Accomplishments 1994-2011

PFRP Pelagic Fisheries Research Program

Joint Institute for Marine and Atmospheric Research · School of Ocean and Earth Science and Technology

University of Hawai`i at Mānoa, Honolulu, Hawai`i

Overview

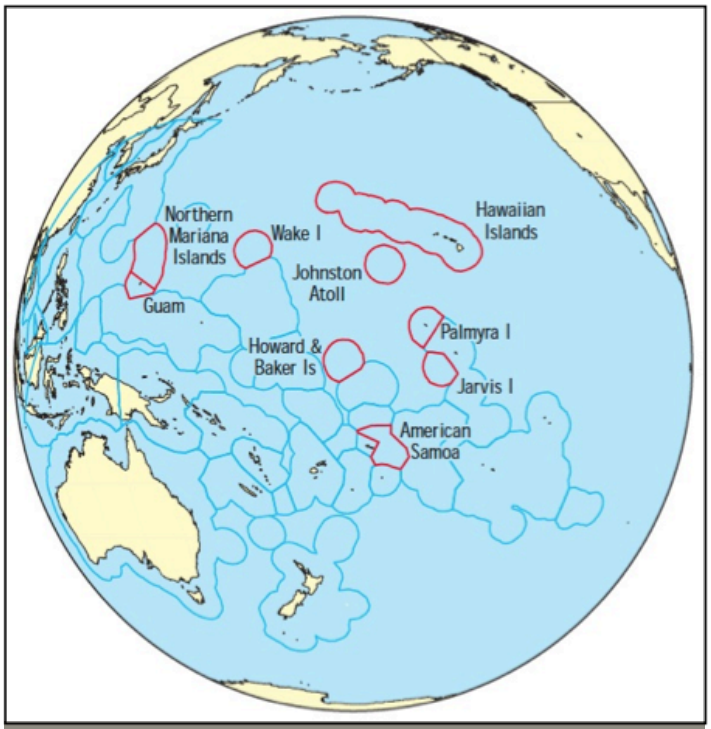
Since 1994, the Pelagic Fisheries Research Program (PFRP) has been funding new science to help improve management of fisheries in the Pacific Ocean. Based in Honolulu, Hawaii, the PFRP has distributed $27 million in competitive grants to scientists from around the world. This research has been crucial to understanding and managing fisheries for tunas, swordfish, and other large fish species that range far across the Pacific Ocean, crossing national boundaries and encountering fishhooks as they go. These fish are of huge economic importance, but overfishing has jeopardized some stocks, and the livelihoods that go with them. And there are other problems, too, like accidental catches of sea turtles and birds. Research funded by the PFRP is bringing new understanding of these animals to the people who need it most: fisheries managers. The PFRP also supports education of new fisheries scientists and encourages PFRP-funded scientists to get involved with agencies that regulate fisheries.

The mission of the Pelagic Fisheries Research Program (PFRP) is to conduct scientific research that supports rational management of fisheries for tunas, swordfish, and other highly migratory species (HMS). The PFRP was established in 1992, when highly migratory species were first included in the Fisheries Conservation and Management Act. The PFRP is a research program within the Joint Institute for Marine and Atmospheric Research (JIMAR) at the University of Hawaii.

The PFRP sponsors research on pelagic (open-ocean) fisheries to improve our understanding of ocean ecosystems and to provide the Western Pacific Regional Fishery Management Council (WesPac) with scientific information that supports their work: development of management policies for pelagic fisheries in Hawaii, American Samoa, Guam, and Commonwealth of the Northern Mariana Islands (CNMI).

At 65 million square miles, the Pacific Ocean is the largest single feature of planet Earth. It is six times as large as the Atlantic Ocean and covers one third of the Earth's surface. Fisheries for pelagic species in the Pacific land about 2.7 million metric tons of fish per year, valued at more than $2 billion.

The Pacific Ocean covers 1/3 of the Earth. PFRP research informs management of tunas and other open ocean fish in the central and western Pacific (Source: Google Earth).



A key part of PFRP's mission is to support the Western Pacific Regional Fishery Management Council (WesPac), which has jurisdiction over fishing in 1.5 million square miles of ocean, outlined here in red (Source: WesPac).

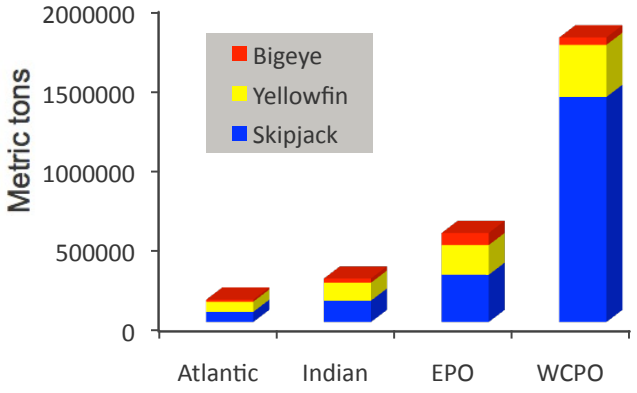
The fish that are caught in these fisheries do not stick close to the continents or stay inside each country's Exclusive Economic Zone (EEZ); boats are seeking these fish throughout the ocean. A large proportion of the catch is landed in United States ports in American Samoa, Hawaii, Guam and CNMI.

WesPac operates at the national level, and is responsible for setting management policies for all fisheries in the United States EEZs of the western Pacific region. This region covers 1.5 million square miles, making it the largest area to be served by any regional fishery management council. Rational, science-guided management of resources and conduct of research on such a scale requires extraordinary efforts by researchers in universities, federal laboratories and international organizations.

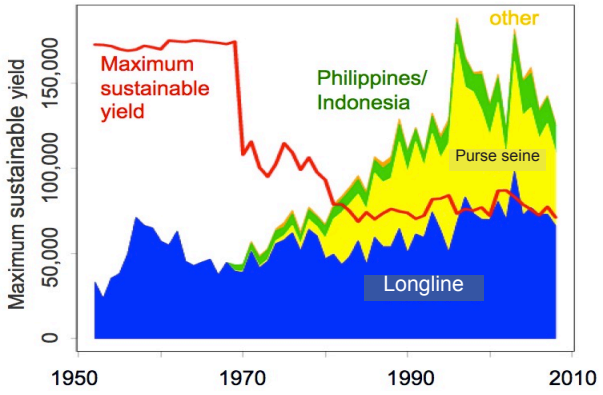
At the international level, the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC) sets fishery management policy for member states. Created in 2004, this commission depends entirely on scientific advice and research from outside sources, primarily the Secretariat of the Pacific Community, New Caledonia (SPC). This commission and WesPac have overlapping areas of responsibility, so supporting research activities are complementary. The PFRP attends the commission's meetings and has supported several research projects to provide key scientific advice to it. The PFRP also has good working relations with the Inter-American Tropical Tuna Commission (IATTC), which manages fisheries for highly migratory species in the Eastern Pacific Ocean.

Fisheries are a major source of employment and an integral part of the culture in the central and western Pacific. PFRP research has quantified fishery values and provided tools to make regulations more efficient (Photos: K Weng).

The PFRP supports the mission of the National Oceanic and Atmospheric Administration (NOAA) by funding peer-reviewed research and making these results accessible to fishery managers. The PFRP supports education of a world-class workforce and produces a newsletter and a series of technical publications. The program exercises international leadership by engaging scientists and managers to focus on critical questions and by participating in both science and management meetings.



The western and central Pacific Ocean (WCPO) produces far more tropical tuna than other oceans (EPO: Eastern Pacific Ocean). Catches have risen continuously since the 1950s; for bigeye and yellowfin tuna, these catches are now too high to be sustainable (D. Itano/ICCAT, IOTC, IATTC, SPC/WCPFC)



The WCPFC has not yet reduced bigeye tuna catch to sustainable levels. So the PFRP funded development of a new computer model that managers can use to try out management options in real time during meetings. This figure shows the maximum sustainable yield (MSY) for bigeye compared with how many are caught by four methods (Source: WCPFC7-2010/14 Summary Report).

The PFRP hosts an annual meeting of principal investigators at the East-West Center in Honolulu. At this meeting, scientists funded by PFRP come together to share results and develop new collaborations (Photo: December 2010 meeting, K. Weng).

Organization

The PFRP operates within the University of Hawaii's Joint Institute for Marine and Atmospheric Research (JIMAR), one of 21 NOAA joint institutes established to foster collaboration between NOAA and academic scientists. The University of Hawaii and NOAA Fisheries have a distinguished record of productive collaboration, which has been fostered by the PFRP.

The PFRP is directed by a Steering Committee comprising representatives from WesPac, the University of Hawaii, and NOAA. This combination of stakeholders assures that research sponsored by the PFRP is relevant to managers' needs, meets the highest scientific standards, and supports NOAA's mission. Day-to-day operation of the PFRP is the responsibility of a full-time Program Manager.

Once a year, PFRP releases a public notice asking scientists to submit proposals on topics relevant to fisheries management. Each proposal is reviewed by at least two independent scientists. The proposals and their reviews are then further scrutinized by a three-person science panel, which then makes funding recommendations to the Steering Committee. Successful proposals are funded for 1 to 3 years. The scientists must report on their research according to standards set by NOAA, including a presentation at PFRP's annual Principal Investigators Meeting in Honolulu.

The PFRP funded its first research project in 1994. Since then, over 110 different research projects have been funded resulting in over 350 scientific publications and reports as well as numerous conference presentations. Many of these research projects have been conducted by scientists affiliated with either the University of Hawaii or the NOAA Pacific Islands Fishery Science Center. Projects have also been funded at other US and overseas universities, international organizations, and in the private sector. The research covers all disciplines relevant to fisheries — biology, oceanography, protected species, statistics and modeling, genetics, economics, and social sciences.

Alphabet Soup?

CNMI	Commonwealth of the Northern Mariana Islands
EEZ	Exclusive Economic Zone
FAD	Fish Aggregating Device
HMS	Highly Migratory Species
IATTC	Inter-American Tropical Tuna Commission
MSY	Maximum Sustainable Yield
NOAA	National Oceanic and Atmospheric Administration
Pelagic	Open-ocean, blue water, far from shore
PFRP	Pelagic Fisheries Research Program
RFMO	Regional Fishery Management Organization
SPC	Secretariat of the Pacific Community
WCPFC	Western and Central Pacific Fisheries Commission
WesPac	Western Pacific Regional Fishery Management Council

Research Highlights

Biology & Oceanography

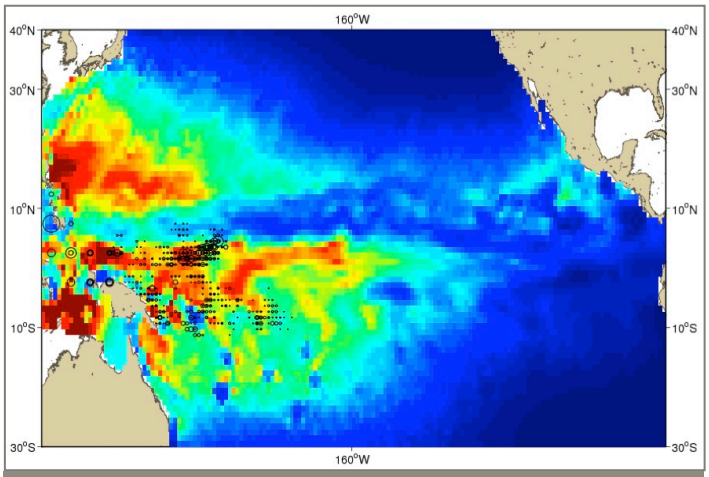
The PFRP has funded a wide range of projects that have helped scientists and regulators understand tunas and other large, open-ocean (pelagic) fishes. In order to establish rules for fishing, managers need information about where fish live, what they eat, how fast they grow, and their relationship to the rest of the ocean community. For example, are all the tuna in the Pacific part of one population? Do they travel across the Pacific or stay in small areas for their whole lives? Are the smaller animals they eat affected by changes in climate? The answers to these kinds of question help regulators work out how to sustainably fish these giants of the sea. Research on food webs lets scientists develop mathematical models of fish populations and move from the old way of managing fish—considering one species at a time—to management that considers the entire ecosystem and its complex relationships.

Adam, M.S., Sibert J., Itano D., Holland, K., 2003. Dynamics of bigeye (Thunnus obesus) and yellowfin (T. albacares) tuna in Hawaii's pelagic fisheries: Analysis of tagging data with a bulk transfer model incorporating size-specific attrition. **Fishery Bulletin**, 101 (2): 215-228

Dagorn , L., D. Pincock, C. Girard, K. Holland, M. Taquet, G. Sancho, D. Itano and R. Aumeeruddy. 2007. Satellite-linked acoustic receivers to observe behavior of fish in remote areas. **Aquatic Living Resources**, 20:4.

PFRP researchers use plastic dart tags, sonic transmitters, data recording tags, and satellite transmitters to track migration of tuna and other open-ocean fishes. The PFRP coordinates with other major research institutions for such activities, notably the SPC's Oceanic Fisheries Program (Photos: left, a diver installs a listening station on an ocean mooring; right, a scientist performs a surgery to implant a transmitter into a tuna before releasing it back to the wild. K. Weng).

Biology & Oceanography (cont.)



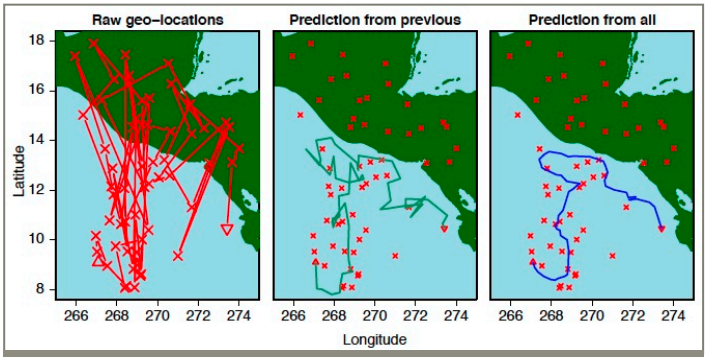
The PFRP has funded development of computer models that describe the entire ecosystem, from climate to algae to the animals that eat them—and the big animals that humans like to eat. Such models will bridge the gap between single species management and ecosystem-based management. This figure shows an estimate of skipjack tuna distribution from the SEAPODYM model (Source: I. Senina, P. Lehodey).

Popp, B.N., B.S. Graham, R.J. Olson, C.C.S. Hannides, M.J. Lott, G.A. López-Ibarra, F. Galván-Magaña, and B. Fry. 2007. Insight into the trophic ecology of yellowfin tuna, Thunnus albacares, from compound-specific nitrogen isotope analysis of proteinaceous amino acids. In Dawson, T.E., and R.T.W. Siegwolf (eds.), Stable Isotopes as Indicators of Ecological Change. Elsevier-Academic Press, Terrestrial Ecology Series, San Diego: 173-190

Dambacher, J.M., J.W. Young, R.J. Olson, V. Allain, F. Galvan-Magana, M.J. Lansdell, N. Bocanegra-Castillo, V. Alatorre-Ramirez, S. P. Cooper, and L.M. Duffy, 2010. Analyzing pelagic food webs leading to top predators in the Pacific Ocean: A Graph-theoretic approach. **Progress in Oceanography**, 86 (1-2): 152-165

Lehodey, P., Senina, I., and Murtugudde, R., 2008, A spatial ecosystem and populations dynamics model (SEAPODYM) - Modeling of tuna and tuna-like populations: **Progress in Oceanography**, v. 78, p. 304-318.

Lehodey, P., Senina, I., Sibert, J., Bopp, L., Calmettes, B., Hampton, J., and Murtugudde, R., 2010, Preliminary forecasts of Pacific bigeye tuna population trends under the A2 IPCC scenario: **Progress in Oceanography**, v. 86, p. 302-315.



PFRP researchers developed new methods to turn the data from an electronic tag into the track of an animal's movement. Left: animal track estimated using the tag manufacturer's algorithm; middle, right: tracks from the new methods (Figure: A. Nielsen).

Nielsen, A., Bigelow, K. A., Musyl, M. K., and Sibert, J. R. 2006. Improving light-based geolocation by including sea surface temperature. **Fisheries Oceanography**, 15(4), 314-325

The PFRP has funded a series of projects on the food-web connecting tunas, billfishes, sharks, and their prey. These studies are using a combination of traditional stomach sampling and novel biochemical techniques to understand the pathways leading to commercial fishes (Photo: J. Drazen).

Protected Species

Managing protected species such as turtles and albatrosses is critical in the central Pacific. Some of these species are endangered, so the loss of just a few animals can be important. The Hawaii-based longline fishery was closed because it killed too many sea turtles—a closure that had serious socioeconomic impacts. The PFRP has supported research to understand the biology of these species so measures could be designed to keep them away from fishhooks, protecting them, and allowing fisheries to continue.

Swimmer, Y., R. Arauz, B. Higgins, L. McNaughton, M. McCracken, J. Ballestero, and R. Brill, 2005. Food color and marine turtle feeding behavior: Can blue bait reduce turtle bycatch in commercial fisheries? **Marine Ecology Progress Series**, v. 295: 273-278, June 23, 2005

Beverly, Steve, Daniel Curran, Michael Musyl and Brett Molony. 2009. Effects of eliminating shallow hooks from tuna longline sets on target and non-target species in the Hawaii-based pelagic tuna fishery. Fisheries Research 96 (2009) 281-288.

Bowen, Brian W., Benjamin M. Bolker et al, 2004. Natal homing in juvenile loggerhead turtles (Caretta caretta). **Molecular Ecology** (2004) 13: 3797-3808.

Curtis, R., Hicks, R.L., 2000. The cost of sea turtle preservation: The Case of Hawaii's Pelagic Longliners. American **Journal of Agricultural Economics** 82(5):1191 -1197

PFRP-funded research showed that when sea turtles are caught on longlines, they are nearly always on hooks that are nearer to the surface of the water. As a result, the catch of turtles can be reduced by deploying the longline so that the hooks are deeper in the water (Photo: Y. Swimmer).

Statistics & Modeling

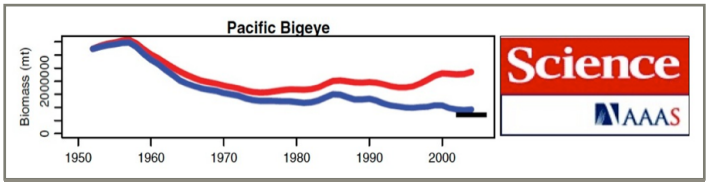
Mathematical models help scientists and managers understand all kinds of issues, from focused ones—how many of a particular species are in the ocean—to broad ones—how a change in one species or fishery might reverberate through the whole ecosystem. The PFRP has supported projects to develop such models, including new tools for building models; tailored models to estimate how many fish can be caught each year; large scale studies of the impacts of fishing on marine ecosystems; and software to allow non-specialists to use highly technical models (allowing fishery managers faster access to information).

MULTIFAN-CL

The PFRP supported development of the model that is presently used to manage tuna fisheries in the central and western Pacific by the WCPFC.

Fournier, D., Hampton, J., Sibert, J., 1999. MULTIFAN-CL: a length-based, age-structured model for fisheries stock assessment, with application to south Pacific albacore, Thunnus alalunga. Canadian Journal of Fisheries and Aquatic Sciences, 55:2105 - 2116

Ward, Peter, and Ransom A. Myers, 2005. Shifts in open-ocean fish communities coinciding with the commencement of commercial fishing. Ecology, 86(4), 2005, pp. 835-847.



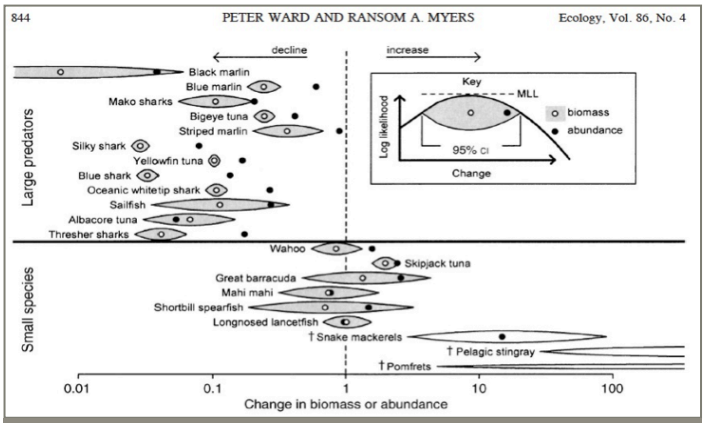
PFRP staff and collaborators published a paper in the journal Science demonstrating that 'alarmist' estimates of the impact of fishing were inaccurate. This figure shows the population size of bigeye tuna since the 1950s. The blue line shows the actual population and red shows how much higher the population would have been if we had not fished for bigeye tuna. (Figure: J. Sibert / Science Magazine).

Sibert, J., Hampton, J., Kleiber, P., and Maunder, M. 2006. Biomass, Size, and Trophic Status of Top Predators in the Pacific Ocean. **Science** 314: 1773-1776

admb
FAST, ACCURATE, STABLE OPTIMIZATION

The PFRP funded and contributed to the development of AD Model Builder, or ADMB, the most powerful software package for the development of state-of-the-art nonlinear models. Researchers and the public can download the software for free. ADMB is used all over the world, and courses are available to learn the software.

Polovina, Jeffrey J., Melanie Abecassis, Evan A. Howell, and Phoebe Woodworth, 2009. Increase in the relative abundance of mid-trophic level fishes concurrent with declines in apex predators in the subtropical North Pacific, 1996-2006. Fisheries Bulletin, 107: 523-531



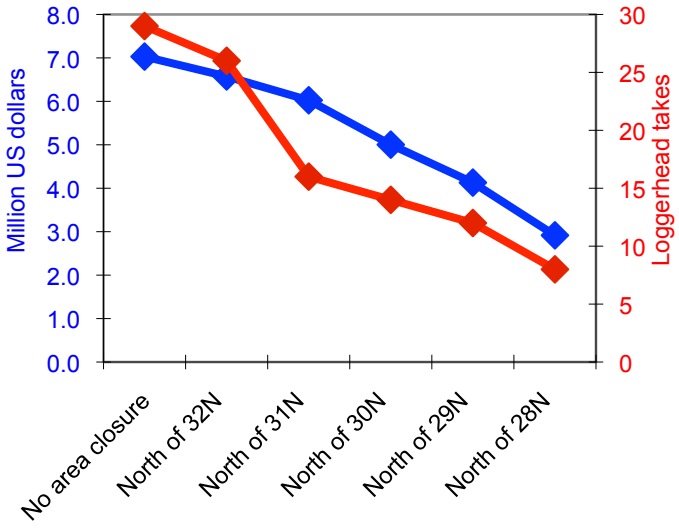
The PFRP funded work showing major changes in ocean ecosystems as a result of fishing. As large animals have decreased due to fishing, the smaller animals they prey on have increased (Figure: P. Ward / Ecology).

International fishery management requires balancing the interests of multiple nations. Uncertainty can lead to inaction. To provide a way forward, the PFRP funded development of a user-friendly version of a stock assessment model that managers can run during negotiations. It's called TUMAS: Tuna Management Simulator (software program, Hoyle et al., South Pacific Commission, 2010).

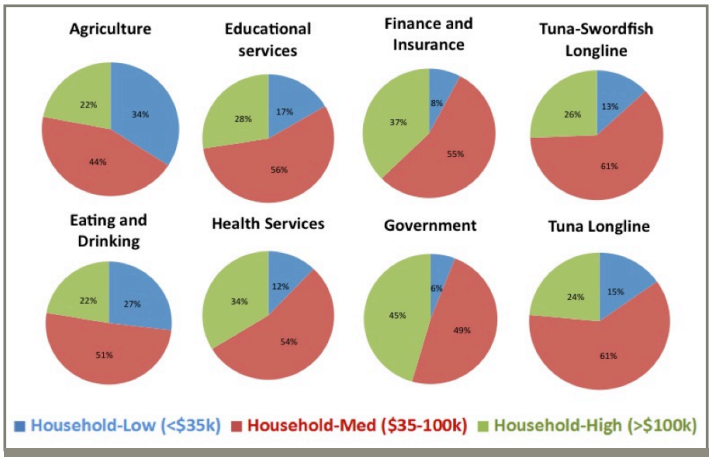
Economics & Social Sciences

Fisheries supply seafood, create jobs, and have a positive 'multiplier effect' through the economy—creating demand for a multitude of goods and services from fishhooks to freezers, from canneries to air cargo. The PFRP has supported a range of projects to put numbers on the economic value of fisheries. The PFRP has also supported work to help optimize management for creating sustainable fisheries with the greatest economic value. For instance, turtles can be protected in many ways, and some have higher economic costs than others. PFRP-funded research has looked into trade-offs between catching more fish and protecting more turtles, and developed tools to help managers optimize the design of regulations.

Chakravorty, U., Nemoto, K., 2001. Modeling the effects of area closure and tax policies: a spatial-temporal model of the Hawaii longline fishery. **Marine Resources Economics**, 15: 179-204.



The objective of fishery management is to reach specific biological goals while maximizing economic value. The PFRP has funded a number of studies to determine the most efficient means of regulating fisheries. This chart shows the trade-off between reducing turtle interactions and revenue for the Hawaii swordfish fishery. (Source: M.L. Pan)



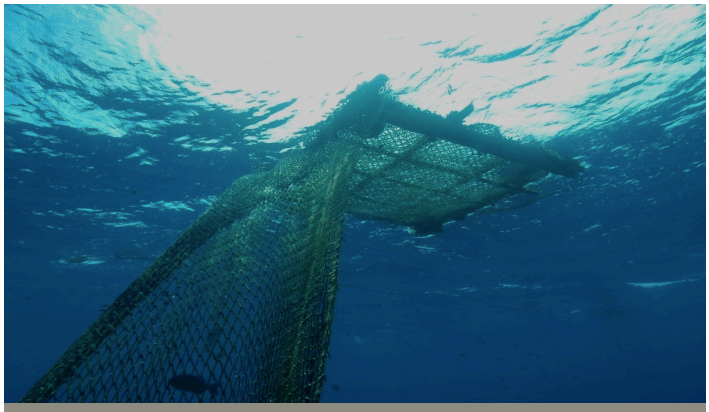
The PFRP has funded a series of studies that quantify the value of fisheries through the economy. This graph shows the breakdown of household income for people in different industries. The longline fishing industry in Hawaii employs predominantly middle-income people, placing it between lower-income sectors such as agriculture and higher-income sectors such as finance (Figure: S. Arita and P.S. Leung).

Graduate Education – Building the Future of Fishery Science

The demand for fisheries scientists is outstripping the supply so the PFRP is actively promoting graduate education in key disciplines. We encourage scientists to include support for graduate students and postdoctoral researchers in their projects. In the past 16 years, the PFRP has supported 57 graduate students and 23 postdoctoral scholars. These young scientists have studied at the University of Hawaii at Manoa and institutions around the world, including the Virginia Institute of Marine Science, Stanford University, the University of Guam, Queens University, University of Toulouse, Centro Interdisciplinario de Ciencias Marinas, University of Caen, University of Montpelier, Dalhousie University, Oregon State University, the University of Aarhus, the University of Washington, and Texas A&M. In addition, the PFRP directly supports one graduate student and one postdoc who work in our in-house research projects. Such support builds the intellectual capital necessary for fishery science and management in

Cai, Junning, PingSun Leung, Minling Pan, and Sam Pooley, 2005. Economic linkage impacts of Hawaii's longline fishing regulations. Fisheries Research, 74 (2005): 232-242.

Pan, M., Leung, P.S., Pooley, S.G., 2001. A decision support model for fisheries management in Hawaii - A multilevel and multiobjective programming approach. North American Journal of Fisheries Management, 21(2): 293-309



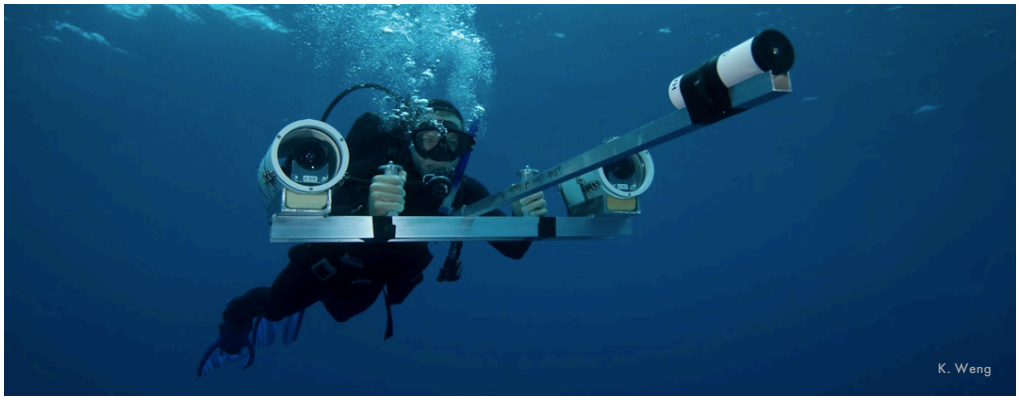
Tunas are attracted to nearly any floating object. Drifting fish aggregating devices (FADs) are widely used in purse seine fisheries. They have many impacts on the ocean environment and are leading to high mortality of juvenile tunas in the western Pacific (Photo. D. Itano).

Graduate student Eunjung Kim is creating a model to predict how drifting fish aggregating devices (FADs) move, in order to quantify their effects on tunas and other ocean animals. (Photos: E. Kim).

the future, and ensures that there are people moving up through the field who understand the Pacific region.

Graduate students assist with fisheries research in many locations. The diverse nature of fisheries research exposes them to class work, lab work, time at sea. Through their work on commercial fishing boats students such as Andrew Gray learn from fishermen, a source of knowledge unavailable in classes (Photo: K Weng).

Graduate student Anela Choy of Oahu, Hawaii, published her PFRP-supported research on how mercury travels through ocean food webs in the prestigious journal Proceedings of the National Academy of Sciences (PNAS). Prior to graduate school at UH Manoa, she attended Roosevelt High School in Honolulu, UH Hilo, and Oregon State. Clockwise from top left: taking stomach samples from tunas aboard a research vessel; deploying a specialized net to capture the tiny animals that form the diet of commercially important species; examples of the diet of large pelagic fishes (Photos: A. Choy, J. Drazen).



Budget

Over 16 years of operation, the PFRP has awarded $27 million (79%) as competitive grants; used $1.9 million (6%) for the JIMAR visiting scientist program; and spent $5 million (15%) for administration. The total budget for the period was $34 million. Competitive grants were awarded to a wide variety of institutions, including a cumulative $10 million to the NOAA Pacific Islands Fishery Science Center, $8 million to the University of Hawaii, and 1.6 million to the Secretariat of the Pacific Community. Smaller levels of funding went to academic, private sector and government research organizations.

Category	Cumulative budget	%
Administration	**$ 5,104,692**	**15**
JIMAR Visiting Scientist	**$ 1,920,285**	**5.7**
Competitive grants	**$26,918,296**	**79**
Genetics	$ 502,257	1.5
Biology	$ 10,835,085	31.9
Statistics & Modeling	$ 4,769,178	14.1
Oceanography	$ 3,319,414	9.8
Economics	$ 4,054,692	11.9
Socio-cultural	$ 1,402,918	4.1
Protected Species	$ 944,083	2.8
Trophodynamics, ecosystem	$ 1,090,669	3.2
Total Awarded	$ 33,943,273	100

Category	Total	Percentage
PFRP Administration, Visiting Scientist & Modeling	$8,642,643	25.5%
University of Hawaii (excl. PFRP)	$7,878,549	23.2%
NOAA PIFSC	$10,453,410	30.8%
Virginia Institute of Marine Science	$239,198	0.7%
University of CA - Davis	$202,395	0.6%
PacMar Inc., Honolulu	$585,118	1.7%
University of Washington (with IATTC)	$542,132	1.6%
Stanford University, Hopkins Marine Station, CA	$240,559	0.7%
Detection Limit Technology, Honolulu	$128,686	0.4%
Secretariat of the Pacific Community, New Caledonia	$1,609,249	4.7%
University of Maryland	$333,715	1.0%
University of Guam	$254,800	0.8%
Queens University, Canada	$110,250	0.3%
University of Montana and Centre National De La Recherche Scientifique, France	$271,633	0.8%
University of Florida	$100,626	0.3%
Dalhousie University, Canada	$103,488	0.3%
Micronesian Archaeological Research Services (MARS), Guam	$79,886	0.2%
Impact Assessment, Inc., La Jolla, CA	$269,259	0.8%
University of New Hampshire and Oregon State University	$291,361	0.9%
Inter-American Tropical Tuna Commission, La Jolla, CA	$296,654	0.9%
CSIRO Marine & Atmospheric Research, Australia	$89,282	0.3%
Institut de Recherche pour le Developpement, France (IRD)	$105,543	0.3%
Collecte Localisation Satellites, France	$678,436	2.0%
Ecological Modelling Services Pty Ltd, Australia (Chaloupka)	$79,525	0.2%
Texas A&M University	$309,249	0.9%
Richard Keller Kopf	$47,627	0.1%
Total	$33,943,273	100.0%

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