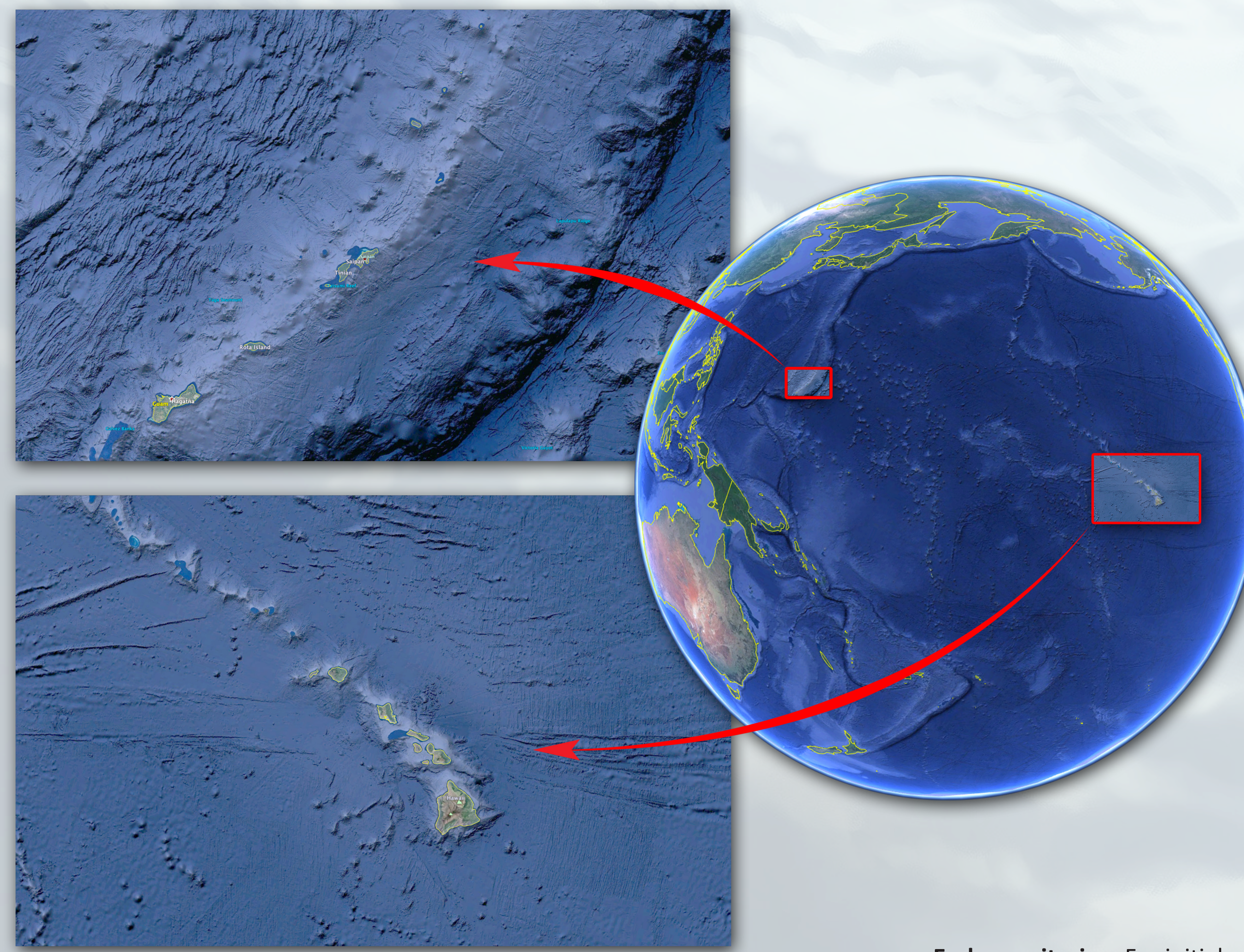




Monitoring in two archipelagos: strategic planning through adaptive management

Julie A. Rivers^{1*} and Robert K. Uyeyama²

1. U.S. Pacific Fleet Environmental Readiness Division, Pearl Harbor, HI
2. Naval Facilities Engineering Command Environmental Planning, Pearl Harbor, HI
*Corresponding author: julie.rivers@navy.mil



Since 2006, U.S. Pacific Fleet (U.S. Navy) has invested \$46.9M in marine mammal and sea turtle monitoring in the Mariana and Hawaiian Islands in support of environmental compliance for its activities authorized under the U.S. Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA). The process of decision-making to fund particular research projects is guided by both making science-based progress on the overarching programmatic goals of the US Navy's marine species monitoring program, as well as by an annual adaptive management review with the regulator (National Marine Fisheries Service)(NMFS) that assesses current progress and incorporates availability of new information and technology. Investments and medium term goals have refocused as the marine species monitoring program has progressed, and is expected to continue to change as shorter term goals are accomplished and new methods for achieving longer term goals of assessing the exposure and response of animals to stressors such as sonar are developed. The differences between the monitoring needs in the Mariana and Hawaiian Islands is illustrative of how adaptive management is continually shaping decision-making for monitoring investment.

Mariana Islands

Early monitoring: For initial environmental planning, began with 2007 large vessel line transect survey (DoN 2007) for baseline occurrence and density estimates. This was the first line transect survey in the region. In 2010 the monitoring program began with annual small vessel surveys, continuing to present.

Adaptive Management, measuring regulatory compliance and success through science:

2010: By forming regional partnerships with National Marine Fisheries Service (NMFS) and Marianas regulatory agencies, limited resources are leveraged to meet mutual scientific objectives.

2011: When one method (small boat surveys) did not result in comprehensive data (any baleen or beaked whale observations) a new method was implemented (focused analysis on NMFS archived acoustic data).

2013-2014: Successive updates to monitoring plan removed effort metrics and specific projects as regulatory requirements, replacing these with suggested methodologies to answer science-based monitoring questions.

2016: Comprehensive monitoring report combined results from the Marianas with all other Pacific training ranges, coinciding with implementation of the strategic planning process via formation of the monitoring steering group. This allows for adaptive management to implement relative changes in investments across different Navy ranges (spanning Atlantic and Pacific oceans) to best make progress on programmatic goals.

2010-2017: Current status: Establishment of basic occurrence knowledge

Regional collaborations and leveraging overlap of federal mission and dollars is cost-effective and resulting in data sharing, new coalitions and developing local expertise. It is expected to continue.

- Visual survey: The annual series of small boat surveys and photo-ID confirmed the occurrence of most expected subtropical species of odontocetes and confirmed a small seasonal population of humpbacks. But primarily due to rough offshore sea conditions, has resulted in very few beaked whale and (other) baleen whale sightings.
- Acoustic analysis: gliders and autonomous recording devices confirmed the occurrence of most expected species groups including baleen and beaked whales, and has described their seasonality.
- Genetics and tagging: Population structure and distribution across islands described for spinner dolphin and pilot whales and compared to some contradictory data from visual sightings. Long range movements to northern islands and offshore described for pilot whales and false killer whales. Introgressive hybridization of Fraser's dolphin mitochondrial and nuclear DNA into bottlenose dolphins discovered (Martien et al. 2015).
- Sea turtle tagging: collaboration with NMFS and local regulatory agencies for sea turtle satellite-tagging. Core habitat areas described for resident juvenile green sea turtles relative to nearshore Navy training areas. Interisland movements also detected between Guam and Tinian (hawksbill turtle).

Adaptive Management, addressing data gaps: No baleen whales sighted from small boats during non-systematic surveys, very few beaked whale sightings, and surveys limited to leeward sides of islands

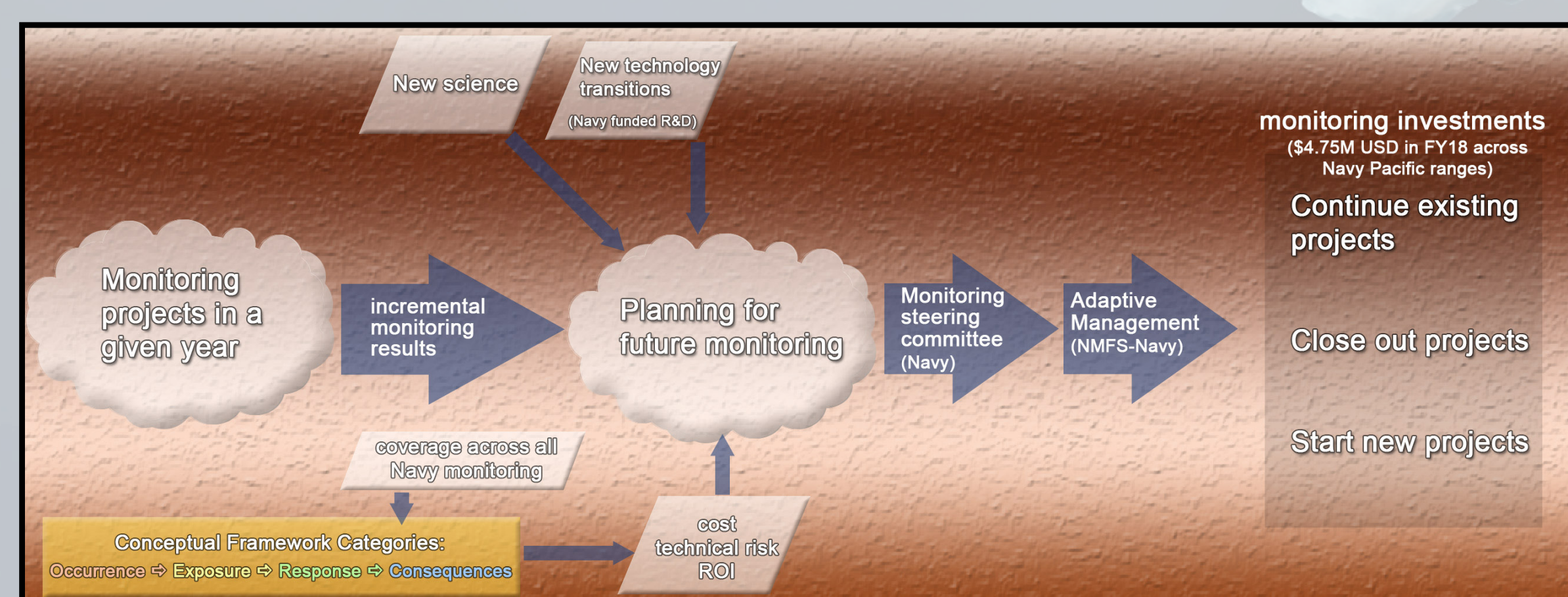
Changes implemented:

- Targeted acoustic analysis of baleen whales and beaked whales from NMFS archived data
- 2015: pilot shore survey of windward sides of Saipan and Guam
- 2015: modify annual winter survey to a targeted humpback survey in areas of anecdotal sightings
- Glider surveys of offshore areas

Results:

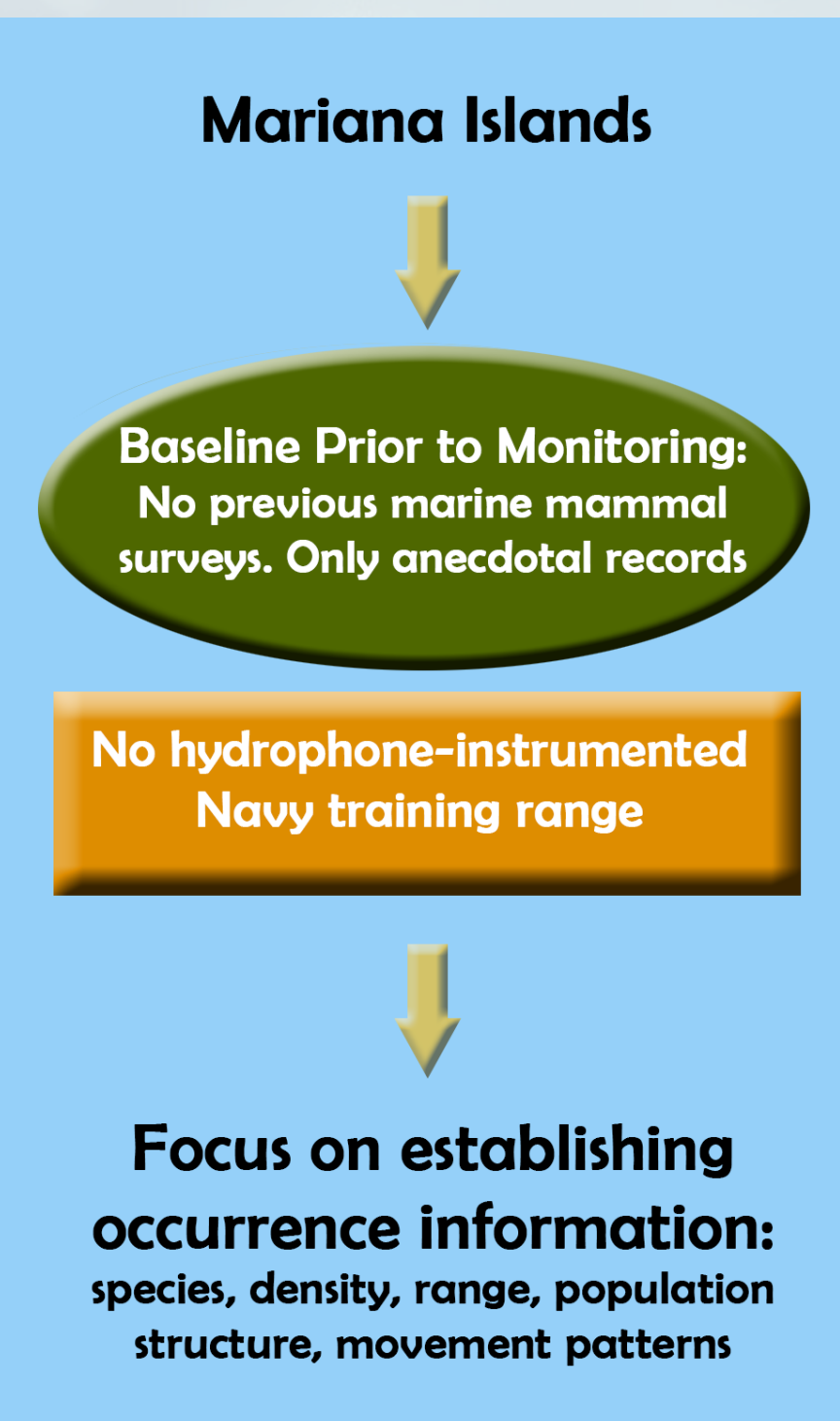
- Visual/biopsy/tagging: new information on western north pacific population of humpback whales from winter vessel survey (photo ID matches to other areas, re-sights within the Marianas, and genetic data on haplotypes) (Hill et al. 2016).
- Acoustic analysis: new information on seasonality of baleen whales, patterns of beaked whale occurrence and potential call variability, and identification of new unknown call (Nieukirk et al. 2016).
- Data shared with NOAA contributing to critical habitat designations.

Present and future 2018-2020: Continue to collaborate with NOAA and local regulators. Likely to complete the intended goal of establishing a core corpus of marine mammal and sea turtle occurrence information for the Marianas. Monitoring investments may gradually shift to other protected species (e.g. coral) or training ranges with hydrophone-instrumented ranges to focus more on the Conceptual Framework categories of Exposure and Response.



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Hawaiian Islands

Early monitoring: Hawaii was the first Navy range complex to develop a monitoring plan. And when monitoring began in 2007, conducting surveys concurrent with training events were viewed as the only way to obtain the exposure and response data that NMFS requested in their MMPA (2009) and ESA (2007, 2009) authorizations.

Adaptive Management, measuring regulatory compliance and success through science:

2002: Archiving of marine mammal acoustic data obtained using the hydrophones at the instrumented range (PMRF) began.

2007-2011: Approval was obtained for research aircraft to conduct orbiting of Navy warships to obtain focal follows. And, additional small vessel and aerial surveys were scheduled during major training exercises. Navy also deployed marine mammal observers on the destroyers, as well as on small boats during training with underwater explosives. Another focus was aerially searching for animals in distress during and after training.

2011 - Development of layered monitoring: The approval to record during Navy training events opened up significantly more monitoring possibilities. Furthermore, surveys conducted during large, pelagic training events were difficult to schedule and producing very little data that could be quantitatively analyzed to investigate exposure and response. In the subsequent years, it became clear that it made the most sense to refocus the multiple components of Hawaii monitoring investments on the instrumented range during a training event regularly held there, Submarine Command Course (SCC).

2012: The Navy and NMFS moved away from evaluating compliance using metrics such as a certain number of hours of visual survey, or a certain number of acoustic listening devices deployed to being based on progress towards scientific questions. Furthermore, both agencies agreed that by utilizing unique assets like the PMRF hydrophone range, and focusing on one location and one training event, that progress towards scientific objectives could be maximized.

2012-2017: Current status: behavioral response study

Multi-layered combination of projects during enabled the development of a behavioral response study conducted during actual training events.

- Visual observers on destroyers, aerial focal follow orbiting the destroyers, instrumented range recording and archiving animals and ships, animals tracked that had been satellite-tagged prior to SCC, aerial shoreline surveys for strandings after SCC.
- Analysis producing estimates of sonar exposure (received level) at specific animals that were sighted over acoustically localized.
- Developing analysis techniques to quantify animal response during sonar training and to associate these with an estimated exposure level. These include baleen whale localizers track movement patterns, and kinematics algorithms to measure behavioral states.
- Fifteen years of archived acoustic data are being analyzed to investigate long term trends in populations at PMRF.

Adaptive Management, shifting investments: Through years of adaptive management, trust between the Navy and NMFS grew and flexibility to adapt grew from that trust.

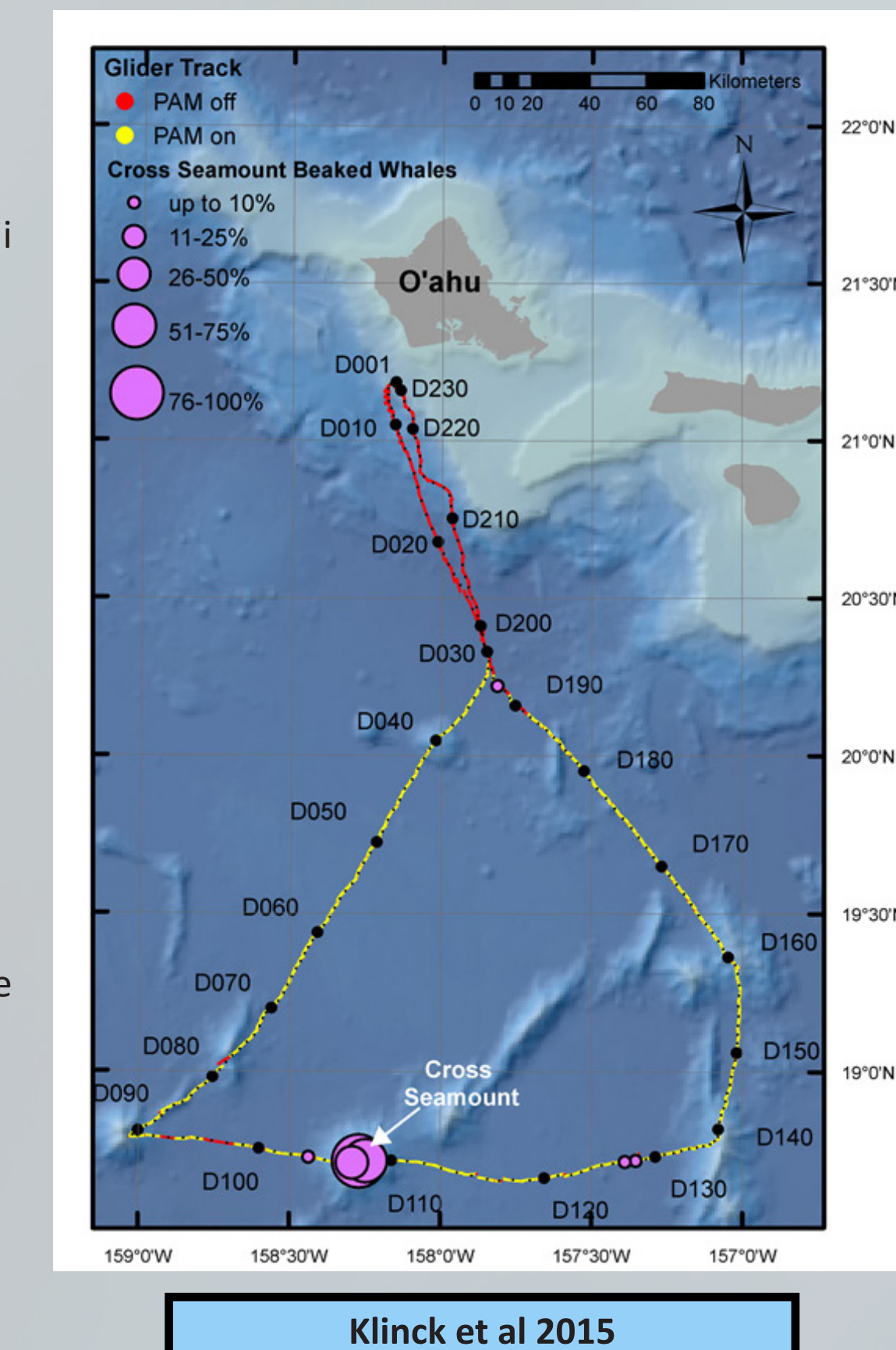
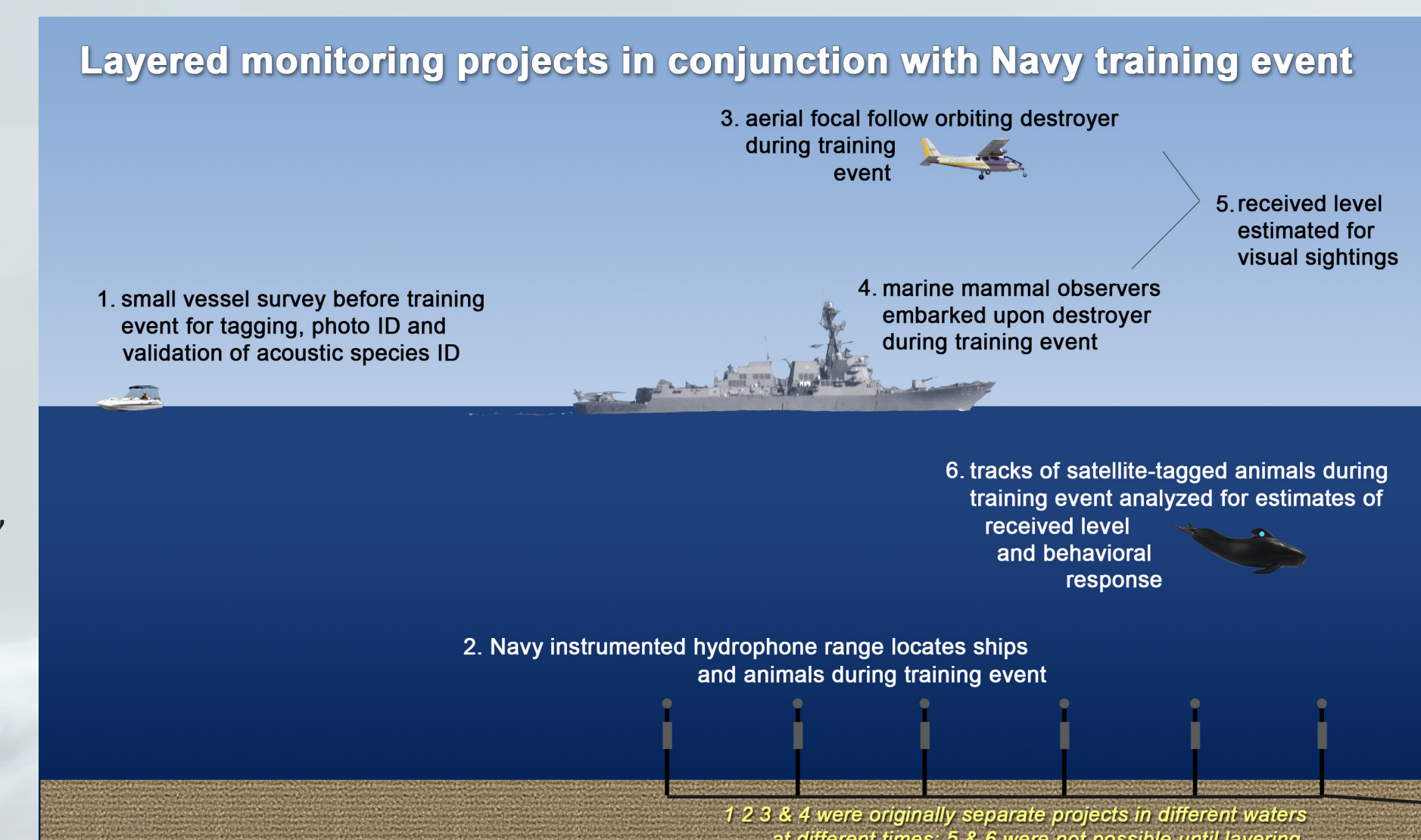
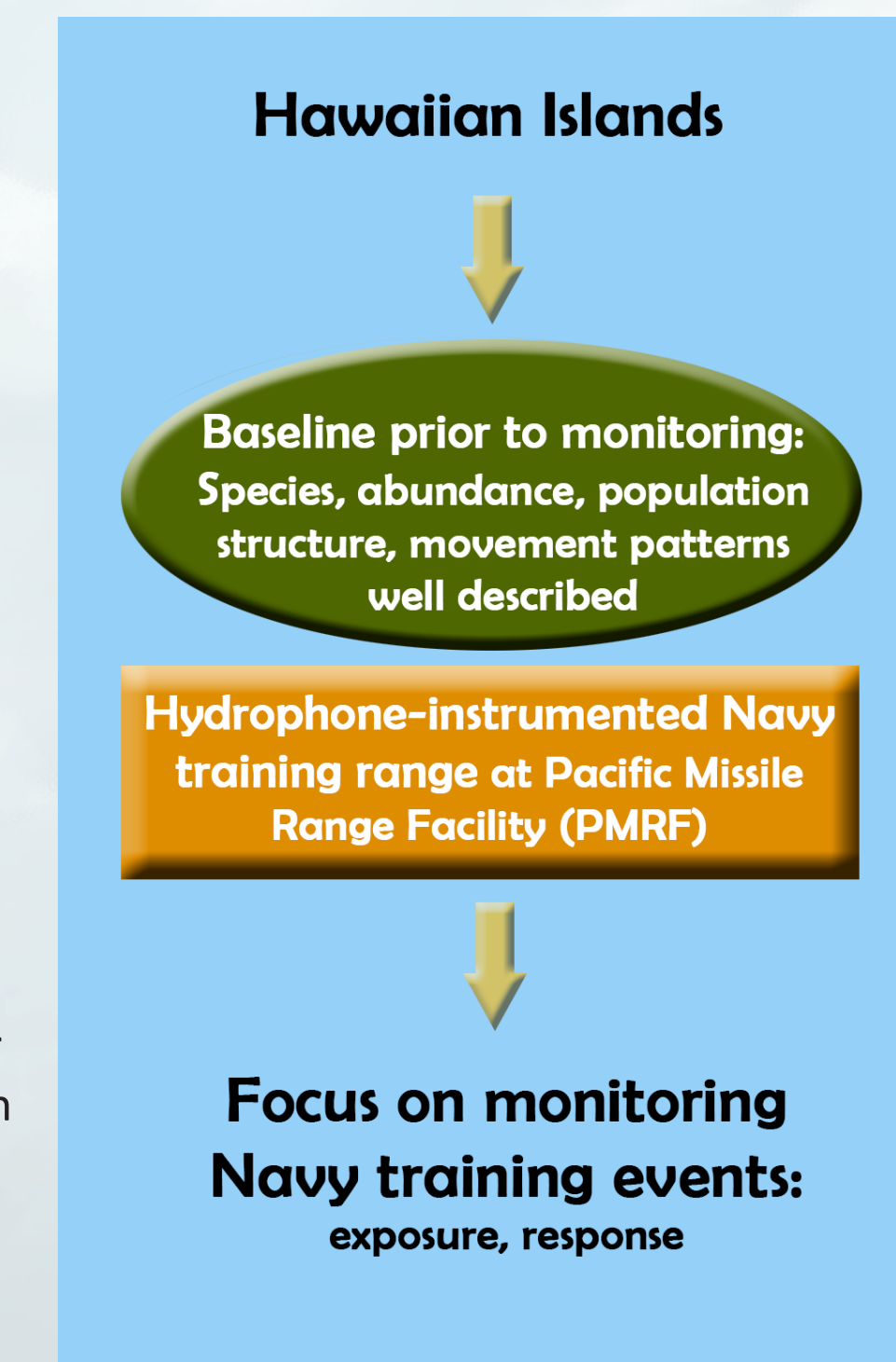
When a promising field method emerged, investments were made. When a method did not return the quantity or type of data desired, the agencies moved on to new methods.

This iterative process has been one of the keys to the success of the program in Hawaii and the Navy's other range complexes in both the Pacific and Atlantic.

Results:

- Numerous publications on marine mammal behavioral response from PMRF.
- Data shared with NOAA contributing to critical habitat designations.
- Analysis of long-term (15 year) archive of acoustic detections from the Navy instrumented range has begun and may enable assessment of population trends for multiple species.
- Offshore glider deployments provided data on Cross Seamount beaked whale, as well as humpback whales and other species.

Present and future 2018-2019: Continuation of behavioral response study at PMRF. Continue to utilize new Mote ARGOS (satellite tag) receiver stations at the islands of Niihau and Kauai, enabling greater data throughput with new GPS (FastLoc) dive tags during monitoring of Navy training events Will continue to evaluate return on investment (per the Conceptual Framework of Occurrence, Exposure, Response, Population Consequences) via Adaptive Management.



Klinck et al 2015

Adaptive management: The U.S. Navy's authorization under MMPA mandates an annual meeting with the regulator (NMFS) to adaptively adjust the monitoring program given the progression of monitoring knowledge and evolution of monitoring needs. The Strategic Planning process incorporates the conclusions of adaptive management to choose monitoring investments based on a programmatic view across the monitoring program spanning all Navy ranges, weighing cost, likely return on investment, and technical risk.



Navy investment in the Pacific Fleet marine species monitoring program (\$USD): Includes all five Pacific Ocean training and testing ranges:
2006 - \$0.50M 2007- \$3.46M 2008- \$0.45M 2009 - \$1.09M 2010 - \$2.90M
2011 - \$3.88M 2012 - \$3.61M 2013 - \$6.68M 2014 - \$5.26M 2015 - \$4.66M
2016 - \$4.45M 2017 - \$5.20M 2018 - \$4.75M

Links: To learn about the Navy actions for at-sea training and testing:
HSTT (www.HSTTeis.com) & MITT (www.MITTeis.com)



Conceptual Framework Categories: The conceptual framework for monitoring defines the progression of monitoring knowledge in the following categories. Occurrence (of species/populations) → Exposure (to stressors such as sonar) → Response (by animals to exposure) → Consequences (population consequences of disturbance [PCoD]). Read more about the Conceptual Framework in the independent Scientific Advisory Group Recommendations report (DoN 2011)

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