National Marine Fisheries Service
Pacific Islands Fisheries Science Center
4(1)
146th SSC
December 2022

Report to the Western Pacific Regional Fishery Management Council

Mother-pup pairs at Manawai, observed during the 2022 season. (Photo: NOAA Fisheries)

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

PIFSC Life History Program Collects BMUS Samples on Marianas Research Cruise

The primary mission of the Pacific Islands Fisheries Science Center (PIFSC) Life History Program (LHP) is to provide biological, ecological, and population dynamic information for federally managed species. Biological sampling of commercial, recreational, and subsistence-valued bottomfish management unit species (BMUS) for life history research is an important component of sustainable fisheries management. These samples (otoliths, eye lenses, gonads, and fin clips) provide estimates of length at age, growth rates, longevity, aspects of reproduction (size and age at maturity, fecundity, and spawning season), stock structure, and mortality. This information is used to determine stock assessments, including assessments that use a data-poor approach. Additionally, life history data are essential for those developing local management strategies.

Biological samples for life history research in the Mariana Archipelago fishing grounds are primarily collected by the Commercial Fisheries Biosampling Programs (CFBS) on Guam and Saipan. However, recent research found that exploitation, specifically of deepwater snappers, results in life history estimates that differ from estimates from unexploited populations. This can lead to an inaccurate portrayal of fish production in the exploited areas which would then lead to stock assessment model misspecification. Hence, biological samples from unexploited areas are required to put the estimates from exploited areas in the proper context. Samples from these areas are also necessary for LHP climate change research. These samples allow examination of latitudinal gradients (a proxy for temperature) to determine plasticity in life history traits and the impact of temperature as a function of metabolism on those traits, thus providing insights into how BMUS will respond to climate change. Because samples from the northernmost islands are beyond the reach of the fishing fleets, research surveys aboard federal ships are currently the only means to acquire these samples.

The NOAA Ship *Rainier* was the support platform for a leg of the *Rainier* Integrates Charting, Hydrography, and Reef Demographics (RICHARD) research mission. Personnel from LHP and a commercial fisherman from Saipan, CNMI, joined the ship for seven days of operations to collect BMUS biological samples from the commercial fishing grounds (Rota, Tinian, Saipan, Marpi Reef) to supplement collections by the CFBS, as well as from the relatively unexploited areas to the north (Anatahan, Sarigan, and Zealandia). Each morning, the small boats, modified for BMUS fishing operations, were launched from the *Rainier* and targeted BMUS habitats (100–500 m). The fish captured during the fishing operations were retained in coolers and processed by the scientists each night. During the processing, the fish were measured and weighed, and their otoliths, gonads, and fin clips were extracted. A subset of *P. zonatus* were also sampled for eye lenses to advance fish ageing research.

Each night, PIFSC scientists worked with the *Rainier* Survey Team to identify potential BMUS locations using the newly acquired bathymetry data. The small boats' fathometers were not capable of reaching BMUS depths and the plotters were outdated. Working with the survey team helped the scientists overcome this 'blind' fishing and increased the efficiency of fishing operations.

Figure 1. A variety of different sized ehu (Etelis carbunculus) (left) wait their turn to be processed by scientists (right). Photo: NOAA Fisheries.

PIFSC Stock Assessment Program Participates in Major Initiative by the Center for the Advancement of Population Assessment Methodology (CAPAM)

Figure 2. PIFSC Stock Assessment scientists at the FAO Headquarters, in Rome, Italy during the CAPAM technical workshop on fisheries stock assessment good practices October 24–28, 2022. From left are John Syslo, Marc Nadon, Nicholas Ducharme-Barth, Felipe Carvalho, Meg Oshima, Jon Brodziak, and Erin Bohaboy. Photo: NOAA Fisheries.

The Center for the Advancement of Population Assessment Methodology (CAPAM) is a NOAA-funded center of excellence and a top organization for advancing scientific methods supporting aquatic resource conservation across the country and the world. CAPAM hosted a 5-day technical workshop on stock assessment good practices to improve quantitative methods used in fisheries stock assessment and facilitate the development of a Good Practices Guide. The workshop was held at the Food and Agricultural Organization of the United Nations (FAO) Headquarters in Rome, Italy, October 24–28, 2022.

The 5-day forum consisted of keynotes, commenters, research presentations, and focused discussions. Major topics included stock and fishery structure, CPUE standardization, growth, selectivity, natural mortality, recruitment, data weighting, random effects/state-space models, spatial stock assessment models, diagnostics, data-limited methods, integrated population models, and close-kin mark-recapture. Felipe Carvalho, with support from SAP staff, presented the results from a program-wide effort to identify model diagnostics that are objective, transparent, and can be automated.

PIFSC SAP shared stock assessment expertise and formed professional connections with scientists from agencies and institutions around the globe, including NOAA Fisheries (all science centers were represented at the workshop), academia (U Washington, U Florida, U California, St. Andrews/UK), FAO, ICES (North Atlantic nations), CEFAS (UK), CSIRO (Australia), the IATTC, and many others. A primary product of the CAPAM workshop was a preliminary set of manuscripts documenting "good" practices in fisheries stock assessment, recognizing that no single set of "best" practices will fit the diverse range of fisheries management needs and data limitations of all stocks. These manuscripts, including a chapter on stock assessment model diagnostics by Carvalho et al., will be published in an upcoming special issue of *Fisheries Research*.

Update on the Bottomfish Fishery-Independent Survey in Hawai'i

NOAA's Science Operations Division (SOD)-Survey & Operations Support Program conducted the stereo-camera portion of the fall 2022 Bottomfish Fishery-Independent Survey in Hawai'i (BFISH) in support of Council 5-year research priorities Insular Fisheries 5 (IF5) and Insular Fisheries 6.1.2(IF6.1.2). This survey included 100 sampling stations completed by cooperative research fishers and 100 sampling stations completed by PIFSC scientists aboard NOAA Ship *Oscar Elton Sette* during SE-22-07. The overall survey is now 78% complete, with plans to finish the remaining 135 research fishing sampling stations by the end of November 2022. Research fishing biosamples are provided to the PIFSC Life History Program in support of IFCR2.

BFISH_2022_F Survey Completion	
Camera (200 grids)	100%
Fishing (400 grids)	66%
Total	78%

Research Fishing	Scientific Name	Catch
Deep 7		260
ehu	*Etelis carbunculus*	152
kalekale	*Pristipomoides sieboldii*	28
gindai	*Pristipomoides zonatus*	25
opakapaka	*Pristipomoides filamentosus*	24
onaga	*Etelis coruscans*	22
paka	Pristipomoides filamentosus	7
hapuupuu	Hyporthodus quernus	2
non Deep 7		164
green eye shark	*Squalus sp.*	85
kahala	*Seriola dumerili*	26
hogo	*Pontinus macrocephalus*	13
table boss	*Bodianus albotaeniatus*	7
reef shark	*Carcharinid sp.*	6
taape	Lutjanus kasmira	5
uku	Aprion virescens	3
deep sea moi	*Polymixia berndti*	3
Yellowtail opakapaka	*Pristipomoides auricilla*	2
shark	Chondrichthid sp.	2
alfonsin	Beryx decadactylus	2
kitsune	*Sarda sp.*	1
Bridled Triggerfish	*Sufflamea fraenatum*	1
boarfish	*Antigonia sp.*	1
gunkan	*Caranx lugubris*	1
pufferfish	Tetraodontid sp.	1
yellowspot papio	Carangoides orthogrammus	1
lizardfish	Synodus sp.	1
weke ula	Mulloidichthys pflugeri	1
stingray	Dasyatidae sp.	1
weke nono	Parupeneus chrysonemus	1
Grand Total		424

USS deployments (all time):	3104

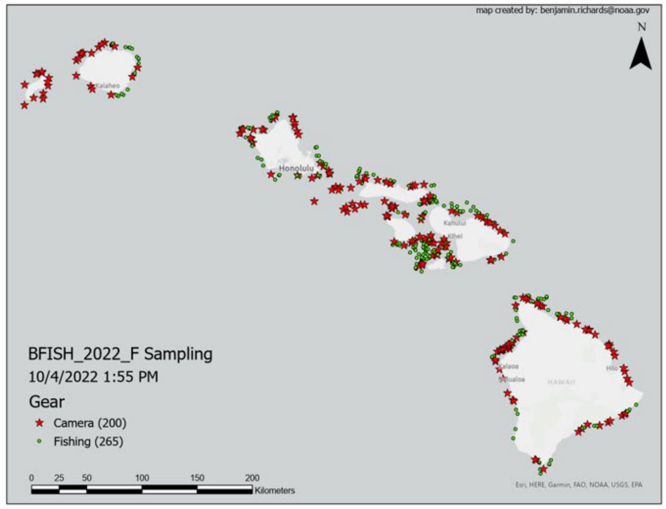

Figure 3. Sampling completed to-date for the 2022 BFISH survey.

During SE2207, PIFSC researchers also began testing underwater artificial lighting systems for the Modular Optical Underwater Survey System (MOUSS) stereo-video camera system. Candidate systems covered four distinct light wavelengths (e.g., red, amber, green, blue) with the goal of identifying a wavelength that is 1) visible by the camera system and 2) invisible or unremarkable to the target species. If successful, this will allow the MOUSS stereo-camera system to extend to cover the full 75–400 m depth range of the stock. Researchers were also testing a prototype robotic operating system camera controller, designed to replace the existing, aging digital video recorder on MOUSS.

During this period, SOD-SOS, in partnership with FRMD-SAP and in support of IF4 and IF6, began assessing existing genetic, mapping, and associated products necessary for future fishery-independent surveys outside of the main Hawaiian Islands.

2. Conserve Protected Species

Hawaiian Monk Seal Research Program (HMSRP) Conducts Assessment and Recovery Camps within Papahānaumokuākea Marine National Monument in 2022

Assessment and Recovery Camps are the foundation of NOAA's Hawaiian monk seal research and recovery efforts in the Papahānaumokuākea Marine National Monument (PMNM) where field research teams conduct population monitoring and undertake numerous activities to aid in the recovery of the species. In 2022, for the first time since the pandemic, HMSRP researchers were able to conduct a full 4-month season of assessment and recovery activities at all Hawaiian monk seal breeding locations within the PMNM. Field staff were deployed in seasonal camps by the NOAA Ship *Oscar Elton Sette* from April 28 to May 25 at five of the six most-studied reproductive sites in the Northwestern Hawaiian Islands (Lalo (French Frigate Shoals), Kamole (Laysan Island), Kapou (Lisianski Island), Manawai (Pearl and Hermes Reef) and Hōlanikū (Kure Atoll)). Additional layers of complexity this year included ensuring safe operations in remote areas during the COVID-19 pandemic and a historic south swell in July that posed such substantial risk to the field staff at Manawai that they were retrieved and redeployed to Pihemanu (Midway Atoll) for the remainder of the season.

Figure 4. Hawaiian monk seal resting on the beach at Kamole, with the HMSRP field camp in the background.

In addition to the main field camps, the HMSRP conducted surveys of Nihoa, Mokumanamana, and Pihemanu during the at-sea camp deployment and recovery missions and worked with USFWS and State of Hawaiʻi Department of Land and Natural Resources biologists to increase partnership in documenting key monk seal data. Malnourished pup and juvenile seals that were identified as needing rehabilitation were rescued and the ship-based scientific team provided supportive care during their transport to NOAA's partner, The Marine Mammal Center's Ke Kai Ola, on Hawaiʻi Island.

During the season, field teams gathered data on the numbers of pups born and pups that survived to weaning; marked, tagged, and vaccinated seals; identified older animals; and documented inter-atoll movements, causes of mortality, and other key demographic variables. At least 178 pups were born at the six major pupping sites within Papahānaumokuākea, the highest number since 2004. Notably, two seals that were rehabilitated at Ke Kai Ola as pups in 2014–2015 were found with pups of their own this year, showing how impactful these rehabilitation efforts can be on the species' recovery.

While collecting these important data, teams also performed a total of 45 survival enhancing activities, including disentangling seals from debris (n=5), freeing seals entrapped in disintegrating infrastructure at Tern Island (n=3), translocating weaned pups away from areas with high shark predation at Lalo (n=14), administering medications to compromised seals (n=12), identifying and capturing animals in need of rehabilitation (n=6), and releasing animals recovered from rehabilitation (n=1).

Figure 5. Freshly weaned male pup with a severe shark bite at Lalo that ultimately proved fatal.

Monk seal field teams also freed other wildlife from aging infrastructure at Tern Island and supported research by other groups within and outside of PIFSC such as by tagging and monitoring turtles in collaboration with MTBAP, deploying acoustic recorders to study seal vocalizations at Lalo and Manawai, and assisting with shark bite DNA and sea level rise research in collaboration with researchers at the University of Hawaiʻi, and staging marine debris for pickup by Papahānaumokuākea Marine Debris Program cruises. After the Manawai team relocated to Pihemanu, they performed similar research and enhancement activities at this new location, which hosts one of the six major monk seal subpopulations in the PMNM.

In sum, field work was successfully completed at the field camps! All field camp personnel, supplies, equipment, and data were collected aboard the NOAA Ship *Oscar Elton Sette*, which returned to Honolulu on September 2. The HMSRP will continue destaging, resupplying, and preparing for the next field season as well as ramp up data analyses collected over the summer.

Figure 6. Mother-pup pairs at Manawai, observed during the 2022 season.

The Next Generation of Hawaiian Monk Seals on Lāna‘i

The year 2022 marked a milestone for monk seals on Lāna‘i. In early July, a local fisherman first reported seeing a mother and pup on a remote beach on the north shore of Lāna‘i. This was exciting news because there have been very few monk seals born on the island. Our partners at Pūlama Lāna‘i soon searched for and located the seals. The mother was identified as R00K, a 4 ½-year old seal that was born on Lāna‘i herself in 2018. What makes this pupping event so unique is that this is the first known Lāna‘i-born seal to give birth on the island (R00K's mother was born on Kaua‘i). Additionally, at 4 ½ years of age, R00K is one of the youngest known monk seal mothers. There have only been a handful of 4-year old seals that have had pups. Most female monk seals start reproducing between 5 and 10 years of age. This marks the beginning of the second generation of Lāna‘i-born seals.

R00K successfully nursed and weaned her female pup in August. After weaning, the pup was given permanent flipper tags by a team of Pūlama Lāna‘i and NOAA staff. The pup (ID RQ88 was assigned) is the 5th known pup to be born on Lāna'i. The first documented pup on Lāna‘i was observed in 2014 but was never tagged. Subsequent pups have been born on Lāna‘i in 2018, 2019, 2021, and 2022.

We are hopeful that RQ88 will carry on her lineage as she matures and reaches reproductive age. Female monk seals tend to return to their natal beach to give birth and rear their own pups. Time will tell if RQ88 will follow the same pattern birth on Lāna‘i as her mother did.

Figure 7. A large gray monk seal (RQ88) rests on a remote beach on Lānaʻʻi, while her young black-coat pup nurses.

Leatherback Sea Turtle Research and Conservation Initiatives in Maluku, Indonesia

Figure 8. Foraging leatherback in Kei Island. Photo credit: WWF-Indonesia

Many leatherback sea turtles interacting with fisheries in the Pacific Islands Region (PIR) are actually connected to the Southeast Asia/Western Pacific region. One of these populations is the endangered Pacific leatherback (*Dermochelys coriacea*) sea turtle that migrates through, nests, and forages in southeast Asian coastal waters, focusing on Indonesia in particular. Due to their presence in the PIR and bycatch of these turtles in U.S. fisheries, population assessments of the Pacific leatherback sea turtle play an important role in determining the management constraints (i.e., take limits) for commercial US fishing activities.

The Western Pacific leatherback turtle population has declined by 78.3% since the 1980s. To improve the accuracy of their population assessments, it is necessary to quantify the hatchling output of nesting beaches, the amount of nest poaching that occurs, the level of bycatch and bycatch mortality, and the number of harvested foraging sea turtles. Ultimately, addressing and mitigating such threats to leatherback sea turtles are necessary to help this endangered population recover. NOAA PIFSC staff (PSD and FRMD) have supported leatherback sea turtle research and conservation projects at two key sites in the province of Maluku, Indonesia. These include a nesting region on Buru Island and a foraging hotspot with extensive leatherback sea turtle take in the coastal waters of the Kei Islands.

Several villages in the Kei islands engage in a hunt (i.e., fishery) of primarily adult stage leatherback sea turtles. In previous years, the annual take of this hunt was over 100 turtles. Since

2017, NOAA has supported a monitoring program to quantify this hunt and a broad-based community and government outreach program aimed at reducing the yearly harvest. Over the past 4 years, the formation of a robust regional monitoring program at 11 villages coupled with outreach activities aimed at a coalition of government agencies, local village officials, cultural leaders, church leaders, and community members has strengthened a growing leatherback conservation ethic within the hunting communities. This has resulted in an 85% reduction of the leatherback sea turtles harvest in the Kei Islands.

Leatherback nesting activity was recorded on Buru Island in 2017. Following this observation, a nesting beach project was implemented and has documented up to 200 nests laid per year. It also discovered high levels of nest and adult female poaching. To date, the project has monitored nesting activity while working with provincial and district governments, local village leaders, cultural leaders, and key community members to reduce poaching pressure. This project is an important component of leatherback turtle conservation as it provides additional life history information which was previously unknown, and over time will complement status assessment and recovery efforts.

Figure 9.Emergence of leatherback hatchlings in Buru Island. Photo credit: WWF-Indonesia.

Key programmatic outcomes include: 1) a year-round, daily beach monitoring program to quantify reproductive output and bolster hatchling production; 2) a multi-pronged outreach that has reduced poaching from 56% to only 4% of leatherback nests and eliminated all take of nesting females; 3) greater involvement by Indonesian government authorities to develop village-level regulations to encourage sea turtle conservation and protection; and 4) genetic sampling and satellite telemetry research to understand habitat use and regional connectivity (i.e., 5 females have been tagged to date).

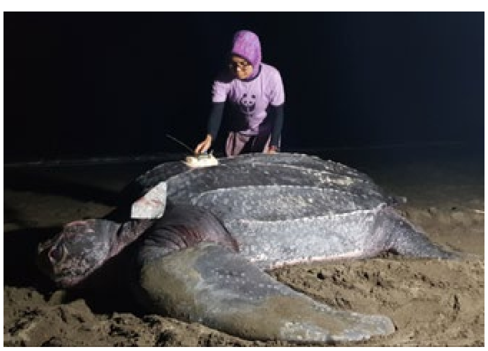

Figure 10. Satellite tagging of a nesting female in Buru Island. Photo credit: WWF-Indonesia.

Support of these community programs in Indonesia and continued efforts to consult, engage, and build capacity within Indonesian government agencies are critical to ensure that these initial sea turtle conservation gains translate to long-term population benefits for the endangered Pacific leatherback sea turtles.

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Papahānaumokuākea Marine National Monument Honu (Green Sea Turtle) Research

MTBAP's field researchers at Lalo (French Frigate Shoals) identified 635 unique turtles this year. On Tern Island, they observed 312 females and 144 males, or about half of what they observed during the 2021 "big year." Because green turtles do not migrate to their nesting grounds every year, variations in the number of nesting females seen at Lalo are normal and expected. The team also applied satellite telemetry tags to six turtles (four males and two females) and sampled an impressive 71 nests! MTBAP uses migration tracks and genetic samples to assess how Hawaiian green turtles are adapting to the changing climate.

The combined monk seal and turtle teams also surveyed Tern Island at Lalo every day to look for wildlife that may have become entrapped in the island's degrading seawall or other entanglement hazards. They saved 35 turtles, 3 seals, and 23 seabirds (20 ʻiwa (great frigatebirds), 2 noio koha (brown noddies), and 1 kaʻupu (black-footed albatross)).

For more information about NOAA's Protected Species' 2022 field research in the Papahānaumokuākea Marine National Monument, see our newly released web blog: [2022 Pacific Islands Field Season a Success.]

Figure 11. The Lalo turtle team excavating a hatched nest to collect samples and data to measure the success of the nest. Photo Credit: NOAA Fisheries.

Olive Ridley Sex Ratio Paper in Review

MTBAP submitted a manuscript titled, "Sex ratios of olive ridley sea turtles foraging in the high seas of the North Pacific establish baselines for climate change research," for publication in the journal Conservation Science and Practice. The manuscript includes data collected from 121 olive ridley sea turtles incidentally captured by the Hawaiʻi longline fishery in the central North Pacific. Sex and maturity state were determined by examination of gonads, which led to finding an *overall female bias in bycaught turtles*; the sex ratio of mature turtles was 1.8F:1.0M, whereas an increase in the female bias was found for immature turtles at 2.5F:1.0M (Table 1). Because sea turtle sex is determined by nest incubation temperature (temperature-dependent sex determination), these data provide baseline information for future examination of sex ratios in light of potential feminization due to climate change (warmer temperatures produce more females). Ultimately, these data will be useful for population viability and sex–based survivorship analyses that can contribute to future conservation measures.

*Table 1. Sex ratios of different life stages (hatchling, immature, and mature) of olive ridley sea turtles (*Lepidochelys olivacea*) at various locations within the North Pacific Ocean. Hatchling (primary) sex ratios are from nesting beaches while immature (secondary) and mature (breeding) sex ratios are from foraging grounds.*

Life Stage	**Sexing Method**	**Location**	**Location Type**	**Year**	**Sex Ratio** (F:M or % F)	**Source**
Hatchling	Nest temperature & gonad histology	eastern Pacific Oaxaca, Mexico	Arribada Nesting Beach	2010–2011	1.2:1.0	(Hernández-Echeagaray et al. 2012)
Hatchling	Nest temperature & gonad histology	eastern Pacific Baja California Sur, Sinaloa, Nayarit, & Guerrero, Mexico	Solitary Nesting Beach	2008–2010	2.1:1.0–124.0:1.0	(Sandoval-Espinoza 2012)
Hatchling	Nest temperature & gonad histology	eastern Pacific Jalisco, Mexico	Solitary Nesting Beach	1994	1.3F:1.0	(Garcia et al. 2003)
Hatchling	Nest temperature	eastern Pacific Ostional, Costa Rica	Arribada Nesting Beach	2017	≥ 80%	(Wen 2018)

Hatchling	Nest temperature	eastern Pacific Guanacaste, Costa Rica	Solitary Nesting Beach	2013–2017	78.6%	(Binhammer et al. 2019)
Hatchling	Nest temperature (hatchery)	Indo-western Pacific East Java, Indonesia	Solitary Nesting Beach	2009–2010	31.5–45.9%	(Maulany et al. 2012)
Immature	Endocrinology	Eastern Tropical Pacific	Foraging Ground	2006	1.6:1.0	**Present Study**
Immature	Necropsy	Central North Pacific	Foraging Ground	2009–2019	2.5:1.0	**Present Study**
Mature	Endocrinology	Eastern Tropical Pacific	Foraging Ground	2006	0.7:1.0	**Present Study**
Mature	Necropsy	Central North Pacific	Foraging Ground	2009 – 2019	1.8:1.0	**Present Study**

Estimating the winter abundance of cetaceans around the main Hawaiian Islands

A NOAA Tech Memo, currently in press and authored by Amanda Bradford, Kym Yano, and Erin Oleson of the Pacific Islands Fisheries Science Center's Cetacean Research Program, describes the first multi-species assessment of winter cetacean abundance around the main Hawaiian Islands. The main conclusions of the paper are that design-based abundance estimation following ship-based, line-transect surveys in the winter of 2020 and summer-fall of 2017 did not reveal seasonal differences in small cetacean abundance but did detect an expected increase in the relative abundance of large whales.

Figure 12. A humpback whale flukes with the NOAA Ship Oscar Elton Sette in the background. Photo by Andrea Bendlin, Pacific Islands Fisheries Science Center, National Marine Fisheries Service (Permit No. 20311).

Twenty-four cetacean species regularly occur in the waters surrounding the Hawaiian Islands, including 18 odontocetes and 6 mysticetes, although most is known about island-associated odontocetes and humpback whales. Abundance estimates are needed to evaluate the impacts of human activities on these species in population assessments and management plans. Most ship-based, line-transect surveys for cetaceans in Hawaiian waters have occurred during the summer-fall period, including the recurring Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) that took place in 2002, 2010, and 2017. There are no recent abundance estimates of cetaceans in Hawaiian waters during winter when seasonally migrating baleen whales are at peak abundance. A winter HICEAS (WHICEAS) was conducted in Jan–Mar 2020 to estimate the abundance and distribution of cetaceans around the main Hawaiian Islands during winter.

Long-standing ship-based visual observation protocols were used for data collection, and a well-established multiple-covariate approach was used for data analysis. Specifically, sightings from previous surveys and from species with similar detection characteristics were pooled to model detection functions (given low encounter rates typical of the study area), and Beaufort-specific g(0) estimates were applied. Abundance in the WHICEAS study area was estimated for winter 2020 and summer-fall 2017 to allow for seasonal comparisons. In total, 152 sightings were used to estimate the abundance of 17 species (14 odontocetes and 3 mysticetes) during WHICEAS 2020; 29 sightings were used for 9 odontocete species during HICEAS 2017. The covariates *Beaufort* and *species* most frequently contributed to the estimates of detection function. Across all species, abundance point estimates for WHICEAS 2020 range from 115 fin whales to 26,627 melon-headed whales. Low encounter rates led to high CVs (range=0.40–1.06) for most estimates and low statistical power to detect seasonal trends in abundance for 9 odontocete species sighted around the main Hawaiian Islands during both HICEAS 2017 and WHICEAS 2020. Sperm whales are the exception among compared odontocetes, with estimates suggesting a significant increase in abundance in winter 2020 from summer-fall 2017. Random variation in encounter rate may be a factor, but the changes in abundance could represent seasonal migration patterns, which are unknown for sperm whales in Hawaiian waters. Additional winter survey effort beyond the main Hawaiian Islands and insight from other data streams may be needed to better evaluate seasonal differences in the abundance and distribution of cetaceans in Hawaiian waters.

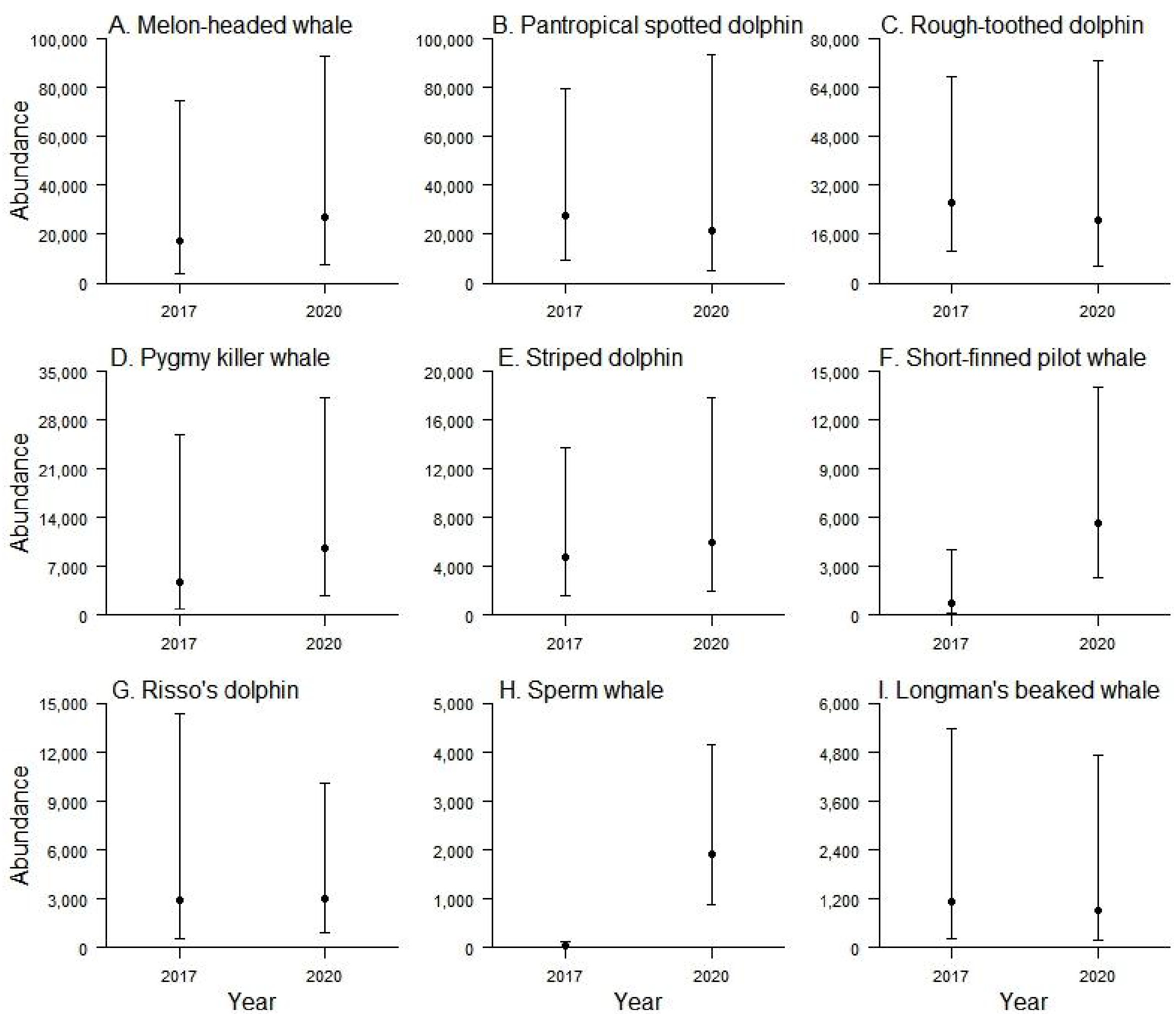

Figure 13. Estimated abundance (with 95% confidence intervals) of the 9 odontocete species sighted within the WHICEAS study area during HICEAS 2017 and WHICEAS 2020: (A) melon-headed whales, (B) pantropical spotted dolphins (pelagic population), (C) rough-toothed dolphins, (D) pygmy killer whales, (E) striped dolphins, (F) short-finned pilot whales, (G) Risso's dolphins, (H) sperm whales, and (I) Longman's beaked whales. Species are shown in order of highest to lowest abundance during WHICEAS 2020.

3. Research to Support EBFM and Living Marine Resource Management

WPRFMC-PIRO-PIFSC Ecosystem-Based Fisheries Management Workshop

On October 4th, 2022, the Western Pacific Regional Fishery Management Council (WPRFMC or Council) joined PIFSC and the Pacific Island Regional Office (PIRO) to map out the implementation of ecosystem-based fisheries management (EBFM) in the Pacific Islands. This inclusive approach works towards sustainable management of the breadth of ecosystem components and management unit species, bringing additional elements into play, such as interactions with other species, the effects of environmental changes, or pollution and other stressors on habitat and water quality. EBFM ensures that fishery managers consider these additional elements to assess the health of any given fishery more effectively and determine the best way to maintain it. EBFM cannot succeed without effective, transparent, and frequent communication allowing adaptive management to respond to emerging science. This workshop provided the opportunity to share priorities and capabilities, as well as discuss and brainstorm activities that can be achieved in the next 5–10 years.

Figure 14. Participants at the EBFM Workshop. An additional 15 individuals participated virtually.

There were several meeting objectives.

- Clarify the scope of EBFM and develop a shared understanding of the current state of EBFM in the region, what changes we want to see in the coming decade, and how we can position ourselves to achieve that goal.
- Foster a shared understanding of the management, science, and data challenges and capabilities in the Pacific Islands.
- Learn from a case study (IEA) and discuss how to "scale up" in the PI region.
- Identify common threads (e.g., human dimensions, climate change, socioeconomics, EEJ) that offer opportunities to maximize efforts and prioritize outcomes.
- Develop recommendations for engaging State and territorial stakeholders for future EBFM initiatives.

Leadership from each of the partner organizations launched the meeting. The Council, PIFSC, and PIRO discussed EBFM priorities and led a suite of talks on the science to support these expressed priorities. They shared details about the West Hawaiʻi Integrated Ecosystem Assessment Program and its potential for use as a template for EBFM in the region. We then spent the afternoon brainstorming how to get from where we are to where we want to be.
The meeting resulted in an agreed to organizational plan. The existing EBFM teams within the organizations will meet on a recurring basis to improve communication and collaboration. This

strategy will be tested on an EBFM project though no project was chosen at the time. Overall, the meeting was a success with improved and renewed relationships and understanding across the region on the power and purpose of true ecosystem based management.

2022 Ecosystem Status Report Update Expands to Cover Main Hawaiian Islands

The Integrated Ecosystem Assessment (IEA) in the Pacific Islands Region has conducted collaborative and interdisciplinary science to support current and future management needs for nearly a decade. These historical efforts have been focused in West Hawaiʻi, where there is a unique confluence of diverse ocean ecosystems, strong community connections to place, and overlapping government, academic, and non-governmental efforts. The IEA program previously published two Ecosystem Status Reports (Gove et al. 2016; Gove et al. 2019). These reports presented a suite of ecosystem indicators useful for tracking the status and trends of marine ecosystems in West Hawaiʻi. This report, under development, expands the geographic scope of the previous efforts and describes the status and trends of marine ecosystems across the main Hawaiian Islands. This broader scope is warranted as socio-cultural connections, climate and ocean ecosystem processes, and human impacts are highly variable across multiple spatial scales in Hawaiʻi. Further, the IEA program aims to better support Federal and State resource management needs in the region. This Hawaiʻi IEA Ecosystem Status Report also includes a greater focus on the diverse linkages between ecosystem health and human well-being.

Marine ecosystems contribute substantially to the local economy and sustain culture, tradition, and social practices that are critical to human communities. Over 85% of people in Hawaiʻi live within a few miles of the ocean. Residents regularly interact with the coastal environment through work, leisure, and cultural activities. The diagram below visualizes these human-land-sea connections as circular and reciprocal in nature, within which human communities affect, depend on, and care for ecosystem health (Figure 15). Our actions and activities influence ecosystem status and trends and are also the conduits through which we experience value, feel meaning, or benefit from ecosystem goods and services. The diagram also highlights the vitally important socio-cultural connections that contribute to human well-being in Hawaiʻi. These connections include spirituality, heritage, sense of place, identity, and knowledge perpetuation (among many others). The intangible benefits that people derive through their relationships with ecosystems are critical to ecosystem health and human well-being yet are often missing in resource management.

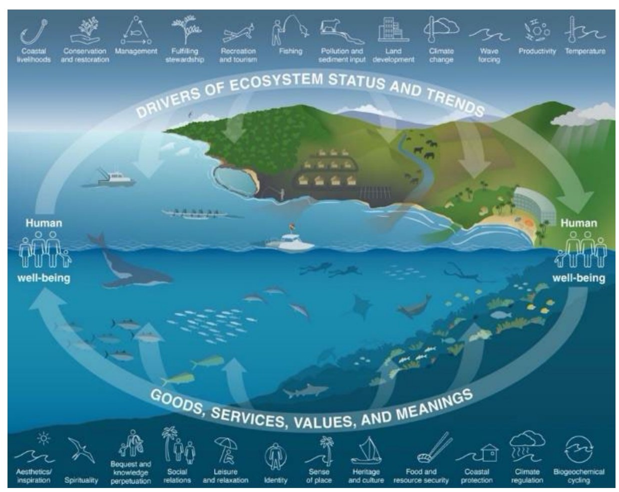

Figure 15. Conceptual diagram of coastal and marine ecosystems in Hawaiʻi highlighting that human actions and activities are both a driver of and dependent on ecosystem health. Human-land-sea connections are visualized here as a circle or cycle. In this integrated social-ecological system, change is constant and human well-being is complex, requiring that we conserve and adaptatively manage for socio-cultural values and meanings along with goods and services.

This 2022 Ecosystem Status Report for Hawaiʻi includes the following thematic sections: Human Connections, Small Boat Commercial Fisheries, Coral Reefs and Reef Fish, Climate and Ocean, Human Impacts, and Vulnerability of Coral Reefs to Climate Change. Each section contains a series of ecosystem indicators to support ecosystem-based fisheries. The final report is forthcoming.

4. Organizational Excellence

PIFSC Scientists Support Regional Meetings for NMFS EEJ Strategy Rollout

During the summer of 2022, PIFSC scientists engaged in collaborative efforts with PIRO and the WPRFMC to support regional meetings for the National NMFS Equity and Environmental Justice (EEJ) Strategy. The goals of the regional meetings were to meet with Pacific Islands Region (PIR) communities to receive feedback on the draft NMFS EEJ Strategy and to solicit input for a PIR EEJ implementation plan. Meetings were held both in-person and virtually with engagement from over 200 community members in American Samoa, Guam, the CNMI, and Hawaiʻi, including elected government officials and their staff, territorial and state partners, NGOs, and fisheries stakeholders, including fishers, marketers, and cultural practitioners.

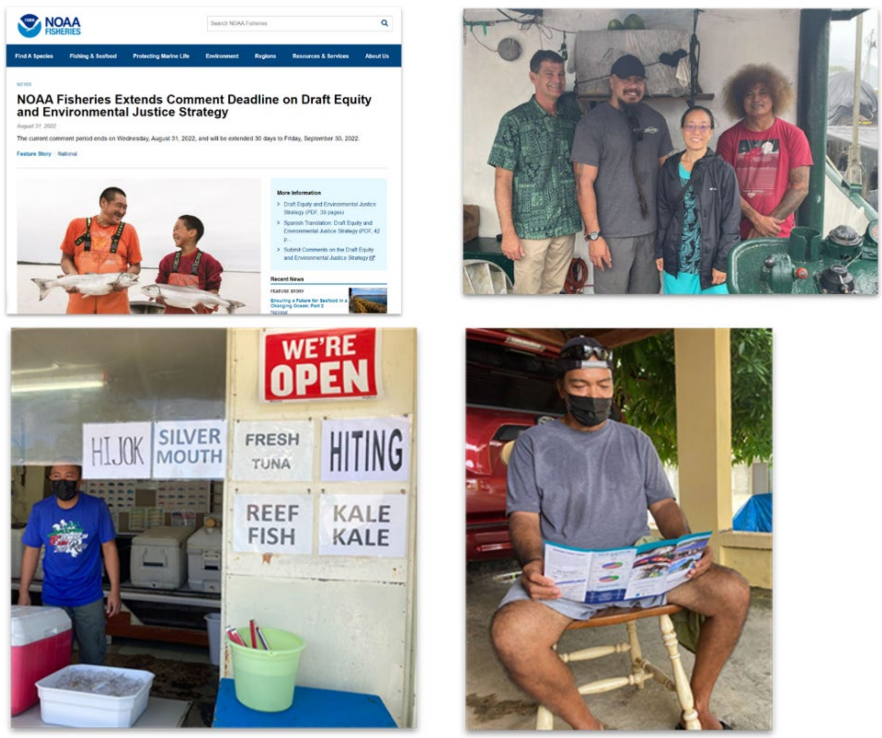

Figure 16. Photos (clockwise from upper left): NMFS EEJ Strategy website, on board a longline vessel with an observer and Fish Captain, Fisherman reviewing a PIFSC brochure, Saipan fish market.

Notes and transcripts from meetings have been analyzed by PIFSC scientists to generate travel and meeting reports for community members, update the national NMFS EEJ Strategy, and to create the foundation for discussions on the PIR implementation plan. It is the hope that these initial meetings will open opportunities for more diverse stakeholder participation and help facilitate future meetings.

Some major themes that came out of the regional meetings include:

- Stakeholder engagement and scientific relationships are experienced as a check-box exercise rather than as a desire for meaningful interactions.
    - NMFS engagement practices and community expectations do not align.

    - Cultural mechanisms and protocols in meetings can help ensure more indigenous voices are heard.

- Without real community understanding or input, regulations feel imposed and out of step with local understanding of management needs.
    - NMFS should support building on-island capacity.
    - Efforts by the PIFSC stock assessment team to work more closely and transparently with local fishers and fisheries agencies has been appreciated and demonstrates an example of good practices going forward.
- NMFS should support local partners by:
    - consulting on research priorities (make NMFS research locally relevant),
    - avoiding replication (do not step on toes), and
    - not diminishing local partner organization capacity (do not steal local staff).
- NMFS staff in the PIR should reflect the communities we serve through:
    - diversity of PIRO and PIFSC staff,
    - island liaisons (territories and other Hawaiian Islands),
    - community representatives on scientific cruises, and
    - paid internships for local and indigenous students.
- Partner territorial agencies experience barriers to funding and services because it is difficult or impossible to meet the requirements.
    - Example: Matching funds often are not available.
- Work with other NOAA line offices and federal agencies to share input on issues that are not in NMFS jurisdiction.
    - Example: Share comments on the Marianas Trench Marine National Monument with the regional NOS office.
- Indigenous communities and NMFS may not have the same views of equity.
- Sea turtle harvest was brought up in CNMI, Guam, and Hawaiʻi.
- Address systemic barriers that prevent indigenous practice.
    - Example: Marine mammal protection act prevents indigenous people from performing important cultural protocols.

Administrative Reports

Walsh WA, Brodziak J. 2022. CPUE Standardization for Whitetip Shark, Carcharhinus longimanus, in the Hawaiian Longline Fishery, during 1994-2019. Pacific Islands Fisheries Science Center, PIFSC Administrative Report, H-22-06, 64 p. https://doi.org/10.25923/07xf-h192.

Data Reports

Bigelow K, Rice J, Carvalho F. 2022. Future Stock Projections of Oceanic Whitetip Sharks in the Western and Central Pacific Ocean. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-22-33, 21 p. https://doi.org/10.25923/yng3-gv19.

McCracken M. 2022. Assessment of Incidental Interactions with Marine Mammals in the American Samoa Permitted Longline Fishery from 2017 through 2021. Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-22-31, 1p. https://doi.org/10.25923/3y1y-5p44.

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Internal Reports

Lamirand M, Lozada-Misa P, Vargas-Angel B, Couch C, Schumacher BD, Winston M. 2022. Analysis of Benthic Survey Images via CoralNet: A Summary of Standard Operating Procedures and Guidelines (2022 update) Internal Version. Pacific Islands Fisheries Science Center, PIFSC Internal Report, IR-22-11, 133 p.

Technical Memorandums

Becker EA, Forney KA, Oleson EM, Bradford AL, Hoopes R, Moore JE , Barlow J. 2022. Abundance, distribution, and seasonality of cetaceans within the U.S. Exclusive Economic Zone around the Hawaiian Archipelago based on species distribution models. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-131, 45 p. https://doi.org/10.25923/9e50-d280.

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Journals

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Forney KA, Kobayashi DR, Johnston DW, Marchetti JA, Marsik MG. 2011. What's the catch? Patterns of cetacean bycatch and depredation in Hawaii-based pelagic longline fisheries. Marine Ecology 32(3): 380-391. https://doi.org/10.1111/j.1439-0485.2011.00454.x.

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