2010
Year in Review

NOAA

PACIFIC ISLANDS FISHERIES SCIENCE CENTER

Science, Service, Stewardship

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

PIFSC Mission

To conduct high-quality, timely research to support the stewardship of fisheries resources, protected species, and ecosystems in the central and western Pacific Ocean.

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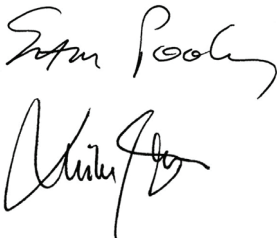
Message from the Science Directors Office

It is our pleasure to present this brief overview of research progress and accomplishments at the Pacific Islands Fisheries Science Center during 2010. It was a year of challenges, change, and opportunity. Our diverse staff of biologists, oceanographers, mathematical modelers, statisticians, economists and social scientists, as well as a wide range of professional support staff, addressed many scientific issues and made important strides forward. We completed an extensive survey of cetaceans in the western Pacific and the Mariana Archipelago; surveyed and described coral reef habitats and ecosystems in American Samoa and remote islands of the central Pacific; established an Integrated Ecosystem Assessment project on the Kona coast of Hawaii; produced comprehensive scientific assessments of resources to inform key management decisions; researched ways to reduce fishery interactions with protected species; improved biological models underpinning critical fish stock assessments; applied climate models to envision ecological changes in the North Pacific; and much more. Throughout, our scientists were ably assisted by the Center's administrators, computer systems specialists, database managers and other devoted technical support staff. Our achievements were also enabled by fruitful collaborations with partners in government, academia and the private sector. As we move ahead in 2011, we hope to build on our recent progress. We will strive to provide innovative and relevant science to meet the growing needs of our stakeholders in the Pacific islands and across the nation.

Sincerely,



Our Research Mission and Challenges

The mission of the Pacific Islands Fisheries Science Center is to conduct high-quality, timely research to support the stewardship of fisheries resources, protected species, and ecosystems in the central and western Pacific Ocean. Our research helps ensure that NOAA and partner organizations have a solid scientific foundation for management decisions and conservation actions affecting marine ecosystems, our economy, and Pacific island fishing communities. Our scientists are active in many research areas: coral reef ecosystem science; marine ecosystem analysis and oceanography; fisheries biology; bycatch mitigation; fisheries monitoring; economic and human dimensions research; protected species population monitoring and recovery research; and more.

The Center's research supports NOAA Fisheries Service goals in several broad areas:

Maintaining Healthy and Sustainable Fisheries and Fishing Communities—Our science supports domestic and international management of fisheries, enabling maximum long-term benefits to U.S. fishermen, coastal communities, the seafood industry, and consumers.

Conserving Marine Habitats and Ecosystems—We help build an understanding of marine habitats and associated biological communities, the ecosystem services they provide, and the forces affecting them, including climate change.

Recovering Protected Species—We assess and monitor populations of marine mammals, sea turtles, and other protected marine species and identify ways to restore them to healthy states.

Other Research Activities—The Center's administrative and technical support staff provides critical services enabling our research endeavors. In addition, our scientific staff is often called upon to take time from the Center's normal activities to join a NOAA task force or lead an agency team in response to an urgent, unplanned mission requirement.

In the following pages, we highlight some of the Center's key accomplishments in these areas of research during 2010.

Readers seeking further information on our research are welcome to visit our website at http://www.pifsc.noaa.gov/ or send an e-mail to Samuel.Pooley@noaa.gov.

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Marine Habitats and Ecosystems

A significant part of the Center's research is directed at surveying, monitoring, modeling and assessing marine habitats and ecosystems and integrating information to support an ecosystem approach to management. Research is conducted in waters within the U.S. 200-mile Exclusive Economic Zone of the Pacific Islands Region and on the high seas of the central and western Pacific. Studies range from surveys of coral reef ecosystems and oceanic habitats using NOAA research vessels to complex modeling of ocean properties and investigations of ocean warming, acidification, and other aspects of climate change. During 2010, progress was noted in several areas:

Coral Reef Ecosystems Assessed in American Samoa and the Pacific Remote Islands

In early 2010, as part of its ongoing Pacific Reef Assessment and Monitoring Program (Pacific RAMP), PIFSC scientists surveyed shallow reef ecosystems of American Samoa and several components of the U.S. Pacific Remote Island Areas —Johnston Atoll, Howland Island, Baker Island, Jarvis Island, Palmyra Atoll and Kingman Reef. PIFSC researchers were joined by partners from American Samoa and several universities. Operating from the NOAA Ship *Hi'ialakai*, the field party surveyed waters of all American Samoa islands, permitting comparisons with data from earlier surveys. At Rose Atoll, now protected within the Rose Atoll Marine National Monument, conditions overall were similar to those observed in 2008. Surveys at Ta'u Island indicated an increase in crustose coralline red algae and a dramatic increase in the density of an invasive didemnid tunicate. Towed divers surveying Tutuila Island noted evidence of damage to coral reefs in some areas caused by the devastating September 2009 tsunami that struck American Samoa; other islands surveyed showed no evidence of tsunami impacts.

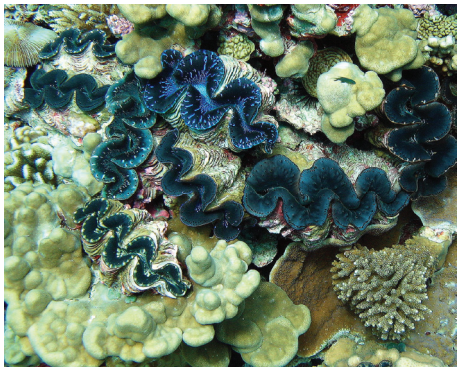
At Howland and Baker Islands, scientists observed mass coral bleaching, likely caused by elevated water temperatures associated with El Niño conditions that prevailed through winter 2009–2010. Data from temperature recorders at Howland Island show that water temperature from the sea surface to about 40 m depth increased during 2009 and remained above 30°C after mid-October; the instruments were recovered in February 2010. Bleaching was widespread and severe at both Howland and Baker, particularly on eastern sides of the islands. Coral bleaching can undermine the health of coral reefs. At Howland and Baker, branching and table corals (e.g., *Acropora* sp.) appeared to be more affected by the bleaching than massive corals.

At Jarvis Island, counts of sharks were higher in 2010 than during the 2008 survey. Reefs at Jarvis were generally dominated by hard corals. However,

on the western side of the island, an area noted for upwelling, an extensive population of soft corals was found, covering almost all the sea floor at the survey depth.

At Palmyra Atoll, divers saw few giant clams or other macroinvertebrates, whereas at nearby Kingman Reef, sampling sites on the southeastern backreef continued to harbor the highest concentration of giant clams of any area explored during the Center's Pacific reef surveys.

While PIFSC researchers and colleagues were collecting new data in the 2010 Pacific RAMP surveys of American Samoa and the remote island areas, information collected in several previous Pacific RAMP expeditions was published in the Atoll Research Bulletin. The peer-reviewed journal issued three papers authored by scientists from PIFSC, the University of Hawaii Joint Institute for Marine and Atmospheric Research (JIMAR), and the U.S. Fish and Wildlife Service. In one article, collaborating ichthyologists compiled a comprehensive list of shore fishes observed at Howland and Baker Islands (in the Phoenix Islands group) and Jarvis Island, Palmyra Atoll, and Kingman Reef (in the Line Islands group). In each location, Pacific RAMP surveys during 2000–2008 identified many fish species previously unrecorded



High densities of giant clams were observed at Kingman Reef.

there. In another pair of articles based on the earlier Pacific RAMP surveys, benthic ecologists described the species composition and abundance of coral communities in different reef habitats at Kingman Reef and at Rose Atoll, in American Samoa. During 2010, several other articles on the Center's coral reef ecosystem research were published in the Journal of Marine Biology. Together, the new publications expanded knowledge of corals, inshore fishes, and other biota inhabiting U.S. islands and atolls across the Pacific Islands Region. The Pacific RAMP research surveys, funded by the Coral Reef Conservation Program, study invertebrate fauna, algae, and other biota as well as corals and fishes, and provide the best available information on marine biological diversity in the U.S. Pacific islands and atolls. They provide an important record for monitoring the response of these coral reef ecosystems to climate change, ocean acidification, and land-based sources of pollution.

Grey reef sharks at Jarvis Island.

Survey Explores Mesophotic Coral Reefs in the Au'au Channel

In early July, 2010, scientists from PIFSC and the University of Hawaii Joint Institute for Marine and Atmospheric Research boarded the NOAA Ship *Oscar Elton Sette* for an expedition to the Au'au Channel between the islands of Maui and Lana'i in the main Hawaiian Islands. The cruise mission was to study a series of light-dependent deep coral reefs in the Au'au Channel. The reefs there feature luxuriant expanses of stony, or scleractinian, corals as well as macroalgae, reef fishes, and other coral reef organisms. Most reefs in Hawaii are found at depths of about 100 ft or less and are most prolific at depths of around 40 ft. The reefs studied in the Au'au Channel are unique in that they are most prolific at a depth of about 280 ft and have been found to flourish even below 400 ft. Using mixed-gas scuba technology, divers surveyed the fish community to identify fish associated with the reefs and estimate their sizes and abundance. Along the same survey transects, other divers recorded high-definition video images of the sea floor; video data will be analyzed to assess the mesophotic coral community. Scientists aboard the ship used sonar to assess the communities of small fishes, squids, and other organisms that typically live offshore but may contribute nutrients to the reefs. And the field party recovered data from oceanographic instruments deployed earlier to learn about currents, water temperature and the passage of tagged fishes over the reefs. Data from the Au'au Channel expedition and subsequent studies will help NOAA understand the factors important to the sustenance and dynamics of mesophotic reef communities and their role in local and archipelago-wide ecosystems.

Climate Model Used to Explore Possible Future Changes in the North Pacific Ocean

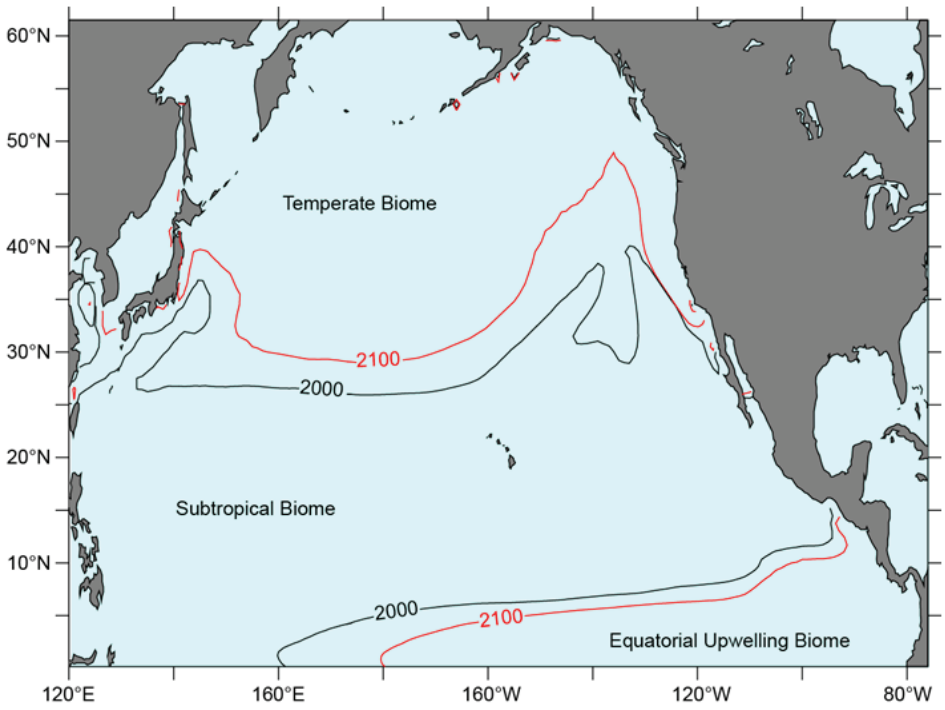
Ecosystem scientists at PIFSC have recently made several contributions toward better understanding of potential impacts of climate change. In 2010, they joined with a colleague at NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) to explore possible future changes in the North Pacific ecosystem. These researchers used a complex computer simulation model (the NOAA GFDL Earth System Model ESM2.1) that mimics the dynamics of temperature, ocean biogeochemistry and phytoplankton. Simulations were run under the so-called A2 greenhouse gas scenario which assumes little international effort to curtail emissions of anthropogenic CO_2 and other greenhouse gases. Output from the model included monthly predictions of several physical, chemical and phytoplankton quantities over the period 1998–2100 at a spatial resolution ranging from 1 degree at high latitudes to 1/3 degree at the equator.

The team used model predictions of phytoplankton density to define distinct regional ecological communities, or biomes, in the North Pacific; specifically, the temperate, subtropical, and equatorial upwelling biomes. Then they examined how the spatial extent and other characteristics of these oceanic biomes changed over time.

A key model projection was that by the end of the 21st century, the subtropical biome, marked by waters with phytoplankton density less than 1.35 g C/m^2, will expand northward and southeastward, increasing in area by about 30%, while the temperate and equatorial biomes shrink by similar amounts. The model predicts a warming of ocean waters during the 21st century, with the 10°C and 20°C surface isotherms shifting northward. Further, there would be a marked expansion of waters within the subtropical and upwelling equatorial biomes warmer than 30°C, creating a new thermal habitat. The suitability of this high-temperature habitat to pelagic biota in the region is unknown.

The model's biological projections indicate that primary productivity (primary production per unit area) will increase by 17% in the equatorial biome while decreasing slightly in the other two regions by the end of the century. Total primary production by phytoplankton in the equatorial and temperate biomes will likely decrease by 15% and 38%, respectively, as those areas shrink, but will increase in the expanded subtropical biome by 26%. In each biome, proportional changes would be expected in total fish catch. Projected trends in biome carrying capacity and fish catch suggest resource managers may need to address long-term trends in fishing capacity and quota levels.

The research is slated for publication in the peer-reviewed journal Bulletin of Marine Science.



Hawaii lies within the subtropical biome, characterized by waters with phytoplankton density less than 1.35 g C/m^2. The region is predicted to expand during the 21st century, as shown by expected boundaries for 2000 (black lines) and 2100 (red lines). Waters farther north are in the temperate biome; these regions have higher phytoplankton density.

Integrated Ecosystem Assessment Program Established on the Kona Coast

The Center launched a pilot Integrated Ecosystem Assessment (IEA) program for the Kona Coast region of the island of Hawaii. The purpose of the program is to compile, synthesize and analyze information on natural and socioeconomic factors in the region, specifically in relation to identified ecosystem management goals. The Kona Coast was a natural choice for the project because of its dynamic ecology and the extensive research already done in the region. It is home to a diverse group of marine species including ornamental fishes, corals, sea turtles, cetaceans, manta rays, and more. The region supports eco-tourism, aquaculture, fisheries and other ecosystem services. The goal of the IEA program is to achieve a comprehensive understanding of the Kona Coast ecosystem enabling scientific advice for ecosystem-based management. During 2010, strides were made to develop a knowledge base and to identify key management issues, ecosystem drivers, data sources, and key research projects. The ongoing process is guided by a working group composed of Center staff and a growing list of public and private partners and collaborators. The IEA pilot program established a website which will include an interactive data portal enabling users to access and view available data.

The program has also begun projects in ecosystem modeling and provided support to survey local coral reefs and develop ecosystem indicators. During July 2011, the Center will conduct a 10-day research cruise in the region to support the Kona IEA project. Then in September 2011, the project will convene a 2-day *Symposium on Kona's Marine Ecosystem: Past, Present and Future*. Scientists, managers and other symposium participants will share their knowledge of the Kona region's marine ecosystems; describe previous, current and planned research; and provide guidance for further IEA project development and integration.

Yellow tang are a primary target of collectors in the aquarium fish trade along Hawaii's Kona Coast.

Protected Species

PIFSC is actively engaged in research to support the conservation of sea turtles and marine mammals in the Pacific Islands Region. Studies conducted by Center scientists support management actions of NOAA and partner agencies under provisions of the U.S. Endangered Species Act and Marine Mammal Protection Act, including recovery plans and take reduction plans. Center biologists conduct population monitoring and other research on threatened and endangered populations of sea turtles and the endangered Hawaiian monk seal. Other PIFSC researchers monitor and assess populations of cetaceans across the Region, in collaboration with the Southwest Fisheries Science Center. During 2010, progress was noted in several areas:

NOAA Ship Surveys Support Assessment and Monitoring of Cetaceans in the Central and Western Pacific

Soon after the Center was established by NOAA in 2004, we developed a research program to expand knowledge of cetaceans in the newly created Pacific Islands Region. The program has broad scope, addressing cetaceans in each U.S. Pacific Island area—Hawaii, American Samoa, Guam, Commonwealth of the Northern Mariana Islands, and the Pacific Remote Island Areas—and the adjoining and interconnecting oceanic waters. Current information on cetaceans in this vast region is meager and improved knowledge is essential to support NOAA goals of protected species conservation and ecosystem-based management.

In early 2010, PIFSC scientists conducted visual and acoustic surveys for cetaceans during a 3800-mile transit of the NOAA Ship *Oscar Elton Sette* between Hawaii and the Mariana Archipelago. While the ship was underway, expedition scientists used high-powered binoculars to scan surrounding waters, looking for whales and dolphins at the sea surface. They sighted 25 groups of cetaceans, including sei whales, sperm whales, false killer whales, melon-headed whales, striped dolphins, and spotted dolphins. To complement the visual survey, the field party used an array of towed hydrophones to detect cetaceans below the sea surface. They frequently heard sounds of minke whales and humpback whales. After arriving in the Marianas, scientists used small boats to conduct visual surveys of cetaceans in nearshore waters around Guam and Saipan, sighting spinner dolphins, sperm whales and pilot whales. During the *Sette's* return voyage to Honolulu, the research team repeated the visual and acoustic surveys, sighting and hearing the same species found earlier. Analysis of data from the cruise will provide valuable new information on the distribution, abundance, and stock structure of cetaceans across the Hawaii-Marianas survey corridor.

Later in 2010, PIFSC scientists joined with colleagues at the Southwest Fisheries Science Center to conduct the Hawaiian Islands Cetacean and Ecosystem Assessment Survey, a collaborative survey of cetaceans in the 200-nautical mile Exclusive Economic Zone around the Hawaiian Islands, including waters of the Northwestern Hawaiian Islands within the Papahānaumokuākea Marine National Monument. The large-scale expedition involved a pair of NOAA research vessels, the *Oscar Elton Sette* and the *MacArthur II*. Operating along parallel, uniformly spaced oceanic tracklines, the ships covered waters from the Island of Hawaii at the southeast end of the archipelago to Kure Atoll at the northwest end. Scientists aboard the ships used standard visual and acoustic survey methods, collecting data to assess the current abundance of cetacean species in the region. They recorded more than 400 cetacean sightings, many accompanied by photographs, and a similar number of acoustic detections. When conditions permitted, they launched small boats to approach cetaceans at the sea surface and used special darts to collect skin biopsy samples for analysis of population genetics and stock structure. Samples from 147 animals representing several cetacean species were collected, including 40 from false killer whales in the offshore and Northwestern Hawaiian Islands portions of the study area. Oceanographic observations collected systematically throughout the survey will help researchers put the cetacean observations into an ecosystem context. Analysis of the cetacean survey data is underway and new abundance estimates should be available for most species by the end of 2011.

High-powered binoculars are used to sight cetaceans at the sea surface.

Fraser's dolphins in the Hawaiian Archipelago.

False killer whales.

Study Expands Knowledge of Loggerhead Turtle Movements and Oceanic Habitat in the East China Sea

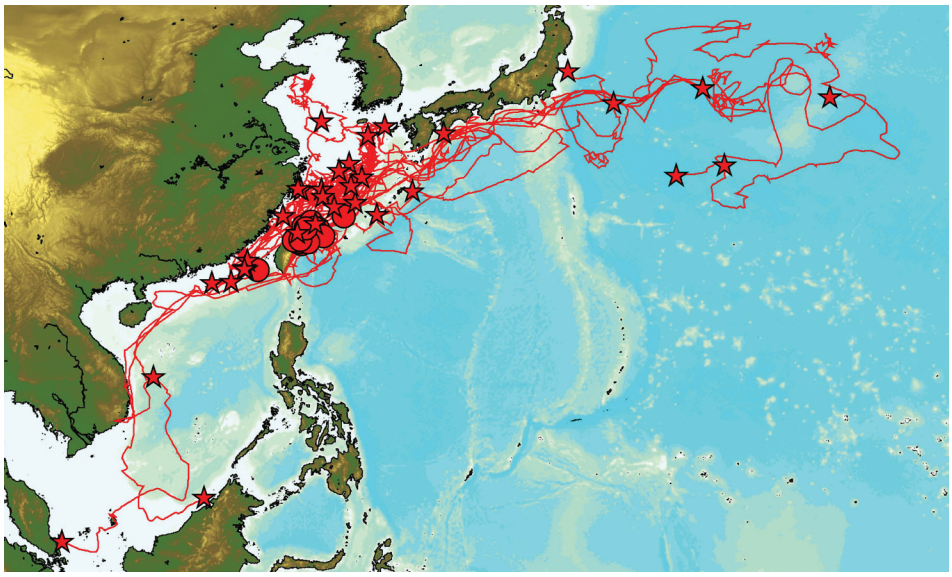
For the past decade, scientists at PIFSC have been on the forefront of research to understand the oceanic distribution and habitat of loggerhead sea turtles in a wide area of the North Pacific, particularly in the transition zone north of Hawaii between subtropical and temperate waters. They have equipped live loggerheads with Argos location transmitting tags, released them, and monitored them by polar-orbiting satellites to learn about their movements and dive behavior. And by combining this information with oceanographic data, also collected by satellites, they have learned the preferred pelagic habitats of the turtles and how to predict areas and time periods where fishing vessels are most apt to encounter turtles. This research is fundamental to developing an ecosystem-based strategy for managing pelagic longline fisheries in turtle habitat and reducing turtle mortality caused by interactions with fishing gear.

In 2010, PIFSC scientists and collaborating researchers from Taiwan and Japan reported new results from studies of 34 loggerheads caught incidentally in pound nets moored in shallow water along Taiwan's Pacific coast. Genetic analysis showed that these turtles, like other loggerheads in the North Pacific, were born on nesting beaches on Japan's Pacific coast. The immature turtles were outfitted with satellite transmitting tags and released. The tracking data, downloaded from Argos, documented oceanic journeys from 6 to 503 days.

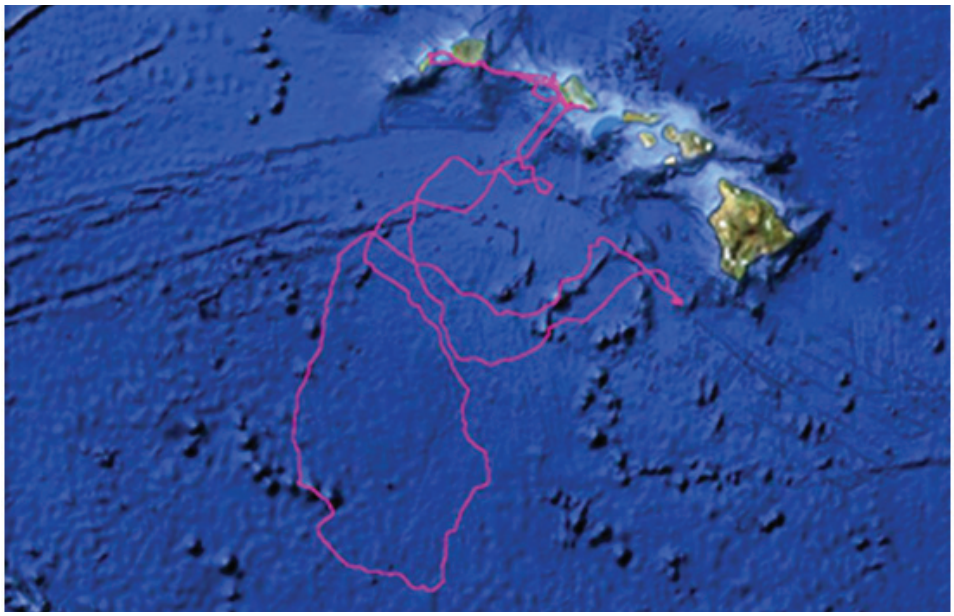
A Bayesian state-space model was used to process the Argos positional data and estimate the post-release paths of turtles. The turtles mostly occupied the Taiwan Strait and East China Sea. Outside this area, some turtles registered locations in Pacific coastal waters of Taiwan and Japan; others ranged more widely, some venturing northeastward into waters of the Kuroshio Extension Bifurcation Region (KEBR) and adjacent areas of the central North Pacific, others into the Yellow Sea, and a few into coastal waters of Vietnam and Malaysia in the South China Sea. Further analysis of positional data revealed a "hotspot" of high turtle occupancy in the East China Sea; 51% of all track days were recorded there. Bathymetric data showed the hotspot to be a relatively shallow area and chlorophyll-*a* data indicated that waters there were twice as productive as those encountered by tagged turtles outside the area.

Modeled turtle time tracks were analyzed in conjunction with various oceanographic data, including a new product based on satellite altimetry that resolves mesoscale eddies. In earlier research in the KEBR, PIFSC scientists showed that such eddies are key features of loggerhead foraging habitat. In the present study, the research team found that among eddy features examined, turtles had the highest affinity for eddy edges, but turtles inside the East China Sea high-occupancy area were much less likely to be found near an eddy than those outside the hotspot; even non-sentient objects (like free-drifting buoys and simulated passive particles originating at turtle release sites) showed higher probability of eddy association than the hotspot turtles. This finding is curious, and suggests more research is needed to understand the distribution of eddies in time and space and other factors, such as benthic habitat, that influence the distribution of forage and the behavior of loggerheads in the complex hotspot area.

The tracking data show that loggerheads susceptible to capture in Taiwan's poundnet fishery are apt to visit waters in many national jurisdictions within the Asian region, as well as the high seas, underscoring the critical need for international cooperation in loggerhead conservation. Fishery interactions with loggerheads have been recorded across the range of the turtles, from Asia to North America but rigorously monitored only in the United States. The East China Sea hotspot is heavily fished, primarily by boats from China.



Tracks of tagged loggerheads determined from Argos satellite data. Circles denote release locations and stars the last transmitted positions.



A GPS-equipped satellite cell phone tag was attached to an adult male Hawaiian monk seal on Oahu. From March through July 2010, the tag recorded the seal's foraging movements, including a visit to neighboring Kauai and oceanic waters far offshore.

New Technology Enables Better Understanding of Foraging Habitat Use by Hawaiian Monk Seals

When they are not ashore resting or nursing their pups, Hawaiian monk seals spend their time at sea searching for something to eat — fish and other marine fauna on the reefs and banks surrounding the islands. Research on foraging habits of monk seals is an important part of the Center's work to support recovery of this endangered species. In parts of the seal's range, persistent declines in seal abundance are caused by high mortality, particularly in juveniles, as a result of chronic food limitation and other factors. Understanding the feeding habits and preferences of the seals, and the abundance of prey species and forage competitors, will help NOAA develop effective recovery strategies.

In the remote Northwestern Hawaiian Islands, where most monk seals live and where the overall seal population is declining at a rate of 4.5% per year, foraging habits have been studied by placing dive recorders, satellite transmitters and cameras (CRITTERCAMS) on seals and analyzing data and video documenting their feeding excursions. Other diet studies have involved analysis of seal scat, spews and blubber.

In the main Hawaiian Islands, where monk seals are increasing in number, a new technology is providing useful information about seal foraging. PIFSC scientists are using telemetry tags featuring a GPS unit, cellular transmitters, and sensors that measure depth and temperature of the water where the seal is swimming. The cell phone transmits the seal's location and environmental data to a computer onshore where scientists can monitor the seal's movements and surroundings at a resolution never before possible.

In 2010, Center researchers put cell phone tags on the backs of 11 older monk seals, gluing the device to their pelage. Data collected so far show that most of the seals made regular trips to sea to forage near shore in a range of habitats from shallow coral reefs to waters over 500 m below the surface. Foraging excursions usually lasted less than 2 days. But one adult male seal tagged on Oahu made an unusually long oceanic voyage lasting for a month, covering 2000 nautical miles.

Between foraging trips, monk seals rest. The GPS-equipped cellular transmitter tag, glued to the seal's back, transmits data on the animal's location and dive depth, and temperature of the surrounding water.

Sustainable Fisheries and Fishing Communities

The Center carries out extensive activities to monitor U.S. fisheries throughout the Pacific Islands Region, assess the status of exploited fish stocks, and provide scientific advice to fishery managers. Fish catch and fishing effort are monitored by Center staff in collaboration with local government partners in American Samoa, CNMI, Guam and Hawaii through the Western Pacific Fisheries Information Network. Research is conducted on fish life history and biology; mitigation of fishery interactions with protected species; fish population dynamics and stock assessment; economics and human dimensions of fisheries; and more. Substantial collaborative research on pelagic stocks is carried out through the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean. Monitoring information and stock assessments support the development and implementation of domestic fishery management plans for insular and pelagic fisheries through the Western Pacific Fishery Management Council. They also contribute to international management of fisheries for tunas, billfishes and other highly migratory pelagic fish through the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission. During 2010, progress was noted in several areas:

Biological Studies Support Improved Bottomfish Stock Assessment

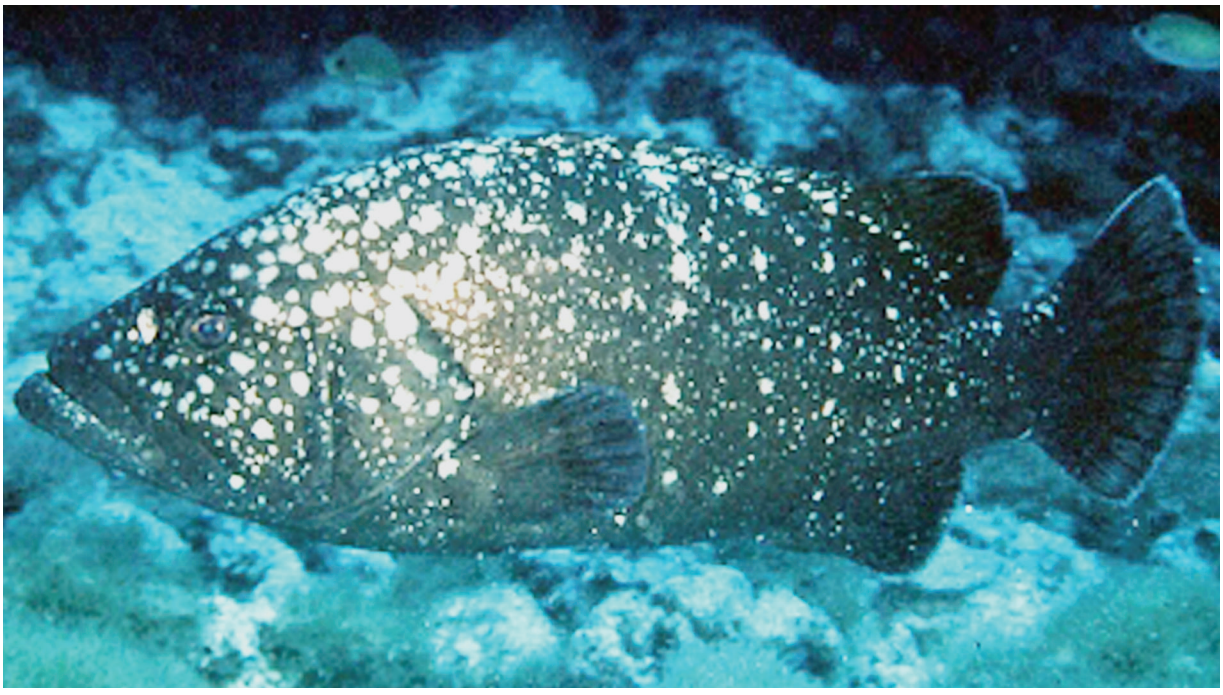
Knowledge of biological processes like growth, longevity and maturation is essential to reliable fish stock assessments. The Center has given priority to improving biological information for Hawaii bottomfish and in 2010 made notable advances for two important species, opakapaka and hapu'upu'u. Both are in the so-called 'Deep-7' group of bottomfish species targeted by commercial and recreational vessels in the main Hawaiian Islands under strict federal and State of Hawaii regulations. For many years, a fishery for bottomfish also operated in the remote Northwestern Hawaiian Islands. That area is now part of the Papahānaumokuākea Marine National Monument, and the bottomfish fishery there ended on January 1, 2010.

Recent research on opakapaka, or pink snapper, has improved knowledge of the species' age and growth. In previous studies, scientists counted daily growth increments on otoliths

Opakapaka

(ear bones) to accurately determine ages of smaller opakapaka, but ages of large fish remained elusive. Using bomb radiocarbon dating and lead-radium dating, PIFSC researchers have extended the range of age determinations to include large specimens. The bomb radiocarbon method is based on a dated radiocarbon marker in growth bands of otoliths; the marker results from a pulse of radiocarbon produced through atmospheric testing of thermonuclear devices during the 1950s and 1960s. Accordingly, bomb radiocarbon dating currently allows accurate ageing of opakapaka up to about 53 years. The lead-radium dating method, based on the decay of radioisotopes, is less accurate but can be applied to fish up to 100 years old. Both methods have provided firm evidence that opakapaka have a lifespan of 40+ years, more than double the longevity previously assumed. Augmented by additional samples, these results will be combined with other reliable opakapaka age determinations to develop an improved age and growth model for stock assessment. Results will be prepared for publication in a peer-reviewed journal. Following the opakapaka research, both lead-radium and bomb radiocarbon dating will be used to study age and growth of two other bottomfish species, ehu (squirrelfish snapper) and hapu'upu'u (Hawaiian grouper).

For the hapu'upu'u, recent studies have advanced our understanding of the species' sexual development and maturation. PIFSC scientists extracted gonads from more than 600 hapu'upu'u caught during research cruises or provided to the Center by cooperating commercial fishermen. The specimens were collected on reefs and banks of the Northwestern Hawaiian Islands from the late 1970s to the present and during all seasons of the year. Tissue samples from the gonads were studied under a microscope to determine the gender and state of maturity of the fish. Both males and females were identified among large adult specimens. But among immature and small specimens, only female or bisexual fish were found; there were no males. The data strongly indicate that hapu'upu'u in the Northwestern Hawaiian Islands begin their life as females and that after reaching maturity, some females become males (biologists refer to such organisms as "protogynous hermaphrodites"). Among adults, there are more than five females to each male. Data on size of females and condition of their ovaries showed that the proportion of mature females increases with size, reaching 50% for fish of about 58 cm body length; this is an estimate of average size at first sexual maturity. At an average body length of about 90 cm, at least some mature female hapu'upu'u transition to mature males. Data on gonadal state and reproductive activity showed no change in the size of testes with time, but the average size of ovaries in relation to fish body weight changed seasonally, indicating a spawning period of February–June for the fish studied. The results of this research, limited to hapu'upu'u in the Northwestern Hawaiian Islands, were recently published in the peer-reviewed journal Fishery Bulletin. Further studies are needed to determine whether fish in main Hawaiian Islands exhibit the same characteristics. A full understanding of hapu'upu'u reproductive biology across the entire archipelago is essential for reliable stock assessment and fishery management.



Hapu'upu'u (*Credit: John E. Randall, FishBase*)

New Assessment Research Shows Decline of Striped Marlin in the North Pacific

In the North Pacific, striped marlin is a valued catch of several commercial pelagic longline fleets and recreational troll fisheries. Assessments of the North Pacific striped marlin stock are carried out by the Billfish Working Group of the International Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) whose members include Canada, China, Mexico, Japan, Republic of Korea, Taiwan and the United States. Within the working group, scientists have assembled the best available fishery data from the multinational fleets, reviewed current biological information on billfish species, and assessed changes in stock size and productivity under different assumptions about stock dynamics, taking into account information uncertainties. However, a full assessment has been problematic because the group has not yet adopted biological reference points for determining striped marlin stock status, such as those based on maximum sustainable yield (MSY); MSY-related reference points are currently used in management of Pacific tuna stocks. In addition, the group has lacked a comprehensive analytical framework to evaluate the full range of alternative assumptions that can affect the stock assessment and determination of stock status. In 2010, PIFSC members of the working group established such a framework. Then they used it to study uncertainties in the striped marlin stock assessment and evaluated the stock status in terms of MSY-based reference points.

A key uncertainty in the assessment concerned the resilience of the stock as measured by its ability to generate a sufficient number of young fish, or recruits, when the adult spawning stock is reduced to low levels; a more resilient stock is able to sustain a higher level of harvest and rebuild more quickly. The ISC working group had identified two possible stock-recruitment scenarios, which they considered equally plausible. The first scenario assumed that the annual number of recruits was dependent on size of the spawning stock as described by a Beverton-Holt model with moderate resilience: when the spawning stock was reduced to 20% of its maximum average level, it was assumed to produce 30% fewer recruits than it would at maximum stock size. Under the second scenario, the stock was assumed to be highly resilient, with recruitment fluctuating randomly around a constant level, independent of spawning stock.

Under each stock-recruitment scenario, the PIFSC team generated 40-year time series (1965-2004) of spawning stock size and associated recruitment, using the Stock Synthesis statistical model (SS2) on which ISC striped marlin stock assessments are based. Then to determine the status of the striped marlin stock, they used the two sets of SS2 output data as input to a Bayesian age-structured production model, SRFIT, which calculated MSY-based biological reference points. In this post-hoc analysis, the production model was applied in four different configurations, taking into account uncertainties in various aspects of model structure and other technical matters. Each candidate model was run under each of the two stock-recruitment scenarios, producing eight alternative determinations of stock status relative to the MSY-based reference points. Instead of assuming a single one of the candidates was correct and basing the stock status determination on that premise, the PIFSC scientists took a more sophisticated approach. For each stock-recruitment scenario, they combined results on stock status from the candidate models using Bayesian model averaging. Then they derived the most probable overall results by simply averaging over the two stock-recruitment scenarios, taking into account the equal plausibility of each scenario. Further analysis showed that conclusions on stock status, and most other post-hoc results, were not sensitive to the scenario plausibility assumptions.

The scenario-averaged results revealed an interesting history of spawning stock biomass. Abundance of the spawning stock declined threefold from 1950 to the late 1960s, followed by a brief but temporary return to the high levels of the early 1950s. Since the early 1970s, though, the stock has steadily declined to very low levels. Spawning stock biomass for 2004, the most recent year for which comprehensive Pacific-wide data were available, was estimated at only 36% of the average stock level needed to support maximum sustainable yield. Moreover, scenario averages of relative fishing mortality showed that fishing mortality has exceeded the MSY level for decades and as of 2004 was almost three times higher than the MSY level; overfishing is clearly occurring. These conclusions take into consideration the best available data, a broad range of uncertainties, and a weighing of reasonable beliefs about the underlying model.

This research on the North Pacific striped marlin stock assessment was published in the Canadian Journal of Fisheries and Aquatic Sciences in 2010.

Compliance with Bigeye Tuna Catch Limit Ensured by Careful Catch Monitoring

In the western and central Pacific Ocean (WCPO), bigeye tuna are harvested by international fleets of open-ocean vessels using longline gear or purse seines, and coastal island fleets using various small-scale gear. Although the impact of individual fleets varies widely, the aggregate impact of all fleets on the bigeye stock is great. Catch data used to monitor the harvest and assess fishery impacts are collected by the Central and Western Pacific Fisheries Commission. On the advice of its Scientific Committee, the Commission has determined that overfishing of the bigeye stock is occurring — the aggregate fishing mortality exceeds the level that would produce MSY. Accordingly, the Commission enacted conservation measures to reduce fishing mortality in the form of bigeye tuna annual catch limits and other measures. For the U.S. longline fleet, based primarily in Hawaii, the WCPO bigeye catch limit in 2010 was 3763 metric tons. To ensure the U.S. did not exceed the limit, PIFSC scientists carefully monitored the catch by U.S. longline vessels throughout the year. By analyzing data from the current fishing season, historical data, and other information they estimated the date when the U.S. longline fleet's bigeye tuna catch in the WCPO would reach the established catch limit. They updated the estimates frequently and issued forecasts to NMFS fishery managers and the public on NOAA websites. Given this information, NMFS was able to issue timely regulations to curtail WCPO catches of bigeye tuna by U.S. longliners on November 22, 2010, enabling the United States to comply with the WCPFC conservation measures.

Bigeye tuna are an important contribution to fresh fish sales in Honolulu.

Center Hosts Workshop on Economics of Catch Shares

In early 2010, PIFSC hosted a national workshop on the economics of catch shares in response to NOAA's recent policy to encourage use of catch shares as a fishery management tool to end overfishing and rebuild fisheries and fishing communities. Currently, no catch share programs have been established in the Pacific Islands Region. The objective of the workshop was to explore potential roles, goals, limitations, and design characteristics of management programs based on catch shares (such as individual fishing quotas, individual tradable quotas, and other schemes) in the context of Pacific Island Region fisheries. Held at the Hawaii Imin International Conference Center on the University of Hawaii's Manoa campus, the workshop featured 20 invited speakers including leading economists and social scientists from the United States, Canada and New Zealand. Participants included researchers from PIFSC, government fisheries managers, and experts from the Western Pacific Fishery Management Council, the NOAA Fisheries Pacific Islands Regional Office, and the University of Hawaii. Workshop discussions allowed participants from the Pacific Islands Region to express their concerns and requirements for catch share programs in a setting where the invited guests could suggest possible alternatives to meet those needs. A report of the workshop proceedings will be issued soon.

Other Notable Accomplishments

ESA Status Reviews

In 2010, PIFSC scientists provided leadership and expertise in the development of Status Reviews in response to public petitions under the Endangered Species Act (ESA). In the petitions, the National Marine Fisheries Service was asked to determine whether there was sufficient scientific information to warrant listing certain marine species as endangered or threatened species under the Endangered Species Act. In each case, NMFS was required to assemble a Biological Review Team (BRT) to prepare a Status Review — a comprehensive assessment of the petitioned species' biological status and its threats based on the best available scientific and commercial information. PIFSC scientists led BRTs to prepare three status reviews: one for the Hawaii insular stock of false killer whales; another for the bumphead parrotfish (photo above); and a third for 82 species of coral occurring in the Pacific and Atlantic Oceans. The BRTs, made up of PIFSC staff and other federal scientists, prepared status review documents after exhaustive research and many arduous technical discussions. The draft documents were then subjected to independent, external peer review and extensive agency comment. The false killer whale status review has been published and the other two documents are being readied for publication.

Gulf Oil Response

Eleven scientists and administrative staff from PIFSC provided key support for NOAA's coordinated response to the 2010 Deepwater Horizon oil spill in the Gulf of Mexico. As part of NOAA's efforts to assess the scope and severity of oil impacts on ecosystems of the gulf, research staff with a wide range of critical skills and experience were organized and dispatched to the gulf. There they worked with others to observe, record, and report facts "on the ground" that informed NOAA leadership and government officials charged with assessing the damage. PIFSC staff helped with response planning and coordination; surveyed Gulf beaches and coastal waters to recover stranded and injured sea turtles; conducted oceanographic surveys of the water column and sea floor from research vessels; operated small boats involved in ecological assessment work; monitored seafood safety; and more. Like NOAA staff from other parts of the country, PIFSC volunteers set aside normal research activities, or more often expanded their workload, to ensure the agency's response to the oil spill was timely and effective.

External Review of Data Management

In July, 2010, PIFSC invited a panel of independent experts, external to the Center, to review and evaluate the Center's approaches to management of scientific data. Panelists were asked to advise Center leadership on ways PIFSC could alter its data management practices to improve the quality of data services provided to clients. In sessions open to PIFSC staff and stakeholders, they heard presentations by PIFSC staff describing data management projects, practices, and issues in all research and monitoring programs and data management support groups. The review covered all major scientific programs and revealed the complexity of data management challenges faced by the Center. The panel also met privately with key PIFSC stakeholders. At the conclusion of the review, the panel chair prepared a report with consensus views and advice of the experts. The external review helped the Center focus sharply on its data management problems, increased Center-wide communication about data management issues, and energized PIFSC staff toward finding and implementing solutions. We have already begun to address many of the panel's recommendations, including development of a Center-wide data management plan.

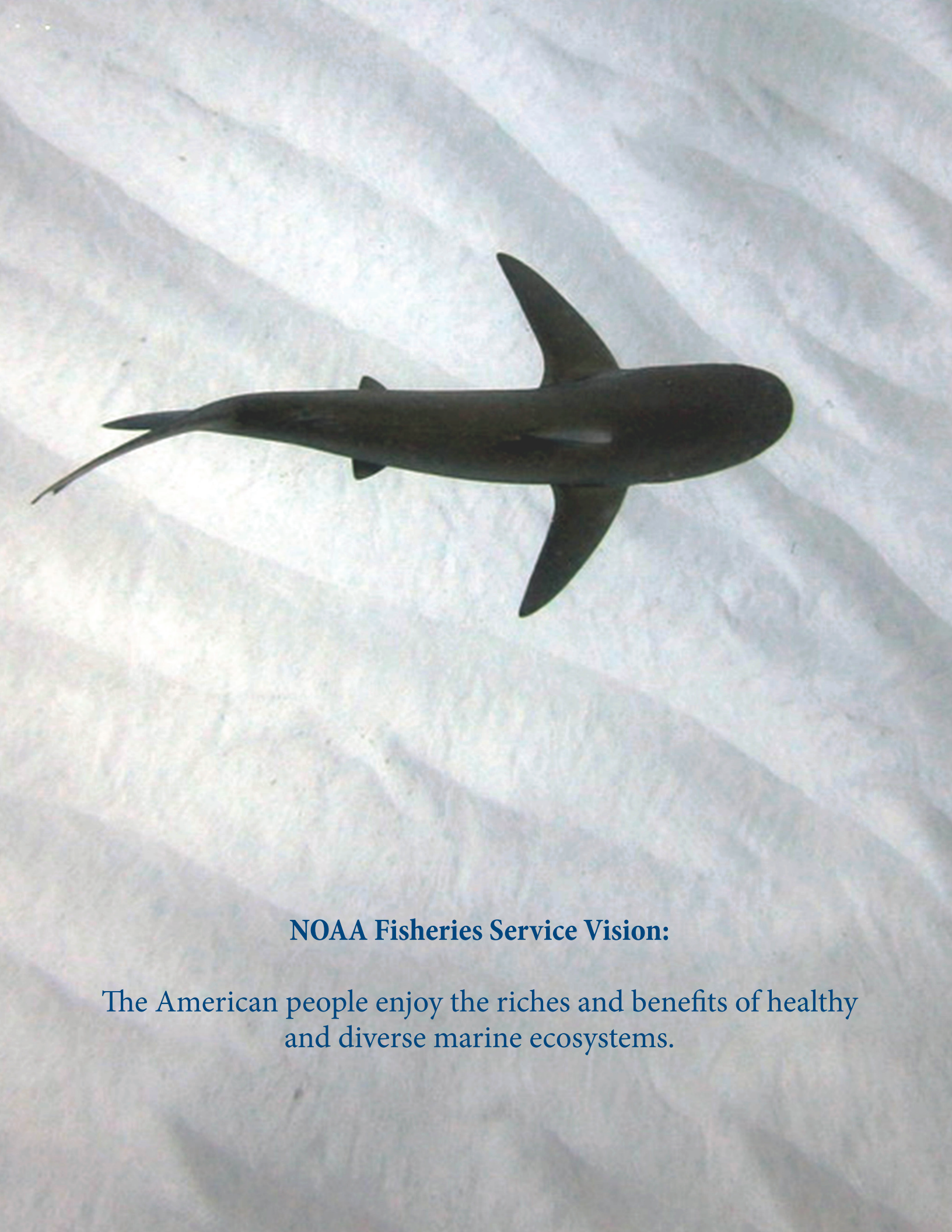
Center Reorganization

In 2010, we made significant organizational changes to improve our effectiveness in addressing the Center's research mission. Previously, fisheries monitoring and fisheries data management activities were conducted separately from programs in fish biology, fisheries interactions, and fish stock assessment. All these fishery-related activities are now organized and coordinated under the new Fisheries Research and Monitoring Division. In addition, research in economics and human dimensions of marine resources, formerly in the same division as fisheries monitoring and fisheries data management, was moved into a new program called the Socioeconomics and Planning Group in the Science Directors Office. This move will foster interactions between socioeconomics staff and other Center research programs and enable a broader reach of socioeconomics studies, addressing topics in all areas of sustainable marine resource use and ecosystem services.

Research Administration, Facilities Planning, and Technical Support

As the number of scientific research mandates grows, while federal budgets shrink, the Center faces increasing challenges to achieve NOAA missions. The burden falls not only on scientists planning and conducting the research, but especially heavily on administrative staff who manage budgets, procurements, facilities, staffing, training, travel, safety, small boat operations, and other critical support functions. In virtually all areas, these responsibilities grew in 2010. The Center continued to have significant involvement in preparations for the new NOAA Pacific Regional Center at Ford Island, Pearl Harbor, which will be home to all PIFSC staff, along with other NOAA workers, in early 2014. Construction of the new facility is underway. Our technical support staff has continued to maintain the Center's expanding information and communication infrastructure, including hardware and software systems, networks, security protocols, and other critical components at our main Dole Street offices and three satellite office and laboratory complexes elsewhere around Oahu. Likewise, our scientific information specialists continued to manage our public library and to ensure that results of Center research are properly vetted and disseminated to the public and other clients through peer-reviewed journals, Center technical reports, and our website. Our data support staff continued to ensure that our scientific data assets are secure and readily accessible by coordinating the collection and publication of metadata, assisting Center staff and partners with data queries, and improving software tools that help users tap directly into the Center's Oracle enterprise databases. They also maintained and improved several critical databases that support the Center's administrative functions.

The Center's small-boat program provides vital support for nearshore research.



NOAA Fisheries Service Vision:

The American people enjoy the riches and benefits of healthy and diverse marine ecosystems.

Copies of this document may be obtained by contacting:

Pacific Islands Fisheries Science Center
2570 Dole Street
Honolulu, HI 96822-2396
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An online version of this report is available at http://www.nmfs.noaa.gov/do/index.php.

Bumphead parrotfish photo (p. 14) courtesy of Sergey Bogorodsky. Other photos are from NOAA collections.

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PIFSC. 2011. 2010 Year in Review, NOAA Fisheries Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-11-01, 16 p.