strait, Alaska (Angliss et al. 2023)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[b].	• What is the occurrence, distribution, and abundance of cetaceans in Behm Canal and Clarence Strait?	In 2022: • Developed vessel survey design. • Deployed PAM recorders.
GOA				
[G1] Telemetry and Genetic Identity of Chinook Salmon in Alaska (Seitz and Courtney 2023) This project is linked to projects [N1] and [N3].	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	• What is the spatial distribution, movement, vertical distribution, population identity, occupied habitat, and natural mortality of Chinook salmon in the GOA?	In 2022: • Captured and tagged 20 immature Chinook salmon with PSATs near Craig, Alaska, in May and June 2022, and another 20 immature individuals near Sitka, Alaska, in June 2022 (Seitz and Courtney 2023). • Of the 100 tags deployed collectively for this project, 95 reported and provided approximately 4,968 days (mean 52.3 days per tag) of depth, temperature, and location data. Analyzed depth, temperature, and light data from 95 tags: 58 tags were attached to live fish on or immediately before the programmed pop-up date or at recapture; 36 tagged fish experienced mortality by predation (n = 27) or unknown causes (n = 9). • Determined stock origin for 47 of the 60 fish tagged in 2020–2021: 11 originated from Southeast Alaska, 23 from western Vancouver Island; two from the Thompson River, B.C., two from east Vancouver Island, B.C., four from the Columbia River in Washington, one from the Oregon coast, and four from the Willamette River, Oregon. • Results indicated non-directed or net westerly movements for the majority of fish tagged near Chignik, net easterly movements of fish tagged near Kodiak, and net southeasterly movement of fish tagged near Yakutat, Craig, and Sitka, Alaska. • Curvilinear track distance from daily location estimates ranged from 114 to 1,865 km (826 ± 494 km, mean ± SD) for fish tagged near Chignik, from 36 to 3,088 km (599 ± 776 km, mean ± SD) for fish tagged near Kodiak, from 49 to 2,535 km (1,152 ± 734 km, mean ± SD) for fish tagged near Yakutat, from 42 to 1,207 km (464 ± 353 km, mean ± SD) for fish tagged near Craig, and from 97 to 1647 km (832 ± 558 km, mean ± SD) for fish tagged near Sitka. While occupying waters of the North Pacific Ocean, tagged Chinook salmon spent the majority of their time in waters over the continental shelf (65%), and a minority of their time over the continental slope (22%) and basin (13%). • Sixteen tagged Chinook salmon occupied the TMAA for an aggregated total of 254 days. • Deployed acoustic tags in non-PSAT tagged Chinook salmon (n = 232); tags near Kodiak (n = 80), Yakutat (n = 32), Craig (n = 21), and Sitka, Alaska (n = 99). • Presented findings from this project at the 2022 virtual Alaska Marine Science Symposium.

Project Title (Technical Report for 2022)	Conceptual Framework Category	Intermediate Scientific Objectives (Numbered as per Figure 1)	Monitoring Questions	Accomplishments[a]
GOA (continued)				
[G2/N1] Characterizing the Distribution of ESA-Listed Salmonids in Washington (Harbison et al. 2022; Huff and Smith 2022; Smith and Huff 2023a, 2023b) This project is also linked to projects [G1] and [N3].			*See Project N1/G2 (above, in NWTT)*	
[G3] PAM for Marine Mammals in the GOA using Bottom-Mounted Devices (Rice et al. 2022a)	Occurrence	#1: Determine what species and populations of marine mammals and ESA-listed species are present 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: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[b].	• What is the temporal occurrence of killer whales in the GOA?	In 2022: • Analyzed PAM data collected at seven sites in the GOA TMAA from 2011 to 2019: (1) Kenai Shelf (~200 m depth); (2) Kodiak Shelf (~230 m depth); (3) Kodiak Slope (~1,200 m depth; (4) Kenai Slope (~900 m depth; (5) Abyssal (~4,000 m depth; hydrophone located at 1,200 m); (6) Quinn (~950 m depth, near Quinn Seamount), and (7) Pratt (~990 m depth, near Pratt Seamount). • Detected killer whales at all seven recording locations and overall, 32% of days with recording effort had killer whale acoustic presence (either possible resident, transient, offshore, or unknown). • Kodiak Shelf and Kenai Shelf had the highest percent of days with killer whale detections (47.9% and 36.6%, respectively), while Quinn and Pratt had the lowest (8.2% and 4.3%, respectively).

[a] As per the regulations implementing monitoring reporting requirements (described in **Section 1**, Introduction), accomplishments from monitoring are reported in a cumulative fashion.

[b] Primary Research & Development and Demonstration-Validation (DEMVAL) investments for tools and techniques were supported by the Office of Naval Research Marine Mammal and Biology and the Living Marine Resource programs.

Key: °C = degrees Celsius; K9 = canine; Argos = Advanced Research and Global Observation Satellite; BARSTUR = Barking Sands Tactical Underwater Tracking Range; B.C. = British Columbia; BW = beaked whale; BWB = BW Baja; BWC = beaked whale cross-seamount; CalCOFI = California Cooperative Oceanic Fisheries Investigations; CRC = Cascadia Research Collective; cSEL = cumulative sound exposure level; CTCRW = Continuous-Time Correlated Random Walk; CTD = Conductivity, Temperature, and Depth; CY = calendar year; DAR = Douglas Distance-Angle-Rate; DASBR = Drifting Acoustic Spar Buoy Recorders; dB re 1 µPa = decibels referenced to 1 microPascal; DPS = Distinct Population Segment; EAR = Ecological Acoustic Recorder; eDNA = environmental deoxyribonucleic acid; ESU = Evolutionarily Significant Units; FFT = Fast Fourier Transform; FL = fork length; FM = frequency-modulated; FY = Fiscal Year; GOA = Gulf of Alaska Training; GPS = Global Positioning System; GVP = group vocal periods; HARP = High-frequency Acoustic Recording Package; HMM = Hidden Markov Models; hr = hour(s); HRC = Hawaii Range Complex; HSTT = Hawaii Southern California Training and Testing; Hz = Hertz; kHz = kilohertz; km = kilometer; LF = low-frequency; LIMPET = Low Impact Minimally Percutaneous Electronic Transmitter; LO = location only; m = meter; M3R = marine mammal monitoring on U.S. Navy ranges; MACS = Mariana Archipelago Cetacean Survey; MarEcoTel = Marine Ecology and Telemetry Research; MFAS = mid-frequency active sonar; MHI = Main Hawaiian Islands; mm = millimeter; MITT = Mariana Islands Training and Testing; NARWHAL = Navy Acoustic Range Whale Analysis; NIWC = Naval Information Warfare Center; NOAA = National Oceanic and Atmospheric Administration; NUWC = Naval Undersea Warfare Center; PAM = passive acoustic monitoring; PCoD = Population Consequences of Disturbance; PCR = polymerase chain reactions; photo-ID = photo-identification; PMRF = Pacific Missile Range Facility; PSAT = pop-up satellite archival tag; RL = received level(s); s = second(s); SCB = Southern California Bight; SCC = Submarine Command Course; SCI = San Clemente Island; SEED = SMART Scholar Seed Grant; SL = source level; SMART = Science, Mathematics, and Research for Transformation; SNP = single nucleotide polymorphism; SOAR = Southern California Offshore Anti-Submarine Warfare Range; SPOT = smart position and temperature; SRKW = Southern Resident Killer Whale; TDOA = time-difference-of-arrival; UH = University of Hawai'i; USACE = U.S. Army Corps of Engineers; WARP = Whale Acoustic Reconnaissance Project; WDFW = Washington Department of Fish and Wildlife.

2.2 2022 Timeline and Methods of Monitoring Efforts

In this sub-section, a graphical timeline of monitoring projects is presented for each range, covering the 2022 monitoring year. The timelines include monitoring projects as well as notable items (e.g., results and outcomes).

Each timeline graphic is followed by a description of each monitoring project's methods; the corresponding monitoring project in the timeline can be identified by the numbered code at the beginning of the project title, which begins with a one-letter abbreviation of the U.S. Navy's training and testing study area or range (e.g., M = MITT; H = HRC; S = SOCAL; N = NWTT; G = GOA).

Project results can be found in the Supporting Technical Reports section of the U.S. Navy's MSM Program website:

https://www.navymarinespeciesmonitoring.us/reporting/pacific/

2.2.1 MITT

A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the MITT Study Area in 2022 is illustrated in **Figure 3**.

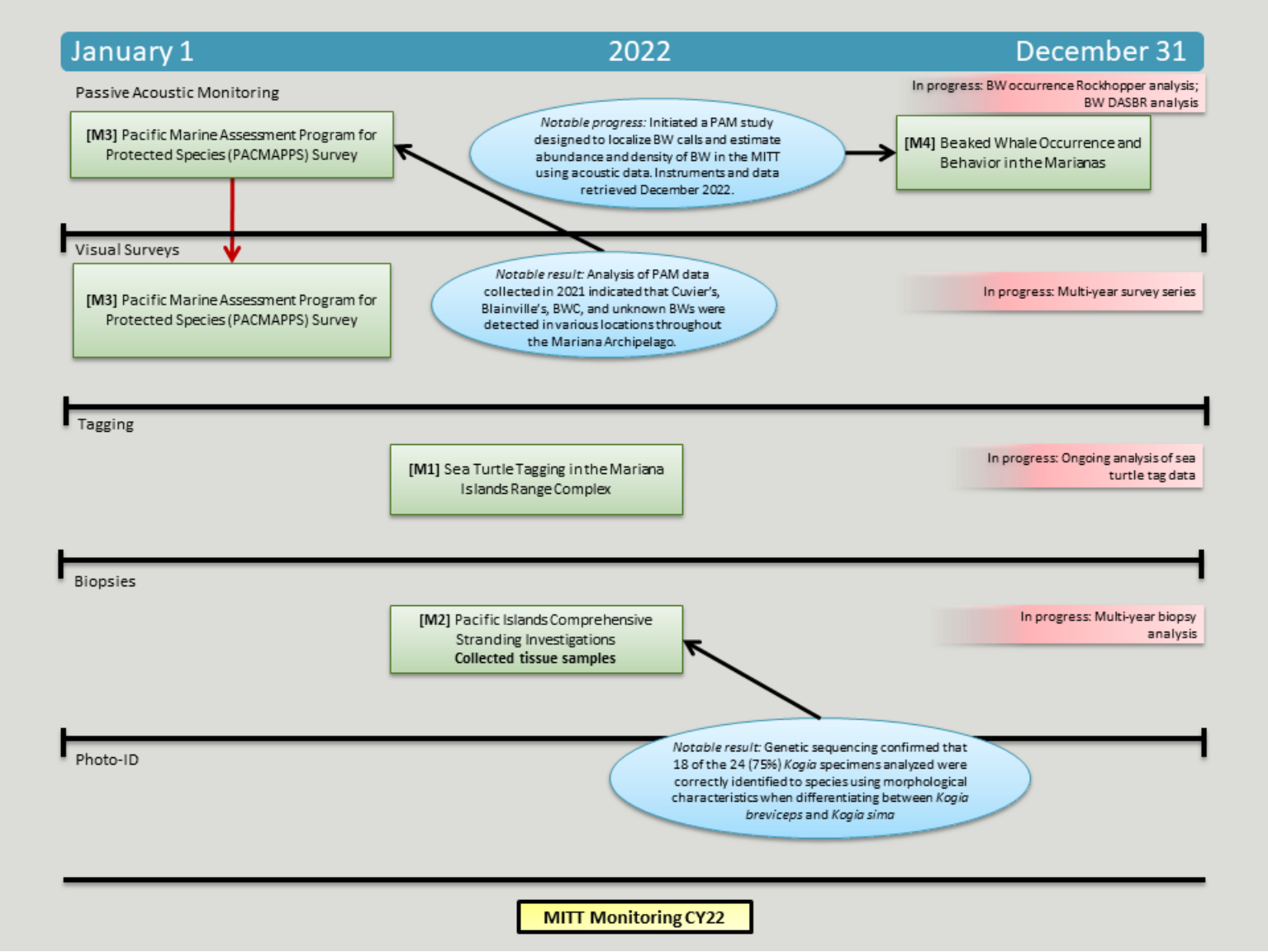

Figure 3. Timeline of 2022 projects in the MITT Study Area. Red arrows indicate projects that are associated with more than one data collection method.

[M1] Sea Turtle Tagging in the Mariana Islands Range Complex

The Pacific Islands Fisheries Science Center's (PIFSC) Marine Turtle Biology and Assessment Program (MTBAP) continued analysis of data gathered during a 9-year field study, initiated in 2013, of marine turtle abundance and spatial-temporal ecology in the nearshore waters of Saipan, Tinian, and Guam. In 2022, PIFSC continued data processing and analysis of all available turtle tracks. Working with the Integrated Ocean Observing System, MTBAP made data from the satellite tags publicly available within the Animal Tracking Network (ATN). To improve the determination of home ranges, a collaborative effort is underway to develop a new processing pipeline in the R Programming language that will facilitate the satellite tag data processing steps, including mapping migrations, calculating home ranges, and evaluating dive parameters (i.e., time at depth, maximum dive depth, time at temperature, dive duration). This work builds upon previous code developed by MTBAP, with the ultimate goal of having an agile processing pipeline that will allow rapid exploration of data trends and maximize the quality of the analyses.

No new data was collected during the 2022 calendar year (CY); a final project report is expected in summer 2023.

[M2] Pacific Islands Comprehensive Stranding Investigations [West et al. 2023a, 2023b]

The University of Hawai'i (UH) Health and Stranding Lab continued to respond to and conduct comprehensive investigations. Investigations were performed to obtain baseline information about the health of cetaceans stranded in the Hawaiian and Mariana Archipelagos as well as other Pacific Island locations between 2006 and 2022. The Lab conducted necropsies, cause-of-death-investigations (where possible), and analyses of historical stranding patterns and causes of mortality. Historical analyses incorporated quantitative estimates of stranding dates, genetic identification of species when necessary, and advanced diagnostic procedures, including histopathology, disease surveillance, and tissue sampling. Methods were developed and validated to analyze archived tissues for newly described pathogens and to age tooth samples. Experiments were carried out to examine the degradation of deoxyribonucleic acid (DNA) over time to determine the time of death and examine the detectability of Toxoplasmosis in degraded tissues. Historical stranding data are being compiled and augmented with data from new analyses to examine stranding patterns and causes of death. Specific analyses included:

- Twelve Cuvier's beaked whale (BW) (*Ziphius cavirostris*) strandings were investigated in the Pacific Islands; stranding locations spanned the main Hawaiian Islands, American Samoa, Guam, and Saipan, and partial or full necropsies were conducted in nine of these cases. Full or partial necropsies were performed on four Blainville's BW stranded in Midway, American Samoa, and the main Hawaiian Islands. A histopathological examination was performed on tissues from the only confirmed Longman's BW (*Indopacetus pacificus*) to strand in the Pacific Islands; that stranding occurred in Hana, Maui, in 2010.

- To quantify the type and potential source of marine debris ingested by a stranding marine mammal, a standardized methodology protocol was developed involving drying, categorization, counts, measurements, and weights of ingested marine debris items that were sorted into size categories.

- For genetic confirmation of *Kogia* species, tissues were chosen based on availability and included kidney, spleen, gingiva, testis, skin, brain, heart, muscle, and lung. DNA was extracted from each tissue using Qiagen Dneasy Blood and Tissue Kits (Qiagen, Germantown, Maryland) and amplified with polymerase chain reactions (PCRs) using primers and thermocycler conditions before genetic sequencing to identify specimens to species.

- To increase understanding of mortality through disease screening, tissues were selected from 35 individuals that stranded in the Pacific region dating back to 2014 to screen for the presence of cetacean morbillivirus (CeMV). Multiple genes from the *Brucella* genome were initially selected for assessment to develop a testing protocol with high specificity for detecting infections, while reducing the likelihood of false positives. All PCR-amplified products were visualized using gel electrophoresis to determine suspected positive cases and submitted to the UH Advanced Studies in Genomics, Proteomics, and Bioinformatics lab for final genetic sequencing. These sequences were then analyzed using the National Center for Biotechnology Information database's Nucleotide BLAST online tool for potential matches with *Brucella ceti* and *Brucella pinnipedialis*.

This is the same project conducted for HRC; refer to **Project [H5].**

[M3] Pacific Marine Assessment Program for Protected Species (PacMAPPS) Survey [Oleson et al. 2023]

As part of the PacMAPPS, the Mariana Archipelago Cetacean Survey (MACS) was conducted from 3 to 31 May 2021 and from 15 June to 14 July 2021 to characterize the abundance and distribution, density, population structure, and habitat preferences of cetaceans that occur within the U.S. waters around Guam and the Commonwealth of the Northern Mariana Islands (Yano et al. 2022).

At the completion of the MACS 2021 survey (reported on last year, DoN 2022b), remaining funds were approved for use towards density and abundance estimates for Cuvier's and Blainville's (*Mesoplodon densirostris*) BWs by fitting the acoustic-based estimator to the Mariana Archipelago DASBR dataset. As no available tag data was collected on these BWs in the Mariana Archipelago, required ancillary data for the DASBR density estimation framework, such as dive cycle durations and echolocation depths to determine probability of detection, were obtained by synthesizing information from other regions. The anticipated completion of the density estimates for both species is by summer 2023, which will be used by the Navy for the next round of compliance documents.

PacMAPPS was also conducted in HRC, SOCAL, NWTT, and GOA during past years; however, there was no activity in those areas in 2022.

[M4] Beaked Whale Occurrence and Behavior in the Marianas

Passive acoustic monitoring (PAM) was conducted off the island of Guam with the goal of detecting, classifying, locating, and deriving abundance and densities of BWs in the MITT. Six Rockhopper marine recording units were deployed for six months off the western side of Guam (depths 670 to 1,030 m) in May 2022. Five of these units were retrieved in December 2022 (several attempts were made to recover the sixth Rockhopper, but the unit did not respond to communications; recovery attempts are still underway). Another six Rockhoppers were deployed in December 2022 at the same locations, and all instruments were deployed in depths greater than 700 m. Analysis of the data

recovered in December 2022 will begin in early 2023. Acoustic data recorded by Rockhoppers will be analyzed to report the detection of BWs, classified to species or click type whenever possible. Any spatial or temporal patterns with respect to animal detections will be described. Spatial data about clicking BWs will be obtained through time-difference-of-arrival (TDOA) information, enabling localization. Abundance and density will be estimated from acoustic data using traditional methods, namely distance sampling and spatial capture recapture.

The acoustic data is continuously sampled at a rate of 197 kHz and with 24-bit resolution (FLAC file format), optimized to capture signals in the 10 hertz (Hz) to 80 kHz frequency range. This frequency range is sufficient to record the signals of all BW species that are thought to utilize the area: Cuvier's BW; Blainville's BW, Longman's BW, Deraniyagala's BW (*Mesoplodon hotaula*), and 'BWC' BW (possibly *Mesoplodon ginkgodens)*. Each mooring was equipped with an acoustic pinger (model EMT-01-3, Sonotronics, Inc., Tucson, Arizona) to synchronize the recording units in the array and enable the collection of accurate TDOA information. Each pinger signals at a specific frequency (between 32 and 40 kHz), and the source level is estimated to be approximately 160 decibels referenced to 1 microPascal (dB re. 1 µPa) at 1 m. The pingers are programmed to ping sequentially, resulting in a short synchronization signal (four short pings emitted at a 1-second [s] interval) being emitted every 15 minutes. The spatially-explicit nature of the analysis will facilitate a better understanding of BW occurrence in the MITT as well as potential exposure and behavioral responses to naval activities.

2.2.2 HSTT

Monitoring in HRC and SOCAL is presented individually in the following sections.

2.2.1.1 HRC

A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the HRC in 2022 is illustrated in **Figure 4**.

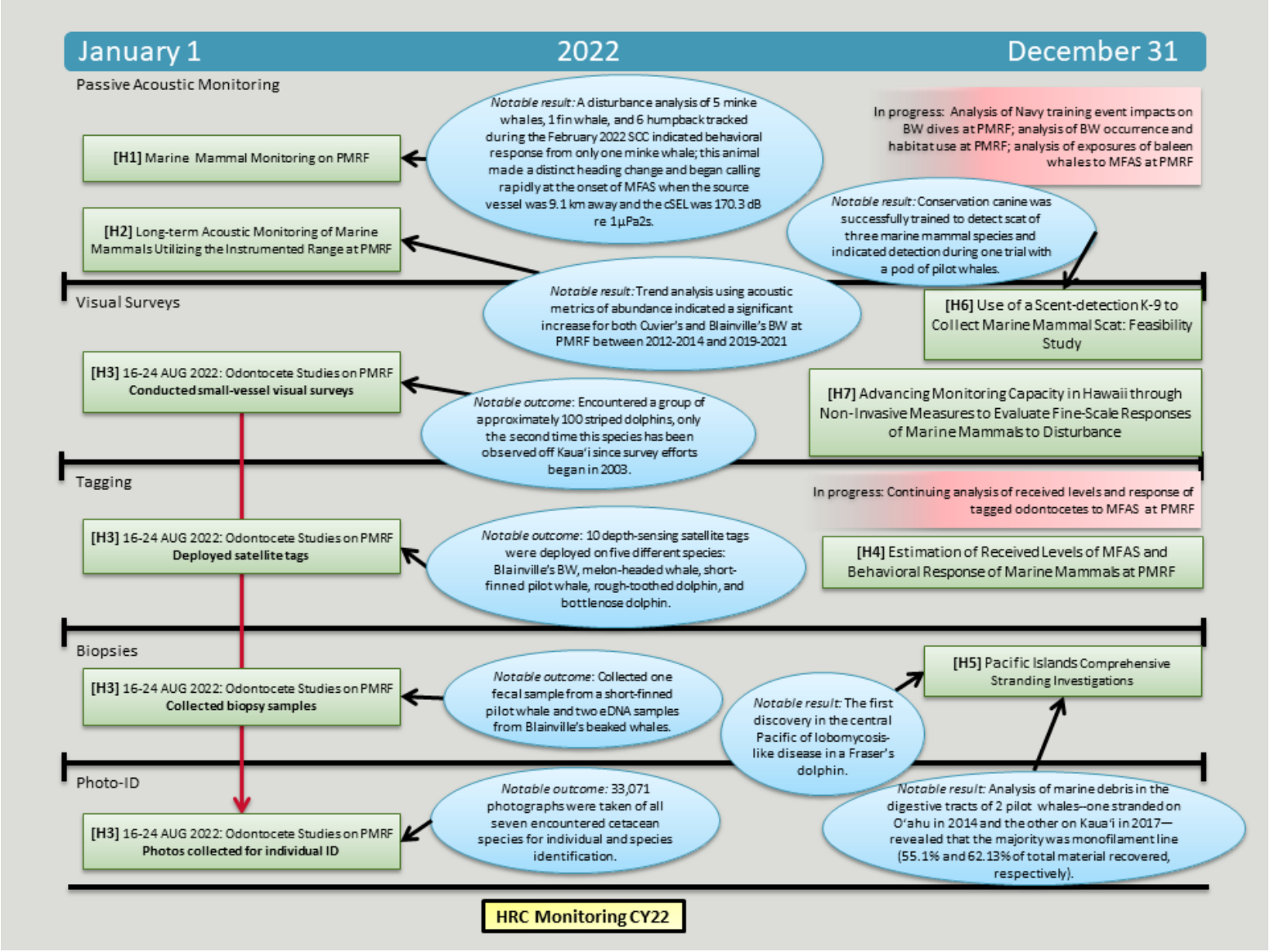

Figure 4. Timeline of 2022 projects in the HRC. Red arrows indicate projects that are associated with more than one data collection method.

[H1] Marine Mammal Monitoring on PMRF [Martin et al. 2023]

Raw acoustic recordings from 63 bottom-mounted hydrophones at full bandwidth (96 kHz) from the Pacific Missile Range Facility (PMRF) were used to analyze marine mammal vocalizations and mid-frequency active sonar (MFAS) transmission times and locations. Noise analyses conducted at PMRF characterized noise in frequency bands of interest to look for changes in noise over a wide variety of spatial and temporal scales and to assess any impact these changes may have on detecting and localizing marine mammal vocalizations. A suite of algorithms known as the Navy Acoustic Range Whale Analysis (NARWHAL) was used to process recorded data for marine mammal vocalizations. Several improvements were made to select detection algorithms in 2022. Abundance results for baleen whales are now presented using both the same metric previously used (maximum number of whales present in any 10-minute snapshot of whale tracks) as well as a new metric of the mean number of whales present in 10-minute snapshots per hour (hr) and for each month to provide a better statistical representation of the number of whales present. For the disturbance analysis, a variety of metrics were calculated/estimated, such as whale orientations (i.e., moving toward or away from the source), ship orientations relative to the whale, and distances relative to all ships. During periods of active sonar transmission (i.e., during the Submarine Command Course [SCC] as determined by PAM analysis of MFAS localizations), propagation modeling was conducted to calculate sound levels that an animal may have received from multiple ships over the duration it was acoustically active. HMMs were developed to analyze minke whale acoustic tracks.

[H2] Long-term Acoustic Monitoring of Marine Mammals Utilizing the Instrumented Range at PMRF and SOAR [Dolan et al. 2023]

NUWC Division Newport maintains the M3R program, which uses the U.S. Navy's instrumented hydrophone ranges and can collect, and archive processed passive acoustic detection data of marine species on a nearly continuous basis (see also **Project [S2]**). This important resource allows for long-term monitoring of certain populations of interest and provides data for answering key questions regarding basic biology, habitat usage, and behavioral responses to U.S. Navy training and testing activities. The archive files provide an electronic record of marine mammal acoustic activity, sonar activity, and marine mammal localization data from multiple algorithms. PAM data were collected from range hydrophones at PMRF from 2011 to 2022 and at the Southern California Offshore Anti-Submarine Warfare Range (SOAR) from 2010 to 2022. The spatial and temporal distribution of Cuvier's BWs at SOAR and Blainville's and Cuvier's BWs at PMRF were examined by evaluating their group vocal periods (GVPs). A trend analysis was conducted to examine changes in abundance over time. Field efforts at PMRF and SOAR were also conducted in conjunction with Cascadia Research Collective (CRC) and Marine Ecology and Telemetry Research (MarEcoTel), respectively, to use the M3R system to identify relevant species and direct CRC (see **Project [H3]**; Baird et al. 2023) or MarEcoTel (see **Project [S2]**; Schorr et al. 2022) to their locations for subsequent tagging.

[H3] Odontocete Studies on PMRF [Baird et al. 2023]

CRC has been conducting small vessel surveys since 2011 to investigate the spatial movements and habitat-use patterns of odontocetes that are exposed to MFAS on and around PMRF before, during, and after the SCC (see Baird et al. 2019a, 2019b, 2021, 2022, 2023). Field efforts in 2022 occurred from 16 through 24 August, immediately prior to Phase B of a SCC, to allow for the collection of

movement and dive data that could be used to examine the exposure and response of cetaceans to U.S. Navy MFAS. Surveys were conducted in conjunction with the M3R PAM system streaming from the instrumented PMRF Range (see **Project [H2]**; Dolan et al. 2023). M3R detections were used to direct the 24-foot (7.3-m) research vessel to high-priority species for satellite-tag deployment, using SPLASH10-F (Fastloc-GPS) tags, biopsy sampling, and photo-ID in addition to providing visual validations of species for the acoustic detections. A subset of animals encountered had satellite tags attached. Tagged animals that overlap in space and time with training events will be used for MFAS exposure analysis (see **Project [H4]**).

[H4] Estimation of Received Levels of MFAS and Behavioral Response of Marine Mammals at PMRF

CRC, NUWC, and NIWC collaborate in a project to examine the received levels of MFAS and behavioral response of marine mammals at PMRF. CRC deploys satellite tags on marine mammals while collaborating with NUWC, which aids in locating species of interest using the PMRF hydrophones. NUWC uses tag and range data to conduct the analyses. The HRC MFAS RL project continued in 2022, and although a supporting technical report is not available at this time, a report is expected in summer 2023.

In order to estimate sound levels received by tagged odontocetes at PMRF, positional data were interpolated in 5-minute intervals using the R-package *crawl*. Using dive data obtained from individual tags, dive depths were also estimated at each of those 5-minute locations. Further, 95% confidence interval (CI) error ellipses were calculated around each 5-minute position, with multiple radials running from source locations through the error ellipses to model transmission loss values (and thus received levels [RLs]) from the source to the far edge of the radial and to the seafloor. RL values were then derived in three-dimensional space within the error ellipse and around the estimated depth value to arrive at the most accurate possible propagation-modeled RL estimate (with associated variance estimates).

In addition to these more detailed RL analyses, the movement and dive behavior of the tagged odontocetes were examined relative to both phases of the SCC. Past analyses have focused only on Phase B, which includes the use of hull-mounted MFAS as well as other sources of MFAS, including helo-dipping sonar and active sonobuoys. The initial part of the SCC, Phase A, does not include any of these sources or any surface-combatant vessels, but does include other surface and subsurface vessels as well as other sources of noise that could potentially cause behavioral responses. Therefore, odontocete behavior was examined before, during Phase A, between phases, during, and after Phase B (when all those periods were available). Movement and dive behavior were also examined in the context of normal patterns, including diel and lunar cycles, to put the context of any potential response into a framework of baseline variability.

[H5] Pacific Islands Comprehensive Stranding Investigations [West et al. 2023a, 2023b]

This is the same project conducted for MITT, refer to **Project [M2]**.

[H6] Use of a Conservation K9 to Detect and Collect Marine Mammal Scat Samples – Feasibility Study [Rivers 2023]

Fecal material from three species (pilot whale, pygmy sperm whale [*Kogia breviceps*], and false killer whale [*Pseudorca crassidens*]) was provided by the UH Health and Stranding Lab from necropsied stranded animals to train a conservation canine (K9). The K9, which was experienced in conservation scent detection, used changes in behavior to indicate which direction the boat should go towards the target odor. The methodology was demonstrated during a short pilot study where pilot whales were observed, and fecal material was detected and collected.

[H7] Advancing Monitoring Capacity in Hawaii through Non-Invasive Measures to Evaluate Fine-Scale Responses of Marine Mammals to Disturbance [Bejder et al. 2023]

The primary goal of this project is to strengthen the monitoring capacity at the UH Marine Mammal Research Program in order to better determine the baseline acoustic and accelerometer-measured movement behavior of marine mammals in Hawaii so that behavioral responses and consequences of U.S. Navy activity can be explored. Infrastructure to maintain large datasets in perpetuity was set up. Additional infrastructure and training for tag setup, calibration, diagnostics, and data processing were added. This has been utilized during field expeditions to Lanai and Maui, resulting in a ~50-hr deployment on a short-finned pilot whale and the successful test of a prototype CATS tag for deployment on deep-diving animals, as well as deployments on humpback whales and a false killer whale. In addition, training workshops and classes will be developed. Data will continue to be analyzed to examine the biomechanics and energetics of large whales.

2.2.1.2 SOCAL

A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in SOCAL in 2022 is illustrated in **Figure 5**.

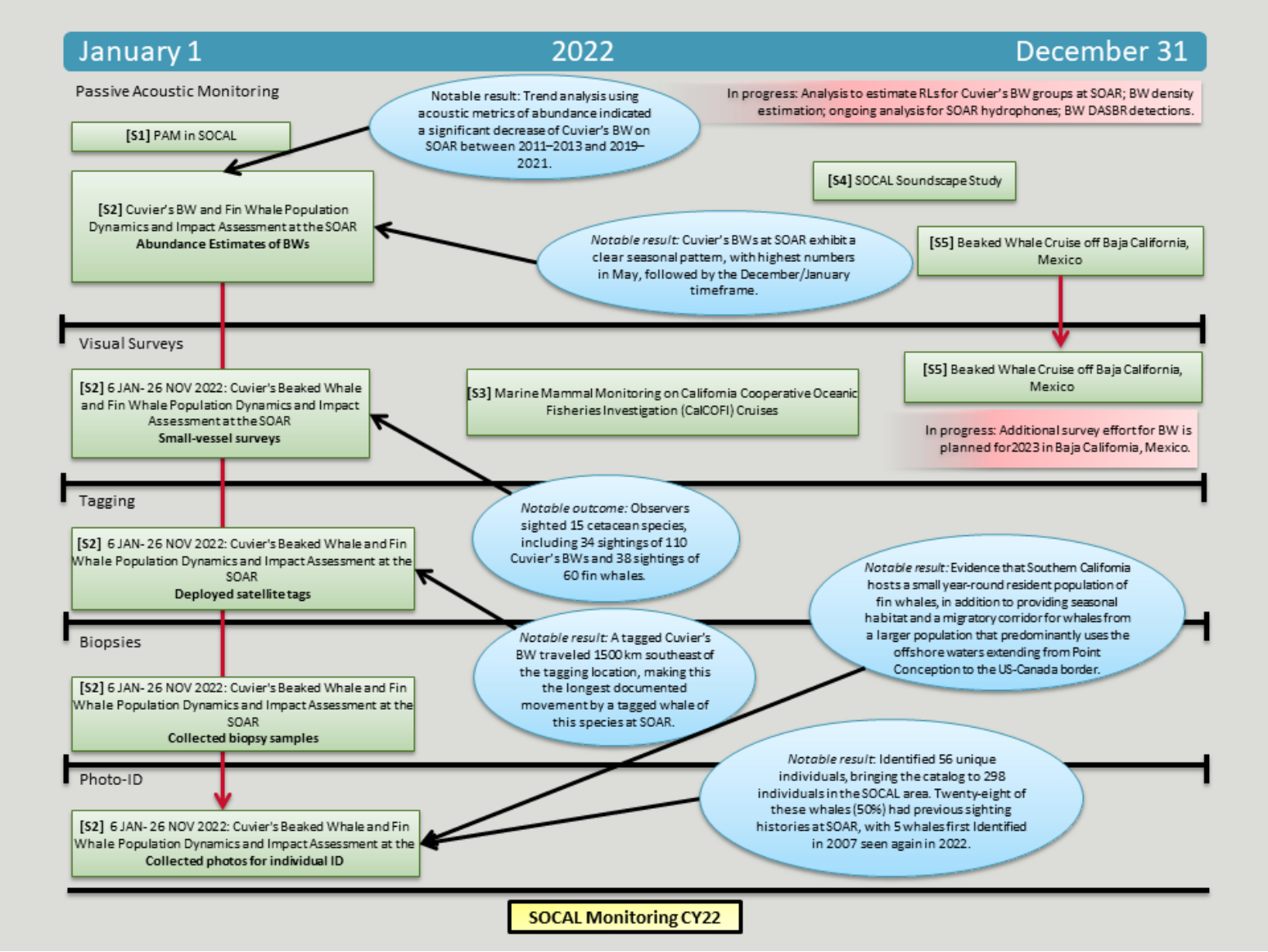

Figure 5. Timeline of 2022 projects in the SOCAL. Red arrows indicate projects that are associated with more than one data collection method.

[S1] Passive Acoustic Monitoring of Marine Mammals in SOCAL [Rice et al. 2023]

Since 2009, the University of California, San Diego's Scripps Institution of Oceanography (SIO) has studied marine mammal presence and acoustic behavior near U.S. Navy training and testing areas within the SOCAL using High-frequency Acoustic Recording Packages (HARPs). HARPs can autonomously record underwater sounds from 10 Hz to 200 kHz and are capable of up to approximately 1 year of continuous data storage. The goal of this project is to characterize the vocalizations of marine mammal species present in the SOCAL area, determine their seasonal presence, and evaluate potential impacts from U.S. Navy training and testing activities. In 2021 and 2022, the study focused on exploring the presence of BWs. Additionally, recordings were analyzed to characterize the low-frequency ambient soundscape (see **Project [S4]**), as well as the presence of MFAS and explosions. The HARPs recorded sounds between 10 Hz and 100 kHz between April 2021 and May 2022 and were deployed at four sites within SOCAL: two to the west of San Clemente Island (Site E at 1,300 m depth and Site H at 1,100 m depth), one to the west of San Nicolas Island (Site SN), and one southwest of San Clemente Island (Site N at 1,300 m depth). For all four sites, a total of 31,380 hr (1,308 days) of acoustic data were included in the 2022 analysis. Data analyses for marine mammal and anthropogenic sounds were performed using automated computer algorithms. For explosives, this year's reporting period once again demonstrates the high volume of unregulated civilian use of underwater explosive deterrents within SOCAL. Cumulatively for all four HARPs between April and May 2022, there were 11,745 explosive events over the reporting period, with the majority at night when Navy would not typically conduct explosive training or testing.

[S2] Cuvier's Beaked Whale and Fin Whale Population Dynamics and Impact Assessment at the SOAR [Schorr et al. 2022; Dolan et al. 2023]

As part of an ongoing, long-term study of the distribution and demographics of BWs and fin whales that use the range, small-vessel surveys were performed by MarEcoTel at SOAR in 2022. Surveys were conducted using a 6.5- to 7.5-m rigid-hull inflatable boat (RHIB), launched from a shore base each morning, with surveys throughout daylight hr as conditions permitted. Surveys focused on SOAR were based at Wilson Cove on the northeastern side of San Clemente Island. On days when SOAR was available for use, staff from the NUWC M3R program monitored hydrophones and directed the RHIB via radio or satellite phone into areas where marine mammal vocalizations were detected. Efforts were focused on BWs and baleen whales, in environmental conditions of Beaufort sea state (BSS) 3 or less. For each group of marine mammals encountered, the species, time, latitude, longitude, group size and composition, and overall behavioral state were recorded using a custom-built Microsoft Access database (Microsoft, Redmond, Washington) on a ruggedized tablet with an integrated Global Positioning System (GPS). Detailed records of surfacing patterns were also collected for BWs. The Cuvier's BW sighting catalog currently has 298 individuals identified in the SOCAL area, with 50% having previous sighting histories at SOAR, and five whales first identified in 2007 seen in 2022. Sightings were made of fin whales, including two females identified with their first calves in the study, one with her second calf, and one with her third calf. This collection brings the researcher's U.S. West Coast fin whale catalog to 1,281 individuals, of which 798 have sighting histories in Southern California. Photographs were also taken for species verification and individual identification; remote tissue biopsies were collected from species of interest for this study and from other species as requested by Southwest Fisheries Science Center (SWFSC) (beaked, fin [*Balaenoptera physalus*], blue [*Balaenoptera musculus*], humpback [*Megaptera novaeangliae*], minke

[*Balaenoptera acutorostrata*], and killer [*Orcinus orca*] whales; common bottlenose [*Tursiops truncatus*], and Risso's [*Grampus griseus*] dolphins) for use in ongoing assessments of population structure and stress hormone analyses; and a limited number of Low Impact Minimally Percutaneous Electronic Transmitter (LIMPET) satellite tags were deployed on species that regularly inhabit the training range to provide additional information on distribution, behavior, and overlap with U.S. Navy activities. Group sizes of Cuvier's BWs were recorded for use in abundance and density estimation on SOAR (Dolan et al. 2023; see **Project [H2]**). The NUWC M3R program continued an ongoing project to develop estimates of the abundance of Cuvier's BWs at SOAR, including investigating seasonal changes in abundance and mean GVPs as well as vocal behaviors (see **Project [H2]**).

[S3] Marine Mammal Sightings During California Cooperative Oceanic Fisheries Investigation (CalCOFI) Cruises

The CalCOFI cruises, a joint agency field effort, have been conducted off southern California since the 1950s, and represent the only continuous, seasonal marine mammal data 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. Visual surveys generally involved two observers using 7x50 Fujinon binoculars during daylight transit between CalCOFI oceanographic stations. Marine mammal sightings were logged systematically, including supporting information such as BSS. In 2021, abundance and density estimates were developed for nine commonly sighted marine mammal species using survey data collected from 2004 to 2021. Abundance and density estimates were calculated for the southern CalCOFI region using distance sampling techniques with the "distance" package in R (Miller et al. 2019). This project continued in 2022, and although a supporting technical report is not available at this time, an interim report is expected in summer 2023. During a CalCOFI cruise, the vessel does not alter course for species identification or group size estimates (termed "passing mode" under line-transect protocols). While this may lead to sightings of unidentified species, cumulatively since this project began in 2004, enough species-specific sightings have been obtained to begin incorporating into density estimates and spatial habitat models. For instance, marine mammal sighting data from CalCOFI surveys has already been incorporated into the SWFSC's spatial habitat models for select species for periods not surveyed by NMFS, winter and spring. These models will be used for the acoustic impact analysis portion of the U.S. Navy's pending Phase IV West Coast EIS.

[S4] SOCAL Soundscape Study [Rice et al. 2023]

As part of an ongoing study performed by SIO (see **Project [S1];** Rice et al. 2023), acoustic recordings from four HARPs (Sites E, N, H, and SN) between April 2021 and May 2022 were analyzed in 2022 in order to characterize the low-frequency ambient soundscape in the Southern California Bight (SCB). HARPs record over a broad frequency range of 10 Hz to 100 kHz, which allows quantification of the low-frequency ambient soundscape, detection of baleen whales (Mysticetes), toothed whales (Odontocetes), and anthropogenic sounds. To determine ambient sound levels, HARP recordings were decimated by a factor of 100 to provide an effective bandwidth of 10 Hz to 1 kHz, from which Long-Term Spectral Averages (LTSA) were constructed with 1 Hz frequency and 5 s temporal resolution. To avoid system self-noise (specifically hard drive disk writes) in daily LTSAs, five of the 5 s sound pressure spectrum levels from the middle of each 75 s acoustic record were

averaged. All spectra of each day were subsequently combined as daily LTSAs. Effort was directed toward finding explosive sounds in the recordings, including military explosions, shots from geophysical exploration, and seal bombs used by the fishing industry. Anthropogenic sounds, including MFAS and underwater explosions, were detected using automated computer algorithms. For MFAS, a modified version of the Silbido detection system was used, and the start and end of each sound or session were logged, and their durations were added to estimate cumulative weekly presence. Individual explosions were detected using a matched filter detector on data decimated to a 10 kHz sampling rate, and weekly totals were reported.

[S5] Beaked Whale Cruise off Baja California, Mexico

A collaborative effort among Mexican and U.S. researchers continued with a vessel survey conducted off Baja California from 28 October to 12 November 2021 (Henderson et al. 2022a). The primary objective of the survey was to locate and document two species of BW: “BW43”, which had previously only been detected acoustically, and BW Baja (BWB), which was first encountered and acoustically recorded in 2020. Data collection methods included visual and passive acoustic techniques for detecting and identifying marine mammals. Acoustic instrumentation included two DASBRs, each with a multi-channel SoundTrap ST4300 recorder (made by Ocean Instruments, http://www.oceaninstruments.co.nz/), and an HTI-92-WB hydrophone, and an HTI-96-min hydrophone. Data collected during visual observations included sighting start time, start latitude and longitude, species, best estimate of group size (including a minimum, maximum, and best size estimate), group behavior, and any other behavioral observations. Photographs were taken for individual identification when possible. For species other than BWs, once the species and group size had been confirmed and photographs had been collected, the sighting was ended with a final time and position update. A BW group sighting was ended if a group was not re-sighted after at least 30 minutes of monitoring. Analyses of the data collected during the 2021 survey are ongoing, and additional survey efforts in 2023 are planned to augment the data.

2.2.3 NWTT

A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the NWTT Study Area in 2022 is illustrated in **Figure 6**.

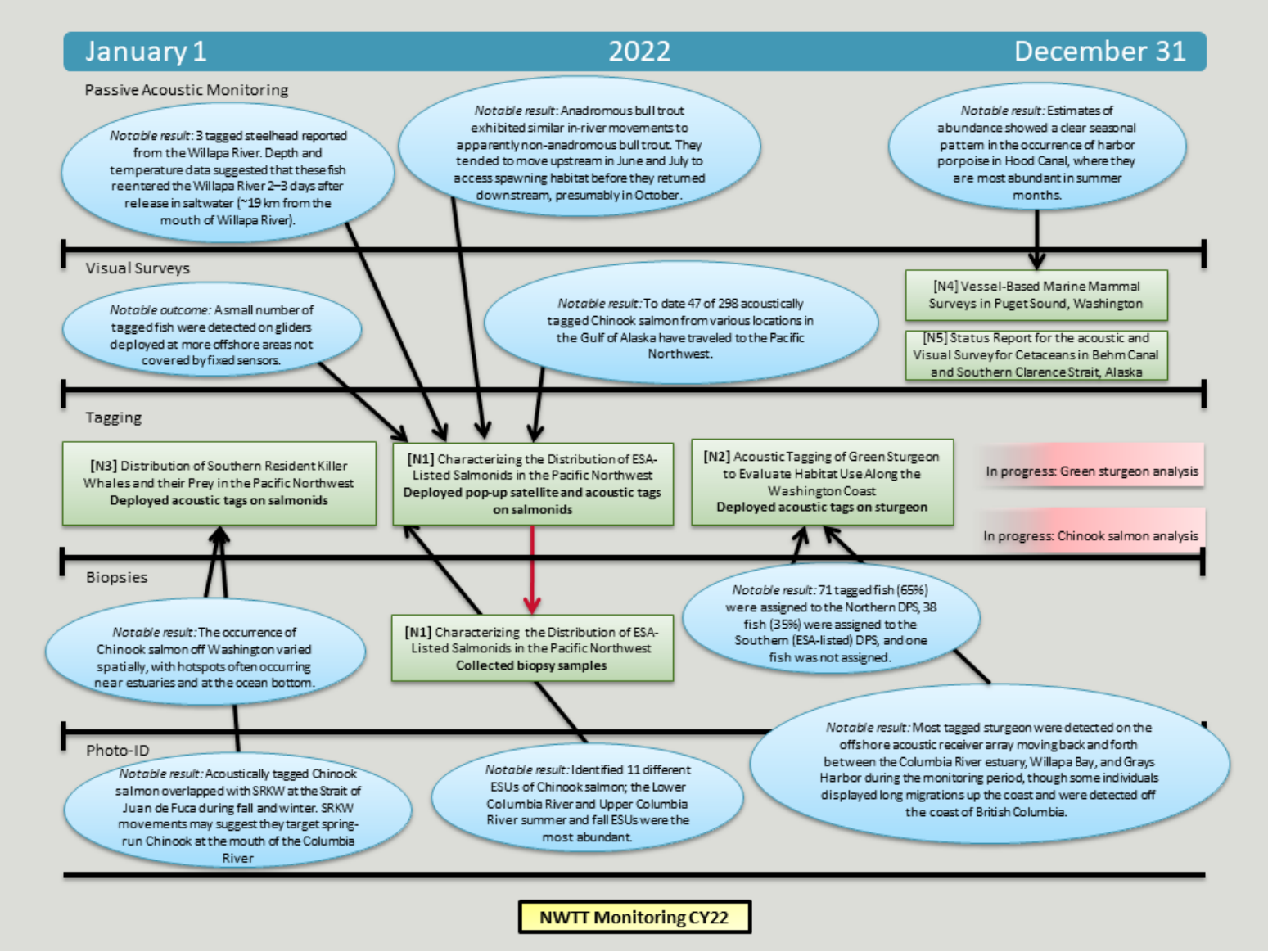

Figure 6. Timeline of 2022 projects in the NWTT. Red arrows indicate projects that are associated with more than one data collection method.

[N1] Characterizing the Distribution of ESA-Listed Salmonids in Washington and Alaska [Harbison et al. 2022; Huff and Smith 2022; Smith and Huff 2023a, 2023b]

Since 2019, an international team of researchers, including scientists from the National Oceanic and Atmospheric Administration (NOAA) Northwest Fisheries Science Center (NWFSC), the Canadian Department of Fisheries and Oceans, the University of Washington, and Oregon State University, have been examining salmonid distribution in relation to U.S. Navy training and testing activities using a stationary acoustic receiver array installed off the Washington Coast, in the Hoh River and Kalaloch Creek on the Olympic Coast, and in the nearshore waters of the Pacific Ocean. Bull trout (*Salvelinus confluentus*) were captured by hook and line using artificial lures with barbless hooks and surgically implanted acoustic tags (VEMCO V9-1L, 2L, 6L). All acoustic tags were programmed with a random ping rate between 60 and 120 s, with a mean of 90 s, to maximize tag life and minimize interference among tags.

This project also explored factors limiting post-spawn survival by assessing behavior and movement patterns exhibited by steelhead trout (*Oncorhynchus mykiss*) using acoustic telemetry and Pop-up Satellite Archival Tags (PSATs) in a coastal tributary of Willapa Bay, Washington, and the near-coastal ocean. Acoustic telemetry receivers were positioned to facilitate the assessment of potential mortality hotspots along the migration route as well as spatiotemporal patterns of post spawn movement more generally. In 2022, tag detections were assessed at each site along the outmigration path (excluding initial detections at the hatchery release site and spawning ground detections) in relation to diurnal and tidal cycles, separated by hatchery and wild fish. Rayleigh's test of circular uniformity was used to analyze diel activity patterns. The chi-square test for goodness-of-fit was used to test whether fish movements were independent of the tidal phase or the crepuscular period. Biometric attributes of sampled fish were assessed, comparing hatchery versus wild steelhead, and fish that survived to reach the ocean versus those that did not. Scale analyses were conducted using acetate impressions of each scale card made using a heated hydraulic press for approximately one minute. Acetate impressions were examined by one reader using a Realist Vista microfiche reader (magnification, 48X). Age notation for steelhead indicated total age, life history, and origin (hatchery versus wild). Total age was defined as the total number of annuli on the scale given a birthday of 1 January. Freshwater annuli were enumerated at the point of marine entry (defined as the discernable and constant increase in circuli spacing).

The project also examined Chinook salmon movements using acoustic tags. More than 400 fish were implanted with acoustic tags at various locations off Washington and Alaska. These were detected on the stationary receivers described above to examine movement patterns and residency along the coast. In addition, a receiver was deployed on an autonomous underwater vehicle (Slocum glider) to survey areas further offshore and at different depths than the stationary array. The glider collected environmental data including salinity, temperature, chlorophyll, and oxygen levels using CTD, chlorophyll, and oxygen sensors. Fin clips of the salmon taken during capture were analyzed for genetic stock identity.

This is the same project conducted for GOA; refer to **Project [G2].**

This project is also linked to **Projects [G1]** and **[N3]**.

[N2] Acoustic Tagging of Green Sturgeon to Evaluate Habitat Use Along the Washington Coast [Heironimus et al. 2022]

To assess the threatened green sturgeon (*Acipenser medirostris*) in the NWTT study area, the U.S. Navy funded Washington Department of Fish and Wildlife (WDFW) biologists to study the migration, occurrence, distribution, and habitat use of this species in nearshore marine waters. In 2020 and 2021, WDFW acoustically tagged 110 green sturgeon using VEMCO 69-kHz V16 tags in Willapa Bay and Grays Harbor. A small clip was taken from the pelvic fin of each tagged fish and sent to the genetics lab at SWFSC for single nucleotide polymorphisms (SNPs) analysis. Using this technique, 188 sturgeon were assigned to either the Northern Distinct Population Segment (DPS) or the Southern (ESA-listed) DPS. From 7 June to 31 October 2022, WDFW operated four VEMCO acoustic receivers at the mouth of Grays Harbor to assess green sturgeon tag survival and determine the period of migration of tagged individuals from the estuarine to marine environment. Estuarine habitat use was also monitored using acoustic receiver arrays in the Columbia River estuary operated by WDFW and in Willapa Bay operated by NMFS.

[N3] Distribution of Southern Resident Killer Whales and their Prey in the Pacific Northwest [Smith and Huff 2023c; Smith et al. 2022]

As part of an ongoing project to characterize the distribution, abundance, and behavior of endangered southern resident killer whales (SRKW) and multiple ESA-listed stocks of Chinook salmon in the northern California current ecosystem, and in and near the NWTT, depth-specific Chinook salmon sampling and analysis was conducted along the coast of Washington in nearshore marine waters from Neah Bay to the mouth of the Columbia River. Fish were captured using modified microtrolling, and multiple leaders were attached directly to a Scotty Depthpower downrigger line using clips spaced 5 m apart and weighted by a 15-pound downrigger ball. Depth loggers (Sensus Ultra by ReefNet Inc.) were attached to the downrigger line near the bottom and top hooks to measure hook depth. Detailed data on each captured Chinook salmon was collected, which included measuring fork length (FL; millimeter and weight (grams [g]), as well as collecting scale samples for estimating life history (sub-yearling or yearling) and total age. To determine the genetic origin, Evolutionarily Significant Units (ESUs), the sex of each fish, and fin clips from the dorsal or anal fin were taken and stored in 70% ethanol. Chinook salmon with a FL greater than 300 mm were anesthetized, and an acoustic tag was surgically inserted into the peritoneal cavity as part of **Project [N1]** (Harbison et al. 2022; Huff and Smith 2022). After tagging, the fish were released back into the water near the capture location; the location tracks and boat speed were recorded for each deployment using a Garmin GPSMAP 64st. In 2022, analyses were conducted to determine the likelihood of capturing Chinook salmon at different locations and times, and to identify whether environmental covariates influenced their distribution, measured as time-to-capture. To examine how environmental variables may affect the probability of capturing Chinook salmon, linear interpolation was used to estimate the depth of each hook between the bottom and top hooks, where depth loggers were deployed. Random effects for the depth, location, and interaction between depth and location were included in the model of Chinook salmon capture rate to account for heterogeneity not explained by the fixed covariates and to allow for hooks on the same line at different depths to be treated as statistically independent observations.

The overlap in distribution of Chinook salmon and SRKW was examined using detections of acoustically tagged Chinook salmon and five stationary passive acoustic monitoring stations to record the vocalizations of killer whales. The distribution of Chinook salmon was estimated by kriging the number of unique individuals detected at each receiver location for each month and season. Their movements were examined by calculating the compass-bearing direction for each detection at a new location and summarized by season. To determine if Chinook move at specific times of day, arrival time was characterized, and a circular plot of detections by hr of day was created for each season. To estimate the overlap, the percentage of time where SRKW were detected at each of the monitoring stations was calculated, and their distribution was compared against that of Chinook salmon.

This project is linked to **Projects [N1], [G2],** and **[G1]**.

[N4] Vessel-Based Marine Mammal Surveys in Puget Sound, Washington [Zerbini et al. 2023]

Systematic vessel-based surveys were conducted in Hood Canal, located in western Puget Sound, Washington. Line-transect surveys were conducted to assess the seasonal distribution and abundance of marine mammals in Hood Canal, with an emphasis on harbor porpoises (*Phocoena phocoena*) and killer whales. Over 2,000 km of trackline was covered over 34 days between 9 February and 13 December 2022. The survey area was divided into six strata of varying geometry to facilitate allocation of survey effort and improve sampling efficiency: Stratum 1 spanned an area of 40 square km (km^2; 12.1% of the study area) and encompassed the entrance of Hood Canal, south to the Hood Canal Bridge, including Port Gamble Bay; Stratum 2 corresponded to an area of 73 km^2 (19.3% of the study area) spanning from the Hood Canal Bridge to just south of Naval Base Kitsap Bangor at Hazel Point; Stratum 3 spanned an area of 75 km^2 (19.8% of the study area) and encompassed the entire Dabob Bay Range; Stratum 4 corresponded to an area of 50 km^2 (13.2% of the study area) encompassing the area from Hazel Point and the mouth of Dabob Bay, and south to Hood Point; Stratum 5 corresponded to an area of 96 km^2 (25.3% of the study area) from Hood Point to Union; and Stratum 6 corresponded to an area of 39 km^2 (10.3% of the study area) from Union to Belfair.

Preliminary estimates of harbor porpoise density and abundance were computed using data collected from the primary (upper) observation platform of the survey vessel (Zerbini et al. 2023). Future work will include integrating the final winter survey data collected in early 2023 and computing estimates of the proportion of animals missed on the trackline to improve the accuracy of the abundance and density estimates. Results from these analyses will be presented at a later date in the final project report.

[N5] Status Report for the Acoustic and Visual Survey for Cetaceans in Behm Canal and Southern Clarence Strait, Alaska [Angliss et al. 2023]

A systematic vessel survey will be designed and conducted in the Behm Canal, central Clarence Strait, Alaska, and adjacent fjords and inlets. The proposed survey design will be consistent with the methods of a research cruise that was conducted in Southeast Alaska inland waters in 2019 so that results are comparable and can be integrated if needed. The first survey is expected to occur in Spring 2023. Visual observations will be carried out by four observers on a rotation during daylight hr

in appropriate visibility conditions and below BSS 4. Position, navigational, environmental, and sighting information will be recorded on a laptop.

In addition to the visual survey, passive acoustic data will be collected with two approaches. A passive acoustic recording system will be installed at a static site at the Southeast Alaska Acoustic Measurement Facility (SEAFAC) early 2023 to provide information on the year-round occurrence of vocalizing marine mammals in the Behm Canal. This system will include two instruments: a SoundTrap ST600 recording continuously at a sampling rate of 96 kHz and an F-Pod click detector and classifier. These will be retrieved as needed to avoid recording classified activities. In addition, a new pair of recorders will be sent every three months to be swapped out by SEAFAC personnel. Sonobuoys will be used for collecting passive acoustic data during the vessel survey to augment visual observations. The sonobuoy will be deployed over the rail of the vessel while underway. All acoustic data will be recorded for post-hoc analysis.

2.2.4 GOA

A timeline of all U.S. Pacific Fleet-funded monitoring tasks implemented in the GOA in 2022 is illustrated in **Figure 7.**

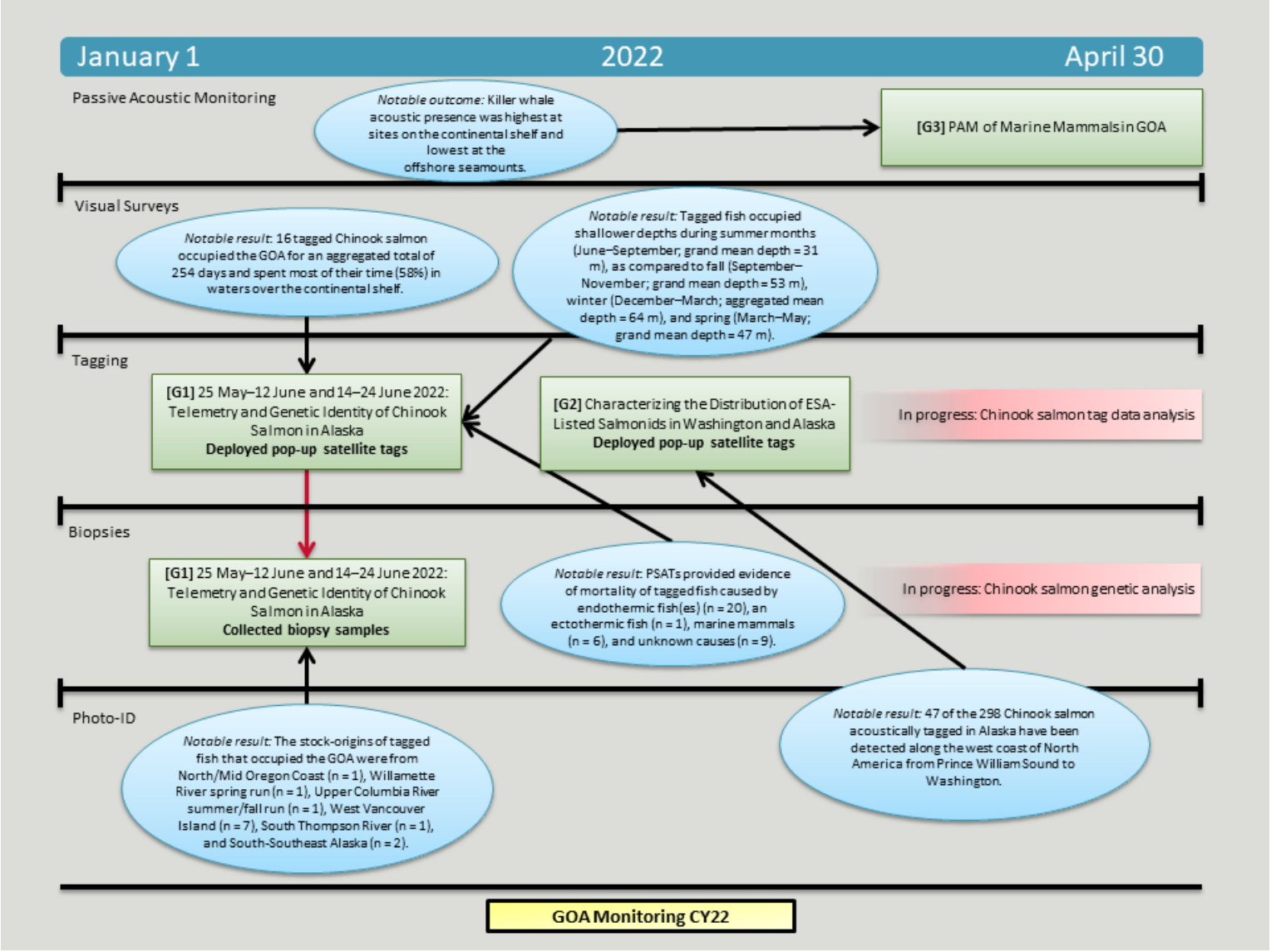

Figure 7. Timeline of 2022 GOA monitoring projects. Red arrows indicate projects that are associated with more than one data collection method.

[G1] Telemetry and Genetic Identity of Chinook Salmon in Alaska [Seitz and Courtney 2023]

This ongoing study provides information about the at-sea spatial and vertical distribution, horizontal movement, genetic identity, occupied habitat, and natural mortality of Chinook salmon (*Oncorhynchus tshawytscha*) in and near the GOA and the overlap of occurrence between populations from western Alaska to California, particularly the ESUs that are listed under the ESA. As part of this study, large (greater than 60-centimeter [cm]), immature individuals were captured using hook and line methods, tagged with PSATs (MiniPAT, Wildlife Computers; Redmond, Washington), and released. Catch-and-release and tag activities took place near Craig, Alaska, from 25 May to 12 June 2022: and near Sitka, Alaska, from 14 to 24 June 2022. After hooking, the salmon were retrieved and brought on board the vessel and assessed for condition, signs of stress, or abnormal behavior, including external injuries, loss of scales, bleeding, loss of equilibrium, pupil dilation, abnormal coloration, frayed fins, and rapid opercular movement. Chinook salmon that were greater than 60 cm in FL and in good condition were selected for tagging, then placed in a custom-fabricated cradle and blindfolded to reduce visual stimuli that can contribute to stress and struggling. PSATs were attached to Chinook salmon while in the cradle using a tag attachment system consisting of a tag that is tethered to two padded straps and secured with surgical-grade wire (0.8 mm) through the dorsal musculature and bony fin-ray supports of Chinook salmon. After tagging, the axillary process of a pelvic fin was removed as a tissue sample for subsequent genetic analysis and stock-of-origin assignments. After tissue sampling, the fish were identified by tag number, photographed, and released back into the ocean. The PSATs measured and archived temperature, depth, and ambient light data at user-programmable intervals, typically between 1 and 15 s. After being released from the fish, the tags floated to the surface of the sea and were transmitted via satellite (the Advanced Research and Global Observation Satellite [Argos] System), along with summarized temperature and depth data (resolution 5.0 to 10.0 minutes), daily dawn and dusk times determined from light data, and an end location. The PSATs were programmed to release from tagged salmon at staggered intervals between 30- and 270-days post-tagging. Additionally, the tags were programmed to be released before their scheduled pop-up date if they triggered a fail-safe mechanism by remaining at a constant depth (depth window of ± 2.5 m) for a pre-defined period (3 days). In 2022, genetic stock-of-origin assignments were conducted by the NMFS NWFSC using the SNPs technique; analyses are ongoing, and results are not yet available.

This project is linked to **Projects [N1]** and **[N3]**.

[G2] Characterizing the Distribution of ESA-Listed Salmonids in Washington and Alaska [Harbison et al. 2022; Huff and Smith 2022]

This is the same project conducted for NWTT; refer to **Project [N1].**

This project is linked to **Projects [N3] and [G1]**.

[G3] PAM for Marine Mammals in GOA using Bottom-Mounted Devices [Rice et al. 2022a]

Passive acoustic data were collected from 2011 to 2019 from seven HARPs in the GOA to characterize the ambient soundscape and detect marine mammal and anthropogenic sounds during times of naval exercises within the area. Hydrophones were suspended at least 10 m above the seafloor except in abyssal regions, where the seafloor was at 4,000 m and the hydrophone was suspended at 1,200 m. Data was collected from the following seven sites: Kenai Shelf (~200 m depth) was located on the continental shelf, offshore of Kenai Peninsula; Kodiak Shelf (~230 m depth) was located on the continental shelf, offshore of Kodiak Island; Kodiak Slope (~1,200 m depth) was located in deep water offshore of Kodiak Island; Kenai Slope (~900 m depth) was located in deep water on the continental slope; Abyssal (~4,000 m depth; hydrophone located at 1,200 m) was located in deep water beyond the continental slope; Quinn (~950 m depth) was a deep, offshore site near Quinn Seamount; and Pratt (~990 m depth) was a deep, offshore site near Pratt Seamount. In 2022, killer whale signals were analyzed to determine the seasonal occurrence and distribution of different killer whale ecotypes at these sites. HARPs recorded continuously at a 200-kHz sampling rate (one deployment occurred at Kenai Shelf and Quinn Seamount where a 320-kHz sampling rate was used, as well as one deployment at Kenai Shelf and Kenai Slope where a duty cycle was used). The data was analyzed by scanning long-term spectral averages for encounters with killer whale pulsed calls. Individual calls were then examined to attribute them to specific ecotypes.

3 2023 Monitoring Goals

The Strategic Planning Process is used to set ISOs, 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 (FY).

Continuing or new monitoring projects for CY 2023 are listed in **Table 2**, in **Appendix B**, and on the U.S. Navy's MSM Program website:

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

Table 2 provides a quick summary of 2023 monitoring for MITT, HSTT (HRC and SOCAL), NWTT, and GOA. For a more detailed view of these monitoring projects, please see **Appendix B**.

Table 2. 2023 Monitoring projects for U.S. Navy Pacific ranges/study areas.

Range/Study Area	Project Title	Continuing or Proposed New Start
HRC, SOCAL	Long-term Passive Acoustic Monitoring of Cetaceans at PMRF and SOAR	Continuing from 2006
HRC	Estimation of Received Levels of MFAS and Behavioral Response of Marine Mammals at PMRF	Continuing from 2011
HRC	Advancing Monitoring Capacity in Hawaii Through Non-invasive Triaxial Accelerometry Tags to Evaluate Fine-scale Responses of Marine Mammals to Disturbance	New start in 2022
SOCAL	Cuvier's Beaked Whale and Fin Whale Population Dynamics and Impact Assessment at SOAR	Continuing from 2016
SOCAL	Southern California Beaked Whale Occurrence [formerly Passive Acoustic Monitoring of Marine Mammals in SOCAL]	Continuing from 1999
SOCAL	Marine Mammal Sightings During CalCOFI Cruises	Continuing from 2004
MITT	Sea Turtle Tagging in the Mariana Islands Range Complex	Final reporting in 2023
MITT	Beaked Whale Occurrence and Behavior in the Marianas	New start in 2022
MITT	Marianas Beaked Whale Expert Panel	New start in 2023
MITT, HRC	Pacific Islands Comprehensive Stranding Investigations	Continuing from 2017[a]
NWTT	Pacific Northwest Distribution of Southern Resident Killer Whales and Prey	Continuing from 2014[b]
NWTT	Acoustic Tagging of Green Sturgeon to Evaluate Habitat Use Along the Washington Coast	Continuing from 2020
NWTT	Visual and Acoustic Survey for Cetaceans in Behm Canal and Southern Clarence Strait, Alaska	New start in 2022
NWTT, GOA	Characterizing the Distribution of ESA-listed Salmonids in Washington and Alaska	Continuing from 2018
GOA	Telemetry and Genetic Identity of Chinook Salmon in Alaska	Continuing from 2020

Notes:

[a] Added emphasis and funding focused on these investigations starting in FY20.

[b] SRKW focus 2014–2018; 2018–2022 focus on killer whale prey (ESA-listed salmonids).

Key: CalCOFI = California Cooperative Oceanic Fisheries Investigations; ESA = Endangered Species Act; GOA = Gulf of Alaska Training; HRC = Hawaii Range Complex; MFAS = mid-frequency active sonar; MITT = Mariana Islands Training and Testing; NWTT = Northwest Training and Testing; PMRF= Pacific Missile Range Facility; SOAR = Southern California Offshore Anti-Submarine Warfare Range; SOCAL = Southern California Range Complex.

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Baird, R.W., A.E. Harnish, E. Corsi, A.M. Gorgone, D. Perrine, A. Franco, C. Hankins, and E. Sepeta. 2022. Unintended Consequences: Common Bottlenose Dolphin Associations with a Fish Farm in Hawai'i Lead to Impacts on Spinner Dolphins and Other Delphinids. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Baird, R.W., S.D. Mahaffy, C.J. Cornforth, J.J. Currie, S.H. Stack, and M.A. Kratofil. 2022. Hawai'i false killer whale photo-identification, tagging, & sampling in 2021, with ongoing and planned future analyses. Presentation, Pacific Scientific Review Group, 24 March 2022.

Cárdenas Hinojosa, G., and R.D. Andrews. 2022. Re-sighting Histories of Dart-Attached Tags in Cuvier's Beaked Whales (*Ziphius cavirostris*) and Fin Whales (*Balaenoptera physalus*) in the Eastern Pacific Ocean. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Coates, S.N., G.S. Schorr, S.L. Watwood, B.K. Rone, R.D. Andrews, D.A. Sweeney, M.P. Johnson, K.M. Dolan, and S.L. DeRuiter. 2022. Insights into Foraging Behavior from Multi-day Sound Recording Tag Deployments on Cuvier's Beaked Whales in the Southern California Bight. Speedtalk Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Corsi, E., R.W. Baird, A.E. Harnish, A.M. Gorgone, J.J. Currie, S.H. Stack, and J.J. Kiszka. 2022. Demographically Independent Stocks of Common Bottlenose Dolphins (*Tursiops truncatus*) in the Main Hawaiian Islands Display Differences in Social Structure. Poster Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Courtney, M., and A. Seitz. 2022. Habitats Occupied by Chinook Salmon in Gulf of Alaska U.S. Navy Activities Areas. Poster Presentation, 2022 Virtual Alaska Marine Science Symposium, 24–27 January 2022.

Courtney, M. B., and A. C. Seitz. 2022. Habitats occupied by Chinook salmon in the Gulf of Alaska and in the U.S. Navy's Temporary Maritime Activities Area. Oral Presentation. Alaska Chapter American Fisheries Society Annual Meeting, Juneau, AK, February.

Douglas, A.D., and R.W. Baird. 2022. Denizens of the Deep: Three Lines of Evidence Suggest a Pelagic Population of Risso's Dolphins in Hawaiian Waters. Poster Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Falcone, E., G. Schorr, D. Sweeney, B. Rone, S. DeRuiter, S. Coates, R. Andrews, and S. Watwood. 2022. Scratching at the Surfacings: Exploring Surface Intervals in Cuvier's Beaked Whales. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Gless, E., S. Mahaffy, G. Olson, S. Stack, J. Currie, and R. Baird. 2022. Photo-Identification of Pantropical Spotted Dolphins in Hawaiian Waters Reveals Long-Term Re-Sightings, Supporting the Existence of Island-Associated Resident Populations. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Guazzo, R., I. Durbach, T. Helble, G. Alongi, C. Martin, S. Martin, and E. Henderson. 2022. Singing Fin Whale Swimming Behavior in the Central North Pacific. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Guazzo, R.A., G.J. Gagnon, D.L. Stevenson, M.K. Edell, A.S. Frankel, and T.A. Helble. 2022. Close encounters of the seismic kind: Behavioral response of large whales to a seismic survey ship. Oral Presentation, Effects of Sound on Marine Mammals, Beaufort, North Carolina, 15–18 March 2022.

Guazzo, R.A., D.L. Stevenson, M.K. Edell, G.J. Gagnon, A.S. Frankel, T.A. Helble. 2022. Low-Frequency Sources with Whale Acoustic Reconnaissance for Mitigation (Low SWARM). SMART SEED Annual Review. Tysons, Virginia.

Hanser, B., K. Robertson, R. Baird, P. Rosel, A. Mignucci, L. Dolar, L. Wilcox, and K. Martien. 2022. The Shyest Blackfish: Examining the Global Phylogeography of the Pygmy Killer Whale (*Feresa attenuata*). Speedtalk Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Heironimus, L. B., M. T. Sturza, M. Moser, and S. Corbett. 2022. Evaluating the timing and distribution of Green Sturgeon in Washington's coastal estuaries. American Fisheries Society Annual Meeting. Spokane, WA. August 21-25. Oral Presentation.

Heironimus, L. B., M. T. Sturza, M. Moser, and S. Corbett. 2022. Evaluating the timing and distribution of Green Sturgeon in Washington's coastal estuaries. North American Sturgeon and Paddlefish Society. Folsom, CA. October 23-27. Oral Presentation.

Helble, T.A., P. Dugan, E.E. Henderson, S. Jarvis, and S. Watwood. 2022. Improving Methods for Automated Detection of Navy Sonar. The 9th International Workshop on Detection, Classification, Localization, And Density Estimation of Marine Mammals Using Passive Acoustics, Honolulu, Hawaii, 7–11 March 2022.

Helble, T., R. Guazzo, E. Henderson, C. Martin, G. Alongi, S. Martin, and I. Durbach. 2022. Fin Whale Song Patterns Shift Over Time in the Central North Pacific. Speedtalk Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Helble, T.A., Martin, C. M., Guazzo, R. A., Henderson, E. E., C. R., Alongi, G. C., Martin, S. W., & I. Durbach. 2022. Slow, Faster, Fastest - Contextualizing Minke Whale Swimming Behavior Relative to the Environment, Conspecifics, and Navy Sonar. 6th International Conference on the Effects of Noise on Aquatic Life. Berlin, Germany, 10–15 July 2022.

Henderson, E., M. Deakos, and D. Engelhaupt. 2022. The First Record of a Continuous Multi-day Association Between a Primary Escort and Female in Hawai'i. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Henderson, E.E., E. K. Jacobson, L. Thomas. 2022. Beyond MFAS: Analysis of Additional Sources of Noise during US Navy Training Activity. The Effects of Noise on Aquatic Life, Berlin, Germany, 10–15 July 2022.

Henderson, E.E., C.R. Martin, M.A. Kratofil, S.W. Martin, R.W. Baird, B.L. Southall. 2022. Improved Satellite Tag Track Analyses and Received Level Estimation of Odontocetes During Navy Training at PMRF. Effects of Sound on Marine Mammals Conference, Beaufort, North Carolina, 15–18 March 2022.

Howe, M., R.W. Baird, M. Kratofil, and D. Webster. 2022. Understanding the Distribution Patterns of Rough-toothed Dolphins (*Steno bredanensis*) Around Kaua'i and Ni'ihau. Poster Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Keene, E., E. Falcone, G. Schorr, B. Rone, G. Cárdenas Hinojosa, and R. Andrews. 2022. Resighting Histories of Dart-Attached Tags in Cuvier's Beaked Whales (*Ziphius cavirostris*) and Fin Whales (*Balaenoptera physalus*) in the Eastern Pacific Ocean. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Kratofil, M.A., R.W. Baird, and D.L. Webster. 2022. Spatial Use of Pantropical Spotted Dolphins in Relation to Stock Boundaries and Environmental Features in Hawai'i. Poster Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Lagerquist, B.A., L.M. Irvine, T.M. Follett, E.A. Falcone, G.S. Schorr, B.R. Mate, and D.M. Palacios. 2022. Use of Navy Training Ranges by Blue and Fin Whales off the U.S. West Coast. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Martin, C.R., Guazzo, R.A., Helble, T.A., Alongi, G.C., Durbach, I.N., Martin, S.W., Matsuyama, B.M., Henderson, E.E. 2022. Minke Whale Call Rate Increases When Calling Conspecifics are Nearby. The 9th International Workshop on Detection, Classification, Localization, And Density Estimation of Marine Mammals Using Passive Acoustics, Honolulu, Hawaii, 7–11 March 2022.

Rone, B., D. Sweeney, E. Falcone, S. Watwood, and G. Schorr. 2022. Movements and Diving Behavior of Risso's dolphins in the Southern California Bight. Speedtalk Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Schorr, G., S. DeRuiter, B. Rone, D. Sweeney, R. Andrews, K. Dolan, E. Falcone, S. Coates, and S. Watwood. 2022. Context Matters: Multi-day to Multi-week Sound and Movement Tag Recordings Reveal Individual Variation in Responses of Cuvier's Beaked Whales to Navy Sonar. Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Shaff, J.F., M.A. Kratofil, and R.W. Baird. 2022. Beneath the Surface: Diving Behavior of False Killer Whales from Two Populations Across Diel and Lunar Cycles in Hawaiian Waters. Poster Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Sturza, M.T., and L. B. Heironimus. 2022. Consistency of Green Sturgeon Distinct Population Segment Genetic Assignments and Telemetry Data. North American Sturgeon and Paddlefish Society. Folsom, CA. October 23-27. Oral Presentation.

Sweeney, D., E. Falcone, S. Watwood, S. DeRuiter, and G. Schorr. 2022. Cuvier’s Beaked Whale Behavioral Responses Persist After Conclusion of Some Navy Sonar Exposures. Poster Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

Yahn, S., R. Baird, S. Mahaffy, and K. Robertson. 2022. Sexually Dimorphic Characteristics of Short-finned Pilot Whales, False Killer Whales, Pygmy Killer Whales, and Melon-headed Whales Assessed Using Fin and Body Morphometrics from Photos taken at Sea. Speedtalk Presentation, 24th Biennial Conference on the Biology of Marine Mammals, West Palm Beach, Florida, 1–5 August 2022.

B

Details of 2023 Monitoring Projects

Table C-1. 2023 Monitoring project details for Pacific Navy study areas/ranges: HSTT (HRC and SOCAL), MITT, NWTT, and GOA.

Project Description	Monitoring Questions	Intermediate Scientific Objectives (numbered as per Figure 1)	Continuing or Proposed New Start
Location: Hawaii Range Complex (HRC)			
Title: Long-Term Passive Acoustic Monitoring of Marine Mammals Utilizing the Instrumented Range at PMRF and SOAR **Methods:** Analysis of archived PMRF and SOAR hydrophone recordings **Performer:** NIWC Pacific; NUWC Division Newport	• What are the long-term trends in occurrence of marine mammals (e.g., minke, humpback, fin, Bryde's, Blainville's BWs) on the PMRF instrumented range?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes and testing ranges. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[a]. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #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[1].	Continuing from 2006
Title: Estimation of Received Levels of MFAS and Behavioral Response of Marine Mammals at PMRF **Methods:** PAM (PMRF), satellite and GPS tagging, photo-ID, biopsy, visual survey. **Performer:** NIWC Pacific; Cascadia Research Collective; HDR, Inc.	• What is the occurrence and estimated received levels of MFAS on 'blackfish,' humpback, minke, sperm and Blainville's BWs within the PMRF instrumented range? • What are the spatial-movement and habitat-use patterns of species that are exposed to MFAS, and how do these patterns influence exposure and potential responses? • What, if any, are the short-term behavioral responses of 'blackfish' and humpback, minke, sperm, and Blainville's BWs when exposed to MFAS/explosions at different levels/conditions at PMRF instrumented range?	#3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[1]. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #10: Evaluate acoustic exposure levels associated with behavioral responses of marine mammals to support development and refinement of acoustic risk functions. #11: Evaluate behavioral responses of marine mammals exposed to Navy training and testing activities to support PCoD. #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[1].	Continuing from 2011
Title: Pacific Islands Comprehensive Stranding Investigations	*(See this project under MITT, below)*		

Project Description	Monitoring Questions	Intermediate Scientific Objectives (numbered as per Figure 1)	Continuing or Proposed New Start
Location: Southern California Range Complex (SOCAL)			
Title: Cuvier's BW and Fin Whale Population Dynamics and Impact Assessment at the Southern California Offshore Anti-Submarine Warfare Range (SOAR) **Methods:** PAM, satellite tagging, photo-ID, visual survey **Performer:** Naval Undersea Warfare Center Newport; Marine Ecology & Telemetry Research	• What are the baseline population demographics, vital rates, and movement patterns for a designated key species in the SOCAL? • What, if any, are the short-term behavioral and/or vocal responses when exposed to sonar or explosions at different levels or conditions? • Does exposure to sonar or explosives impact the long-term fitness and survival of individuals or the population, species or stock (with focus on Cuvier's BWs)?	#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: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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. #7: Determine what behaviors can most effectively be assessed for potential response to Navy training and testing activities. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[1]. #9: Application of analytic methods to evaluate exposure and/or behavioral response of marine mammals to Navy training and testing activities. #11: Evaluate behavioral responses of marine mammals exposed to Navy training and testing activities to support PCoD development and application. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives. #13: Assess existing data sets which could be utilized to address the current objectives[1].	Continuing from 2016
Title: Southern California BW Occurrence **Methods:** PAM (moored, glider, towed-array, drifting buoys), visual survey **Performer:** Scripps Institution of Oceanography (University of California San Diego)	• What is the distribution of BW occurrence in the waters within and outside the SOCAL?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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. #8: Application of passive acoustic tools and techniques for detecting, classifying, locating, and tracking marine mammals.	Continuing from 2009, with special focus on BW since 2020

Project Description	Monitoring Questions	Intermediate Scientific Objectives (numbered as per Figure 1)	Continuing or Proposed New Start
Location: Mariana Islands Training and Testing (MITT)			
Title: **Pacific Islands Comprehensive Stranding Investigations** **Methods:** Necropsy, disease screening, genetic testing, stomach content analysis **Performer:** University of Hawaii Health and Stranding Lab	• What are the temporal and spatial patterns of odontocete strandings in the Hawaiian and Mariana Islands between 2000 and 2021? • What are the causes of mortality associated with odontocete strandings in the Hawaiian and Mariana Islands between 2000 and 2021? • What is the prevalence of diseases (morbillivirus, circovirus, toxoplasmosis) in stranded marine mammals?	#4: Evaluate potential exposure of marine mammals and ESA-listed species to Navy training and testing activities.	Continuing from 2018
Title: **Sea Turtle Tagging in the Mariana Islands Range Complex** **Methods:** Satellite tagging, visual survey **Performer:** PIFSC Marine Turtle Biology and Assessment Program	• What is the occurrence and habitat use of sea turtles in the MITT Study Area? • What is the exposure of sea turtles to explosives and/or sonar in the MITT Study Area? • Are there locations of greater sea turtle concentration in the MITT Study Area?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur. #4: Evaluate potential exposure of marine mammals and ESA-listed species to Navy training and testing activities. #12: Evaluate trends in distribution and abundance for populations of marine mammals and ESA-listed species that are regularly exposed to sonar and underwater explosives.	Final reporting in 2023

Project Description	Monitoring Questions	Intermediate Scientific Objectives (numbered as per Figure 1)	Continuing or Proposed New Start
Location: Mariana Islands Training and Testing (MITT) (continued)			
Title: **Beaked Whale Occurrence and Behavior in the Marianas** **Methods:** PAM **Performer:** HDR, Inc.; Cornell University	• What species of marine mammals, specifically beaked whales, are present in areas defined by the Navy as priority areas? • What are their spatial and temporal patterns of acoustic behavior?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur. #4: Evaluate potential exposure of marine mammals and ESA-listed species 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: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[1].	New start in 2022
Title: **Marianas Beaked Whale Expert Panel** **Methods:** Expert elicitation, literature review **Performer:** HDR, Inc; expert panel to be determined	• What is the status of the science, data gaps, and information applicable for consideration for future mitigation regarding beaked whale behavioral response, biology, Navy operations, and geographic features associated with strandings?	NA, potentially all	New start in 2023

Project Description	Monitoring Questions	Intermediate Scientific Objectives (numbered as per Figure 1)	Continuing or Proposed New Start
Location: Northwest Training and Testing (NWTT)			
Title: **Acoustic Tagging of Green Sturgeon to Evaluate Habitat Use Along the Washington Coast** **Methods:** Acoustic tagging **Performer:** Washington Department of Fish and Wildlife	• Where have acoustically tagged green sturgeon been detected on acoustic receivers deployed in Washington coastal and estuarine waters? • Do acoustically tagged green sturgeon demonstrate a predictive seasonal movement pattern between estuaries and coastal waters? • How frequently do tagged green sturgeon move between coastal and estuarine waters? • What is the typical range of distribution for acoustically tagged green sturgeon when occurring in Washington coastal waters?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	Continuing from 2020
Title: **Distribution of Southern Resident Killer Whales and their Prey in the Pacific Northwest** **Methods:** PAM, model development, visual survey, satellite tagging, analysis of archival data, acoustic pinger tagging glider, and stationary receivers **Performer:** NMFS Northwest Fisheries Science Center; University of Washington (School of Aquatic and Fisheries Sciences); Naval Undersea Warfare Center Keyport; Oregon State University	• What are the seasonal and annual occurrence patterns of Southern Resident killer whales relative to offshore Navy training ranges? • What is the oceanic distribution and seasonal variability of ESA-listed salmonid species that may be important prey for the Southern Resident killer whale?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #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: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species 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, with focus on salmonids starting 2020

Location: Northwest Training and Testing (NWTT) (continued)			
Title: Vessel-Based Marine Mammal Surveys in Puget Sound, Washington **Methods:** Visual survey **Performer:** Marine Ecology & Telemetry Research	• What marine mammal species are present in the area? • What is the seasonal occurrence and abundance/density of cetaceans in the study area? • Which and how do environmental variables affect the distribution and abundance of species in the study area?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	New start in 2022, final reporting 2023
Title: Characterizing the Distribution of ESA-Listed Salmonids in Washington and Alaska **Methods:** Acoustic tagging, biopsy **Performer:** NOAA Northwest Fisheries Science Center	• What is the oceanic distribution and seasonal variability of ESA-listed salmonid species that may be important prey for the Southern Resident killer whale?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	Continuing from 2018
Title: Acoustic and Visual Survey for Cetaceans in Behm Canal and Southern Clarence Strait, Alaska **Methods: Passive Acoustic monitoring, Visual survey** **Performer: NOAA Alaska Fisheries Science Center, Cooperative Institute for Climate, Ocean, and Ecosystem studies at University of Washington**	• What is the occurrence, distribution, and abundance of cetaceans in Behm Canal and Clarence Strait?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #8: Application of passive acoustic tools and techniques for detecting, classifying, and tracking marine mammals[1].	New start in 2022

Project Description	Monitoring Questions	Intermediate Scientific Objectives (numbered as per Figure 1)	Continuing or Proposed New Start
Location: Gulf of Alaska (GOA)			
Title: Telemetry and Genetic Identity of Chinook Salmon in Alaska **Methods:** Acoustic tagging, satellite tagging, biopsy **Performer:** University of Alaska Fairbanks; NMFS Northwest Fisheries Science Center	• What is the spatial distribution, movement, vertical distribution, population identity, occupied habitat, and natural mortality of Chinook salmon in the GOA?	#1: Determine what species and populations of marine mammals and ESA-listed species are present in Navy range complexes, testing ranges, and in specific training and testing areas. #2: Estimate the distribution, abundance, and density of marine mammals and ESA-listed species in Navy range complexes, testing ranges, and in specific training and testing areas. #3: Establish the baseline habitat uses, seasonality, and movement patterns of marine mammals and ESA-listed species where Navy training and testing activities occur.	Continuing from 2020

[1] Primary Research & Development and Demonstration Validation (DEMVAL) investments for tools and techniques supported by Office of Naval Research (ONR) Marine Mammal and Biology and Living Marine Resource programs.

[2] As continuing from 2018, this project is conceptually a refinement and continuation of 2017 **Project [N3]**, "Modeling the Offshore Distribution of Chinook Salmon in the Pacific Northwest." The updated project retains substantially the same monitoring questions.

Key: AFSC = Alaska Fisheries Science Center; BW = beaked whale; ESA = Endangered Species Act; GOA = Gulf of Alaska Training; GPS = Global Positioning System; HRC = Hawaii Range Complex; MFAS = Mid-frequency active sonar; MHI = Main Hawaiian Islands; MITT = Mariana Islands Training and Testing; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NWTT = Northwest Training and Testing; PAM = Passive Acoustic Monitoring; PCoD = Population Consequences of Disturbance; photo-ID = photo identification; PIFSC = Pacific Islands Fisheries Science Center; PMRF = Pacific Missile Range Facility; SOAR = Southern California Offshore Anti-Submarine Warfare Range; SOCAL = Southern California; SWFSC = Southwest Fisheries Science Center; UH = University of Hawaii.