13 Joint Institute for Marine and Atmospheric Research

13.1 Introduction

Strengths:

- Availability of UH (especially SOEST) talent to bring into the program as opportunities arise.
- Flexibility of RCUH for personnel and procurement.

Weaknesses:

- Lack of meaningful direct state support, RTRF only.
- Vulnerability to federal funding fluctuations—the reality of soft-money.
- Opportunities:
- Climate services needs in the Pacific (PEAC)
- Evolving Pacific Islands Monument

Threats:

- Vulnerability of RTRF in current UH environment
- Growth limited by space.
- As for many others, the Federal Budget scene.

The Joint Institute for Marine and Atmospheric Research (JIMAR) manages The Cooperative Institute for the Pacific Islands Region, a partnership between the University of Hawaii and the National Oceanic and Atmospheric Administration (NOAA) and one of 18 NOAA cooperative institutes nationwide. JIMAR's mission is to conduct research that is necessary for understanding and predicting changes in the Indo-Pacific region, for conserving and managing coastal and marine resources in island environments, notably the Hawaiian Islands and the U.S.-affiliated Pacific Islands, and for meeting the Nation's economic, social, and environmental needs in these regions. Over the past 5 years, JIMAR principal investigators received $76,353,681 in external funding (see Figure 1), and published 546 papers in peer-reviewed journals (Figure 2). In the past five years JIMAR has supported an average of 26 undergraduate and 19 graduate students annually. Currently JIMAR maintains a staff of 180 employees, with over 80% of the positions directly involved in scientific research.

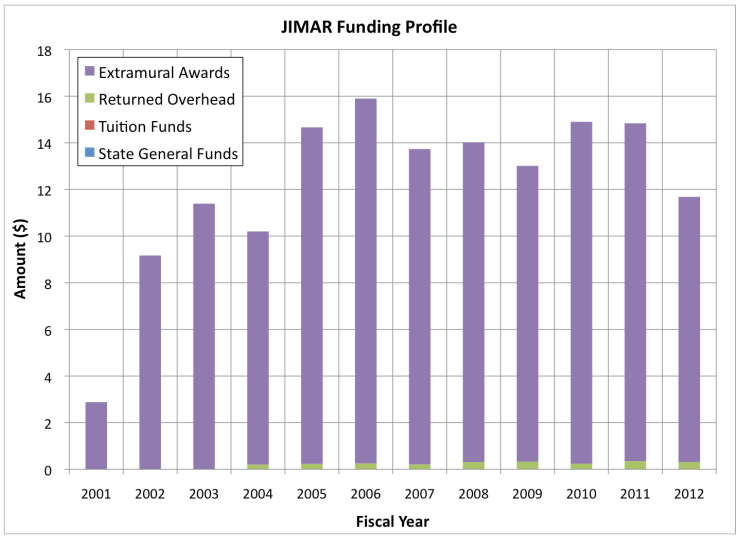
JIMAR's vision is to support NOAA's concept of Resilient Ecosystems Communities and Economies while recognizing the special challenges and opportunities that the Pacific Islands

face in achieving a sustainable and prosperous future in changing global and regional environments. JIMAR seeks to:

- Provide a sound infrastructure that facilitates innovative collaborative research between scientists at NOAA and the University of Hawaii in the JIMAR research theme areas;
- Support high quality educational opportunities for basic and applied research in the Earth Sciences at the undergraduate, graduate, and post-doctoral levels;
- Encourage the exchange of new ideas and differing views through sponsorship of visiting scientists and scholars at the University of Hawaii;
- Promote the effective dissemination of research outcomes for societal benefit in the Pacific Basin region.

JIMAR research is closely aligned with the SOEST areas of excellence in oceanography, meteorology, and ocean engineering. JIMAR supports faculty and students in all SOEST academic units as well as research units including the Hawaii Institute of Geophysics and Planetology (HIGP), the Hawaii Institute for Marine Biology (HIMB) and the International Pacific Research Center (IPRC). The Pelagic Fisheries Research Program (PFRP) under JIMAR has supported faculty and students in other UH programs including the colleges of Tropical Agriculture and Human Resources and Social Sciences. JIMAR research priorities are determined collaboratively between JIMAR and NOAA scientists. The current JIMAR research themes under the new cooperative agreement are:

1. Ecosystem Forecasting
2. Ecosystem Monitoring
3. Ecosystem-based Management
4. Protection and Restoration of Resources
5. Equatorial Oceanography
6. Climate Research and Impacts
7. Tropical Meteorology
8. Tsunamis and Other Long-period Ocean Waves



Research highlights in each these area are described in section 4.

JIMAR was created in 1977 under a memorandum of agreement to pursue collaborative research between the University of Hawaii and NOAA. The original research themes were tsunamis

and other long period ocean waves, equatorial oceanography, and climate research. An early emphasis of JIMAR was the multi-national Tropical Ocean Global Atmosphere (TOGA) research program. Over the following decades JIMAR has expanded to include fisheries oceanography, tropical meteorology, and coastal research. The funding instrument has been a series of cooperative agreements (three to five years in duration). NOAA reorganized its cooperative institutes program and issued RFPs for new cooperative institutes in a range of regions and scientific themes. A newly defined Cooperative Institute for the Pacific Islands Region was announced in Winter 2010-2011. The University of Hawaii submitted a successful proposal and has been permitted to manage the new entity while retaining the JIMAR brand. At this time we are in the midst of negotiating a new memorandum of agreement with NOAA. The principal NOAA Line Office with which JIMAR collaborates is the National Marine Fisheries Service (NMFS). JIMAR also interacts with NOAA National Weather Service (NWS), National Environmental Satellite, Data and Information Services (NESDIS) and Ocean and Atmospheric Research (OAR) Line Offices. Prior to 2011 OAR was the principal Line Office collaborating with JIMAR. Of the 18 NOAA Cooperative Institutes JIMAR is most similar in breadth of themes to the Joint Institute for Study of Atmosphere and Oceans (JISAO), Seattle; the Cooperative Institute for Marine and Atmospheric Science (CIMAS), Miami; the Cooperative Institute for Research in the Environmental Sciences (CIRES), Boulder; and the Cooperative Institute for Marine Ecosystems and Climate (CIMEC), San Diego.

Under the new cooperative agreement JIMAR is capped at a total of $19 million per annum under these three tasks:

- Task One supports the JIMAR administration and the Visiting Scientists Program. This has been funded at a basic level of approximately $200,000 per year. Task One funding is exempt from university indirect costs.
- Task Two supports programs directly involving NOAA scientists and facilities, most notably the Pacific Islands Fisheries Science Center (PIFSC). JIMAR investigators take the lead in the preparation of Task Two proposals. A 16% program development fee is applied to all Task Two projects.
- Task Three consists of competitive awards to University of Hawaii scientists from NOAA programs. Task Three projects are subject to university indirect costs.

13.2 JIMAR Organization

The organizational structure of JIMAR includes a director; senior fellows; two advisory boards representing senior management officials (Executive Board) and scientists (Council of Fellows) from JIMAR, the University of Hawaii, and NOAA; and an administrative services unit. The state/university contribution to JIMAR consists of the Director's time and a return of a portion (25%) of the indirect costs generated by Task Three projects. The ratio of Federal to State support for JIMAR is unusual compared to other SOEST units.

13.2.1 Director

The current JIMAR director is Dr. Mark Merrifield, a professor in the Department of Oceanography. He succeeded meteorologist Dr. Tom Schroeder, who served as the JIMAR director since 1995. The JIMAR director is responsible for scientific leadership and is expected to contribute actively to the development of research programs, and to involve local and visiting scientists in JIMAR activities. The director is a regular member of the University of Hawaii faculty and appointed through joint decision by UH and NOAA leadership. The director reports to an Executive Board composed of University and NOAA Officials and serves as ex-officio member of that Board. The director manages day-to-day operations through the administrative staff and a deputy director for PIFSC-collaborative projects, Dr. Jeff Hare.

13.2.2 Senior Fellows

JIMAR Senior Fellows are scientists of established national or international standing who hold faculty appointments in the University, or who are staff members of NOAA holding authorized NOAA billets. Their assignment as JIMAR Senior Fellows requires the concurrence of both parent organizations. In making these assignments, the University and NOAA will take into consideration the advice of the Council of Fellows and the recommendation of the JIMAR Director. Senior Fellows are normally appointed for three years and may be reappointed.

Table 2. JIMAR Senior Fellows

NOAA Fellow	Affiliation	UH Fellow	Affiliation
Steven Bogard	PFEL	Gary Barnes	Meteorology
Richard Brill	NMFS	Steven Businger	Meteorology
Ed Harrison	PMEL	Eric DeCarlo	Oceanography
Gregory Johnson	PMEL	Charles Fletcher, III	Geology & Geophysics
William Kessler	PMEL	Kim Holland	HIMB
Frank Marks, Jr.	AOML	Roger Lukas	Oceanography
Michael McPhaden	PMEL	Douglas Luther	Oceanography
Dennis Moore	PMEL	Julian McCreary	Oceanography
Jeffrey Polovina	PIFSC	Bin Wang	Meteorology
Samuel Pooley	PIFSC		
Mark Powell	AOML		
Frank Schwing	PFEL		

Visiting Fellow	Affiliation		
Gerald Meehl	NCAR		
Jagadish Shukla	George Mason Univ.		
Akimasa Sumi	University of Tokyo		

Visiting Senior Fellows are appointed by the University after approval by the Council of Fellows, and recommendation by the JIMAR Director. Their selection is based on JIMAR program needs and upon scholarly criteria. Visiting Senior Fellows are normally given appointments for one year, but may be renewed upon approval of the Council of Fellows.

13.2.3 Advisory Boards: Executive Board and Council of Fellows

The Executive Board consists of senior management officials from JIMAR, the University of Hawaii, and NOAA. The Board is responsible for providing advice and recommendations to the JIMAR Director concerning management and budgetary issues. The Board also evaluates JIMAR programs and activities, recommends new program directions, reviews general policies of JIMAR, and initiates appropriate recommendations. The Board also is responsible for recommendations for the JIMAR Directorship and changes to the Memorandum of Agreement (MOA) between the University of Hawaii and NOAA.

The Council of Fellows consists of mid- and senior-level scientists from JIMAR, the University of Hawaii, and NOAA. It is comprised of three (3) members from the University of Hawaii, three (3) members from NOAA, and the JIMAR Director. Its role is to ensure that high-quality scientific research is being conducted, to promote cooperation between UH and NOAA, and to help identify other research opportunities that will maintain and enhance the current research program. The Council also advises the director of major expenditures on visiting scientists, the selection of and renewal of Fellows, and adoption of appropriate rules for the operation of JIMAR. The JIMAR Advisory Boards are in the process of being reconstituted as part of the new MOA.

13.2.4 Administrative Services Unit

Under the direction of the JIMAR Director, the Administrative Services Unit is responsible for the administrative operations for the institute. The unit is comprised of Administrative Services Managers who are responsible for the day-to-day administrative operations, a Personnel Services Specialist, and several Administrative Services Associates. The Administrative Services Unit is responsible for pre- and post-award administration including, but not limited to, proposal review and submission; fund oversight and management; and maintaining compliance with institutional policies and procedures, as well as award terms, conditions, and federal assistance (grant) regulations. The JIMAR administrative staff members are employees of the Research Corporation of UH (RCUH) and are totally supported via funding from Task One and Task Two.

13.2.5 Scientific Staff

JIMAR scientific staff members are primarily RCUH employees who work closely with NOAA and UH scientists. Most work on site at Federal facilities both in Hawaii (PIFSC, the Pacific Islands Regional Office, PIRO)), and in a few instances in NOAA labs in continental U.S. locations (e.g. the Pacific Marine Environmental Laboratory, PMEL). Those working at Federal facilities work with Federal sponsors. The RCUH personnel system is very flexible and responsive, allowing the institute to recruit, attract, retain, and reward valuable employees. Working with RCUH, JIMAR has been able to develop several "in-house" programs and policies including a deployment compensation and accumulated time off policy for field personnel, an outstanding performance award program, a hardship allowance policy, and a policy for alternative work schedules and telework.

13.3 JIMAR Activities

13.3.1 Support of Academic Programs and Students

JIMAR UH Fellows are regular faculty members in SOEST academic units. They participate in all aspects of their home units' educational endeavors. The contributions of the JIMAR Fellows, including Curricula Vitae, are described in the self-assessments of the individual SOEST units.

The National Weather Service maintains Honolulu Forecast Office on the UH Manoa campus adjacent to the SOEST Meteorology Department. In lieu of rent, the NWS provides funds to JIMAR that are allocated in support of instructional programs in Geology and Geophysics, Meteorology and Oceanography. The JIMAR Director works with the respective department chairs on usage of the funds. The NWS Fellows program has provided important educational support through the provision of classroom computers, work experience stipends for undergraduates, and instructional materials used in the classroom as well as for outreach activities, in particular the SOEST Biennial Open House. The NWS Fellows project has supported numerous graduate research associates over the years, including many in Meteorology who have moved into NWS careers.

While NOAA does not provide direct funds for JIMAR to conduct Education and Outreach activities, the Institute annually leverages program development funds to support these important activities. Some examples of initiatives supported in this way are:

- The translation of digitized historic Hawaiian language newspapers. This project has been supported by JIMAR and the Hawaii Sea Grant College Program. The goal is to augment historic records (especially 19th century) of natural phenomena including earthquake, tsunami. Volcanic eruption, hurricane, flood, and winds. The JIMAR/Sea Grant support has led to successful proposals to the National Science Foundation in support of applications to K-12 education and teacher education.
- The procurement of a rotating tank that is being used for classroom demonstrations and for geophysical fluid dynamics experiments. In addition to its application in advanced

classes in Meteorology and Physical Oceanography, the apparatus served as basis for an undergraduate student thesis on development of exercises for use in undergraduate laboratory courses.

- Experimental forecasts of Volcanic Smoke and Haze (VOG).
- Tropical cyclone research collaboration with the Atlantic Oceanic and Meteorological Laboratory (AOML) Hurricane Research Division.
- The UH Department of Biology Albert L. Tester Memorial Symposium.
- The Aloha Bowl, the regional competition for the National Ocean Science Bowl.

On February 29th, 2012, JIMAR hosted a one-day symposium at the East-West Center's Imin Conference Center to present the depth and breadth of science conducted by JIMAR researchers at the NOAA Pacific Islands Fisheries Science Center (PIFSC) and to develop deeper research engagement between JIMAR scientists, PIFSC staff, and the traditional faculty departments at UH and elsewhere. The program included oral presentation and poster sessions on Fisheries Research, Protected Species Research, and Coral Reef Research. About 150 scientists, managers, and administrators attended the inaugural JIMAR/PIFSC Symposium, including individuals from JIMAR, PIFSC, the NOAA Pacific Islands Regional Office (PIRO), the Pelagic Fisheries Research Program (PFRP), the UH Department of Zoology, Hawaii Institute of Marine Biology (HIMB), Department of Oceanography, Department of Natural Resources and Environmental Management, Public Policy Center, Department of Geology and Geophysics, Botany Department, Sea Grant, the International Pacific Research Center (IPRC), and other several other federal and university research offices. The symposium presented a unique opportunity for networking, for initiation of scientific exchange, for student presentation, and for development of research collaborations.

13.3.2 Service and Outreach

JIMAR has no direct funding for outreach and service. A number of JIMAR programs have inherent outreach components. We also benefit from outreach programs at our NOAA partners and within SOEST. Examples of JIMAR service and outreach activities include:

- Our Pelagic Fisheries program serves the public interest through the efforts of the Western Pacific Regional Fishery Management Council and through a newsletter.
- The UH Sea Level Center (USLC) serves as a global data base for tide gage observations used in defining sea level change and variability, as well as supporting real-time monitoring of tsunamis. All this information is available online. UHSLC scientists serve on international committees supporting climate and tsunami and initiatives.
- Our Pacific ENSO (El Nino Southern Oscillation) Applications Center (PEAC) provides direct outreach to the U.S. Affiliated Pacific Islands through quarterly newsletters (Pacific

ENSO Update), monthly teleconferences with local agencies, and by visits of UH scientists to consult with local governments.

- Since 1999 we have managed the Pacific International Training Desk at the Honolulu National Weather Service Forecast Office. This program trains young meteorologists throughout the World Meteorological Organization Regional Association 5 in modern forecasting technique and technology. These budding meteorologists attend SOEST seminars, interact with faculty and students and return as future leaders in their countries.
- JIMAR works with the SOEST Outreach office. A highlight is the Biennial SOEST Open House which hosts over five thousand elementary and high school students as well as parents. JIMAR has been a consistent participant.
- JIMAR provides administrative support for the Pacific Islands Ocean Observing System (PacIOOS) program, which disseminates products to the public that help to ensure a safe, clean, and productive ocean and a resilient coastal zone for the U.S. Pacific Islands.

JIMAR staff work in the NMFS/PIRO to coordinate community education on NOAA and NMFS management and regulatory programs. The PIRO outreach program educates young people to become environmental stewards, informs communities on available NOAA and NMFS resources, promotes careers in the ocean sciences, and develops curricula with local teachers to support the mission of PIRO. The program also designs information resources to increase communication and understanding between all stakeholders, and JIMAR outreach personnel are a key component of these efforts.

13.3.3 Ongoing Challenges

As a cooperative institute, JIMAR faces unique benefits and challenges tied to its dependence on the NOAA agency and federal funding in general, and to its ability to access talent and expertise in a university setting. Some of the main strengths and weaknesses, and opportunities and threats facing JIMAR are summarized here.

13.4 JIMAR Research

JIMAR Fellows and staff are actively involved in wide-ranging research across the globe, covering topics as diverse as equatorial oceanography, tsunamis, climate, tropical meteorology, fisheries oceanography, and coastal ecosystems. Project titles within each JIMAR focus area are listed on the following pages, with detailed project descriptions in Appendix 13.

13.4.1 Equatorial Oceanography

JIMAR Senior Fellows are actively involved in equatorial oceanographic research. Current activities include current profiling, sea level monitoring, equatorial circulation studies, and dynamic modeling.

- NOAA Shipboard ADCP Support
- Penetration of Anthropogenic CO_2 in the Oceans Based on Analysis of Recent WOCE/JGOFS/OACES Carbon Data Using the Remineralization Ratios Obtained by the New Three-End-Member Mixing Model
- The University of Hawaii Sea Level Center
- WHOI Hawai‘i Ocean Timeseries Station (WHOTS)

13.4.2 Tsunami Research

JIMAR originated from the Joint Tsunami Research Effort and has maintained a long collaboration with the Pacific Marine Environmental Laboratory (PMEL) in tsunami research. JIMAR scientists have been heavily involved in tsunami hazard mapping and preparedness throughout the Pacific basin with special emphasis on Hawai'i. JIMAR scientists have collaborated with PMEL, the Pacific Disaster Center, and Hawai'i State Civil Defense.

- Archive of Rapidly Sampled Hawaiian Sea Level
- Three-dimensional Model of Tsunami Generation and Near-field Characteristics
- University of Hawaii Sea Level Center—Tsunami Research

13.4.3 Climate Research

JIMAR's climate theme evolved in concert with the equatorial oceanography theme. The focus was the El-Niño Southern Oscillation (ENSO) phenomenon in all its oceanic and atmospheric aspects. JIMAR scientists continue to study fundamental aspects of climate and climate variability. The UH Sea Level Center is a major contributor to NOAA's climate program. The project's Pacific ENSO Applications Center (PEAC) has continued the JIMAR tradition by developing interdisciplinary approaches to the study of climate impacts and development of experimental forecasts. Partners in PEAC include the NWS Pacific Region, the University of Guam, the Pacific Basin Development Council and NOAA Research through its Climate Program Office.

- Changes in the Tropical Pacific Climate Variability During the Last Millennium: External Forcing Versus Internal Variability
- Development of an Extended and Long-range Precipitation Prediction System over the Pacific Islands
- Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center
- Investigating the Transport and Transformation Mechanisms of Atmospheric Mercury in the Remote Central North Pacific Marine Free Troposphere
- Multi-Model Ensemble Forecast of Madden-Julian Oscillation
- Pacific ENSO Applications Center
- Pacific RISA Integrated Climate Program Support
- Profiling CTD Float Array Implementation and Ocean Climate Research
- Remote Versus Local Forcing of Intraseasonal Variability in the IAS Region: Consequences for Prediction
- Roles of Ocean-Atmosphere-Land Interaction in Shaping Tropical Atlantic Variability and Toward Reducing Climate Model Biases in the Equatorial Atlantic and Adjacent Continents

13.4.4 Tropical Meteorology

The JIMAR tropical meteorology theme developed in response to the move of the National Weather Service (NWS) Honolulu Forecast Office to the UH Campus. The move was associated with the modernization of the NWS and motivated in part by the long history of interaction between the Honolulu Forecast Office and the UH Department of Meteorology. Interactions among faculty, students, and NWS staff have been excellent. NWS supports student research through the NWS Education Fund (supported by in-lieu-of-rent monies) and the NWS Pacific Region Fellowship Program. Interactions with the Pacific Region extend to climate service (see ENSO Applications discussion under the climate theme) and establishment of the Pacific Training Desk.

- National Weather Service Fellows
- National Weather Service International Pacific Training Desk

13.4.5 Fisheries Oceanography

Fisheries oceanography has become the largest component of JIMAR. The program has three components: collaborative research with the Pacific Islands Fisheries Science Center of the National Marine Fisheries Service (NMFS); collaborative research with the Pacific Environmental Group in Monterey, CA; and the Pelagic Fisheries Research Program (PFRP), managed by JIMAR in cooperation with the NMFS Southwest Fisheries Laboratory, La Jolla, CA and the Western Pacific Regional Fishery Management Council.

- Cetacean Oceanography
- Climate Change and Ecosystem Variability in the North Pacific Ocean and the Dynamics of Marine Resource Populations
- Contribution, Linkages, and Impacts of the Fisheries Sector to the Economies of Hawai‘i and other U.S. Affiliated Pacific Islands: An Extended Input-Output Analysis
- Data Administration of Pelagic Fisheries Data
- DeepWater Horizon Response
- Fisheries Oceanography: Ecosystem Observations & Research Program

- Fisheries Oceanography: Ecosystem Observations & Research Program: Analyses of Catch Data for Marlins
- Fisheries Oceanography: Ecosystem Observations & Research Program: Methods to Reduce Marlin Catch and to Estimate Post-release Mortality
- Fisheries Oceanography: Methods Aimed to Reduce Sea Turtle-Longline Interactions: Tests of Modified Baits and Fishing Gear
- Fisheries Oceanography: Protected Species Investigation: Marine Turtle Research Program
- Fisheries Oceanography: Protected Species Research Program
- Human Dimensions of Fishing and Marine Ecosystems in the Western Pacific/Sociocultural Profiles of Pacific Islands Regions Fishing Ports
- Kona Integrated Ecosystem Assessment
- Marine Resource Dynamics & Assessment Program (MARDAP): Economics of Fisheries Initiative
- Marine Resource Dynamics & Assessment Program (MARDAP): Research Support
- Marine Resource Dynamics & Assessment Program (MARDAP): Research Support—Fisheries Data Monitoring
- Marine Resource Dynamics & Assessment Program (MARDAP): Research Support—Main Hawaiian Islands Deep 7 Bottomfish Fast Track Project
- Marine Resource Dynamics & Assessment Program (MARDAP): Stock Assessment Research Program
- Marine Turtle Conservation and Management Initiative
- Mesophotic Reef Ecosystems of Hawai‘i’s Au‘au Channel
- Oceanography Initiative
- Pacific Islands Monitoring and Sampling Program
- Pacific Islands Regional Observer Program
- Pelagic Fisheries Research Program (PFRP): Program Management
- PFRP: ADMB Open Source Project
- PFRP: Age and Growth of Striped Marlin (*Kajikia audax*) Caught in the Hawai‘i-based Longline Fishery
- PFRP: Analyses of Catch Data for Billfishes (Istiophoridae)
- PFRP: Assimilating in situ Bioacoustic Data in a Mid-trophic Level Model and its Impact on Predicted Albacore Feeding Habitat in the American Samoa Waters
- PFRP: Biological, Economic, and Management Drivers of Fishery Performance: A Global Meta-analysis of Tuna and Billfish Stocks
- PFRP: Biology and Habitat Use of Monchong (*Eumegistis illustris*) at Cross Seamount, Hawai‘i
- PFRP: Biotelemetry Tag Retention in Pelagic Tuna

- PFRP: Descriptive Assessment of Traditional and Small-Scale Fisheries in the Western Pacific
- PFRP: Early Life Stage Dispersal of Yellowfin Tuna (*Thunnus albacares*) in the Central North Pacific
- PFRP: Hawai‘i Tuna Tagging Project 2
- PFRP: Impacts of Fishing on Vulnerable Non-target Species at Seamounts
- PFRP: Improved effectiveness of WCPFC through better informed fishery decision maker
- PFRP: Integrating Conventional and Electronic Tagging Data into the Spatial Ecosystem and Population Model SEAPODYM
- PFRP: Integrating Electronic and Conventional Tagging Data into Modern Stock Assessment Models
- PFRP: Integrative Modeling in Support of the Pelagic Fisheries Research Program: Spatially Disaggregated Population Dynamics Models for Pelagic Fisheries (PFRP Modeling Project)
- PFRP: Ocean Acidification Impacts on Tropical Tuna Populations
- PFRP: The Role of Social Networks on Fishermen Economic Performance in Hawai‘i’s Longline Fishery
- Protected Resources Environmental Compliance Initiative
- Reducing Shark Bycatch with Electropositive Metals in Hawai‘i-based Fisheries
- Review and Possible Refinements to Essential Fish Habitat and HAPC Designations All Federal Management Unit Species in the Western Pacific Region, Excluding Hawaiian Bottomfish Management Unit Species
- Social and Economic Analysis of Western Pacific Fisheries
- Sustainable Fisheries Initiative
- Western Pacific Fisheries Information Network Project
- Coastal Research
- Applications of Satellite Ocean Remote Sensing to Living Marine Resources (Ocean Remote Sensing)
- Coral Reef Management Initiative
- National Environmental Policy Act (NEPA) Initiative
- Sustaining Healthy Coastal Ecosystems