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# Report to the Western Pacific Regional Fishery Management Council

The Pacific Islands Fisheries Science Center (PIFSC or Center) administers and conducts scientific research and monitoring programs that produce science to support the conservation and management of fisheries and living marine resources. This is achieved by conducting research on fisheries and ocean ecosystems and the communities that depend on them throughout the Pacific Islands region, and by dedicating efforts to the recovery and conservation of protected species. The Center is organized into five major divisions: the Operations, Management, and Information Division (OMI); Science Operations Division (SOD); Fisheries Research and Monitoring Division (FRMD); Protected Species Division (PSD); and Ecosystem Sciences Division (ESD).

PIFSC continues to improve its science and operations through collaboration and integration across divisions, and increased communication, cooperation, and coordination with partners and stakeholders. In 2018, the Center developed a 5-year framework for annual prioritization of research and monitoring activities in order to fully utilize the capabilities of PIFSC and its partners (e.g., NOAA Fisheries Pacific Islands Regional Office (PIRO); Western Pacific Regional Fishery Management Council (WPRFMC)). In 2019, the Center released an updated 5-year science plan. All activity updates and reports herein are organized in accordance with the research themes (per the PIFSC Science Plan 2019-2023) outlined below:

1) Promote Sustainable Fisheries
2) Conserve Protected Species
3) Research to Support Ecosystem-based Fisheries Management (EBFM) and Living Marine Resource Management
4) Organizational Excellence

This report concludes with a listing of publications produced during this reporting cycle.

# 1. Promote Sustainable Fisheries

### Fisheries Research and Monitoring Division Scientists Convened the First Guam Bottomfish Management Unit Species Data Workshop

NOAA Fisheries scientists from the Pacific Island Fisheries Science Center (PIFSC), Fisheries Research and Monitoring Division (FRMD) convened the first Bottomfish Management Unit Species (BMUS) Data Workshop on the island of Guam. The purpose of the workshop was to review all available data for Guam BMUS that may be used for the 2024 benchmark stock assessment. The BMUS Data Workshop is a partnership among PIFSC, the Western Pacific Regional Fishery Management Council (WPRFMC), and the Division of Aquatic and Wildlife Resources (DAWR). It is part of a larger overall effort to engage with fishing communities in the region and enhance inclusion, transparency, and partnership in the stock assessment process. This series of data workshops kicks off an 18-month process of developing the assessment. On day one of the workshops, ten DAWR staff offered their insights on creel survey implementation and data management in two breakout groups. Twelve fishers provided their interpretation, perspective, and information on the various bottomfish data sources through three break-out groups on day two. Six fishers from the Guam Fishermen's Cooperative Association provided their insights on the bottomfish fishery, the species trend over time, and data collection through two break-out groups on day three.

Overall, the fishermen's perspective provided much needed context to the data collected by DAWR. The perspective on the catch trend for each BMUS is species-specific because some fishermen target particular species like onaga and ehu while others target more mixed-species particularly those occurring at shallow and mid-depths. The fishery is highly dependent on the weather. Good weather is relatively rare and overlaying that with the fishery occurring on weekends, there are only a few days in the year where the fishery operates. The fishermen and data collectors provided a substantial amount of information that the stock assessment scientists, Dr. Erin Bohaboy and Dr. Toby Matthews, can use to prepare the available data for the upcoming 2024 BMUS benchmark stock assessment.

Some of the highlights from the data workshop include:

- Fishermen's experience agreed with many of the trends that we see in the boat-based survey participation and landings estimates, including: 1) deepwater bottomfishing has increased in recent years, especially since the pandemic; 2) bottomfish catch is highly variable between years, often spiking in 2–7 year cycles; 3) some BMUS are only rarely landed because they are generally undesirable (e.g., *Caranx ignobilis* / mamulan) or not commonly caught (e.g., *Variola louti*/gadao matinggan and *Pristipomoides sieboldii*/buninas/pink kalekale).
- Fishermen's behavior regarding if, when, where, and how to fish, as well as which species to target, varies depending on many diverse factors such as wave size / swell

direction/current/wave period, wind, boat/fisherman size/ability, fishing experience, fuel prices, market fish prices, market fish supply (not always possible to sell all the catch), catch rates (whether fish bite is good enough), work / primary job schedules, requests from family and friends for fish or certain species (including special events), shark interactions at fishing sites, and crowding of other fishermen / people / vehicles / trailers at launch points and fishing grounds.

- *Etelis boweni* / giant ehu are definitely present around Guam and are being caught by fishermen. DAWR staff seem confident in their abilities to differentiate all sizes from *E. carbunculus* or ehu. Fishermen can also determine which are the large ones (often based on shape of the tail); and they show interest in learning more. There was likely confusion between *P. sieboldii* (buninas / pink kalekale) and *P. filamentosus* (buninas/pink ōpakapaka) over the boat-based creel survey time series, but identification has improved, especially since 2014.
- Charter fishing boats, mostly small six-customer crafts, continue to operate trips. Fishing behavior of charters is different from the majority of Guam fishermen (generally lower catch rates, shorter trips) and can vary depending on the customer (e.g., military charters may harvest more fish, tourists may be only interested in big gamefish or fishing fun). No fishing head boats remain, and charters are less common than they were in the 1990s.

The valuable insights from the bottomfish fishermen will not only contribute to the improvements in the available data but the interactions between the fishermen and the scientists help build the trust and increase the potential for further collaboration. All parties involved in the workshop worked together towards a common goal of sustaining the bottomfish fishery through collaboration, open communication, and transparency.

*Figure 1. Opening day of the Guam bottomfish fisherman session of the Bottomfish Management Unit Species Data Workshop bringing brought together twelve fishermen, PIFSC scientists, staff from Division of Aquatic and Wildlife Resources and the Western Pacific Regional Fishery Management Council.*

*Figure 2. Dr Erin Bohaboy presenting to the GFCA participants on all gathered available data that can potentially be used for the 2024 benchmark stock assessment.*

**Evaluation of a Long-term Information Tool Reveals Continued Suitability for Identifying Bycatch Hotspots but Little Effect on Fisher Location Choice**

Bycatch represents a critical threat to many marine megafauna species. Dynamic ocean management (DOM) has been introduced to reduce bycatch interactions, but it currently provides information products only. These products delineate spatiotemporal areas of high bycatch of specific species with the goal of helping fishers engage in self-directed avoidance. Information-based DOMs are only effective if fishers use them. We reviewed one of the longest and earliest DOM informational products, TurtleWatch, a U.S. government program which provides information to help Hawai‘i shallow set pelagic longline fishers avoid North Pacific loggerhead sea turtle (*Caretta caretta*) interactions based on a specific sea surface temperature band. TurtleWatch has defined an area that covers 47% of loggerhead interactions; however, fishers have not been incentivized to use the product. Further, the rate of interactions has actually increased since TurtleWatch's deployment in 2005; fishers continue to operate within and closer to the recommended avoidance area as interaction limits are approached. This indicates that the interaction limit, which is shared among all fishers, may have created a common pool resource that disincentivizes individual fishers to avoid hotspots of loggerhead bycatch. Our findings suggest strong and appropriate incentives are needed for DOM to effectively reduce bycatch.

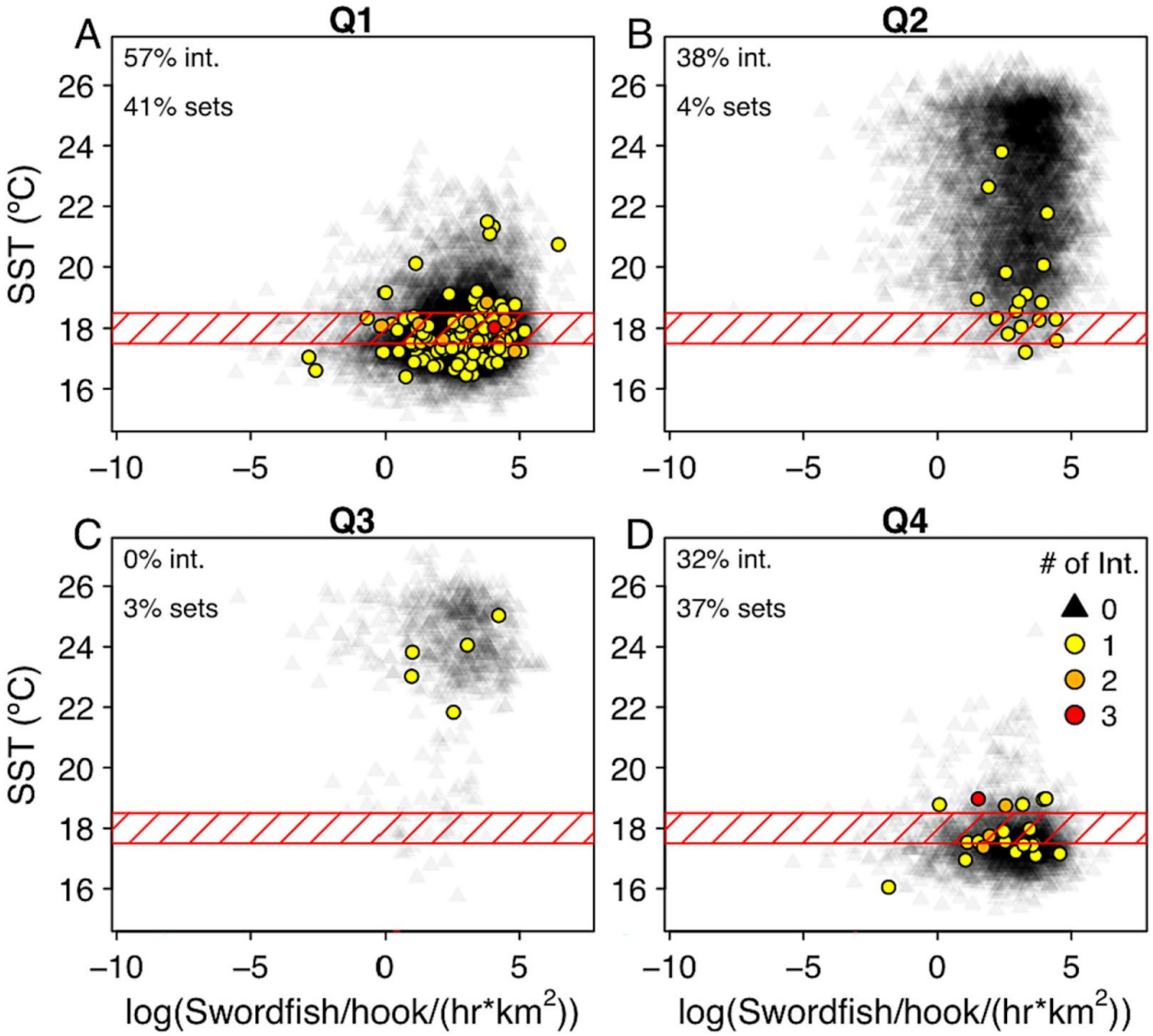


*Figure 3. Sea surface temperature (SST) as a function of swordfish CPUE (log(swordfish/hook/(h * km$^2$))) for every Hawai'i shallow-set pelagic longline fishery set without a loggerhead sea turtle interaction (black triangles) or with an interaction (colored dots; warmer colors indicate more turtles per set) for the first (A), second (B), third (C), and fourth (D) quarters aggregated from the years 2005–2019. The 17.5–18.5 °C TurtleWatch band is shown in the red hash. In the upper left of each plot is the percent of interactions occurring in the band (% int.) and the percent of fishery sets occurring in the band (% sets) for that quarter.*

**Tackling Technical Debt in the Pacific Islands Region**

Technical debt refers to maintaining data systems that rely on older technologies, are costly to maintain, require a lot of manual steps and maintenance, and are often incompatible with other data systems.

The Fisheries Monitoring Program (FMP) and Fisheries Reporting and Bycatch Program (FRBP) work closely together to collect, verify, analyze, and report on catch and effort data to support

fisheries management in the Pacific Islands Region (PIR). The programs currently rely on a combination of modern and legacy software and technologies to support the entire data lifecycle. Over the next few years, the programs will continue to tackle technical debt by investing resources and money into developing modern and interoperable data systems. The programs will use lessons learned from recent development projects such as the integrated reporting system for Hawai‘i data and the Logit application suite. FMP/FRBP staff participate in the NOAA Fisheries Information System (FIS) program, a state-regional-federal partnership that fosters collaboration across regions and funds innovative projects focused on implementing modern technologies and improving the quality of fisheries-dependent data. In August 2022, FIS hosted an annual meeting in Seattle, Washington, which brought together participants in the FIS community from all regions and headquarters. Participants recognized that there is an immense negative impact of legacy data and information systems and technical debt, and a pressing need for modernization of NOAA Fisheries systems.

As a result, the FIS Project Management Team made the following recommendation:

*FIS should host a workshop on the topic of legacy fishery-dependent data and information systems modernization. It should include discussions on transition planning to ensure thoughtful progression through the project lifecycle to avoid accumulating future technical debt. Using the Fisheries Information Management Modernization Workshop (FIMM) as a model, this workshop would provide NOAA Fisheries with aggressive, actionable steps for moving forward.*

FMP/FRBP staff are on the planning team for this workshop and will use the outcomes to help prioritize projects which focus on reducing technical debt in the PIR.

# 2. Conserve Protected Species

## ARC Light: Evolving Survey Approaches for Hawaiian Monk Seals in the Northwestern Hawaiian Islands

*Figure 4. A field camp at Manawai (Pearl and Hermes Reef). While most camps in the NWHI will be abbreviated in the 2023 season, field biologists will make the most of the time to identify, tag, and rescue animals.*

NOAA's Hawaiian Monk Seal Research Program (HMSRP) has been monitoring monk seals in the Northwestern Hawaiian Islands (NWHI) for four decades, compiling one of the most comprehensive and long-running data sets in conservation science to guide recovery of this endemic Hawaiian species. As with any long-running effort, our program evolves to meet research needs with ever-changing conditions and constraints. In 2023, we will pilot a new framework to maximize scientific value and recovery actions within a shortened NWHI field season.

During a standard ARC season, camps are established for 3–4 moths at 5 sites: Lalo (French Frigate Shoals), Kamole (Laysan), Kapou (Lisianski), Manawai (Pearl and Hermes Reef), and Hōlanikū (Kure Atoll). Our general plan for the 2023 ARC Light season is to maintain a full

camp season only at Lalo (in conjunction with the NOAA Marine Turtle Biology and Assessment Program and other partners as appropriate), where the majority of life-saving interventions for seals occurs annually. The islands of Nihoa and Mokumanamana will be surveyed briefly during the cruise which drops off the Lalo camp staff (similar to a standard ARC season). Throughout our ~30 day research cruise, we will establish short (16–20 day) camps at Kamole, Kapou, and Manawai. As other agencies conduct work at Hōlanikū (Kure Atoll Conservancy), Kuaihelani (Midway Atoll; U.S. Fish and Wildlife Service (USFWS)), we will support those partnerships and add staff to those teams during our research cruise and as other opportunities permit. We will also rely on partnerships with the U.S. Navy and Niʻihau Ranch to survey seals on Niʻihau (typically conducted by HMSRP teams during research cruises in ARC years).

Given the abbreviation of field efforts at most sites during the ARC Light season, some of our normal research and recovery activities will necessarily be deprioritized. We acknowledge that a reduction in on-the-ground presence will translate to fewer opportunities for life-saving interventions. However, this shortened season is designed to maintain sufficient continuity on our most essential population assessment activities so that the following ARC season is as efficient and complete as possible. Our top priorities in the ARC Light season will include

- conducting survival-enhancing interventions (e.g., disentangling seals from marine debris, treating abscesses);
- monitoring births to maintain data crucial to understanding reproductive rates of the population and tagging weaned pups to identify individuals and track survival;
- documenting threats to seal survival, and
- identifying/re-sighting marked individuals for population counts and tracking (with a priority on juvenile individuals that contribute most to survival estimates).

The 2023 pilot season of ARC Light will give us the opportunity to evaluate new survey and analytical methods, explore greater partnerships, consider ways in which technological advances can improve our efficiency, and refine our survey approach for future years. We anticipate a full ARC season will occur in 2024, which will be critical to the success of our long-term monitoring and recovery program.

**Cetacean Research Program**

The Cetacean Research Program has advanced our passive acoustic data collection and processing enterprise which strives to improve assessments for false killer whales and other species. Among these improvements is automating the process of detecting animal location using the towed hydrophone array data. In the field, localizing false killer whale subgroups is a painstaking process that can be influenced by analysts' decisions about animal groupings. By automating the signal detection and tracking process, the potential for subjective decisions is reduced, providing a reproducible approach and outcome. This study, in collaboration with the

University of Hawai‘i Ocean and Resources Engineering Department, developed automated tools to track and localize acoustic subgroups of animals with towed hydrophone arrays. These tools will allow acoustic information to be incorporated in future monitoring and assessment work, including abundance estimation efforts.

As part of this endeavor, three packages were developed (Fig. 5). The first package allows raw audio data to be processed into Time-Differences-Of-Arrival (TDOA) tracks. These tracks indicate the bearings (direction) to different acoustic sources (groups/subgroups of animals) with respect to the boat position. The tracks are then used as an input into the second package, in which groups/subgroups are localized and perpendicular distances from the boat trackline are measured. The third package optionally processes and imports information from Pamguard field databases for a quality assessment check. Since these packages allow for automated processing, they provide an efficient and objective way to localize animal groups/subgroups based on both whistles and echolocation clicks. While the packages were developed for false killer whales, they also perform well on data from other species. For example, CRP is currently collaborating with Southeast Fisheries Science Center to modify the approach used with stationary sensors with a goal of localizing and tracking endangered Rice's whales.

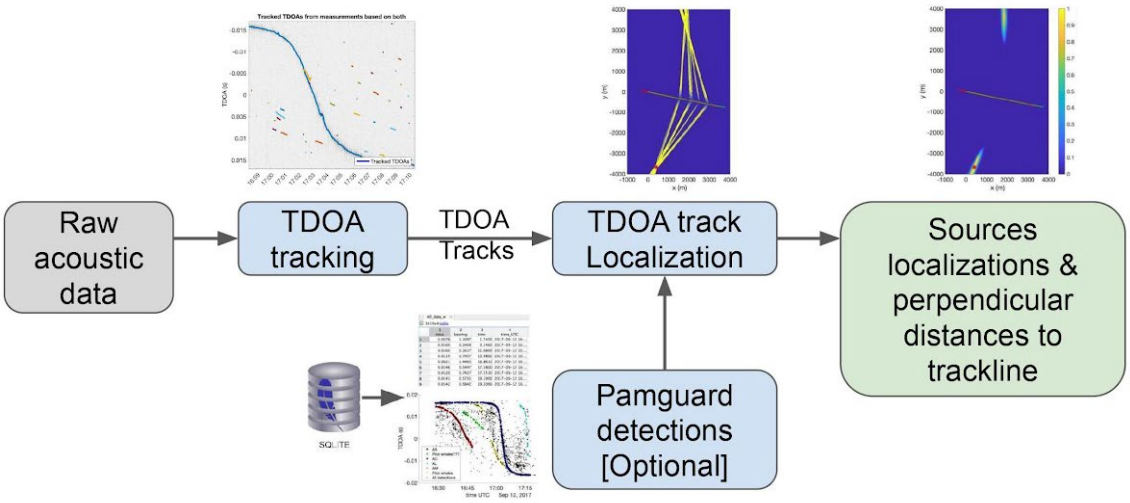


*Figure 5. Localization workflow with the developed packages. These packages (blue boxes) allow for tracking and localization of subgroups by utilizing the Time-Differences-Of-Arrival (TDOA) of a signal between a sensor pair and corresponding ambiguity surface computation. An optional package brings in detections from a database produced by the open source software, Pamguard. The outputs are the location of sources along with the perpendicular distances between sources and boat trackline (green box).*

**Leatherback Turtle Monitoring and Conservation in the Solomon Islands**

Endangered western Pacific leatherbacks have declined by 5.7% per year at their primary index nesting beach (2001–2017, Jamursba Medi, Indonesia); therefore, this population is of particular

interest to NOAA Fisheries. The Solomon Islands host some of the most important nesting grounds for the western Pacific population of leatherback turtles, and PIRO has supported a research and conservation program overseen by The Nature Conservancy (TNC). in the country since 2020. After helping establish the project, Dr. Alexander Gaos spent 12 days in the Solomon Islands in early December 2022, advising and supporting research endeavors and engaging with national and local stakeholders, with a focus on improving the research and conservation program at Haevo Beach. The visit was extremely productive, with two successes of particular note:

1) *Satellite tagging:* Dr. Gaos helped oversee the initiation of TNC's satellite tagging campaign at Haevo Beach, providing instructions and guidance on applying satellite tags and guiding the overall process. In previous years, NOAA researchers in California applied a satellite tag to a leatherback that subsequently traveled to the Solomon Islands where it was observed nesting at Haevo Beach. Despite this direct knowledge of connectivity between the two countries, no satellite telemetry efforts have been undertaken at Haevo Beach until Dr. Gaos's visit. He led the application of satellite tags to an unprecedented 7 leatherback turtles (Fig. 6) and taught local rangers to apply additional tags after he departed. With these efforts, the team hopes to understand how frequently Haevo leatherbacks migrate into the U.S. EEZ and generate other important spatial ecology information.
2) *Improve hatchling production:* A large proportion of the nests deposited by leatherbacks in Haevo are subject to tidal inundation (which leads to mortality) and poaching. Given this context, most nests are relocated to protected areas on the beach. Gaos helped the Haevo research team (Fig. 7) plan efforts to improve the hatching success of these nests and thus maximize hatchling production. He trained the team on the handling of eggs during relocation and preparation of the sand in the protected areas to ensure appropriate gas exchange and minimal organic content, two factors that are important for embryonic development.

*Figure 6. A female leatherback emerging from the ocean at night (full moon, no flash!) with a satellite tag applied by the local team and Dr. Alexander Gaos of NOAA PIFSC.*


*Figure 7. Dr. Alexander Gaos with members of the Haevo, Solomon Islands, leatherback conservation team.*

## 3. Research to Support EBFM and Living Marine Resource Management

The RICHARD (*Rainier* Integrates Charting, Hydrography, and Reef Demographics) mission aboard the NOAA Ship *Rainier* will conduct research and hydrographic survey over the reefs and slopes surrounding the islands of American Sāmoa and the Pacific Remote Islands. NOAA Scientists from across several different line offices, including PIFSC, will conduct a joint mission to complete hydrographic surveys that measure water depths and diver-based surveys to collect information on corals, fish, and changing ocean conditions as part of the National Coral Reef Monitoring Program. NOAA staff and scientists collect data to

- ensure that coastal regions are safe for navigation,
- map the ocean floor and update nautical charts, and
- examine fisheries habitat, coral reef health, and marine geologic processes.

*Figure 8. Vibrant array of tropical coral reefs and fish at the National Marine Sanctuary of American Sāmoa.*

The coral reef surveys are conducted by scientists from PIFSC Ecosystem Sciences Division, Archipelagic Research Program. The data collected will bolster NOAA's long-term, fisheries-independent data sets (known as Reef Assessment and Monitoring Program (RAMP), from 2000–2013) that are used to track the status and trends of coral reef fisheries, their habitats, and changing ocean conditions. These data complement monitoring efforts by local agencies and support their coral reef fisheries management efforts. Managers can also use the data to understand how the coral reefs and ocean conditions have changed— an important part of sustainably managing the coral reef ecosystems and the fisheries for the communities that depend on them.

During the mission, NOAA Ship *Rainier* will deploy four 28-foot boats each day; two will support the mapping surveys in shallow areas and two will support diver-based surveys on the reef. Multibeam echo sounders on the *Rainier* and the two small boats will measure water depth and provide a detailed image of the seafloor using sound waves.

*Figure 9. Graphic of a NOAA survey vessel scanning the ocean floor using multibeam sonar.*

The other two small boats support PIFSC divers on multiple survey sites around the islands from 0 to 30 meters depth. The scientists record fish and habitat data, collect images of the ocean floor, and swap out instruments that track ocean chemistry. These surveys are non-invasive and do not involve taking any marine life.

The RICHARD mission will run from March through September, during which we will make several stops in American Sāmoa. NOAA will provide opportunities for the public to tour the *Rainier* and learn more about our mission during outreach events when the ship is in port.

# 4. Organizational Excellence

## Publications

### Technical Memorandum

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