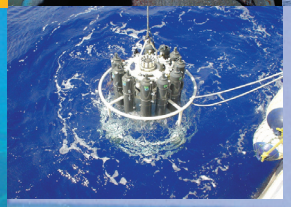
2007 Annual Report

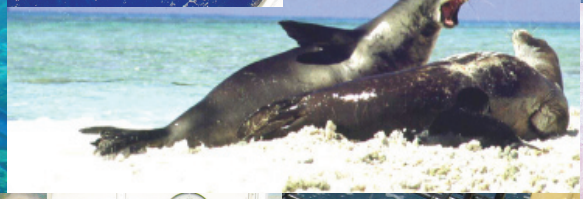
Pacific Islands Fisheries Science Center

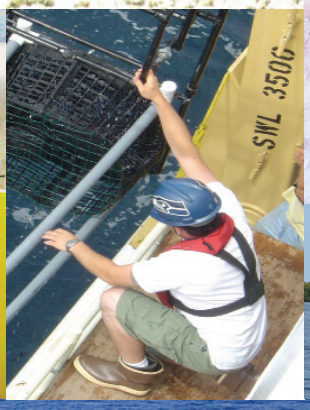


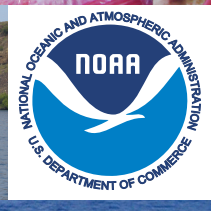








NOAA Fisheries

2007 Annual Report

Pacific Islands Fisheries Science Center

NOAA Fisheries

April 2008

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.

Copies of this document may be obtained by contacting:

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Science Center
2570 Dole Street
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An online version is available at http://www.pifsc.noaa.gov/do/index.php

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Contents

Foreword

We are happy to provide you the 2007 Annual Report of NOAA Fisheries' Pacific Islands Fisheries Science Center. The Center's research covers a wide range of scientific issues and topics requiring expertise in many disciplines. Our principal areas of research include coral reef ecosystems; ecosystem analysis and oceanography; fish biology and stock assessment; bycatch mitigation; fisheries monitoring and socioeconomics; and protected species population monitoring and recovery. Support programs within the Center ensure success of our science endeavors by providing help in administration and infrastructure, information technology and communications, and scientific information services.

Last year we conducted our first external review of the Center's overall research program. The review provided critical insights into areas where we need to improve and where we can develop more fully. Information on the review can be found on our Web site at: http://www.pifsc.noaa.gov/do/pifscreports.php. This year we will be holding a similar review focused on our ecosystem research.

As you can see from the pictures throughout this report, we have a diverse and energetic staff. Our workforce of 204 includes 85 Federal employees, 104 employees of the University of Hawaii's Joint Institute for Marine and Atmospheric Research, and several external contractors. We operate four research facilities, all in central Honolulu: our original Dole Street adjacent to the University of Hawaii Manoa campus; our Kewalo Research Facility located on the Honolulu waterfront; an office and laboratory complex for fish biology in Aiea, and shared space with the National Marine Fisheries Service Regional Office downtown. In addition to our land-based operations, we engage in research expeditions year-around throughout the central and western Pacific, including American Samoa, the Marianas, and remote island area in the mid-Pacific, on the NOAA Ships *Oscar Elton Sette* and *Hi'ialakai* and maintain extensive temporary field camps at remote islands and atolls in the Northwestern Hawaiian Islands.

We welcome your comments and thank you for your support.

Samuel G. Pooley, Ph. D.
Science Director

Michael P. Seki, Ph. D.
Deputy Science Director

External Review Highlights Center's Successes and Identifies New Challenges

During March 6-8, 2007, we convened a panel of experts to provide a critical, external review of the Center's science programs, consult with our principal partners and provide constructive feedback to Center leadership about the job we are doing. The panel learned about the Center's scientific objectives, methods, and accomplishments and the key issues we face in meeting needs of our clients in the Pacific Islands Region. Discussions between the panelists and Center staff were frank and stimulating. Comments from the review panel provided the Center with a better appreciation of our strengths while identifying new directions we can explore to provide better, more comprehensive science products and services throughout the Region. The panel report is available on our Web site at:

http://www.pifsc.noaa.gov/do/ExternalReview_2007.php

Overview of the Center

Function and Mission

The Pacific Islands Fisheries Science Center (PIFSC) is one of six NOAA Fisheries Science Centers. Established in 2003 with the creation of the Pacific Islands Region (PIR) within NOAA Fisheries and headquartered in Honolulu, Hawaii, PIFSC is responsible for research on Federally managed marine fisheries, protected species such as the endangered Hawaiian monk seal, and ecosystems in the entire western and central Pacific Ocean, in both near-island (insular) habitats and open ocean (pelagic) environments.

The Center's mission is to conduct timely, high quality applied scientific research to support conservation and management of living marine resources in the central and western Pacific Ocean. The PIFSC mission is linked directly to the NOAA Strategic Plan and, in particular, NOAA's Ecosystem Mission Goal:

"To protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management."

In providing the science to support an ecosystems approach to the conservation, management and recovery of living marine resources, the PIFSC has adopted a multidisciplinary strategy. The strategy involves integrated data collection and monitoring of marine resources and their environment, including an extensive ecosystem observation system, scientific research programs with activities focused on nearshore and pelagic fisheries, coral reef species and habitats, marine mammals and sea turtles, marine ecosystems and oceanography, and conservation and management advice.

The Center's fisheries-oriented research programs monitor U.S. fisheries throughout the PIR and conduct biological, ecological, and economic research in support of five Fishery Management Plans and emerging Fishery Ecosystem Plans developed by the Western Pacific Regional Fishery Management Council (WPFMC). Similar scientific contributions are made toward international management of fisheries for tuna and other highly migratory species by the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission. In both domestic and international fisheries management arenas, PIFSC provides scientific support and advice to the NOAA Fisheries Pacific Islands Regional Office (PIRO).

PIFSC coral reef ecosystem research focuses on comprehensive surveys of reef ecosystems in the archipelagoes of the Pacific Islands Region. Protected species research and recovery programs monitor the status of the Hawaiian monk seal and sea turtles in the Pacific and identify the factors affecting their population, health, and recovery. A newer component of the Protected Species program is focused on surveys of cetacean populations in the central Pacific. Other PIFSC research investigates the structure and dynamics of central North Pacific marine ecosystems and how marine populations are affected by changes in their predators, prey, and habitat, and by ocean climate.

History

PIFSC has a long and illustrious history. The initial staff and facilities of PIFSC derived from the former Honolulu Laboratory, until 2003 a component of the NOAA Fisheries Southwest Fisheries Science Center in California. Before NOAA's establishment in 1970, the Honolulu Laboratory was part of the U.S. Fish and Wildlife Service, originating in 1948 as the Pacific Oceanic Fishery Investigations. In almost 6 decades of scientific studies, PIFSC staff and our predecessors have engaged in fishery resource exploration, fisheries development, fisheries biology and ecology, protected species recovery research and conservation, and oceanographic research throughout the Pacific and as far away as the Indian Ocean. More recently, PIFSC has established extensive programs in coral reef ecology through collaboration with NOAA's Coral Reef Conservation Program.

The Pacific Islands Fisheries Science Center

Pacific Islands Fisheries Science Center FY 2007

Personnel	
Federal	85
JIMAR	104
Other	15
Total	204

Budget by NOAA Program	$ M	%
Protected Species Program	2.9	11
Ecosystem Observation Program	16.9	67
Corals Program	5.5	22
Total	$ 25.3	

Geographic Area of Responsibility

Bounded by the Hawaiian Archipelago in the north, American Samoa and U. S. Pacific Remote Island Areas in the south, and the Mariana Archipelago in the west, the Pacific Islands Region encompasses the largest geographical area within NOAA Fisheries' jurisdiction. The U.S. Exclusive Economic Zone within the Region includes more than 1.7 million square nautical miles of ocean, roughly equal to the total EEZ of the continental United States and Alaska. PIFSC is also responsible for research on living marine resources in the high-seas areas of the central and western Pacific.

Budget and Staffing History

In fiscal year (FY) 2007, the PIFSC budget was $25.3M and supported a staff of 204 researchers, technical personnel, and administrative employees. Almost all the Science Center's budget supports the NOAA "ecosystems" mission, and its activities generally fall within the Ecosystems Observation Program and Corals Program. In addition to federal employees, Center programs include a large number of scientists and seasonal technical staff employed by the University of Hawaii Joint Institute for Marine and Atmospheric Research (JIMAR) and by a private contractor, Aquatic Farms. Several UH students also work at the Center or are engaged in graduate research with Center projects, and a number of Center scientists serve on graduate committees within the university.

Facilities and Vessels

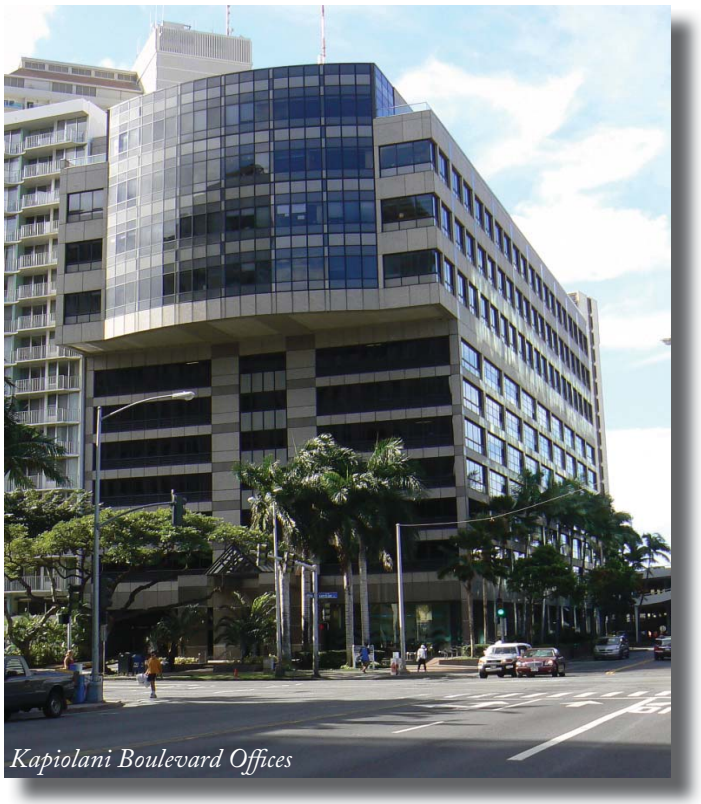
The main PIFSC office facility is located on Dole Street, adjacent to the University of Hawaii at Manoa campus. A smaller seawater research facility is located at Kewalo Basin on the Honolulu waterfront enabling research on live, large pelagic fishes, monk seals, and sea turtles. Another research facility, with offices and a wet laboratory supporting fish biology work, is leased in Aiea near Pearl Harbor. Additionally, several PIFSC researchers have recently moved from the Dole Street facility into offices adjoining the PIRO headquarters on Kapiolani Blvd in downtown Honolulu.

The NOAA Ship *Oscar Elton Sette*, homeported at Ford Island in Honolulu, is the primary research vessel supporting the Science Center's extensive field activities. Center staff also conduct benthic habitat mapping and other coral reef ecosystems research aboard the NOAA Ship *Hi'ialakai* in partnership with NOAA's National Ocean Service. PIFSC also has a "fleet" of about 30 small boats, ranging from 14 to 25 ft in length, to facilitate nearshore research.

Research Focus

PIFSC research currently focuses on several areas of high priority:

- Identifying and understanding the effects of ecosystem linkages and environmental processes on fish stocks, protected species, and other marine life and developing the scientific basis for ecosystem oriented management
- Monitoring and reducing fishery interactions with protected species
- Monitoring the status of Hawaiian monk seals and finding ways to increase their survival and population sustainability
- Assessing the populations of deepwater snappers,



Kapiolani Boulevard Offices

Oscar Elton Sette

groupers and jacks (bottomfish) in the main Hawaiian Islands

- Monitoring the status of Hawaiian green turtles and other marine turtle populations in the Pacific
- Assessing cetacean populations and the effects of human activity on them
- Mitigating fisheries bycatch, particularly in multinational pelagic longline fisheries
- Providing scientific advice in support of international and domestic management of fisheries for highly migratory species—including tunas, billfishes, and sharks
- Assessing stocks of tunas, billfishes, and other pelagic fishes in the central and western Pacific
- Researching the use of barbless hooks by recreational fishers to reduce post-release fish mortality and risks of injury to protected species
- Expanding the understanding of socioeconomic and cultural aspects of living marine resource use and appreciation throughout the PIR
- Assessing the physical and biological structure, dynamics, and health of coral reef ecosystems
- Monitoring and removing derelict fishing gear and other marine debris from reefs and nearshore waters of the Hawaiian Archipelago

Science Center Organization

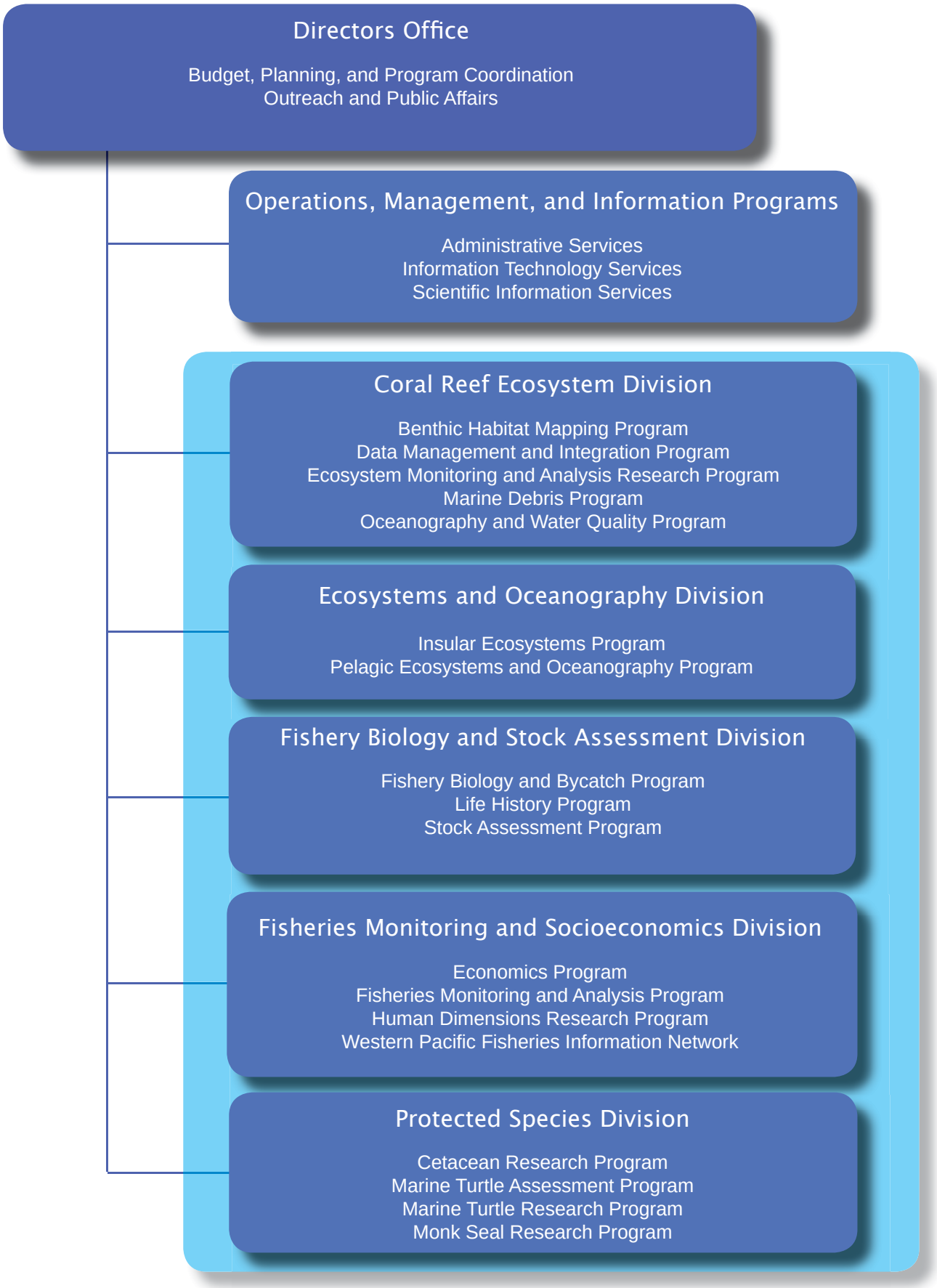
The PIFSC is organized into five research divisions:

- Coral Reef Ecosystem Division (CRED)
- Ecosystems and Oceanography Division (EOD)
- Fisheries Monitoring and Socioeconomics Division (FMSD)
- Fishery Biology and Stock Assessment Division (FBSAD)
- Protected Species Division (PSD).
- The Operations, Management, and Information (OMI) Division has three programs providing essential support:
  - Administrative Services
  - Information Technology Services
  - Scientific Information Services


Kewalo Research Facility


Aiea Heights Research Facility

Pacific Islands Fisheries Science Center



Directors Office

The Directors Office provides overall scientific leadership, strategic guidance, research direction, program management, and operational policy for the Science Center. In addition, the office is responsible for liaison with our many partnering agencies and offices, including the Pacific Islands Regional Office and other NOAA offices locally and nationally; the Western Pacific Fishery Management Council; resource management agencies of American Samoa, Guam, Hawaii, and the Northern Mariana Islands; the University of Hawaii and the University of Guam; the U.S. Fish and Wildlife Service; fishing industry members and organizations; recreational fishers; nongovernmental conservation organizations; other groups and the general public. The Directors Office provides coordination and leadership for U.S. participation in international scientific committees and commissions in the Pacific. The Center Director serves on the NMFS Science Board and is the U.S. delegate to PICES, the North Pacific Marine Science Organization. The Directors Office also manages the Center's planning and budget functions and outreach and public affairs.

Budget, Planning, and Program Coordination

Many Center-wide budget, planning, and program coordination activities are implemented from the Budget and Planning Office to ensure responsiveness to and consistency with the NOAA and NOAA Fisheries Strategic Plans. These activities include:

- Generation of current and projected 'Annual and Program Operating and Spending Plans'
- Center-wide budget formulation, execution, and requests
- Development of guidelines and policies governing maintenance of the budget
- Research program oversight, coordination, and integration
- Strategic planning and input to the NOAA Program Planning and Budget Execution System
- Establishment and tracking of performance measures and milestones
- Ensuring National Environmental Policy Act compliance for PIFSC research
- Coordination of PIFSC efforts to support the Integrated Ocean Observing System
- Scheduling and coordination of NOAA research vessel and aircraft operations

Outreach and Public Affairs

The community outreach program serves as the focus for the communication of scientific programs with outside agencies and the public. The objective of the program is to seek and create opportunities to inform and educate the public about the Center's mission and its impact on the economy and environment in the Pacific. This is accomplished by:

- Raising awareness of the general public to gain support for programs of the Pacific Islands Fisheries Science Center
- Teaching young people to become stewards of the environment
- Establishing PIFSC as a resource for the community and networking with community groups, schools, and other organizations
- Promoting careers in ocean sciences
- Helping teachers develop a science and conservation curriculum that supports the objectives of PIFSC.

The program also designs educational resources and implements strategies to increase communications and understanding between the agency, our constituents, and the general public.

All hands meeting

Operations, Management, and Information Programs

Administrative Services

The Office of Administration provides a comprehensive range of services in support of the Pacific Islands Fisheries Science Center's mission and staff. The office manages Center hiring and personnel issues, grants, procurement and property, safety, facilities, small boats, and staff training.

Administration staff specialists help PIFSC announce and fill federal job vacancies in Center programs, manage the orderly entry and exit of personnel from Center programs, ensure accurate and timely accounting of staff work time and attendance, and handle other personnel issues in cooperation with NOAA's Workforce Management Office.

Members of the Administration staff manage several grants and cooperative agreements supporting research and related activities for protected species, coral reefs, fisheries, oceanography, aquaculture, and other areas of scientific research critical to the NOAA mission. In 2007, the Center completed timely processing of grants totaling more than $10 million.

Our procurement specialists help Center staff obtain services, supplies, and equipment they need to meet program requirements and achieve operational goals. We strive to process invoices quickly, so contractors and vendors are paid promptly, and to record transaction accounting data accurately and make needed adjustments in a timely manner. We monitor the Center's equipment inventory to ensure accurate and timely accounting of all property. In 2007, the Center executed 285 contracts and purchase orders totaling more than $5.3 million.

The Facilities Program is responsible for maintaining Center facilities in good order and recording and reporting material deficiencies to NMFS facility program managers. The Administration staff actively monitors the status of PIFSC facilities and coordinates with the Center's Safety Officer and Executive Officer to identify needed repairs or improvements, determine costs, and ensure proper completion of work orders. In 2007 we completed a facility condition survey and accomplished several notable improvements including: retrofitting of light fixtures in the main building on Dole Street; upgrading of our closed-circuit television security system; and installing new air conditioning systems in the IT server room, conference room and other spaces.

Small boat program exercise

The Safety and Environmental Compliance Program is responsible for ensuring that PIFSC research programs and activities abide by federal rules and regulations designed to prevent injury to employees and adverse effects to the environment. The program manages facility compliance inspections and training and promotes behavioral changes in Center staff to reduce injuries and adverse environmental impacts. In 2007, we met or exceeded all NMFS Safety Action Plan milestones, including continued implementation of NOAA's Operational Risk Management initiative.

The Small Boat Program is responsible for ensuring PIFSC compliance with NOAA policies related to boats and skiffs. The program maintains an up-to-date PIFSC vessel policy, conducts boat and water safety training for Center staff, and manages the PIFSC small boat fleet. The program coordinates with Center research divisions conducting boating operations and provides assistance and guidance to them on boating and safety issues.

The PIFSC Office of Administration also coordinates and tracks training and professional development activities for Center managers and staff, including guidance and training on equal employment opportunity matters. The Office of Administration sponsors several activities during the year to encourage diversity in the workplace, including training seminars, brown bag luncheons, internship opportunities, and educational poster displays. In 2007, PIFSC conducted training sessions on a range of topics including contract management, EEO, prevention of sexual harassment, prevention of workplace violence, retirement planning, and more.

Key Activities/Issues

- To improve management of the Center's growing property inventory, staff members within each research division were designated and trained to act as property custodians.
- A comprehensive Facility Condition Survey was conducted to identify deficiencies in buildings and infrastructure. The survey produced a "punch list" of needed improvements which were prioritized and completed as resources allowed.

- Planning for the Pacific Regional Center continued in 2007 with the focus on early stages of construction, including facilities for storage and seawater facilities. Storage facility requirements were identified with respect to air conditioning, security, and other aspects with help of a logistics and storage consultant. Likewise, seawater system requirements were identified for support of live animal science, and facilities were planned with a seawater systems design specialist.
- In coordination with IT staff, plans were developed to create a personnel database and user interface software to improve administrative tracking, querying, and reporting of staff information such as personnel counts, organization, training course completion, badge issuance, and more.

Scientific Information Services

The Scientific Information Services (SIS) group provides comprehensive support to the Pacific Islands Fisheries Science Center in the management and dissemination of scientific information collected, acquired or produced by Center programs. SIS handles many kinds of information, including fisheries data, scientific publications, educational materials, graphics, and library resources, and also manages the Center's Web presence.

SIS data services staff carefully screen, validate, and archive catch statistics and other information provided to NMFS by commercial fishing vessel captains or collected by the Center's fisheries research programs. SIS strives to provide full access to the data for statistical analyses, stock assessment studies, and fishery reports while meeting legal requirements to protect the confidentiality of commercial fishing enterprises. In 2007, SIS made significant progress in its PIFSC Metadata Project to compile, organize, and publish information describing all data holdings of the Center, including data reported to NMFS by fishers and data collected by PIFSC research programs. SIS staff completed a survey of data collections and launched a project to register key metadata in preparation for creating a comprehensive Center Data Catalog. SIS staff also worked to develop DARTS, a Web-based tool for managing client requests to SIS for data access and other data services.

SIS publications specialists carefully examine and edit reports, manuscripts, and other documents prepared by Center scientists to ensure they meet NOAA information quality standards before they are released to the public or submitted for publication in peer-reviewed journals. In addition to editing journal articles, SIS publications staff managed the editing, review and approval of operating plans and cruise reports for PIFSC expeditions on the NOAA Ships *Oscar Elton Sette* and *Hi'ialakai* and chartered commercial research vessels. They also edited numerous PIFSC internal reports, working papers, conference abstracts, and other documents.

SIS helps Center staff at all locations with graphical design and layout, photography, digital image processing, and other graphics needs. In 2007, SIS continued to meet needs of Center scientists for posters, banners, leaflets and other materials for presentation at conferences. Our SIS graphics specialist also provided key support for NOAA outreach events and public educational activities.

SIS manages a NOAA reference library for use by Center scientists and the public. The library has extensive up-to-date collections of scientific journals and technical books on fisheries science, oceanography, marine ecology, conservation biology, and other subjects with an emphasis on Pacific Island insular and oceanic ecosystems. In 2007, the SIS librarian continued to develop a comprehensive Oracle database of PIFSC documents enabling ready public access to the Center's publications via the PIFSC Web site. She also scanned valuable documents from historic research expeditions conducted during the 1950s and 1960s by our predecessor organization, the Pacific Oceanic Fishery Investigations, and created an electronic archive of the documents and key metadata.

SIS is responsible for developing and maintaining the PIFSC Web site. The PIFSC webmaster disseminates the Center's scientific reports, public data products, news about current research activities and other information over the Internet. Web content is produced by subject matter experts in the Center's research divisions.

PIFSC library

Several advances were made in 2007, including full compliance with agency standards and improvement of Web page templates and contents. A new home page design is in the works for release in 2008.

SIS also manages the PIFSC Intranet, providing Center staff with comprehensive information about administrative support resources; policies and procedures; reports of current Center research activities; NOAA and NMFS corporate news; announcements of upcoming meetings, seminars, and other events; current cruise schedules; and more. In 2007 an improved "Bulletin Board" feature was created in collaboration with the Center's ITS group, enabling dynamic uploading of announcements and other content by authorized staff.

As a diverse information support group, SIS aims to ensure that marine resource managers, research colleagues, and the public have ready and timely access to important data products and the research findings of Center scientists.

SIS has established several milestones for 2008:

- Launch the DARTS online data services request tracking system
- Develop a Web-based manuscript processing system using the DARTS software template
- Coordinate registration and publication of metadata for the Center's research and fishery monitoring programs using InPort
- Create a template for publishing metadata in topic-specific online data catalogs
- Revamp the PIFSC Intranet, improving contents, accessibility, and user features

Information Technology Services

The Information Technology Services (ITS) group is composed of a team of System Administrators and a team of Systems Design specialists. The System Administrators are responsible for providing core IT support to PIFSC staff at the Dole Street facility and all satellite work sites. ITS system administrators maintain, monitor, and upgrade computer hardware, software, networking, communications, and related infrastructure and ensure compliance with growing IT security requirements. The ITS system design team is responsible for leading or assisting in the design and development of data systems to meet needs of users in all Center divisions and programs.

System Administrators

During 2007, IT administrators maintained and enhanced information and technology support for Center staff in the face of significant logistical challenges, including the continuing dispersal of scientists to work centers away from the Dole Street facility. The addition of new PIFSC offices at the Kapiolani Boulevard work site required expansion of networking capability and other onsite IT support there. In addition, IT staff spent significant effort identifying future IT requirements for NOAA's Pacific Regional Center at Ford Island. Several accomplishments of IT administrators in 2007 are noteworthy:

- Procurement and installation of a new 20kVA UPS in the Center's Dole Street computer room to provide additional protection of server and network equipment during electrical storms and other events causing power interruptions or surges.
- Upgrade of the Center's e-mail server and the VPN server to support increasing needs for secure remote access to information archives and computing resources.
- Enhancement of building and work site security at the Dole Street facility through the installation of a video surveillance and monitoring system and associated network support.
- Completion of a comprehensive certification and accreditation of the PIFSC local area network in collaboration with NMFS CIO staff and contractors. Adjustments and enhancements were made to correct deficiencies identified in the audit.
- Provision of technical support for other Center IT needs, including evaluation and installation of new software for the Intranet bulletin board.

Systems Design Team

The ITS Systems Design Team (SDT) helps PIFSC and PIRO scientists, data managers and administrators complete their missions by designing and building cost effective, time-saving information management solutions. The SDT provides database design and management expertise, application

IT servers

development services, and project management support both within the Pacific Islands Region and on a cross-regional basis through partnerships with NOAA Fisheries' national Fisheries Information System.

In 2007, SDT staff made good progress on several key projects to improve scientific and administrative information systems at the Center. Among the notable accomplishments were the following:

- Completed a PIFSC personnel database in 2007 that gives administrative staff and other authorized users ready access to current and timely staff information and reports. The underlying Oracle database also supports other Center applications such as purchasing, property accountability, and SIS online data service requests.
- Migrated a PIFSC software/hardware database from MS-Access to Oracle to facilitate data entry and access from remote work sites and enable integration with the Center's property and purchasing systems. The Oracle database provides ITS with timely system security information. Other enhancements enable improved management of property inventories and custody and usage of equipment and software.
- Continued to provide support for the Longline Observer Data System (LODS) used by the Pacific Islands Regional Office (PIRO) for critical monitoring of the Hawaii longline fishery. SDT designed a LODS user maintenance module and system enhancements to accommodate new observer requirements to collect marine mammal biological data. In 2007, a LODS Service Targets Agreement was adopted by PIFSC and PIRO that details the requirements for LODS system operation, service, and technical support.
- Initiated a project to modernize the Hawaii Longline Logbook Data System. LLDS will integrate with LODS and other fisheries data systems.
- Worked to standardize and automate production of quarterly and annual reports of fisheries data and help PIFSC staff access the data for scientific studies, fishery monitoring and reporting.
- Continued to develop and support the InPort Metadata Catalog, the software tool now being used to inventory and document all PIFSC data holdings. Additional work was completed enabling the January 2008 migration of InPort to a server in the NOAA Fisheries Office of Science and Technology, where it will support agency-wide metadata management.

InPort Launch Improves NOAA Fisheries Information Management

Management decisions by NOAA Fisheries and regional Councils typically require access to a complex array of fisheries statistics, stock assessments, background documents, and other information from Science Centers, Regional Offices, and other sources. One of the best ways to facilitate better decision making is to improve access to data and documents across the agency. A big step toward that goal was recently achieved by a team of information scientists at PIFSC with the development and launch of InPort, a comprehensive online metadata registry and information catalog.

Karen Sender and Janet Pappas, members of the ITS Systems Design Team, led a group of PIFSC data specialists and contractors in a project to build a Web-based application enabling the registration, organization, and publication of NOAA Fisheries metadata. Development of InPort was funded in part by the Fisheries Information System in the NOAA Fisheries Office of Science and Technology.

The online Information Portal allows authorized users within each NOAA Fisheries work unit to register metadata describing fisheries statistics, research survey data, reference codes, technical reports, policy documents and other information. Descriptors and key elements in the metadata provide for cross-referencing and association of diverse information assets. After the entered metadata are verified, the local InPort "librarian" publishes them, making them available on the Web. Any person with a Web browser can then search the InPort metadata archives and retrieve metadata quickly.

After development and rigorous testing at PIFSC, the InPort software was recently installed in NOAA Fisheries headquarters in Silver Spring, MD. Data managers in several Science Centers and Regional Offices have been trained in use of InPort and have already entered basic metadata for fisheries-dependent information. As InPort is integrated into other business processes across the agency, more metadata will be assembled, organized, and registered. Wide adoption of InPort will provide significant benefits to NOAA Fisheries and our constituents.

Coral Reef Ecosystem Division

The Coral Reef Ecosystem Division (CRED) conducts integrated, multidisciplinary ecosystem research, benthic habitat mapping, and long-term monitoring of coral reef ecosystems in the U.S.-affiliated Pacific Islands. CRED work supports NOAA's Coral Reef Conservation Program. CRED collaborates with federal, state, and territorial agencies and nongovernmental organizations and conducts work in the main Hawaiian Islands (MHI), the Northwestern Hawaiian Islands (NWHI), the Territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and the Pacific Remote Island Areas (PRIA). CRED's Pacific Reef Assessment and Monitoring Program (RAMP) surveys employ standardized methods to conduct ecological assessments, collect oceanographic and water quality measurements, and produce benthic habitat maps that improve understanding of spatial and temporal processes influencing the health of coral reef ecosystems throughout the region. The knowledge gained is shared with local, regional, national, and international resource managers and stakeholders to improve decision-making for the long-term conservation and management of coral reef resources. In addition, CRED conducts research and activities to directly mitigate human impacts on reef ecosystems, including assessment and removal of marine debris.

The CRED is organized into five thematic program areas:

- The *Oceanography and Water Quality Program* observes and monitors key oceanographic processes, environmental parameters, and water quality conditions using: in situ observations collected from ships and small boats, surface and subsurface moored instrument arrays, and satellite-tracked drifter buoys; data from satellite-borne remote sensors; and oceanographic models. The program also develops instrumentation including Ecological Acoustic Recorders to acoustically monitor ambient biological and vessel sounds, Autonomous Reef Monitoring Structures (ARMS) to assess invertebrate biodiversity, and Bottom Camera (BotCam) bait stations to assess relative abundance of bottomfish.
- The *Ecosystem Monitoring and Analysis Research Program* conducts Rapid Ecological Assessments (REAs) and towed-diver surveys which quantitatively and qualitatively document the spatial distribution, density, species composition, size structure, and condition of corals, other macroinvertebrates, fish, and algae observed during biennial Pacific RAMP surveys. The REAs involve stationary point counts of organisms, roving diver surveys, belt transects, photoquadrats, video transects, and specimen sample collection. Towed-diver surveys using digital video or still cameras provide broad spatial coverage of benthic composition and the abundance and distribution of ecologically important fish and macroinvertebrate taxa. The research contributes to the International Census of Marine Life's Census of Coral Reef Ecosystems.
- The *Benthic Habitat Program* uses multibeam echo sounders, towed cameras, autonomous underwater vehicles, and other tools to create benthic habitat maps describing the depth, character, and composition of the seafloor in and around coral reefs.
- The *Marine Debris Program*, with support from the NOAA Marine Debris Program, uses towed-diver and swim surveys to assess distributions and accumulations of derelict fishing gear and other marine debris in the MHI and NWHI and unmanned aerial systems to locate marine debris at sea. CRED divers manually remove marine debris from reefs and shorelines and collect data on the type, distribution and density of debris. The Program also conducts research to better understand impacts of marine debris and develop cost-effective means to locate and remove marine debris at sea.
- The *Data Management and Integration Program* formats, documents, synthesizes, integrates, distributes, and archives data collected by CRED and its partners. The program implements data quality control, produces metadata compliant with NOAA's Coral Reef Information System, and enters the data into an Oracle database and/or ArcSDE geodatabase. These databases facilitate access to the data and enable spatial and temporal analyses and integration of CRED's multidisciplinary ecosystem observations.

Arc-eye Hawkfish (Paracirrhites arcatus) in American Samoa

CRED has 64 staff members, including 8 federal employees, 48 employees of the University of Hawaii's Joint Institute for Marine and Atmospheric Research (JIMAR), and other staff. Grants—primarily to

Coral Reef Ecosystem Division FY 2007

Personnel	
Federal	8
JIMAR	48
Other	8
Total	64

Budget	$	%
Salaries and benefits	856,681	15.4
Grants	3,500,000	63.0
Contracts	765,541	13.8
Equipment	65,590	1.2
Supplies	268,850	4.8
Travel & transportation	49,509	0.9
Rent, vessel charters, and communication	50,180	0.9
Printing	1,331	0.02
Total	$5,557,682	

JIMAR—accounted for the largest CRED expenditures in FY 2007.

Key 2007 Accomplishments

- Completed a draft of the Coral Reef Ecosystem Monitoring Report for American Samoa: 2002–2006. The report is the culmination of surveys accomplished during three American Samoa RAMP cruises in 2002, 2004, and 2006. The document is under review for publication as a PIFSC Special Report. The draft document is available at http://www.pifsc.noaa.gov/cred/hmapping/amsareport.php.
- The Marine Debris Program removed 34 tons of derelict fishing gear from the NWHI and 17 tons from the MHI during 2007. The Program and its partners have removed nearly 600 tons of marine debris from the NWHI since 1996.
- Continued benthic habitat mapping with 56 sea days aboard the NOAA Ship *Hi'ialakai* and 23 days on the R/V *AHI*. About 13,500 km^2 of seafloor were surveyed in the Mariana Archipelago. Significant progress was made in processing and analyzing benthic habitat mapping data around the PRIA, American Samoa, MHI, NWHI, and the Mariana Archipelago. Multibeam bathymetry and backscatter data, optical validation data, and high-resolution benthic habitat mapping products are available at http://www.soest.hawaii.edu/pibhmc.
- In collaboration with NOAA's Office of Coast Survey, CRED used the R/V *AHI* to conduct nautical charting surveys in Saipan, Tinian, and Rota Harbors at the request of the CNMI Port Authority and the U.S. Navy. Survey data were processed and made available for nautical charts within 90 days of the survey.
- Led Pacific RAMP cruises on the NOAA Ship *Hi'ialakai* to the NWHI, Wake Atoll, and the Mariana Archipelago, and conducted extensive REA surveys at each location. Cruises were accomplished in partnership with the U.S. Fish and Wildlife Service, U.S. Air Force, University of Guam, CNMI Division of Fish and Wildlife, CNMI Division of Environmental Quality, CNMI Coastal Resources Management, CNMI Commonwealth Port Authority, Guam Division of Aquatic and Wildlife Resources, Hawaii Institute of Marine Biology, Hawaii Division of Aquatic Resources (DAR), Bishop Museum, and University of Hawaii.
- Continued monitoring of oceanographic and water quality conditions. CRED currently monitors conditions at 54 islands, atolls, and banks throughout the U.S. Pacific Islands using 33 moored surface telemetered buoys and 220 subsurface oceanographic moorings.
- In partnership with NOAA's Pacific Marine Environmental Laboratory, CRED collected water samples at hydrothermal vent sites at Maug Islands in the CNMI to assess long-term impacts of climate change-induced ocean acidification on coral reef ecosystems.
- In partnership with the NOAA Hawaii Undersea Research Laboratory and the Hawaii DAR, CRED conducted BotCam surveys to assess the efficacy of Restricted Fishing Areas for bottomfish in the MHI.
- Recovered ARMS from French Frigate Shoals. Samples of organisms collected by the ARMS since their deployment in 2006, including colonizing, hard-to-sample, cryptic invertebrates will support taxonomic and molecular genetics research.

Crown-of-thorns seastar (Acanthaster planci)

- Published eight manuscripts on scientific topics ranging from coral reef communities to oceanographic upwelling, marine debris, and fisheries. CRED scientists also contributed to several chapters in the forthcoming NOAA publication 2008 State of the Reefs Report and the National Coral Reef Institute book *Coral Reefs of the U.S.*

Challenges, Problems, and Limitations

The primary challenge for CRED is to provide timely, unbiased scientific information on coral reef ecosystems in the Pacific Islands Region as a largely grant-based activity of NOAA's Coral Reef Conservation Program. To maintain its long-term integrated ecosystem observation network of the reef resources around the vast and remote U.S. Pacific Islands, CRED requires sustained funding of the research programs and extensive access to NOAA ships and other research vessels. The Division is also challenged to develop methods to integrate and examine the complex spatial and temporal patterns and relationships across multidisciplinary biotic and abiotic observational data sets.

Future Focus and Direction

Using the Coral Reef Ecosystem Monitoring Report for American Samoa: 2002–2006 as a template, CRED is initiating similar reports for the Hawaiian Archipelago, Mariana Archipelago, and the PRIA to be completed over the next 2 years. CRED continues to focus on organizing Pacific-wide ecosystem observations into databases to enable data integration and support analyses required to generate the monitoring reports and other data products.

In 2008 CRED will continue to:

- Lead multidisciplinary, cooperative Pacific RAMP cruises in American Samoa, the PRIA, and the Hawaiian Archipelago
- Produce Coral Reef Ecosystem Monitoring Reports for the Hawaiian Archipelago and Mariana Archipelago
- Produce comprehensive, high-resolution digital maps of shallow (< 30 m deep) coral reef ecosystems in the U.S. Pacific Islands, with a focus on characterizing priority moderate-depth reef systems by 2009
- Provide leadership of the CReefs biodiversity project
- Integrate the Coral Reef Ecosystem Integrated Observing System with the larger Global Earth Observing System of Systems
- Collaborate with partners to understand the impacts of climate change-induced ocean acidification on reef ecosystems
- Make greater use of CRED's extensive data collections to improve understanding of the ecological impacts of climate change

Baseline Surveys Describe Diversity of Macroalgae in Coral Reef Ecosystems of the Mariana Archipelago

As NOAA works to conserve marine ecosystems and assess impacts of climate change, there is a critical need to establish accurate baseline information for monitoring ecosystem status. Surveys to describe baseline conditions have been the thrust of CRED's coral reef studies in the Mariana Archipelago. Surveys conducted during 2003 and 2005 produced a comprehensive catalog of marine organisms and their habitats along the entire reach of the archipelago from Guam and Santa Rosa in the south to the northernmost islands of Maug and Uracas. In addition to quantitative data on corals, invertebrates, and fishes of these reef environments, the surveys yielded important information on macroalgae. These marine plants come in many forms and are vital components of reef ecosystems, contributing to the reef's framework, affecting sedimentation, and forming an important base of the food chain. Because they are highly responsive to changes in nutrients, grazing, and other natural and anthropogenic events, macroalgae can serve as useful bioindicators of environmental change.

CRED scientists collected and studied specimens of macroalgae at sites across the Mariana Archipelago and found 47 different genera of green, red, and brown algae. The diversity of macroalgal genera was generally higher around the larger, southern carbonate islands that provided a more heterogeneous reef habitat than the smaller volcanic islands in the northern part of the archipelago. Besides island geomorphology, factors affecting algal diversity and abundance in the archipelago include typhoon frequency and intensity, volcanic eruptions, and human activity.

Results of the macroalgae baseline studies were published in 2007 by JIMAR scientists Aline Tribollet and Peter Vroom in the journal *Phycologia*.

Subtropical red algae Asparagopsis taxiformis in the Mariana Archipelago.

Ecosystems and Oceanography Division

The Ecosystems and Oceanography Division (EOD) conducts research to advance our understanding of the structure and dynamics of Pacific basin marine ecosystems. In particular, EOD seeks to understand how marine populations change directly in response to changes in their predators and prey and indirectly as a result of broader habitat-based changes in the ocean climate, including El Niño, La Niña, and other interannual or decadal events.

EOD research covers topics on many different spatial scales ranging from fine-scale habitat characterization to basin-scale oceanography, and various temporal scales from short-term individual foraging behavior to long-term ecosystem changes and population trends. Accordingly, a variety of approaches are necessary, including collaborations with scientists in other PIFSC divisions, other government agencies, academic departments, industry, nongovernmental organizations, and foreign institutions.

The EOD has three major research themes:

- Insular Habitat and Ecology focuses on understanding the dynamics of island-associated species and processes.
- Pelagic Habitat and Ecology considers the ocean from the perspective of large pelagic animals.
- Ecosystem Oceanography identifies changes in the ocean that may affect the marine ecosystem.

EOD provides scientific advice in support of improved stock assessment and fisheries management, develops indicators of ecosystem changes, and publishes scientific findings related to effects of habitat and environment on individuals, populations, ecosystems, and fisheries. To accomplish these goals, EOD researchers use a variety of platforms including deep diving submersibles, remotely operated vehicles, and SCUBA, both small and large research vessels and commercial vessels. EOD employs a broad spectrum of advanced technologies and tools, including pop-up satellite archival tags, animal-borne instruments such as CRITTERCAM, shipboard and moored echo sounders, satellite remotely sensed oceanographic and atmospheric data products, ocean circulation models, and ecosystem models.

EOD has 11 staff, including 6 federal employees and 5 JIMAR employees. Salaries and benefits made up the largest share of expenditures in the EOD budget.

The EOD Chief also serves as Principal Investigator for NESDIS-funded Central Pacific OceanWatch Node (http://oceanwatch.pifsc.noaa.gov/) managed by a JIMAR oceanographer. This program archives and distributes a suite of satellite remotely sensed oceanographic data to a diverse group of users in government agencies and the private sector.

Key 2007 Accomplishments

- Completed a paper on abundance and movements of jacks (giant trevally) at Midway Atoll based on tag-and-recapture data from a recreational fishery.
- Completed a paper on the expansion of oligotrophic gyres in the world's oceans.
- Completed a revised ECOPATH model to describe energy flow in the French Frigate Shoals ecosystem.
- Completed a paper on movement of opakapaka (Hawaiian pink snapper) based on conventional tagging data.
- Developed a method to estimate and map loggerhead turtle habitat in waters north of Hawaii and distributed the product to Hawaii longline fishermen in a weekly TurtleWatch bulletin. The information, available in both English and Vietnamese versions, helps fishers reduce incidental interactions with the protected turtles.
- Conducted a research cruise to Cross Seamount to estimate biomass of tuna using shipboard acoustic instruments.

Challenges, Problems, and Limitations

Ecosystems & Oceanography Division FY 2007

Personnel	
Federal	6
JIMAR	5
Total	11

Budget	$	%
Salaries and benefits	729,649	58.1
Grants	200,556	16.0
Contracts	100,231	8.0
Equipment	23,137	1.8
Supplies	152,123	12.1
Travel & transportation	22,870	1.8
Rent, vessel charters, and communication	26,017	2.1
Printing	510	0.04
Total	$1,255,093	

Noise contamination in the acoustic data collected by the NOAA Ship *Oscar Elton Sette* continues to be a problem for research surveys of tunas and their forage. Due to funding limitations at the Pacific Marine Center (NOAA), the problem has yet to be resolved. Storage and handling of the massive data sets produced by passive and active acoustic recorders, satellite-borne sensors, and coupled physical-biological ocean models remain significant challenges.

Future Focus and Direction

In collaboration with the Protected Species Division, we are continuing to deploy passive acoustic recorders on the seafloor to collect information on the occurrence of cetaceans at various locations in the central North Pacific. The Division also plans to expand studies to describe climate-induced changes in the subtropical gyre marine ecosystem using remotely sensed oceanographic data, longline and observer fishery data and ecosystem models.

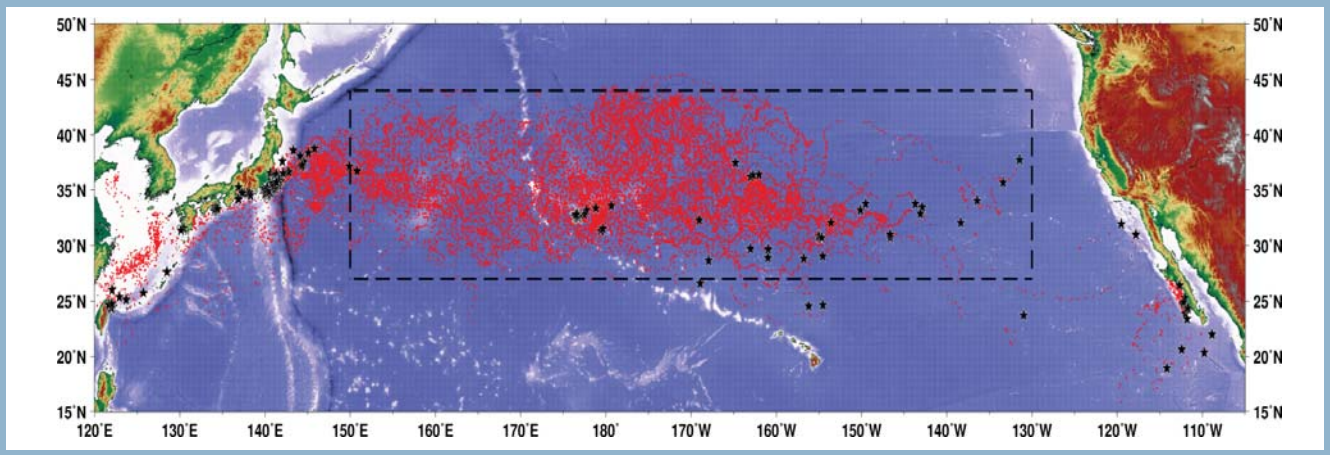
Satellite Data Key to Describing Habitat of North Pacific Loggerhead Turtles

PIFSC scientists led an international project to collect data on movements of loggerhead sea turtles in the North Pacific and analyzed the data in combination with environmental measurements to describe the loggerhead's oceanic habitat. The turtles nest on beaches in Japan and spend most of their lives foraging in a broad expanse of the ocean from Baja California, Mexico, to the East China Sea. Their population has been severely reduced by human activity and they are listed as threatened under the U.S. Endangered Species Act.

Wild loggerheads, including many captured in fishing gear, and other turtles reared in captivity, were outfitted with geolocation transmitters and released at locations in mid-ocean and off Baja California, Japan and Taiwan. Satellite tracking data showed the turtles occupying surface waters of the North Pacific Transition Zone where fishing fleets from several countries pursue tunas, billfishes and other species. Turtle location data were analyzed along with concurrent environmental information. Temperature and chlorophyll-*a* concentration at the sea surface, measured by sensors on satellites, were identified as two key environmental predictors of loggerhead habitat, along with a trio of geomagnetic variables that could influence turtle migration. Sea surface temperature and chlorophyll-*a* are considered proxies for availability and abundance of turtle forage.

Habitat maps for pelagic loggerheads were created using a habitat selection model driven by the five predictor variables. The maps indicate where loggerheads are most likely to be encountered at different times of the year, and therefore provide valuable guidance for international efforts to avoid or mitigate incidental turtle interactions with fishing gear. Such encounters may not only be detrimental to recovery of the loggerhead turtle population, but to economic returns of the fisheries, which may be closed if turtle interactions exceed allowable limits.

The loggerhead habitat research was recently published by PIFSC scientist Donald Kobayashi and several colleagues in a special sea turtle issue of the *Journal of Experimental Marine Biology and Ecology*.



Location data collected from 186 loggerhead sea turtles released with transmitters attached and tracked by satellite have provided information on the oceanic habitat of this protected species. Red dots show turtle locations determined by satellite, and black stars indicate points of release. The research is vital to assessing and reducing risks of mortality to turtles caused by their incidental interactions with fisheries across the North Pacific Transition Zone, ranging from Baja California, Mexico, to coastal waters of Japan, Taiwan, and the East China Sea.

Fisheries Monitoring and Socioeconomics Division

The Fisheries Monitoring and Socioeconomics Division specializes in the collection, management, and analysis of data from U.S. fisheries in the Pacific Islands Region. The FMSD monitors and reports on U.S. fisheries in the PIR; provides technical support to the PIFSC partner agencies in Hawaii, American Samoa, Guam, and the Northern Mariana Islands (CNMI) in developing and administering local fishery monitoring programs; and conducts social and economic research on marine resource use in the PIR. Fishery-dependent data collected, processed, and analyzed by FMSD, and products derived from them, comprise most of the information requests received by FMSD from fishery scientists and managers and are the foundation of many fisheries management decisions. FMSD provides fishery statistics to fulfill U.S. obligations for data exchange and reporting under several international agreements. FMSD socioeconomic data collection and research provide valuable insights into the effects of those decisions on fishery participants.

The FMSD is organized into four programs:

- The *Western Pacific Fisheries Information Network* is a cooperative program involving the WPacFIN central office at PIFSC and fisheries agencies of American Samoa, CNMI, Guam, and Hawaii. WPacFIN compiles fisheries information collected by these agencies and provides technical expertise and tools to help them collect fishery-dependent data needed for local, federal, and international fishery management decisions.
- The *Fisheries Monitoring and Analysis Program* collects, processes, compiles, interprets, and disseminates federally mandated logbook data. FMAP also provides information on federally regulated fisheries to fishers and industry constituents and makes nonconfidential data available to fishers to improve PIFSC communication and working relationships with them.
- The *Economics Program* (EP) contributes to Pacific Islands Region fisheries management by collecting cost-earnings data, assessing the economic health and capacity of fishing fleets, studying fish markets, examining economic effects of fisheries regulations, and evaluating nonmarket values of living marine resources.
- The *Human Dimensions Research Program* studies the "people" side of fishing and other uses of marine ecosystems in the Pacific Islands Region. HDRP research complements biophysical and economic studies by exploring social and cultural benefits and values associated with marine resources.

Fisheries Monitoring and Socioeconomics Division FY 2007

Personnel		
Federal	11	
JIMAR	12	
Other	4	
Total	27	
Budget	**$**	**%**
Salaries and benefits	1,202,266	40.9
Grants	1,181,576	40.2
Contracts	384,019	13.1
Equipment	24,122	0.8
Supplies	19,588	0.7
Travel & transportation	121,407	4.1
Rent, vessel charters, and communication	178	0.01
Printing	6,780	0.2
Total	$2,939,936	

FMSD has a staff of 27, including 11 federal employees, 12 JIMAR employees, and others. Personnel and grants made up the largest fractions of expenditures.

Key 2007 Accomplishments

Many products provided by FMSD are recurrent. Examples are quarterly and annual summaries of logbook statistics for longline fisheries in Hawaii and American Samoa, sections of annual reports for Fishery Management Plans, and annual inputs to Fisheries of the United States. Some of the Division's new initiatives and accomplishments in 2007 included the following:

- Provided local fishery offices in American Samoa, CNMI, Guam, and Hawaii with technical support and software to improve data collecting and reporting.
- Monitored the U.S. longline catch of Pacific bigeye tuna in waters east of 150° W longitude, enabling U.S. compliance with the annual catch quota established by the Inter-American Tropical Tuna Commission.
- Provided data and analysis in support of U.S. fishery reports and data submissions to the Western and Central Pacific Fisheries Commission.

- Expanded outreach programs to educate the public, including a program to encourage use of barbless circle hooks by recreational fishers, enabling them to reduce mortality or injury of incidentally hooked protected species and fish caught and released.
- In collaboration with the Hawaiian Division of Aquatic Resources (HDAR), the Pacific Islands Regional Office, and the Western Pacific Regional Fishery Management Council (WPFMC), provided support for monitoring of bottomfish fishing effort and catch in the main Hawaiian Islands, including development and implementation of public outreach and education, field guides and training for species identification, and fast-track procedures for catch monitoring.
- Established a program to monitor Hawaii's retail fish markets.
- Launched a Hawaii small boat cost-earnings study to estimate the economic contribution of commercial small boat fishing to the State of Hawaii.
- Developed case studies of successful implementations of bycatch reduction techniques by Hawaii-based longline fishers, with funds from the Fisheries Disaster Relief Program.
- Collaborated with other economists, including NOAA Fisheries headquarters staff, to survey economic values associated with recreational fishing for blue marlin in Hawaii.
- Conducted a Socioeconomic Assessment and Monitoring Training Program in American Samoa, with participants from local agencies.
- Initiated a project to document traditional knowledge of marine use and resource management in American Samoa, with mini-grant funding from the NOAA Preserve America Initiative.

Onaga (Etelis coruscans) at a fish auction

- Conducted research on social and cultural aspects of spearfishing in Hawaii, with support from NOAA's Rotational Assignment Program.

Challenges, Problems, and Limitations

The FMSD must meet increasing demands for improved fisheries data collection, management, and reporting to enable agency compliance with federal statutes and regulations. We must support the WPFMC in amending Fishery Management Plans and developing Fishery Ecosystem Plans. New mandates under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) with respect to permits, reporting, and management of total allowable catch will provide challenges in the Pacific Islands where regulations governing such management measures are mostly absent. Additional challenges in data collection are anticipated as the agency implements annual catch limits and works to improve recreational fisheries data programs. Accordingly, the FMSD must invest in expanding and training PIFSC personnel, build greater technical capacity of WPacFIN partners, increase the efficiency of data operations, and improve the timeliness of reporting. Staff will also need to complete and maintain comprehensive metadata and documentation for fishery data collections and reports.

Bottomfishing boat tied to the dock in Kewalo Basin

Future Focus and Direction

WPacFIN will continue to improve long-term data collection programs and address new developments. We will work closely with partner offices throughout the Pacific Islands Region to identify ways to improve data collection and coverage and help local fishery offices implement new monitoring programs. WPacFIN will continue to develop database applications to support several projects, including integration of HDAR fish catch data with fish dealer sales data, improvement of recreational fisheries monitoring, and collection of data on local fishing fleets and

fish imports in CNMI and American Samoa. WPacFIN also plans to improve its Web site content, data request service protocols, and documentation for data collection programs and database applications.

FMAP will provide technical assistance for ongoing efforts to develop simpler and more efficient alternatives for reporting of catch and effort by fishers. In particular, FMAP will assist with development of electronic longline logbooks which will enable secure, efficient, and timely compliance with federal reporting requirements and quicker and more accurate fishery monitoring. FMAP will also develop software applications that integrate data from different data sets, perform fishery analysis and monitoring functions, and generate the summary statistics needed to meet the agency's domestic and international reporting requirements. FMAP will also continue to improve its section of the PIFSC Web site so the public will have ready access to current non-confidential fishery statistics, fishery reports, and other information.

EP will continue to seek support to expand research in American Samoa, Guam, and the CNMI. EP intends to expand its research on the economics of coral reef resources, protected species, and ecotourism.

HDAR plans to complete profiles of fishing communities in Hawaii and American Samoa as required by the MSA, complete a framework for long-term monitoring of the human dimensions of coral reef ecosystems in the main Hawaiian Islands, and further develop its geographic information system capability to support analysis of fishing impacts at the sub-island scale in the main Hawaiian Islands.

Hook storage bins and line shooter on stern of longline boat

Outreach Project Encourages Use of Barbless Circle Hooks to Aid Conservation of Shoreline Fish and Protected Species

Shoreline fishing has long been a popular pastime in Hawaii. But as our local human population continues to grow, the pressure on shoreline fish stocks also increases, and care is needed to ensure a healthy shoreline fishery. Fortunately, shoreline and small-boat recreational fishers in Hawaii include many ardent marine conservationists who practice catch-and-release fishing to minimize their impacts on the fish stocks. What's more, thanks to an outreach program by PIFSC, the fishers have learned that by using barbless circle hooks instead of ordinary barbed fishing hooks, they can greatly reduce the severity of injuries to the fish they release and increase their chances for survival. The barbless hooks also reduce injury to any protected species fishers happen to hook incidentally and cut loose from the line.

Kurt Kawamoto of FMSD and other PIFSC staff conduct an outreach and education program with local shoreline fishing clubs and tournaments to promote awareness of marine conservation issues and the benefits of using barbless circle hooks. They distribute barbless hooks – over 35,000 hooks so far – and information leaflets to enthusiastic fishers and collect catch data from tournaments to demonstrate how the barbless hooks help resource conservation while having little effect on fishing success and retention of fish kept for the table. For fish in the latter category, tournaments offer special prizes for those caught using barbless hooks. It's a win-win situation.

Local fisher proudly displays his "once in a lifetime" 117 lb white ulua caught on a barbless circle hook.

Fishery Biology and Stock Assessment Division

The Fishery Biology and Stock Assessment Division conducts fundamental biological and ecological research on fish and crustaceans caught in federally managed fisheries to enable improved understanding of the mechanisms that influence their distribution and abundance. Life history studies on age and growth, reproduction and fecundity, migration and movement, and mortality are conducted to provide estimates of vital rates for stock assessments and ecosystem-based management. Research is focused on tunas, billfishes and other pelagic species; bottomfish; and the Northwestern Hawaiian Islands lobster. Attention is also being directed toward coral reef species.

The research involves field surveys using a variety of sampling gears, laboratory studies of biological specimens, and analysis of data from experiments using conventional and electronic tags and other tracking methods. New fishing technologies are developed, tested, and promoted internationally to reduce fisheries bycatch and effects of pelagic longline and other fisheries on populations of sea turtles, seabirds, sharks, and other species caught incidentally. The ecology of exploited stocks and effects of stock levels, harvests, bycatch, and conservation measures on the broader ecosystem are explored through food web analyses and ecosystem models. Stock assessments are currently conducted for tunas, billfishes, pelagic sharks, bottomfishes, and lobsters. These assessments, along with estimates of the bycatch of sea turtles, seabirds, and marine mammals are provided to support informed decisions by the NOAA Fisheries Pacific Islands Regional Office (PIRO), the Western Pacific Regional Fishery Management Council (WPFMC), and international organizations such as the Western and Central Pacific Fisheries Commission (WCPFC), the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC), and the Inter-American Tropical Tuna Commission.

Fishery Biology & Stock Assessment Divison FY 2007

Personnel		
Federal	19	
JIMAR	9	
Total	28	
Budget	**$**	**%**
Salaries and benefits	2,037,025	54.5
Grants	524,944	14.1
Contracts	400,441	10.7
Equipment	83,262	2.2
Supplies	234,004	6.3
Travel & transportation	107,501	2.9
Rent, vessel charters, and communication	344,173	9.2
Printing	4,124	0.1
Total	$3,735,474	

The FBSAD is organized into three programs:

- The *Fishery Biology and Bycatch Program* focuses on identifying methods to minimize incidental capture of sea turtles and other bycatch species in pelagic longline and other fisheries, including modifications to fishing gear and bait, and promotes adoption of such methods through outreach and education programs. The program also conducts research on habitats, movements, distribution, and post-release survivorship of animals released from pelagic fishing gear. Other research is conducted to model the effects of various factors on the vulnerability of pelagic fishes to capture in longline and other fisheries and to use the results in standardizing catch-per-unit-effort (CPUE) data for pelagic stock assessments. Staff in this program also lead the Council's Pelagic Fishery Management Plan (FMP) Team.
- The *Life History Program* conducts basic research on the age, growth, and reproductive strategies of managed fish species and bycatch species. The program also collaborates in studies of coral reef fish community structure and responses of reef fish populations to anthropogenic factors.
- The *Stock Assessment Program* conducts population assessments of pelagic species, including yellowfin tuna and bigeye tuna in the western and central Pacific and swordfish, striped marlin, and blue shark in the North Pacific. Assessments are also produced for insular species including Hawaiian Archipelago bottomfish and the Northwestern Hawaiian Islands lobster. Top priority is given to the main Hawaiian Islands bottomfish. The program also estimates incidental takes of sea turtles, seabirds, and marine mammals, and the bycatch of fish species (mostly sharks) in the Hawaii longline fishery. Leadership of the Council's Crustaceans and Bottomfish FMP Teams resides in this program.

In addition to directing research activities of the Division, the FBSAD Chief serves as International Science Advisor to the Directors Office, providing critical support and counsel on scientific issues arising with respect to tunas, billfishes, and ecologically associated species in the Pacific. The International Science Advisor is responsible for: providing scientific advice, technical reports, and informed opinion on scientific matters at meetings of the WCPFC, ISC, and other regional fisheries organizations; providing similar scientific support to PIRO, the U.S. State Department, and other members of official U.S. delegations to such meetings; and leading the U.S. delegation to meetings of the WCPFC Scientific Committee. The International Science Advisor also oversees the compilation of official fishery statistics for U.S. fishing fleets harvesting tunas and billfishes in the Pacific Islands Region and, as the U.S. data correspondent, submits such statistics to the WCPFC and other RFOs.

FBSAD staff members also help the Directors Office in overseeing NOAA Grants to the Oceanic Institute, advise the State of Hawaii on matters related to introduced and invasive species, and organize and maintain the PIFSC schedule of research cruises on the NOAA Ship *Oscar Elton Sette*.

FBSAD has a staff of 28 people including 19 federal employees and 9 employees of the Joint Institute for Atmospheric Research or other nonfederal entities. Staff salaries and benefits made up the largest share of expenditures in FY 2007.

Key 2007 Accomplishments

- Completed draft or final Environmental Assessments for Division research on longline gear, captive turtles, finfish, and crustaceans.
- Participated in international workshops on sea turtles, where scientists presented their country's information on fisheries, including data on interactions of fishing gear with sea turtles, and planned statistical analysis to test hypotheses using such data.
- Prepared a document summarizing related collaborative research and results in preparation for a national workshop on sea turtle bycatch.
- Prepared a paper for a meeting of the WCPFC's Science Committee detailing viable solutions for reducing sea turtle bycatch in a region-wide context.
- Reported preliminary results of an experiment in the Hawaii tuna longline fishery showing that use of deep-set gear without shallow hooks (no hooks down to 100 m depth) results in higher catches of bigeye tuna and greatly reduced catches of marlins and other incidental species compared with unmodified deep-set gear. Prepared a paper promoting use of the modified gear as a way to reduce catch of striped marlin for the WCPFC's Northern Committee.
- Convened and chaired meetings of the ISC Bycatch Working Group, Swordfish Working Group, and Marlin Working Group. Meeting reports are posted on the ISC Web site at: http://isc.ac.affrc.go.jp.

Spiny lobster (Panulirus marginatus) and slipper lobster (Scyllarides squammosus) ready for biological studies

- Published a paper on differential heating and cooling rates in bigeye tuna using data from archival tags.
- Established a sampling program to collect data from Hawaiian groupers caught by Hawaii bottomfish vessels for studies of age, growth, and maturity.
- Estimated incidental takes of sea turtles, seabirds, and marine mammals in the 2006 Hawaii longline fishery.
- Estimated bycatch of sharks and other fish species in the 2005 Hawaii longline fishery.
- Collaborated in updating stock assessments of yellowfin tuna in the western and central Pacific and bottomfish in American Samoa, Guam, and CNMI.
- Contributed scientific inputs to the WCPFC on a range of topics including status of stocks, catch-per-unit-effort (CPUE) standardization, bycatch mitigation, and post-release mortality of sea turtles.
- Conducted an annual fishery-independent survey of lobster populations at Necker Island and Maro Reef in the NWHI and ancillary biological sampling of bottomfish at these locales to improve stock assessment.

Challenges, Problems, and Limitations

Increasing FBSAD staff to meet new mandates continues to be difficult due to limited funding and lack of office space. While adequate funding of sea turtle bycatch studies will likely continue, the budget for fish bycatch research has dwindled, and funding for other fish and ecosystem research is very limited. Core fish stock assessment tasks are substantially funded, but mandates to assess additional species and meet new requirements of the MSA, particularly establishment of annual catch limits for all fisheries are unfunded. FBSAD scientists acquired some short-term funding for fish research from the State's Fisheries Disaster Relief Program.

Opah (Lampris gutattus) aboard a fishing vessel

The Division Chief's new role as International Science Advisor was successfully enabled by delegating leadership of all three FBSAD research programs to senior science staff. However, PIFSC has not received adequate funding for its new PIR responsibilities to provide scientific support for international fisheries agreements.

On the international front, many nations participating in the WCPFC have strongly resisted U.S.-recommended methods for reducing sea turtle bycatch, methods largely tested and widely promoted by FBSAD.

Within the Center, FBSAD is challenged with developing and coordinating integrated research programs needed to support ecosystem approaches to management of living marine resources. In particular, FBSAD scientists need to collaborate more with the EOD in using oceanographic data to improve stock assessments. Among new challenges, FBSAD has been asked to help assess coral reef fisheries and provide scientific advice to the State of Hawaii on management of fisheries in the main Hawaiian Islands through closed areas and other means. Information is often lacking to adequately address these issues, which have traditionally been outside Federal jurisdiction.

Future Focus and Direction

Collaborative testing of improved fishing gear to reduce longline bycatch will continue, with a return to studies of longline–seabird interactions, continued collaboration with other nations on sea turtles and increased attention to sharks. Recommendations for international fisheries conservation measures on bycatch will be actively promoted. Bycatch work will include completion of a new National Bycatch Report with coverage of all fish species and protected species.

New research will be focused on Hawaiian bottomfish life history, distribution, and stock dynamics, using results of the major new sampling projects funded by FDRP. Work will be undertaken on standardizing bottomfish CPUE data to account for previous changes in the fisheries, so that trends in stock abundance over time can be more accurately described and future assessments can be improved. A total allowable catch risk analysis model for MHI bottomfish will be provided to the WPFMC and other stakeholders for their use in scenario analyses. This will satisfy technical requirements for setting annual catch limits for MHI bottomfish, which recent stock assessments indicate have been experiencing excessive fishing mortality.

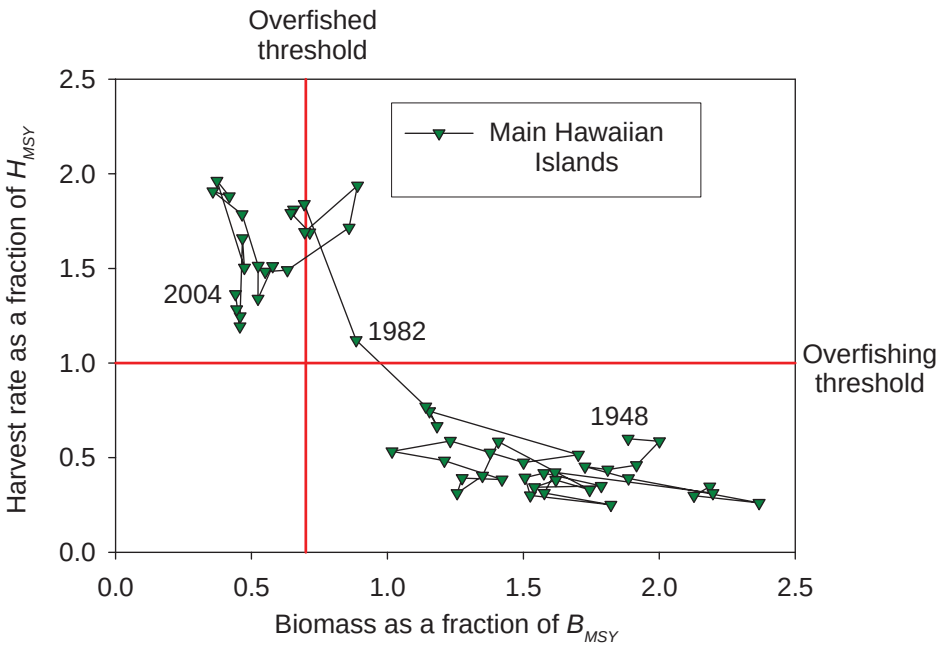
Review and improvement of stock assessments for tunas, billfishes, and sharks will continue under the auspices of the WCPFC and ISC. Work will be published describing the influence of fish habitat, fishing gear configuration, and other variables on indices of abun-

dance for large pelagic species and the vulnerability of these species to fishing gear. Results will be used in CPUE standardization to improve stock assessments. In addition to stock assessment research, significant effort will be devoted to standardizing and documenting methods of fishery data processing and reporting to meet increasing demands of international agreements for information and advice. Production schedules and report formats will be improved and more detailed and comprehensive fisheries statistics will be reported than in previous years.

Research Priority Given to Main Hawaiian Islands Bottomfish

Biologists and mathematicians in the Fishery Biology and Stock Assessment Division are working together to improve stock assessments of the important multispecies bottomfish complex in the main Hawaiian Islands (MHI). In contrast to the healthy bottomfish resource in the Northwestern Hawaiian Islands, the MHI complex is being exploited at a level in excess of the maximum sustainable yield (MSY) harvest rate, and the stock biomass has been depleted well below the level required to produce the MSY. Preliminary stock assessments in 2007 showed this undesirable condition has existed for the past 25 years and indicated the reductions in fishing mortality needed to restore the bottomfish stock to a healthy status.

Scientists in the Division have launched an ambitious program to improve understanding of bottomfish biology and collect the data critical to improved stock assessment and effective management. Bottomfish specimens for the study are being collected from catches landed at the Honolulu fish auction and provided by cooperating local fishers. Sampled fish are thoroughly examined to learn more about aging and longevity, growth, maturation, fecundity, and genetics of each species making up the complex. Results of the biological studies will enable construction of more sophisticated and realistic models of bottomfish population dynamics and more useful stock assessments.

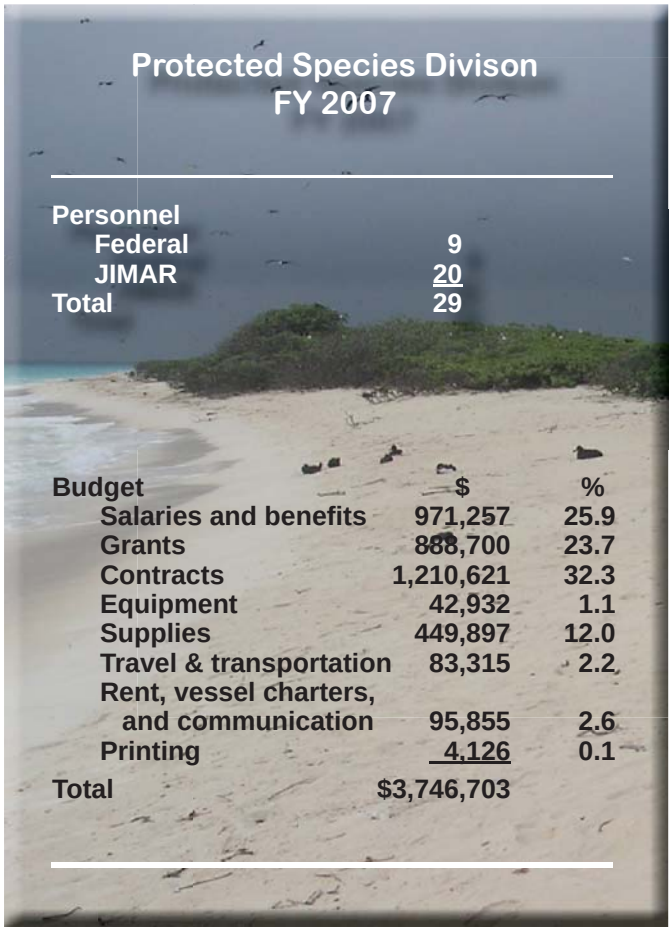


Measures of harvest rate and stock biomass for bottomfish in the Main Hawaiian Islands together reveal a healthy stock in early years of the fishery (lower right) in contrast to the current situation (upper left) in which the stock biomass is depleted to unsafe levels and subject to excessive fishing mortality. The graph shows the hypothetical status of bottomfish in the MHI based on averaging a set of single-zone production models and assuming MHI was assessed as a separate management unit. Status of the Hawaii bottomfish complex is determined through an archipelago-wide assessment.

Protected Species Division

The Protected Species Division (PSD) conducts research supporting the recovery and sustainability of marine mammals and sea turtles in the Pacific Islands Region (PIR). Marine mammal studies involve the highly endangered Hawaiian monk seal population and cetaceans. Marine turtle studies involve primarily the threatened Hawaiian green turtle population, but also address other species including hawksbill, loggerhead, olive ridley, and leatherback turtles. PSD research covers a broad range of topics in life history, ecology, health and disease, and demography.

The research employs several advanced technologies. Passive acoustic monitoring systems are used to detect underwater sounds produced by cetaceans and by vessels and other anthropogenic sources. Other instruments deployed concurrently record oceanographic features. Satellite-linked Geographic Positioning System (GPS) tags are attached to monk seals and turtles to track their movements and describe dive patterns. Archival electronic tags are used to obtain fine-scale dive pattern information. Fatty acid profile analysis is used to determine the diet of monk seals. Mathematical and statistical methods are used to model population dynamics and analyze data from field studies and surveys.



The PSD is organized into four programs:

- The *Monk Seal Research Program* conducts research on the Hawaiian monk seal population with the goal of enhancing its recovery. Their work extends the length of the archipelago and includes an annual census of seal abundance and other field studies to assess population trends and demographics at the main breeding sites in the Northwestern Hawaiian Islands (NWHI); investigations of foraging ecology; monitoring and assessment of health and disease parameters; and identification of natural and human factors that may be limiting monk seal recovery.
- *The Cetacean Research Program* studies populations of whales and dolphins in the central and western Pacific Ocean and involves a range of topics, including surveys of cetacean distribution, abundance and stock structure; studies of habitat use, reproduction, and mortality; and assessment of natural and anthropogenic threats. The cetacean group's research includes ship-based visual and acoustic line transect surveys, photo-identification studies, passive acoustic surveys using High-Frequency Acoustic Recording Packages (HARPs), habitat modeling, and ecosystem studies.
- The *Marine Turtle Research Program* is responsible for research on the threatened Hawaii green turtle population. The research agenda is comprehensive: field studies of growth rates, mortality, and movements; long-term monitoring of abundance trends, including annual surveys of the primary nesting colony at East Island, French Frigate Shoals, in the NWHI; and the biology, etiology, and effects of fibropapilloma disease. The group also trains Pacific islanders and fishery observers in sea turtle biology and handling, collects data on fishery interactions with sea turtles, and studies the pelagic biology of sea turtles in the Pacific.
- The *Marine Turtle Assessment Program* studies marine turtle population biology and stock status across the U.S. Pacific Islands Region, with a focus on areas outside the Hawaiian Archipelago. Research is conducted on a wide range of topics, including: turtle demography and population dynamics; assessment of natural and anthropogenic factors affecting turtle populations; evaluation of management strategies influencing marine turtle recovery; development of simulation models to identify data gaps, study demographic trends and design and evaluate management strategies; and a variety of other marine

turtle studies. The group has explored the feasibility of working with biologists in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) to help develop monitoring programs in these areas to assess abundance and stock structure of marine turtle populations.

The PSD staff of 29 includes 9 federal employees and 20 JIMAR staff.

Key 2007 Accomplishments

- Conducted annual NWHI monk seal population assessment
- Conducted a workshop to develop a Collaborative Spinner Dolphin Photo ID Catalog
- Built, installed and tested a passive acoustic array for use on the NOAA Ship *Oscar Elton Sette* to facilitate cetacean studies
- Completed preliminary analysis of acoustic data from a HARP deployed at Cross Seamount near the main Hawaiian Islands (MHI)
- Integrated Hawaiian monk seal health and disease data with other monk seal data sets to enable more comprehensive analysis
- Completed field collections of Hawaiian monk seal health and disease information in the NWHI
- Updated the Hawaiian monk seal Unusual Mortality Plan
- Completed the Health and Disease Investigation Plan for monk seals in the MHI
- Expanded the volunteer network for reporting monk seal sightings in the MHI
- Improved the database for MHI monk seal observations and obtained a new estimate of minimum abundance for the area
- Successfully deployed a cellular phone-based GPS tag for tracking marine mammals in collaboration with the Sea Mammal Research Unit, St. Andrews, Scotland
- Established an age and growth laboratory for Pacific marine turtles
- Estimated the number of green turtles nesting at East Island, French Frigate Shoals, during the 2007 nesting season

Studies Provide First Comprehensive Information on Odontocete Cetaceans in Waters of American Samoa

Studies by the new cetacean research program at PIFSC have led to vital baseline information about these marine mammals in the Pacific Islands Region. Cetaceans in American Samoa are designated as protected species under the U.S. Marine Mammal Protection Act.

During 2006, PSD researchers conducted cetacean sighting surveys around the islands of American Samoa. Some surveys were conducted from small vessels in coastal waters. Others were conducted from the NOAA Ship *Oscar Elton Sette* in offshore waters using standard distance sampling and line transect methods. Detailed records were kept of each group of cetaceans encountered, including species, location, group size, and behavior. Photographs were taken to allow for identification of individual animals and development of sighting histories. In some cases, scientists were able to obtain a small sample of skin or blubber from the cetacean for DNA studies.

Several species of cetaceans were seen, including spinner dolphins, pilot whales, sperm whales, and four species previously undocumented in this region — bottlenose dolphins, rough-toothed dolphins, false killer whales, and dwarf sperm whales. The survey results indicate that the cetacean fauna of American Samoa is similar to those in other Pacific island areas.

Analysis of DNA revealed a relatively high genetic diversity within spinner dolphins in American Samoa. This finding, together with photo-ID information and the geographic isolation of the archipelago, suggests that spinner dolphins in American Samoa are one component of a metapopulation structure with limited gene flow occurring between populations in American Samoa and other Pacific locations.

Spinner dolphins approach Anu'u Island in American Samoa

- Completed analysis of age and growth of olive ridley turtles in the North Pacific based on skeletochronology and published the findings
- Finished analysis of a 20-yr collection of mtDNA samples from Hawaiian green turtles and prepared a manuscript detailing the research
- Completed analysis and synthesis of data on the epidemic outbreak, rise, and decline of fibropapilloma tumor disease in the resident green turtle foraging population at Palau, Molokai, in the MHI
- Initiated and implemented an international cooperative research project on the pelagic ecology of South Pacific loggerhead turtles

Hawaiian monk seal

Challenges, Problems, and Limitations

Through comprehensive efforts to monitor Hawaiian monk seals in the NWHI, we continue to document a persistent population decline in this imperiled species. An ongoing challenge is to diagnose the root causes of the decline and develop tools and strategies for enhancing the species' recovery. In the sea turtle and cetacean programs, we have broadened research agendas and identified research priorities, but we lack adequate funding and other resources to carry out new mandates.

Future Focus and Direction

During 2008, we will place more emphasis on characterizing the ecological factors influencing decline of Hawaiian monk seals, in part by studying the habitat needs and foraging behavior of juvenile seals, a segment of the population that suffers high mortality. At the same time, PSD will build partnerships with other agencies and nongovernmental organizations to develop methods for increasing survival of juvenile seals. If sufficient funds are available, we will continue field camps in the NWHI to collect demographic data for long-term monitoring, mitigate mortality (e.g., by disentangling seals from debris and reducing shark predation), and collect specimens for foraging and health studies. We also hope to expand monk seal monitoring and assessment in the MHI, where the monk seal population is increasing and human contact with seals is becoming more frequent. Another PSD goal will be to further develop and implement the cetacean stock assessment research program. This will include analyzing cetacean sound data from acoustic recorders, modeling spinner dolphin resting habitat characteristics, and expanding the community-based photographic identification catalog for Hawaiian spinner dolphins. PSD scientists will continue research on the foraging ecology of Hawaiian green sea turtles and address stock assessments of marine turtles in Hawaii, American Samoa, Guam, and the CNMI. We will also continue to assess the status of marine turtle populations that forage in the central North Pacific but nest outside the United States, including leatherbacks, loggerheads, and olive ridleys.

Male honu coming ashore at Lisianski Island

Notable Milestones

- ❒ Compiled report of the 2006 field season for marine debris survey and removal
- ❒ Completed the Coral Reef Ecosystem Monitoring Report for American Samoa and provided draft to partners
- ❒ Conducted a research expedition on the NOAA Ship *Hi'ialakai* to map benthic habitat in the Commonwealth of the Northern Mariana Islands
- ❒ Created maps of benthic habitat at Pearl and Hermes Atoll based on optical surveys and disseminated them on the CRED Web site
- ❒ Contributed high-resolution data sets from sampling sites in American Samoa and the Pacific Remote Island Areas to the national Coral Reef Information System
- ❒ Conducted an external review of Pacific Islands Fisheries Science Center programs
- ❒ Launched a facilitated plan to ensure high quality data management at the Pacific Islands Fisheries Science Center
- ❒ Coordinated participation in the North Pacific Marine Science Organization
- ❒ Ensured compliance with National Environmental Policy Act requirements, including documentation of PIFSC research programs on fish biology and stock assessment
- ❒ Completed ecosystem and oceanography research on four key topics: competition between Hawaiian monk seals and other apex predators in the NWHI; pelagic habitat of loggerhead sea turtles; habitat of moonfish; and albacore fisheries oceanography in the American Samoa longline fishery
- ❒ Compiled and submitted national reports and U.S. fishery statistics for highly migratory species to regional fishery management organizations and subsidiary bodies
- ❒ Convened meetings of the ISC Billfish Working Group and ISC Bycatch Working Group and reported scientific findings and guidance to ISC Plenary
- ❒ Estimated bycatch of fish and protected species in Pacific Islands Region fisheries and contributed results to the updated National Bycatch Report
- ❒ Updated stock assessments of bigeye tuna and yellowfin tuna in the western central Pacific Ocean for presentation to Western and Central Pacific Fisheries Commission
- ❒ Updated stock assessments of bottomfish in American Samoa, Commonwealth of the Northern Mariana Islands, and Guam and reported findings to the Western Pacific Fishery Management Council
- ❒ Analyzed the economic impact of the 2006 swordfish fishery closure
- ❒ Analyzed the impact of changes in fishing technology in the Hawaii longline fishery
- ❒ Monitored Hawaii longline fishery catches of bigeye tuna in eastern Pacific Ocean to aid U.S. compliance with the Inter-American Tropical Tuna Commission catch quota

(continued on next page)

Notable Milestones *(continued from previous page)*

- ❒ Completed a study of American Samoa, Guam, and Hawaii as "Fishing Communities" under the Magnuson-Stevens Act
- ❒ Developed a system for monitoring bottomfish prices in the Hawaii fish market
- ❒ Improved monitoring of commercial bottomfish landings in the main Hawaiian Islands
- ❒ Produced reports of U.S. fishery statistics in Western Pacific Region and quarterly reports of the American Samoa and Hawaii-based longline fisheries
- ❒ Completed IT certification and accreditation for PIFSC
- ❒ Developed integrated database applications for dissemination of longline fishery statistics and management of PIFSC requisitions
- ❒ Developed NOAA Fisheries guidelines for certifying an electronic logbook application
- ❒ Developed, tested, and implemented InPort Metadata Catalog v. 1.2 for installation on the NOAA Fisheries server
- ❒ Completed safety and environmental compliance inspections for all PIFSC facilities and implemented improvements
- ❒ Built, installed and tested a passive acoustic array for research surveys on the NOAA Ship *Oscar Elton Sette*
- ❒ Completed a plan to assess sea turtle populations in the Pacific Islands Region outside the Hawaiian Archipelago
- ❒ Updated the Hawaiian Monk Seal Unusual Mortality Event Plan
- ❒ Conducted population assessments of Hawaiian monk seals in the NWHI and MHI
- ❒ Conducted analysis of acoustic data from high-frequency acoustic recording package deployed at Cross Seamount
- ❒ Developed a database to integrate Hawaiian monk seal health and disease information with other monk seal data
- ❒ Established an age and growth laboratory for Pacific marine turtles
- ❒ Hosted workshop to develop a collaborative spinner dolphin photo ID catalog and helped establish the community-based Pacific Islands Photo-Identification Network
- ❒ Published 33 peer-reviewed articles in scientific books and journals and 15 technical reports in support of the NOAA mission

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