



University of Hawai'i Sea Grant College Program
School of Ocean and Earth Science and Technology

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The National Sea Grant College Program is a network of institutions working together to promote the wise use, development, and conservation of the nation's coastal, marine, and Great Lakes resources. Provisions of the National Sea Grant College and Program Act of 1966 called for the creation of Sea Grant Colleges, and in October 1972, the University of Hawai'i was designated one of the first five Sea Grant Colleges in the nation. Locally, Sea Grant is a unique partnership of university, government, and industry focusing on marine research, education, and advisory/extension service.

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1968—1998
30th Anniversary

Hawai'i Sea Grant College Program

University of Hawai'i at Mānoa

School of Ocean and Earth Science and Technology



Mission Statement

The University of Hawai'i Sea Grant College Program supports an innovative program of research, education and extension services, directed to the improved understanding, management, and use of marine resources of the state, region and nation.

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Preface

This 30th Anniversary publication celebrates the achievements of the Hawai'i Sea Grant College Program. Now in its third decade of providing funding and leadership for worthwhile marine research, extension and education programs, Sea Grant stands alone in the uniqueness of its contributions to the well-being of Hawai'i's people. More than any other ocean program, Sea Grant has awakened Hawai'i to its rich marine potential and responsibilities and prepared a citizenry to use and manage these resources wisely. Indeed, in very real ways, Sea Grant accomplishments are responsible for weaving the state's ocean endowment into the fabric that is Hawai'i.

The influence of Hawai'i Sea Grant programs extend far beyond the state and region through their excellent contributions to scientific knowledge and content and art of public and formal education. To illustrate a few of these achievements and accomplishments, this document will concentrate on three general areas: the development of new knowledge and technologies, the development of institutions and the development of people.

It is seldom possible to fully document the range of accomplishments of a good research, extension or education program since many of the effects are indirect and often lead into other avenues and opportunities. Even the most direct and most easily measured results do not have sharp cutoff points with respect to their societal or peer impacts. Finally, while many funding agencies call for a report of accomplishments of a program within three to five years, full blossoming may take 10, 20 or 30 years and, even then, continue to significantly influence whole chains of future endeavors.

Sea Grant is a partnership program which in many ways is more than the sum of its parts, more than a "one of its kind" federal mission and source of funding, more than a University program and even more than the missions and resources provided by its other partners. The Hawai'i Sea Grant College Program has drawn the interest and commitment of a unique group of highly motivated people, administrators, marine advisors, marine scientists and educators and staff, who through their efforts, commitment and love for their work, the islands and their people, amplify the Sea Grant mission to a level unparalleled in the network of Sea Grant universities.

The projects and programs presented here are chosen to show Hawai'i Sea Grant in terms of its unique achievements in marine knowledge, institutions and people. This publication is an affirmation, vindication and celebration of careers and achievements of those who have chosen to be associated with the Hawai'i Sea Grant College Program.



*Dr. Jack Davidson,
Sea Grant Director Emeritus*

Introduction

With the adoption of the National Sea Grant College and Program Act of 1966, Congress established Sea Grant as an institutional program at the University of Hawai'i in 1968. In October 1972, the University of Hawai'i was designated a Sea Grant College for sustained excellence in research, education and public service dedicated to the wise use of America's marine resources.

Today, the Hawai'i Sea Grant College Program is housed within the School of Ocean and Earth Science and Technology on the campus of the University of Hawai'i at Mānoa. The program is part of a nationwide network of 29 institutional programs of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, that promote the understanding, development, sustainable use and conservation of marine resources through university-based research, education, community outreach and communication efforts.

Hawai'i Sea Grant's extension activities began in the late 1960s as a loose collection of advisory projects funded through the National Science Foundation. From 1970 through 1980, the first Marine Advisory Program Coordinator was hired, a publications staff added, and marine advisory agents hired for Kaua'i, O'ahu, Maui, and the Big Island. In 1979, the program expanded rapidly into the western Pacific when it established agent positions in Guam, Saipan and American Samoa.

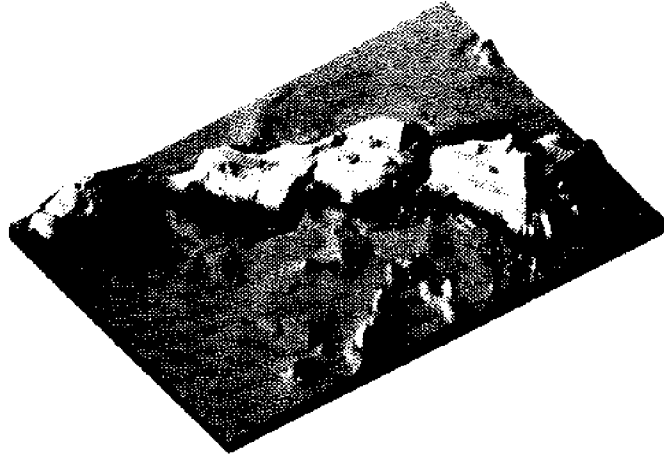
By 1982, funding cuts began to impact program size and direction. With a major shift in focus, based on statewide input from the marine community, the Sea Grant Extension Service emerged to develop working partnerships with existing agencies, organizations and businesses. It secured cooperative funding of programs with various partners, improved links with Sea Grant researchers, increased specialist positions, and expanded regional and national programming. Since 1988, the program has grown significantly with the addition of staff positions, initiatives in global environmental issues and coastal processes, expansion of activities in aquaculture development, and establishment of education and outreach projects.

Sea Grant Extension Service efforts in the U.S.-affiliated Pacific islands have expanded from an initial focus on coastal resource management to initiatives in environmental education, sustainable economic development, and capacity building and training. The addition of specialist positions with joint responsibilities in Hawai'i and the Pacific, and the increasingly regional program focus, have redefined the program as a regional extension service which now serves Hawai'i and its Extended Economic Zone, the U.S. flag territories and the U.S.-affiliated insular states of the Pacific, including the Republic of the Marshall Islands, Commonwealth of the Northern Mariana Islands, Guam, Federated States of Micronesia, Republic of Palau, and American Samoa.



*Dr. Charles Helsley,
Hawai'i Sea Grant Director*

State of Hawai'i



Hawai'i Seafloor Alita

After more than a century in which the giant agrobusinesses of pineapple and sugar dominated Hawai'i's economy, the mid-1970s ushered in a new wave of travel and with it a new source of revenue for the insular state of Hawai'i – tourism. By 1997 the visitor industry accounted for one-fourth of the state's economy, one-fourth of tax revenues and one-third of all jobs. Earth's most geographically isolated land mass had become one of the world's most popular tourist destinations.

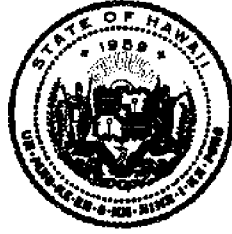
Today, Hawai'i welcomes more than seven million visitors a year. These numbers, and the unexpected growth rates for Hawai'i's resident population, add up to ever-increasing social and ecological impacts on the entire state, including coastal regions where recreational sites are the very backbone of Hawai'i's \$9 billion+ annual tourism industry. At the same time, a shift in the global economies now pits Hawai'i against less expensive travel destinations in Southeast Asia, Mexico and the Caribbean. More sophisticated travelers now seek destinations which offer an educational or cultural "experience."

Hawai'i Sea Grant is helping to identify opportunities in areas, such as aquaculture development, marine technology and ecotourism, for diversifying the state's economy using marine resources. It supports the development of well-trained technicians, managers and scientists capable of capitalizing on these opportunities as well as meeting

the challenges inherent in insular environments, such as Hawai'i and the western Pacific. To accomplish these goals Sea Grant works in partnerships with governmental agencies at all levels, non-profit organizations and private businesses. Sea Grant research, education and outreach activities have focused on providing scientific data to policy makers and legislators in Hawai'i and the western Pacific to help them make informed decisions, as well as transferring scientific and technical methodologies to marine resource managers.

For 30 years, Sea Grant has supported the education of marine scientists and technicians through opportunities for graduate education and training in Sea Grant-funded research projects in such diverse fields as ocean engineering, chemistry, microbiology, oceanography, physiology, biology, geology and economics. Formal and informal education for Hawai'i residents and Pacific islanders is also available through internships, research fellowships, seminars, workshops, the mass media and publications.

As it celebrates the International Year of the Ocean, and 30 years of service to Hawai'i and the Pacific, Hawai'i Sea Grant continues to be a leader in aquaculture, coastal processes and technology development. Among its most noteworthy past achievements are advances in ocean water quality monitoring, seaweed agronomy, prawn aquaculture, fisheries research, fisheries enhancement, precious corals and deep sea technology.



Proclamation

WHEREAS, in 1968, Congress established Sea Grant as an institutional program at the University of Hawaii and in 1972 designated the university as a Sea Grant College -- noting its sustained excellence in research and education and its dedication to the wise use of America's marine resources; and

WHEREAS, Hawaii Sea Grant has funded research projects in diverse fields -- including ocean engineering, chemistry, microbiology, oceanography, physiology, biology, geology and economics; and

WHEREAS, Hawaii Sea Grant has been a leader in aquaculture, coastal processes and technology development -- and has supported the education of hundreds of marine scientists and technicians through opportunities for graduate education and training; and

WHEREAS, Hawaii Sea Grant's outreach activities continue to provide information for policymakers and legislators, along with scientific and technological methodologies to marine resource managers; and

WHEREAS, Hawaii Sea Grant's Extension Service has provided initiatives in capacity building, training, environmental education and sustainable economic development; and

WHEREAS, Hawaii Sea Grant, during this International Year of the Ocean, is celebrating thirty years of distinguished service to the people of Hawaii and the Pacific;

NOW, THEREFORE, I, BENJAMIN J. CAYETANO, Governor of the State of Hawaii, do hereby proclaim October, 1998, to be

SEA GRANT MONTH

in Hawaii, and commend the Hawaii Sea Grant College Program for its outstanding dedication to the development and conservation of marine resources in Hawaii and throughout the Pacific.

DONE at the State Capitol, in the Executive Chambers, Honolulu, State of Hawaii, this eighteenth day of August, 1998.

Benjamin J. Cayetano

Marine Knowledge



Aquaculture in Hawai'i

Thirty years ago, aquaculture began its resurgence in Hawai'i and was considered a fledgling but growing segment of the state's diversified agriculture industry. By the late 1970s the freshwater prawn was the dominant production species. Sea Grant's Hawaiian Prawn Aquaculture Program focused on prawn biology and pond ecology, including feeds and feed management, crisis management, stress and disease, growth patterns, genetic performance and alternate management systems.

Sea Grant's Hawaiian Backyard Aquaculture Program was started in 1981 to develop and distribute techniques of small-scale, or "backyard," aquaculture to interested Hawai'i residents. The program still offers "how to" information on construction and maintenance of ponds for subsistence or avocation on house lots and other small spaces. By these means, along with on-site technical advising by its Extension agents, Sea Grant routinely transfers information on research and practices of commercial-sized aquaculture systems to small-scale operations.

Aquaculture efforts in the state continued to expand, and by 1983, the wholesale value of harvests from farm pond production — prawns, oysters, tilapia and trout — was worth about \$1.6 million. Expansion of aquaculture efforts throughout the islands demonstrates the industry is recognized as an opportunity for economic expansion and diversification. One unanticipated offshoot of the assembling of the expertise needed to develop culture technologies necessary for the growth of the aquaculture industry in Hawai'i is the creation of an aquaculture consulting industry within the state. This industry, generally considered part of the service sector "research and technology transfer" is now quite substantial. This particular sector of the industry has steadily increased through a combination of public and private sector development and at present generates more revenue than the production sector. In



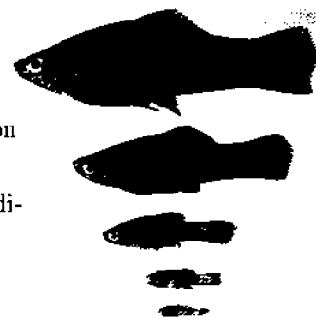
As Sea Grant's aquaculture extension project serves as an information conduit to farmers, educators and researchers, it attempts to develop cooperative projects between private and public sectors. This cooperation provides an extensive network of collaborative partners that can be called upon to address constraints facing the aquaculture industry.

1997 Hawai'i's aquaculture industry was worth \$37 million.

The role of the Hawai'i/Pacific Sea Grant Extension Service is to transfer the results of research to the aquaculture industry in Hawai'i and the Pacific islands. Extension agents work with researchers in the private and public sectors to improve production efficiency and hatchery operations, increase the number of viable aquaculture enterprises, and to investigate the potential

culture of additional species. Agents provide technical assistance and information to aquafarmers, and assist new farmers with business planning, operations design and management programs. The program supports industry development which uses and manages coastal resources wisely. Its primary objectives include the efficient transfer of technology to the local user, feedback to the research community, evaluation of new species for culture, personnel training, engineering improvements, disease diagnosis and treatment, permit acquisition and site selection.

Sea Grant's philosophy of networking with other agencies underscores a plan to develop the \$12 million Pacific Aquaculture and Coastal Resources Center at a decommissioned wastewater treatment plant along the Big Island's Keaukaha coast in partnership with the University of Hawai'i at Hilo, the County of Hawai'i, the Keaukaha Homelands Community Association and the State of Hawai'i. An education program will provide training for the local community and encourage development of aquaculture farms along the Keaukaha coast. Main functions of the center are research and development of aquaculture technologies, pilot-scale demonstration site, and center of aquaculture extension activities for the Big Island, state and Pacific region. Planners estimate the center's construction will bring \$5.5 million into the area, and operations are expected to bring in an additional \$650,000 a year.



Viral Diseases and Penaeid Shrimp

In 1994, the shrimp aquaculture industry was dealt a severe blow when two viral diseases, the yellow head virus and the Chinese baculovirus, caused massive mortalities in farms worldwide, resulting in an estimated \$3 billion annual loss to the industry. Besides causing massive mortalities in cultured shrimp, these viral pathogens are highly infectious, easily transmissible and cause the most severe viral diseases so far reported in cultured shrimp. Both viruses are serious threats to two penaeid species, the blue shrimp (*Penaeus stylirostris*) and the white shrimp (*P. vannamei*), commercially cultured in Hawai'i's growing broodstock industry. Microbiologist, Dr. Philip Loh, has reported 19

To date, the only solution to controlling the yellow head virus and the Chinese baculovirus has been to destroy infected shrimp and start over with new stocks.

—Rich Bailey photo

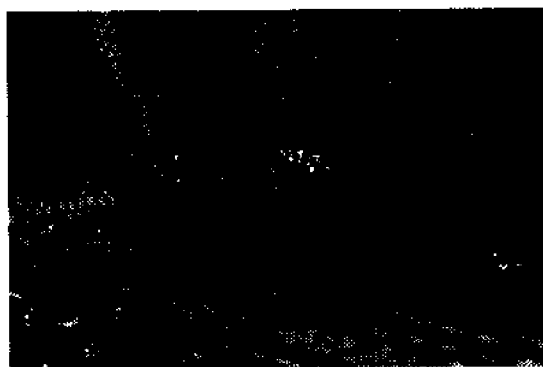
viruses in penaeid shrimps and was the first researcher to successfully culture shrimp viruses in a test tube, the first step in developing a virus detection protocol. The expeditious control and eradication of the virus problem would identify infected shrimp before they showed clinical signs of infection.

Loh is now working to adapt



the successful virus detection methods he has developed to track down the yellow head virus and the Chinese baculovirus. This protocol also is being used to monitor the rhabdovirus of the penaeid shrimp infection on farms throughout Hawai'i. Plans to extend field evaluation studies to Southeast Asia and Asia are underway.

Feeds and Growth Technology



As the world's second largest importer of seafood (second only to Japan), the U.S. imports more than 60 percent of its fish and shellfish. Importing 75 percent of its tilapia, the U.S. consumed about 82 million pounds of the fish in 1997. —Priscilla Billig photo

Dr. Gordon Grau, marine biologist and interim director of the Hawai'i Institute of Marine Biology, has entered into a collaboration with the Monsanto Company to explore biotechnology aimed at enhancing fish growth and development. With support from Hawai'i Sea Grant and the State's Aquaculture Development Program, studies have produced a feed formula that improves fish growth as much as seven times and makes fish conversion of food into energy more efficient.

Sea Grant researchers studying the tilapia (*Oreochromis mossambicus*), aquaculture's fastest growing industry worldwide, have identified its growth hormones and developed technology that improves its growth and food conversion efficiency, thereby reducing grow-out costs and the excretion of nitrogen into the environment. These findings will aid the U.S. aquaculture industry by enhancing feeds performance and thus lowering costs. In collaboration with the Monsanto Company, Grau and his research team will examine the efficacy of a growth hormone as a growth-promoting agent in finfish aquaculture.

Mini-OTEC (Ocean Thermal Energy Conversion)

y 1979, the concept of harnessing the ocean's energy in the process of ocean thermal energy conversion, commonly called OTEC, had gained international attention.

Hawai'i Sea Grant funded early research into the aquaculture of coldwater species in deep ocean water upwelled onto the OTEC platform. In 1980 Sea Grant researchers tested the feasibility of cold-water aquaculture using cold, deep ocean water available through the OTEC system. Experiments with nori (*Porphyra tenera*), an edible seaweed, demonstrated that growing cold-water species in the subtropics was possible. A second experiment with coho salmon showed that it too could be raised in a subtropical climate and using OTEC technology.

At the edge of North Kona's barren lava flows, the garden uses cold seawater pumped from an ocean depth of 2,000 feet and plumbed to plastic irrigation pipes embedded in the soil at root depth. As the tropical sun heats the pipes, the naturally occurring freshwater condensation irrigates the crops. Tapping into pipes used for Ocean Thermal Energy Conversion (OTEC), the garden plot has yielded more than 100 varieties of fruits, vegetables and herbs — all having a surprisingly high sugar content and aroma.

The wide temperature difference between the tropical climate and the cold seawater pipes pumps nutrients into the plant, stimulating growth much like Mother Nature does in Spring or Fall. But it also seems to speed up the process, possibly stimulating early fruiting, especially in pineapples which are growing to maturity in 10 months rather than the usual two years. Exploiting the biophysical applications of cold, gardeners can induce and break dormancy in a plant at any time. This manipulation produces three or four annual harvest cycles in one year — a veritable "Super Spring" 365 days a year.

And where does the seawater go after it completes its cycle through the garden's irrigation pipes? Rich Bailey, an aquaculture extension agent with Hawai'i Sea Grant, offers a surprising new use that integrates crop growing with fish farming. Tapping into the garden's drain line, Bailey will use the still unused and bacteria-free seawater to fill aquaculture tanks and grow cold-water marine species of fish and seaweed. Clean, cold deep-ocean water presents advantages in raising seafood crops, such as steelhead trout, salmon, sturgeon and shellfish. Cold-water algal species, or seaweed, are promising aquaculture candidates. Usually found in temperate climates with less sun, these types of seaweed may grow faster in cold water under the tropical sun — a boon to arid areas that have limited freshwater but have access to nearshore deep water, such as West O'ahu and Wai'anae.



Hawai'i Sea Grant provided "seed" money for the Common Heritage Corporation's initial test crop of strawberries at its experimental garden located on the grounds of the Natural Energy Laboratory of Hawai'i and co-sponsored a 1992 conference on the use of low-cost cold in tropical agriculture. Dr. John Craven, president and founder of the Common Heritage Corporation, showed off papaya and pineapple crops growing in the coastal desert. —Priscilla Billig photo

Hawaiian Fishponds

Aquaculture, the farming of freshwater and marine aquatic species, was first practiced in Hawai'i at least 600 years ago. Ancient Hawaiians managed aquaculture resources as part of the extensive agricultural complexes which traditionally encompassed ecosystems stretching from the mountains to the sea, practicing marine aquaculture in walled fishponds strung along the coastline. These fish farmers depended on the natural ebb and flow of ocean tides for pond circulation, restocking and entrapment.

While some traditional Hawaiian fishponds remain, most have fallen into disuse over the years, clogged with silt and partially lined with broken walls. Today their historic and cultural significance, as well as their economic potential, are the driving forces behind restoration efforts throughout the state.

The *loko kuapa* Hawaiian fishponds, unique to the Hawaiian Islands, are at the center of a Sea Grant-funded study by ocean engineer, Dr. Cengiz Ertekin and Dr. Mark Merrifield, who continue to survey a number of fishponds to create a database of environmental parameters and to track water circulation within the ponds. The information will provide engineers with design parameters that will help decide the location and number of sluice gates to optimize water circulation and reduce silt accumulation.

But revitalization of traditional Hawaiian fishponds as an economically feasible industry has met with state and federal permitting constraints, one of which requires compliance with federal water quality guidelines for discharge into coastal waters. Sea Grant aquaculture specialists, Dr. Clyde Tamaru and Dr. Robert Howerton, hope to solve this problem by determining the water quality characteristics of active and inactive fishponds and comparing them to those required in federal guidelines. This information is essential in determining whether federal guidelines should be applied to modern Hawaiian fishpond operations.

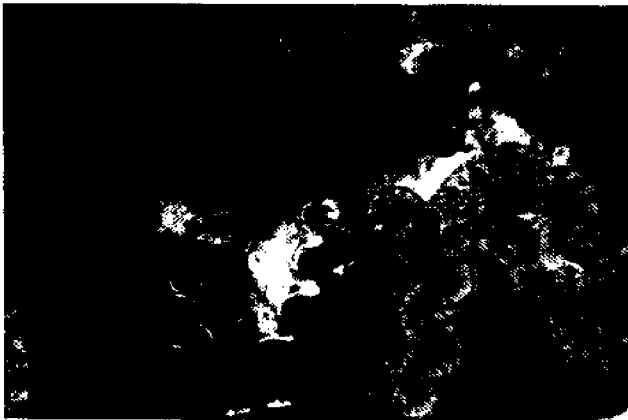


Sea Grant extension specialists have explored ways in which fishponds can be used as an educational tool for science teachers. Their expertise guided on-site learning in the first high school-level Hawaiian fishpond study program in the state. Castle High School students enrolled in the "Plants and Animals of Hawai'i" class applied what they learned in science class to a fishpond restoration project at the edge of Kāne'ōhe Bay. Lt. Gov. Mazie Hirono (above) got a lesson in net throwing at Kaikalua-Loko Fishpond on O'ahu. — Clyde Tamaru photo

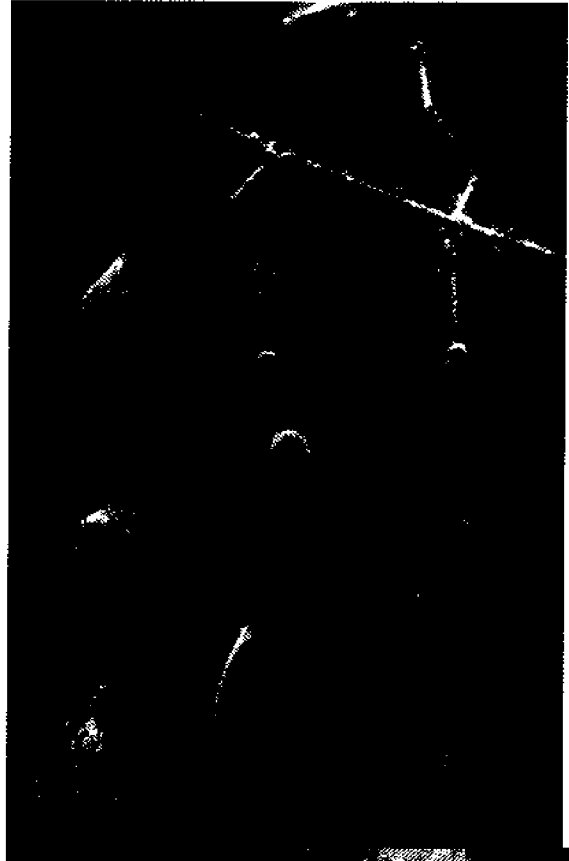
Aquaculture in the Pacific

Beginning in 1986, Jack Davidson, the director of Hawai'i Sea Grant, the National Sea Grant Aquaculture Specialist, James McVey, and Office of Territorial and International Affairs (OTIA), U.S. Department of Interior, began discussions on how the Hawai'i Sea Grant might help OTIA meet islanders' requests for applied aquaculture programs in the U.S.-affiliated insular Pacific. These discussions resulted in the development and funding of Hawai'i Sea Grant's Pacific Aquaculture Development Program (PADP) in 1987. Anne Orcutt-Bailey became the manager of this program, now called the Pacific Regional Aquaculture Extension Service, or PRAES.

Today in the western Pacific, Sea Grant's Pacific Regional Aquaculture Extension Service is collaborating with island nations which recognize the development of local marine resources as a viable balance to economic and population pressures. Sea Grant works to further the development of industries for black pearls, giant clams, sponges and saltwater aquarium species in the Pacific islands.

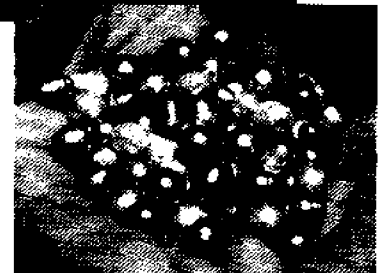


Hawai'i Sea Grant has helped Pacific island businesses set up giant clam farms where underwater cages protect young clams from predators, such as the wrasse and ray. —Simon Ellis photo



*At the heart of a multi-million dollar industry, black lip pearl oysters (*Pinctada margaritifera*) hang off lines (l) awaiting surgical implantation of an artificial nucleus by a "seeding" technician. A "gem-quality" pearl can fetch as much as \$10,000.*

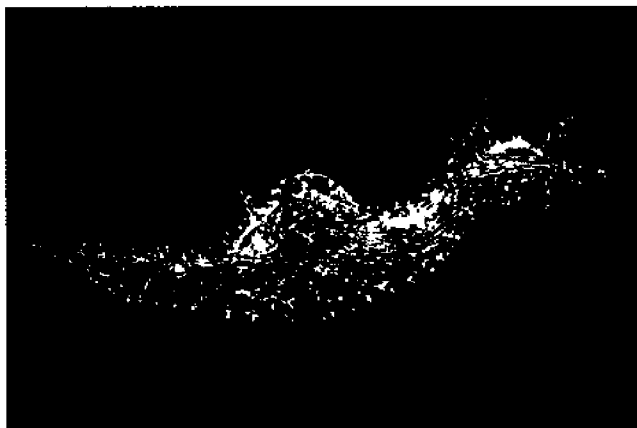
—Maria Haws photos



Bioactive Marine Metabolites

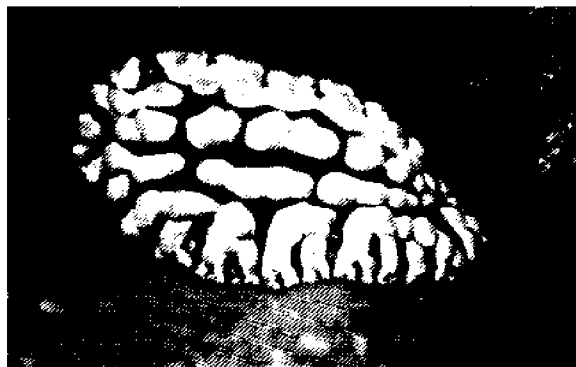
Within its depths the ocean nurtures 80 percent of all Earth's life forms, offering a bounty of organisms whose unique chemistry may hold the cure for old, and some not so old, diseases. UH Professor Emeritus Paul Scheuer, an organic chemist for almost 50 years, has spent his career searching the waters and coral reefs surrounding the islands of Hawai'i and the western Pacific. In his quest, Scheuer has come to believe that the cure for some of the world's most persistent and deadly ailments may, in all likelihood, exist in the sea. After all, there are more undescribed species in the ocean than anywhere else on Earth.

Reaching down to the lower rungs of the evolutionary ladder, Scheuer focuses his research on sponges and primitive marine invertebrates, like the shell-less mollusk and sea hare, for bioactive marine compounds with pharmaceutical potential. What he has discovered is that some of the ocean's strangest and seemingly most vulnerable creatures may hold curative powers against diseases, such as malaria, arthritis, and colon and lung cancers.



The sea hare, *Stylocheilus longicauda*, is a strictly vegetarian, snail-like mollusk which feeds on blue-green algae. From the unique chemistry of the *Phyllidia speciosa*, with its diet of blue-green algae-eating sea hares, Paul Scheuer and his research team discovered a peptide, a sequence of amino acids, which may hold promise in future drug lead investigations.

—Paul Scheuer photo



With its characteristic yellow dots and blue body, the nudibranch (*Phyllidia varicosa*) nibbles on the sponge (*Ciocalypa* sp.) - not only its food source, but the source of the nudibranch's defensive secretions.

—Paul Scheuer photo

Scheuer's basic philosophy or rationale for collecting has been to focus on the soft-bodied, sessile or slow-moving organisms with no hard shell and no spines and which either cannot move or are very poor swimmers, making it difficult or impossible to get away from predators. These simple organisms, therefore, have developed sophisticated chemistry in order to survive the rigors of life in the ocean. A recent discovery taken from the herbivorous sarcoglossan mollusk *Elysia rufescens*, kahalalide F is currently in preclinical testing against colon and lung cancers and is also being processed for an Investigative New Drug license.

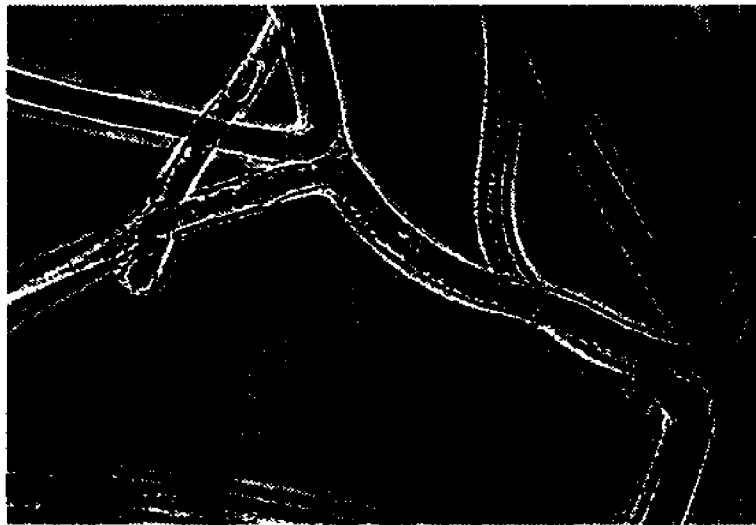
In 1972, Scheuer was cited for Excellence in Research by the Regents of the University and the following year wrote *Chemistry of Marine Natural Products*, the first book on the subject in any language. Having directed the research of more than 100 postdoctoral associates, dozens of graduates and undergraduates, and authored more than 260 publications, Scheuer received the Ernest Guenther Award of the American Chemical Society and the Research Achievement Award for the American Society of Pharmacognosy in 1994. Dr. Scheuer continues to receive steadfast funding from the National Science Foundation, the National Cancer Institute and the Hawai'i Sea Grant College Program.

Microbiology of Blue-Green Algae

In the hunt for new medicines UH chemist, Dr. Gregory Patterson, searches out bacteria in the most far-flung locations. He's plucked his samples from the reflecting pools at the state Capitol, the summit of Haleakalā, the remote Northwestern Hawaiian Islands, and the shark-infested waters at Enewetak Atoll. The object of Patterson's search is the microscopic blue-green algae, called cyanobacteria, collected from marine waters, moist soils, fresh or brackish waters, and trees and plants.

Within these chemicals, Patterson searches for substances to combat cancer, the second leading cause of death in the U.S., accounting for 20 percent of all deaths. Using process engineering and applied microbiology, the cyanobacteria are isolated, identified, cultured and allowed to grow for about four weeks, at which time they are harvested, freeze-dried, extracted, and used for biological evaluation.

Stored samples in liquid nitrogen provide seed material for future cultures. Inside these tiny cells is an armory of chemicals used for self defense: some can detect and stop the growth of deadly fungi, others can protect the cells from damaging solar rays.



Using process engineering and applied microbiology, Dr. Greg Patterson has discovered a mechanism for increasing synthesis of chemical dense compounds, called phytoalexins, in cyanobacteria such as *Scytonema*. —Greg Patterson photo

Natural products have been the source of most drugs in use today. Approximately 75 percent of the 20 most used hospital drugs are derived from natural products.

Bioactive Macrocycles in Soft Corals

About 20 years ago, Japanese researchers discovered a marine natural product in the chemistry of the Indo-Pacific soft coral, *Sarcophyton glaucum*, which inhibits tumor growth. While the extracted compound called Sarcophytol A showed promise, the overharvesting and endangerment of the soft coral was not a viable ecological option.

The alternative was to create an analog, a synthetic twin of the original compound, a substance that could be recreated in the lab. What UH chemistry professor, Dr. Marcus Tius, has found since he took up this research 10 years ago proved to be more than a good copy. His synthetic compound, called Canventol, is not only a close duplicate, it is proving in large-scale studies to have stronger anti-tumor potential than the original natural product.

The National Cancer Institute is currently screening the synthesized material for chemopreventive agents. Canventol is showing promise as an inhibitor to HIV-1 replication.

Diving Physiology

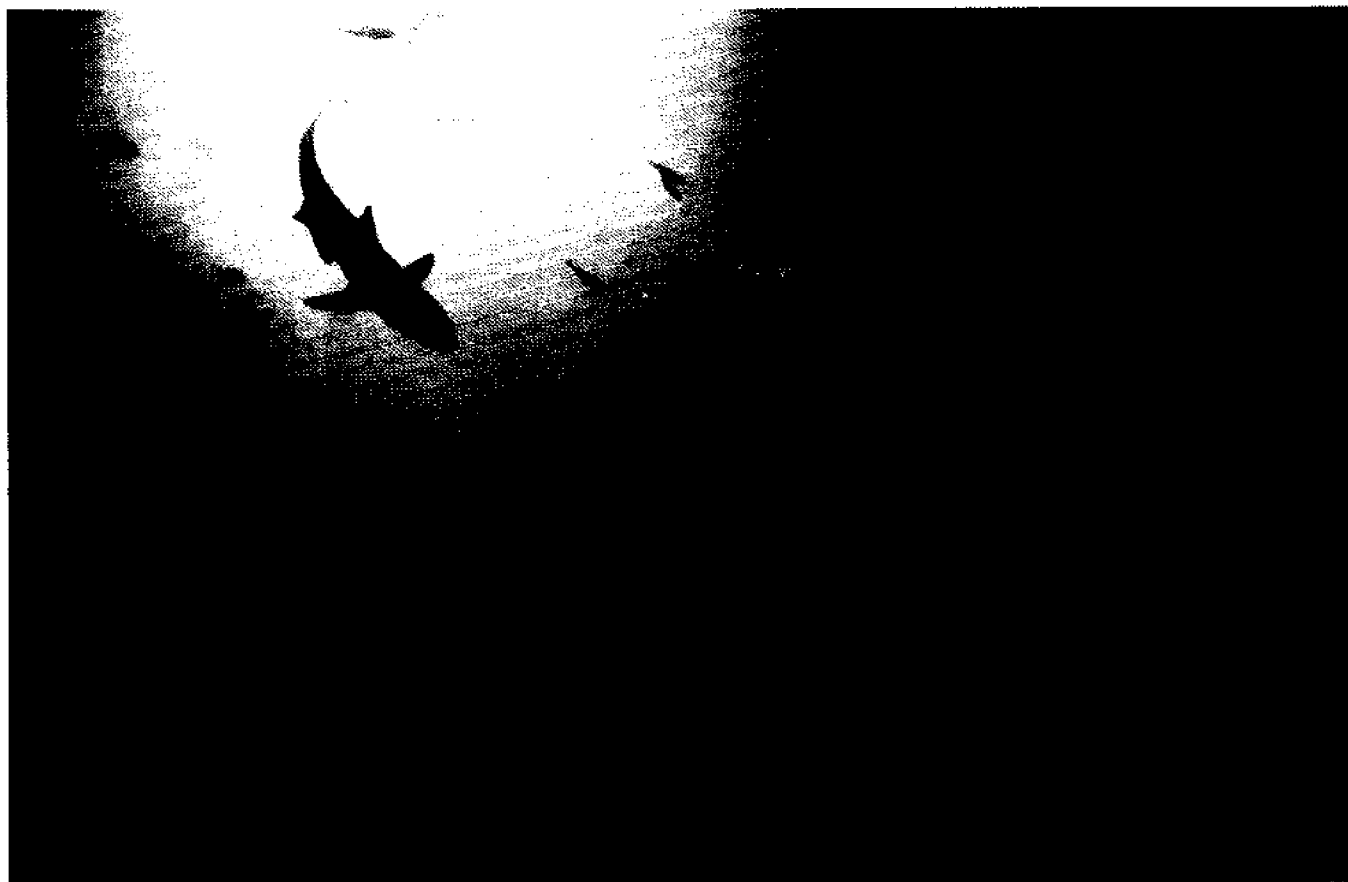
For almost 20 years the emphasis of the diving physiology program at the University of Hawai'i, under the direction of physiologist, Dr. Yu-Chong Lin, focused on the development of improved dive safety through the understanding of basic physiology of humans in the sea. The project focused on skin diving and saturation diving. Skin diving, also known as breath-hold or free diving, is an important part of any inwater activity. The circulatory and respiratory effects of pulmonary air embolism were studied in a whole body system. Studies of physiological limits of a human as diver yielded an abundance of information that is readily applicable to humans in the areas of gas exchange, oxygen transport, cardiovascular responses, hormonal changes and survival limits.

In the area of saturation diving, Lin focused research on development, refinement, and validation of decompression tables and adaptation to prolonged exposure to high

ambient pressure. For the decompression tables, it is necessary to understand the relationships between acute decompression sickness and the decompression-induced bubbles in the blood, inert gas uptake and elimination, and immunological responses to gas bubbles in the blood.

Lin has proposed a new system of universal decompression tables which are currently under experimentation in an international cooperative research venture with the Japan Marine Science and Technology Center.

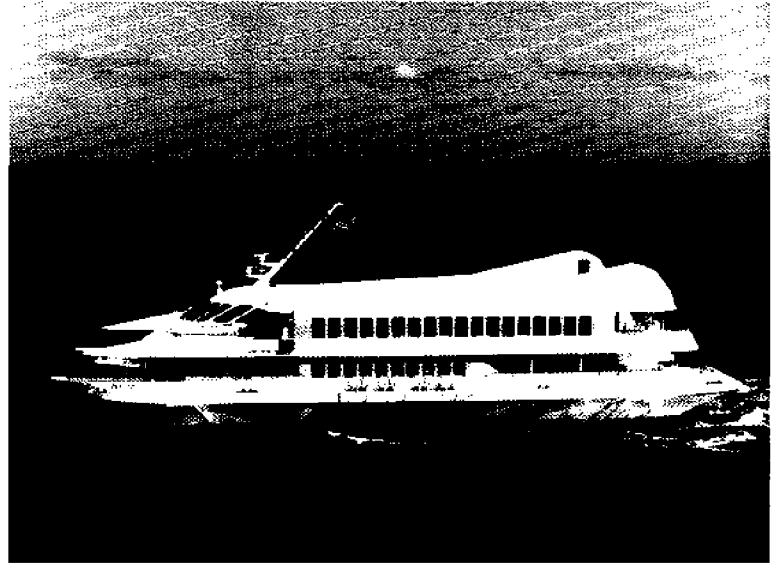
In case of equipment failure, a scuba diver becomes a skin diver and knowledge of physiological changes during breath-hold diving is crucial for survival. —SOEST Photo Lab



SWATH Technology

When Hawai'i Sea Grant funded a 1974 project to analyze various interisland ferry systems for the islands, it also supported research by Dr. Ludwig Seidl, UH naval architect and then chairman of the UH Ocean Engineering Department. Working on a Small Waterplane Area Twin Hull, or SWATH, ship technology, Seidl had been investigating the interaction and hydrodynamic effects of twin submerged hulls to reduce the effects of wave motion in rough seas and thereby reduce crew and passenger seasickness and fatigue. Investigation into a marine transit system included work on a SWATH-type vessel. Theory merged with practical experience and research gradually switched to technical application in partnership with private marine engineering firms to begin commercialization of SWATH technology.

SWATH technology went into construction of the \$6 million, 140-foot tour excursion and dinner cruise craft *Navatek I*, built by Pacific Marine. The world's largest commercial SWATH ship, whose two submerged hulls ride below the waves like submarines rather than bob on the crest of a wave like the conventional catamaran, is calculated to handle the worst kind of North Sea conditions. Since hull shape and changes in size are adaptable in SWATH construction, a variety of ship designs is possible. In 1992 the National Association of Passenger Vessel Owners bestowed on *Navatek I* its first annual Excellence in Hull Design Award.



With SWATH technology, the low-resistance hull stabilizes wave motion and decreases drag, reducing the horsepower needed and lowering fuel consumption. The vessel's wide beam-to-length design provides more deck space since the conventional standard diesel engines, or the alternative electric diesel engines, are located in the submerged hulls instead of on deck. Engine noise and vibration are also significantly reduced. —Pacific Marine photo

Undersea Monitoring System for Loihi

In the early 1980s Sea Grant began studying underwater areas south of the Big Island of Hawai'i to uncover valuable energy and mineral resources. Researchers, lead by Sea Grant oceanographer and geophysicist, Dr. Alexander Malahoff, and oceanographers Dr. Gary McMurtry and Dr. David Karl, discovered and mapped major sites of volcanic activity on the developing island, collected and analyzed gaseous emissions from smokers, and developed instrumentation to monitor future volcanic activity in real time.

Project Pele began as a Sea Grant-supported study of the East Rift Zone of the Big Island's Kilauea Volcano and Loihi Seamount, about 12 miles south of the island and 3,000 feet deep. Deploying the two-person submersible *Makali'i*, maintained and operated by the Hawaii Undersea Research Laboratory under the direction of Dr. John Craven and later Malahoff, and with funding from NOAA's National Undersea Research Program, researchers studied the hydrology, chemistry and microbiology of the geothermal systems at these two sites. Spearheaded by McMurtry, one of the goals of the study was to understand the movement and distribution of freshwater in the ground supply and its role in hydrothermal systems along the rift, one of the state's most dynamic geothermal energy sites.

To monitor the activity of Loihi, researchers are deploying a permanent ocean-bottom observatory. With



A bathymetric map of Loihi.

fiber optic cable technology using more than 20 cameras, sensors and instrumentation, the Hawai'i Undersea Geo-Observatory (HUGO) will provide a real-time view of Loihi and its volcanic activity. Researchers, again lead by Malahoff, also periodically deployed the Ocean Bottom Observatory (OBO) which monitored pressure, temperature and seismic activity, and videotaped the changing environment of this underwater volcano. As scientists learn more about the fundamental processes of volcanoes, monitoring on Loihi continues to reveal a wealth of information.



The HURL submersible Pisces V allowed researchers access to depths of more than 6,500 feet as they explored Pele's Pit, a new crater on Loihi whose hydrothermal vents heat up the surrounding water to 410 degrees Fahrenheit. —HURL photo

Intelligent Underwater Vehicles

In 1989, Sea Grant funded a new project called "Automatic Optical Stationkeeping for a Subsea ROV" spearheaded by UH professors Drs. Joel S. Fox and Junku Yuh. The project was the first federally funded research project in the area of underwater robotics. Sea Grant funding continues to support Yuh's research on "An Intelligent Control System for Underwater Robotic Vehicles" and recently funded a workshop on "Future Research Directions in Underwater Robotics" in partnership with the National Science Foundation and the State of Hawai'i.

Yuh now directs the Autonomous Systems Laboratory at the University of Hawaii which supports a staff of 30 and, with funding from NSF, the Office of Naval Research (ONR), Sea Grant and the private sector, operates on a budget of \$2.5 million. This research team designed and built a fully autonomous underwater vehicle called the "Omni-Directional Intelligent Navigator," or ODIN, for shallow water and a "Semi-Autonomous Underwater Vehicle for Intervention Missions," or SAUVIM.

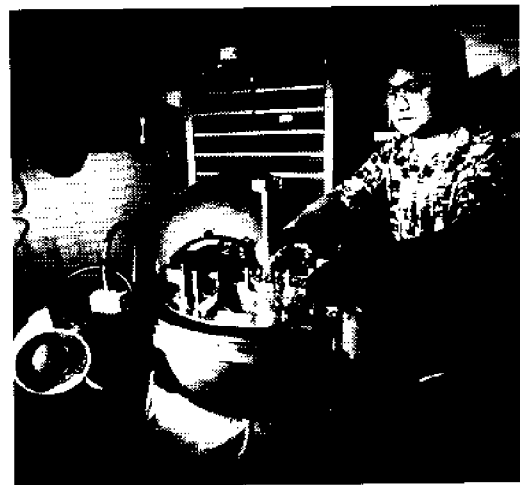
Remotely operated vehicles (ROVs) have become an important tool for inspection and repair of underwater structures, equipment retrieval, pipeline laying, and other marine applications. Maneuvering the current ROVs require highly skilled operators and even the experienced operators can err with fatigue or inattention during long survey tasks, particularly in turbid water or strong currents. The development of intelligent underwater vehicle systems that can see will allow much more efficient and economical underwater exploration and development. This project will develop and demonstrate an optical sensor-based control system that detects the vehicle's planar motion and compensates for position errors near the ocean bottom. Yuh's advanced vehicle control system makes ODIN's position, compared to other vehicles, accurate within approximately 20 cm.

Yuh's technical contributions to the field are well documented in more than 70 papers and five edited books, two of which are the only single-bound books on underwater robotics.



Research vehicle ODIN, or Omni Directional Intelligent Navigator, is used in the development of more advanced autonomous underwater vehicles. The two-foot-wide sphere, with its white thrusters attached, can travel to a depth just under 100 meters at a speed of two knots. Researchers have mounted cameras on ODIN's front and bottom and have adjusted the sphere for increased pressure at greater depths.

—Junku Yuh photo

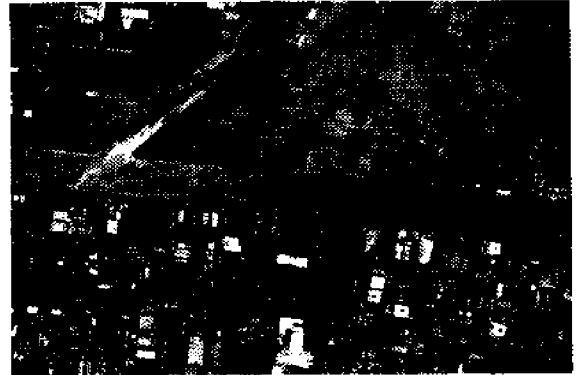


In 1991 President George Bush presented Yuh (pictured above) with the prestigious Presidential Young Investigator Award. The award, a research grant from NSF and industrial matching funds, provided approximately \$500,000. —UH Relations photo

Quality of Coastal Waters

The Quality of Coastal Waters Project, headed by hydraulic and sanitary engineer, Dr. Stephen Lau from 1971 to 1979, was a Sea Grant study on pollution of coastal waters which produced information needed to support the development of special water quality standards for Hawai'i's nearshore waters. Research centered on finding solutions to specific pollution problems and on finding ways to prevent future pollution from such sources as land development and population growth.

Out of this multidisciplinary project researchers identified the following: land-use activities detrimental to coastal water quality and marine biological resources, land-use management or wastewater management changes, and situations where land use exerts relatively little impact on the quality of coastal waters. The Quality of Coastal Waters Project permitted a savings of \$120 million in capital costs and \$13 million in annual operating costs for sewage disposal for the City and County of Honolulu.



The project's main objectives included identifying and measuring pollutants entering coastal waters, monitoring changes in water quality, evaluating the adequacy of coastal water quality standards set in the late 1960s, developing scientific data for establishing basic protection measures, making recommendations for changes in policy and maintaining an advisory program to inform the public about the project's findings.

— Sea Grant photo



Extreme examples of anchor damage occurred along the Kona coast of the Big Island and at Molokini's marine life conservation district, where anchors and chains dragging across the ocean bottom noticeably damaged coral heads and left swaths of rubble in their wake.

— Sea Grant photos

Day-Use Moorings

With the rise in tourism comes a rise in ocean recreation activities, such as diving and snorkeling. By the 1980s, the proliferation of tour and dive boats returning time and again to the same popular sites began to raise concern about coral reef damage from dropped anchors. Responding to the concern of the public, as well as the recreational dive industry, Sea Grant brought in Dr. John Halas from Florida's Key Largo National Marine Sanctuary. Halas briefed local tour and dive boat businesses about the innovative day-use mooring system he had developed. From this initial meeting, interest in adapting Florida's system for Hawai'i grew rapidly among the Hawai'i diving community. To date, more than 100 moorings have been installed in waters around O'ahu, Molokini and the Big Island of Hawai'i. Sea Grant conducted a study of Hawai'i's \$30 million recreational dive industry, provided technical assistance, including start-up funding, established the non-profit Malama Kai Foundation to support community projects like day-use moorings, and obtained state and federal approval for the installation of more than 300 day-use moorings.

Water Quality Monitoring

In recent years, there has been a heightened environmental awareness by the general public, including concerns over water pollution. Two of Hawai'i's major ocean sewage outfalls release advanced primary treated effluent under EPA 301h waivers. These waivers issued to the City and County of Honolulu require monitoring for impact to the biota of the receiving

waters. Public perception has been that the release of this sewage has caused great harm to the marine communities of nearshore waters. Over the last 10 years researchers from the University of Hawai'i

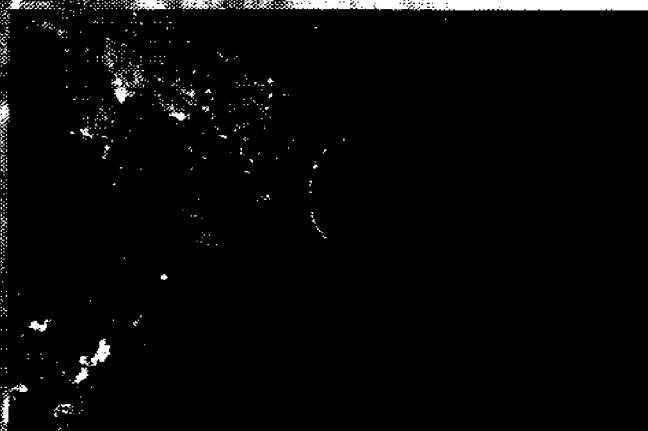
Water Resources Research Center, the Hawai'i Sea Grant College Program and the UH Department of Zoology have carried out monitoring and research aimed at determining the level and degree of

impact that may be occurring. These scientists' efforts, headed by the senior scientist, Dr. Richard Brock, have focused primarily on addressing concerns over impacts to shallow coral reef resources. Recent studies have

not found evidence of impact to coral reef communities from these deep ocean discharges. Quantitative studies focus on coral, algae, macrobenthos and fish communities located downcurrent of these ocean discharges. The present five-year research program receives external funding of more than \$1.8 million.

These deep ocean outfalls traverse large, sandy plains with few submarine features. The outfalls are protected by armor stone that creates considerable topographical relief which serves as shelter for fishes — in essence creating artificial reefs. Sea Grant studies have found that these "artificial reefs," and the particulate materials discharged from them, may attract and support a diverse fish community with many commercially desirable species present in high abundance.

However, not all is well on the coral reef. Sea Grant research has turned up an unusual cutaneous tumor on at least one coral reef fish species in proximity to both sewer outfalls and nonpoint sources of pollution. This cancerous growth has been identified as a neurofibroma, the second to be reported in fishes worldwide. Hawai'i Sea Grant is investigating this disease problem with funding from the Hawai'i State Department of Land and Natural Resources.



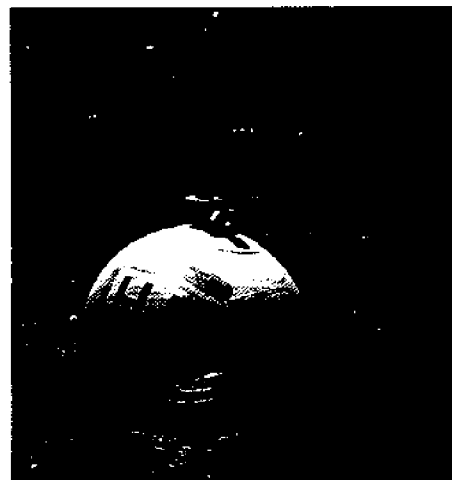
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Fishery Enhancement

Since 1983, fisheries research has focused on fishery enhancement with fish aggregation devices, called FADs, and with artificial reefs. Harvest refugia, marine conservation areas where no fishing is allowed, have also gained considerable attention as efficient strategies for sustaining fisheries resources.

Sea Grant research, headed by marine biologist, Dr. Kim Holland, is providing data for evaluating the effectiveness of harvest refugia in Hawaiian waters, especially for highly mobile species, such as tuna.

Capturing various species of fish, which are measured, marked with identification tags and released back into the ocean, researchers are describing movement patterns, habitat usage and dispersal patterns of mobile reef fishes within conservation zones. Initial tracking has demonstrated that even modestly sized harvest refugia afford significant protection to adults of these species and may indeed be the best hope for management.



The statewide system of moored, buoy-like fish aggregating devices, or FADs, attract pelagic fishes such as bigeye tuna (ahi), mahi mahi, wahoo (ono), billfish and many others. Today, there are 55 surface and four subsurface FADs monitored and maintained in waters around the main Hawaiian Islands. In a joint project with the Hawai'i Institute of Marine Biology and the state Department of Land and Natural Resources, Hawai'i Sea Grant offers commercial and recreational fishermen access to daily information about FADs online at Sea Grant's website. —Sea Grant photo

Tracking the Tiger Shark



Researchers from the Hawai'i Institute of Marine Biology render tiger sharks completely immobile by gently turning them on their backs. This state of "tonic immobility" makes possible the insertion of small transmitters into a shark's belly wall. —Aaron Bush photo



Marine biologist, Dr. Kim Holland, is also pioneering new developments in aquatic research technology while shedding light on the habits of fish and their predators. His work on the tiger shark (*Galeocerdo curvier*), the largest nearshore predator in Hawaiian waters and the species responsible for the most shark attacks on humans, is designed to generate information that will help resource managers make informed decisions relating to protection and management of the nearshore ecosystem and its inhabitants. Holland and his research team have used sonic transmitters implanted into sharks and a combination of active tracking and data loggers deployed on the ocean floor to form a consistent profile of typical daily behavior and movement patterns of the tiger shark in Hawaiian waters. Research indicates the tiger shark can travel more than 30 miles within a 24-hour period, often venturing far from coastal areas and even navigating between the islands. Technology used also demonstrates the tiger sharks ability to move rapidly and repeatedly to depths exceeding 1,000 feet.

Artificial Reefs

After a 50-year history of intensive coastal development Hawai'i's inshore fishery resources have declined considerably, with some species populations down by as much as 80 percent. Degradation of water quality, introduction of alien species, destruction of fishery habitat and overfishing are blamed. To help rejuvenate the fisheries and, at the same time provide added revenue to Hawai'i's \$700 million annual ocean recreation industry, Hawai'i Sea Grant undertook an evaluation of Japan's artificial reef technology, modifying it for local conditions.

In 1985, with \$250,000 of extramural funding, Hawai'i Sea Grant began its preliminary work on its first reef design and assisted governmental agencies in designing artificial reefs where habitats had been lost. Under the coordination of fisheries specialist, Dr. Richard Brock, Sea Grant has designed, developed and demonstrated a low-cost artificial reef system that attracts juvenile fishes, and has assisted in the design, deployment and documentation of a 5.4-acre Waikiki dive tour reef that now generates more than \$15 million annually to Hawai'i's economy.



Sea Grant Fisheries Specialist Richard Brock designed, developed and demonstrated a low-cost artificial reef system that focuses the recruitment of juvenile fish to specific sites and improves their chances for survival. —Richard Brock photo

Coastal Erosion

Hawai'i Sea Grant funds scientific research to better understand the causes and patterns of coastal erosion.

Fifty years of coastal development – combined with winter waves, flooding and today's rising sea levels – are causing much of Hawai'i's coastline to inch its way landward.

Also contributing to coastal erosion are the byproducts of coastal development: beach sand mining, dune grading, construction of drainage channels and navigational dredging operations.

To help balance the rights of private landowners with protection of public beaches, state and county coastal managers first had to learn where eroding beaches are, and how fast they are disappearing. To answer these questions, UH geologist, Dr. Charles Fletcher, put a new spin on the ancient art of mapmaking by comparing digitally enhanced aerial photographs taken between 1949 to 1997. Fletcher and his research team created the first high-resolution photomosaic maps in the nation to chart the coastal erosion process.



Building a seawall, as many coastal residents have, blocks the amount of sand and sediment available to maintain beach width. Land erosion stops, but beach erosion begins. The beach narrows and, in time, disappears altogether.

—Priscilla Billig photo



High-resolution photomosaic maps provide data on shoreline erosion, illustrating where erosion hazard areas, or "hot spots," exist now and where they are likely to exist, property by property, 60 years into the future. —Charles Fletcher & Melanie Coyne photomosaic

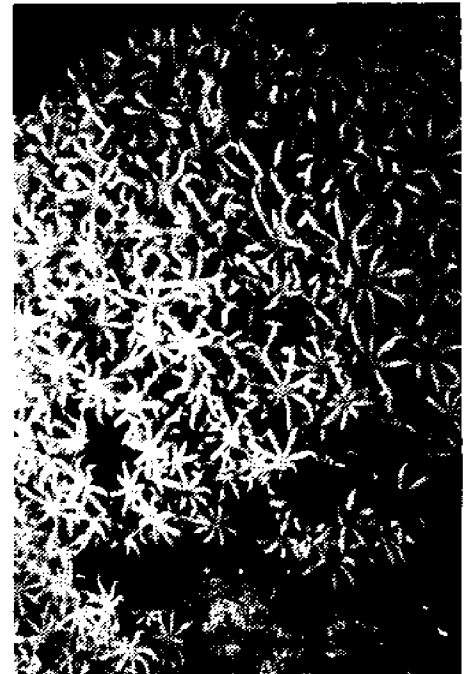
Resource Investigations in the Northwestern Hawaiian Islands

The enactment of the Magnuson Fishery Conservation and Management Act in 1976, and the placement of a 200-mile zone under exclusive local jurisdiction, underscored the need to survey and assess the resources of the entire Hawaiian Archipelago.

Sea Grant's effort included resource assessment and ecological, economic and policymaking studies. A primary goal was to determine the potential of the area's fisheries for economic development in an ecologically compatible way. Using a multidisciplinary approach, the investigations consisted of 13 projects designed to meet the goals of federal and state partners for developing and managing the natural resources of the Northwestern Hawaiian Islands.

The investigations resulted in a storehouse of ecological information and data on the Northwestern Hawaiian Islands and the Hawaiian Archipelago in general. The information was used by state and federal agencies in fish and wildlife management planning and policymaking. It was also used by fishermen to determine the profitability of expanding operations into the Northwestern Hawaiian Islands. These resource investigations, and the researchers who conducted them, became the source of data and expertise for the development of the fisheries management plans mandated under the Magnuson Fishery Conservation and Management Act of 1976.

A team of about 200 researchers and students, headed by UH oceanographer, Dr. Richard Grigg, conducted investigations into the area's primary productivity and oceanographic environment. Their work led to the vital Fish Management Plan for Commercial Species in the Western Pacific, including precious corals, crustaceans, bottom fish and pelagic species. The team also devised a refuge management plan for the entire archipelago, and identified critical habitats and created recovery plans for the endangered Hawaiian monk seal and the green sea turtle. During these investigations, Grigg discovered and named Darwin's Point, the threshold latitude where coral growth ceases and coral islands drown as the Hawaiian Islands gradually move northwestwardly on the Pacific Plate. The Resource Investigations in the Northwestern Hawaiian Islands project resulted in almost 200 published papers and two symposia and set the way for creation of the state's Main Hawaiian Islands-Marine Resource Investigations.



When the 200-mile Exclusive Economic Zone was established in 1976, the move served as impetus for the State of Hawai'i to survey and assess the tropical reef ecosystems of the Hawaiian Archipelago. Hawai'i Sea Grant, in partnership with the National Marine Fisheries Service, the U.S. Fish and Wildlife Service and the Hawai'i Division of Fish and Game, embarked on a five-year investigation to assess the area's resources and ecology for the purpose of protecting unique wildlife and managing potential fishery resources of the Northwestern Hawaiian Islands, from Nihoa Island to Kure Atoll. — Sea Grant photo

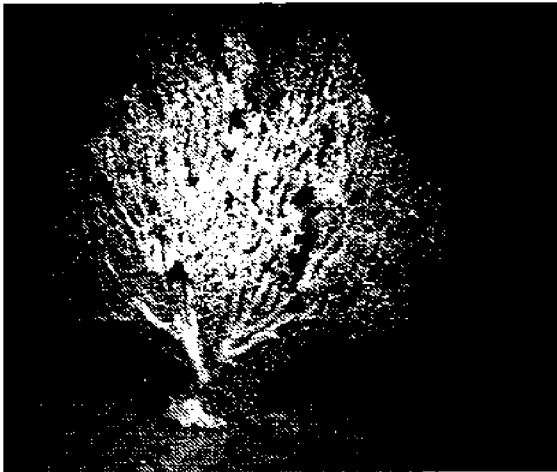
Coral Reef Studies

In celebration of the International Year of the Reef, Hawai'i Sea Grant joined hands with the Pacific Science Association (PSA) to produce a volume on the status and health of coral reefs in the Pacific. The PSA study was an activity of its Scientific Committee on Coral Reefs which in turn received support for the project from the U.S. State Department's International Coral Reef Initiative. The joint effort produced a series of nine country reports on the health of reefs in nine regions of the Pacific published by Hawai'i Sea Grant in a volume titled Status of Coral Reefs in the Pacific, edited by Charles Birkeland and Richard W. Grigg. — Richard Grigg photo

Hawai'i's 410,000 acres of coral reefs provide a home and food for aquatic species, help prevent coastal erosion and serve as a major tourist attraction. While they rank second only to fresh water as the state's most critical environmental resource, coral reefs are also subject to threats from overfishing and pollution from sewage and other sources. Often called "underwater tropical rainforests," coral reefs take hundreds of years to develop. In recent years, coral reefs have become increasingly threatened by naturally occurring disturbances and dangers caused by human negligence. From its early investigations into precious corals to present-day research into the crucial connections between coastal development and the offshore reef environment, Hawai'i Sea Grant has supported studies which facilitate the management of coral reef resources.

Research focus has evolved from basic coral reef studies to a more holistic approach which looks at the health of the entire coastal ecosystem — information useful to coastal resource managers as they develop best management practices for watersheds, as well as coastal recreational resources. To this end Sea Grant microbiologist, Dr. Maqsudul Alam, is attempting to understand the implications of disease and tumors in reef-building corals; marine biologist, Dr. Paul Jokiel, studies stream discharge into tropical estuaries; geochemist, Dr. Eric DeCarlo, examines the fluxes of heavy metals from non-point source pollution on nearshore biota; oceanographer, Dr. Richard Grigg, analyses core samples from 100-year-old corals to determine the impact of urban runoff on reef building corals; and, marine biologist, Dr. Marlin Atkinson, is developing an understanding of how coral reefs take up nutrients.

Besides research, Hawai'i Sea Grant attempts to raise public awareness about coral reefs since informed management decisions are critical to their continued maintenance and health. Sara Peck, Sea Grant Extension Agent for West Hawai'i, has developed a coral reef monitoring program designed to raise public awareness and involve the general public in coral reef issues. In collaboration with the University of Hawai'i at Hilo Marine Science Department and the Department of Land and Natural Resources, Division of Aquatic Resources, Peck has trained 24 volunteer SCUBA divers and snorkelers to monitor West Hawai'i reefs incorporating a protocol useful for data collection.



Hanauma Bay Educational Program

Hanauma Bay, a horseshoe-shaped fringing reef, located on the southeast coast of O'ahu, was formed about 7,000 years ago when a violently exploding crater was invaded by the sea. In an effort to preserve the bay's unique natural beauty and resources, Hawai'i Sea Grant collaborated with the City and County of Honolulu to develop the Hanauma Bay Plan, an eight-point management plan which restricts public use of the Hanauma

Bay Nature Preserve. The plan, which limited motor vehicle and tour bus access to the bay and increased the number of park rangers and education staff, won the "British Airways Tourism for Tomorrow Award" for 1997.

In the late 1980s, O'ahu's Hanauma Bay Nature Preserve was almost being visited to death. At peak times the beach saw 13,000 people a day. These crowds stirred up sediment, touched and trampled the coral and algae, dropped trash,

fed the fish and left a slick of suntan lotion on the bay's surface.

In 1989, Hawai'i Sea Grant joined county and state park administrators to establish the Hanauma Bay Educational Program (HBEP) which it administers and staffs with volunteer docents organized into the 70-member strong Friends of Hanauma Bay. With a \$100,000 allocation from the Honolulu City Council, the Hanauma Bay Educational Program is now housed in a new interpretive educational kiosk atop the crater rim where more than a million visitors a year can learn about coral reefs, geology, oceanography, fishes and conservation.

Besides helping to educate bay visitors, the HBEP helps establish bay etiquette and creates a sense of stewardship for the bay's marine resources.

The result has been a drop in visitors from 3 million in 1988 to 1.2 million in 1996. Litter has been reduced by 70 percent, sewage problems have been solved, there are no more sunscreen slicks, and new coral has been spotted on nearshore reefs.



During the 1980s, the rapidly increasing number of visitors to Hanauma Bay overtaxed the ecosystem's ability to recover. Practices, such as littering, nutrient increase from urination, feeding fish with junk food, oils and chemicals from sunscreen lotions, and freshwater input from shower runoff, led to serious impacts on the bay's environment. —Cory Crooks photo



The Yellow Butterfly Fish, also known as Lau hau and Kika kapu in Hawaiian, is among the myriad species seen in the waters of Hanauma Bay. —Sea Grant photo

Marine Option Program

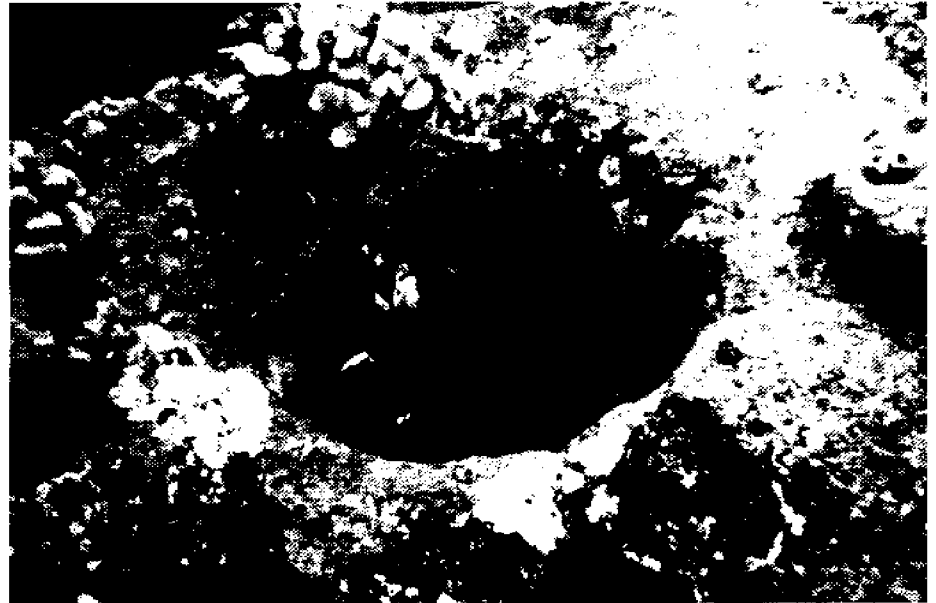
The principal mission of the Marine Option Program (MOP) is to provide ocean-related education to undergraduates.

MOP was conceived and initially implemented through the creativity and perseverance of Dr. John Craven (then UH Dean of Marine Programs), Jack Davidson (Director, Hawai'i Sea Grant College Program), Barry Hill (a graduate student in tropical agriculture and first director of MOP, 1971-1975) and the first class of students.

This program was designed with a two-prong approach to student development: marine studies and marine experience. Both the marine curriculum and the marine experience were to be tailored to the individual student's desires and, to the extent possible, their area of career development. Faculty volunteers in various specialities were to serve as personal advisors and monitors of the quality of the individual student effort.

The students initially drawn to MOP represented a prime example of the best results of the national student movement of the late 1960s and 1970s as students across the nation fought to achieve more voice and see more relevance in their education. This first class of students were extraordinarily motivated by opportunity to be involved in ocean studies and ocean experiences.

Drawn to the program by a love for the sea and it's land interface, MOP students were soon seeking answers to some of the most complex and challenging marine problems facing the state.



After 27 years the basic outline of the original MOP model still guides the program, MOP is a unique experiential learning program within an academic framework, students may be from any field of study and students still earn an MOP Certificate (analogous to a minor) by completing a core of 3-4 marine-related courses plus a research project or internship. To keep abreast with changing student needs, Maynard and his staff have developed curricula and programs in marine science, scientific diving, nearshore ecological surveying, maritime archaeology and history, fisheries, aquaculture, ocean policy and related areas. — John Coney photo

Evolution of MOP

MOP began at University of Hawai'i Mānoa and spread to other campuses in the now 10-campus UH system. UH Hilo, Windward Community College and Maui Community College began programs which still operate today. To date MOP has had three directors, enrolled about 8-10,000 students and awarded 500 Marine Certificates, the top achievement. John McMahon served as director from 1975 to 1980. Dr. Sherwood Maynard (a former Sea Grant graduate student) has served as MOP director since 1980.

Hawai'i Sea Grant provided MOP with partial programmatic

support for the first 20 years, but the initiative of the various directors and the students in defining the marine experience component of the program drew much additional support to the program both from the community and agencies.

The results of MOP projects have greatly benefitted county, state and federal agencies, marine business and the general public. The personal growth, leadership and technical skills acquired have prepared these students to step directly into responsible marine resource agency position upon completion of their university education.

Spinoffs from MOP

MOP has been the inspiration for an impressive assortment of programs that have become or are becoming Hawai'i and Pacific marine institutions. These include:

The Blue-Water Marine Laboratory (BML) is a sea-going science education program for high school students which utilizes peer instructors who are supervised by MOP teaching assistants. This began in the early 70s as a MOP student's project, was administered by MOP for about 15 years, and then transferred to the Waikiki Aquarium where it continues today.

The Quantitative Underwater Ecological Surveying Techniques (QUEST) workshop began as a non-credit program to train MOP students in coral reef baseline surveying and

monitoring techniques. It has evolved into two for-credit courses at UH Hilo where it serves students throughout the UH system and Indo-Pacific region.

Modeled after QUEST, the Maritime Archaeological Surveying Techniques (MAST) workshop started as a two-to-three-day addendum to MOP's annual Symposium on the Maritime Archaeology of Hawai'i and the Pacific. MAST is now a six-credit, five-week graduate course. In conjunction with another MOP-created course, World Maritime History, MAST forms the core curriculum of a graduate certificate program.

The MOP staff worked with a UHM committee to design a Graduate Ocean Policy Certificate

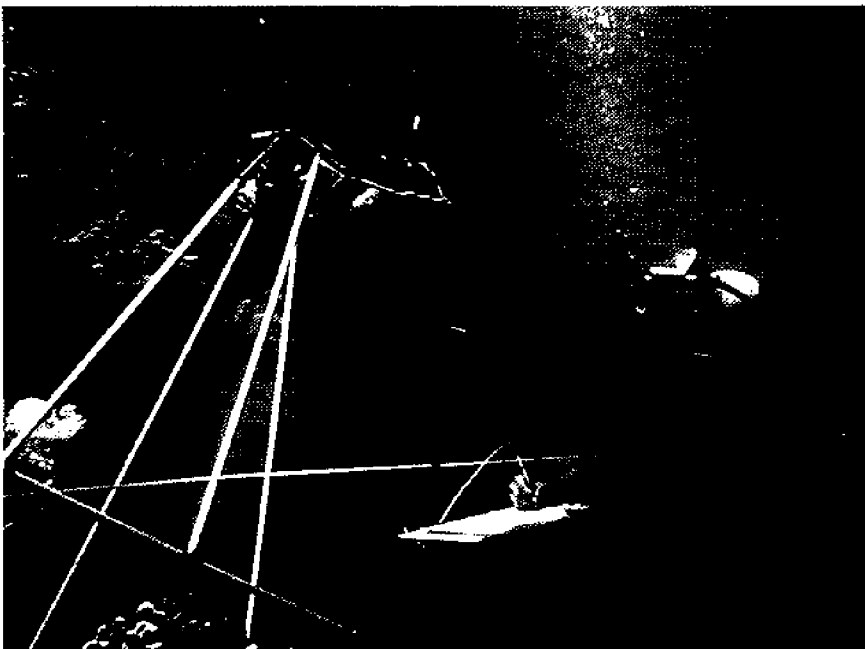
Program. MOP was then asked to administer this program, which remains a viable program after almost 10 years.

Most recently, MOP introduced the Graduate Maritime Archaeology and History Certificate Program, the only program in this field based at an academic institution in the Pacific.

The former faculty coordinator at Windward CC is now on the faculty at Oxnard College in California where she adapted the MOP model to create the Ocean Resources Conservation Alliance (ORCA) in 1996.

MOP has also promoted experiential education through introducing courses which allow students to earn academic credit for preparing project proposals (MOP Seminar) and for earning credit for their projects (ocean research and internships). MOP has also helped a number of other experience-based education programs get started and staffed: Hanauma Bay Educational Program, He'eia State Park, Micronesia and American Samoa Student Internship Program, Hawaiian Internship Program, and others.

Currently, MOP is collaborating with the U.S. Fish and Wildlife Service to place interns in their refuge program and to develop student-based educational programs at the Midway Atoll Refuge. Maynard has assisted UNESCO in marine science education initiatives primarily in the Indo-Pacific, and he supports the environmental education programs of Sea Grant's Pacific Program in the U.S.-affiliated Pacific Islands.



Almost every state and county agency, legislative office and branch of the federal government dealing with marine affairs in Hawai'i now have one or several former MOP students on their professional staff. This also extends to the governor's office and the city and county of Honolulu administrations. The Division of Aquatic Resources, State Department of Land and Natural Resources, for example, has fully a dozen of these MOP professionals to help look after Hawai'i's fisheries resources. — MOP photo

Hawai'i Maritime Center

In 1982, Hawai'i Sea Grant was instrumental in the formation of the Hawai'i Maritime Center, located at Pier 7 in Honolulu. About 50 exhibits illustrate the unique tapestry of Hawai'i's maritime history from the early Polynesian voyages to today's modern high-tech marine industries.

A feature attraction is the Lei'iwi (lei of bones), a 46-foot humpback whale skeleton, is one of only two complete humpback whale skeletons known in the world. Other displays range from modern waterfront careers, to Hawai'i's move from whale hunting to whale watching, surfing and windsurfing.

Some 6,000 school children visit the Hawai'i Maritime Center each year and participate in its educational programs. These activities, and others at the center, are supported by an active volunteer program. In one new educational program focusing on the *Hokule'a*, students plan a long distance voyage, deciding what and whom is necessary to take along for survival. The exercise highlights the finite and limited space of a voyaging canoe. The issue of limited resources is then extrapolated to an area the size of an island, and then to planet Earth.

The Hawai'i Maritime Center is a focal point for various marine activities, hosting lectures and symposia including the "8 Bells" lecture series and the Marine Option Program's Maritime Archaeology and History of Hawai'i and the Pacific symposium. The Hawai'i Maritime Center is now a subsidiary of the Bishop Museum.

It is the home port for the Falls of Clyde, the last four-masted, full-rigged ship in existence, and the Hokule'a, the Hawaiian double-hulled voyaging canoe of navigational fame.
— *Hawaii Maritime Center photo*



Interpret Hawai'i

In the mid-80s, Hawai'i Sea Grant was a catalyst for Interpret Hawai'i, a program that trains tour guides in the islands' rich cultural and natural heritage. With the help of Sea Grant's Coastal Recreation & Tourism Specialist Ray Tabata, the Interpret Hawai'i Program grew from a 1984 Sea Grant-sponsored conference, "Community Interpretation and Tourism." Kapi'olani Community College is the administrative base for the program, which has continued to grow since its inception.

Interpret Hawai'i educates Hawai'i's frontline tourism workers to ensure the visitor experience is an accurate, informative and enjoyable one. The program centers around the Professional Standards for Tour/Guide Drivers voluntary certification program. The training manual and classes cover Hawaiian history, pronunciation, music, dance and native plants and animals. To date, 1,400 of a possible 2,000 tour guide drivers have been certified statewide. Each island has its own advisory council, which has developed an individual manual and certification in addition to the basic certificate.

Interpret Hawai'i is putting the final touches on a new ecotourism training manual that reflects Hawai'i's move from the traditional "sun, sea and surf" image to encompass the growing ecotourism market. The success of the tour guide program has resulted in it being used as a model for airport employee training. In addition, a hotel industry training program and certificate is now in the works. This may ultimately lead to an Associate in Arts degree for the visitor industry, which would be based at Kapi'olani Community College.

Tabata was also instrumental in organizing the 1994 State Ecotourism Conference from which the Hawai'i Ecotourism Association was created. The organization won the 1996 Ecotraveler Award for its sponsorship of the Earth Maui Nature Summit.

The Ocean Recreation Council of Hawai'i

The Ocean Recreation Council of Hawai'i (TORCH) was established in 1985 when Hawai'i Sea Grant and the State Department of Business, Economic Development and Tourism's Ocean Resources Branch realized that the ocean recreation community needed to work together to promote the wise use of Hawai'i's oceans.

Hawai'i Sea Grant went on to help develop TORCH chapters in each county. Today, TORCH has 75 active members and chapters on the islands of Hawai'i, Maui, O'ahu and Kaua'i.

This year, state analysts estimate ocean recreation industry

revenues at approximately \$600 million. Revenues come from activities such as snorkel and dive tours, competitive ocean swims, interisland cruises, chartered fishing trips, canoe races, yacht races and parasailing.

For the past 13 years, TORCH has served as an advocacy group for the ocean recreation community in Hawai'i. It serves in an advisory capacity to government agencies, businesses and other organizations; provides forums for the discussion of ocean recreation issues and concerns; promotes marine education; and sponsors and promotes legislation of interest to its members and the marine environment.

In conjunction with Hawai'i Sea Grant, TORCH has been instrumental in the installation of day-use mooring buoys around the islands that are designed to protect coral reefs from anchor damage. TORCH has facilitated the designation of the newest Marine Life Conservation District off the Old Kona Airport and installed a swim lane at the Kailua-Kona pier.

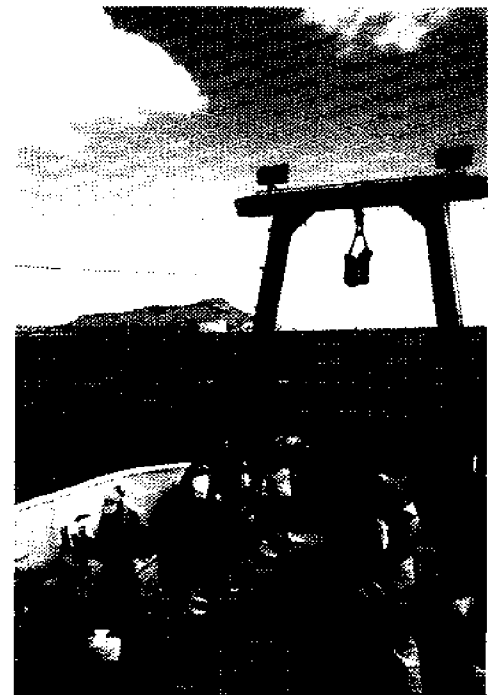
The organization also participates in and organizes coastal and underwater clean-ups. One of the group's latest projects is facilitating the creation of artificial reefs as underwater attractions for the diving community in Hawai'i.

Blue-Water Marine Lab

For more than 25 years, the University of Hawai'i's Blue-Water Marine Laboratory (BML) has been increasing high school students' awareness and understanding of the ocean. In its early days, BML was administered by the Marine Option Program, then a part of Hawai'i Sea Grant. In 1986, the program moved to the Waikiki Aquarium.

In 1997 the program was unable to continue funding the shipboard component of BML, but with private funding, the Waikiki Aquarium still offers the Summer Ocean Studies (SOS) course, a challenging marine science program for high school students. The five-week course encompasses classroom, laboratory and fieldtrip work. Students have a rare opportunity to learn first-hand from experts about marine science and ocean affairs, ocean-wise safety and conservation skills, teamwork and leadership, public speaking and more.

Program managers with the Blue-Water Marine Lab are Hawai'i college undergraduates. They hold internship-like positions, learning about marine life and marine education and helping to instruct and manage the Summer Ocean Studies course.
— Waikiki Aquarium photo



Pacific Program

owhere within the jurisdiction of the United States was there a greater need for sustainable economic development than in the U.S.-affiliated islands including American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), Guam, the Federated States of Micronesia (FSM), the Republic of the Marshall Islands (RMI), and the Republic of Palau. These island states have faced an uphill battle to develop a sound economic base while at the same time protecting their environment and culture due to limited land resources, geographic isolation and increasing populations. While these island communities have little arable land, they are rich in marine resources.

U.S. government support to islands since WW II had largely focused on administration, public health, education, infrastructure support and, to a limited extent, agriculture development. Starting in 1968 and for the next decade, U.S. government interest in island development actually decreased and there was essentially no funding forthcoming which would permit the University of Hawai'i to become involved in helping meet these island needs.

When an International Sea Grant Program was funded in 1979, one component of this program established cooperative marine extension positions with the U.S.-affiliated island's governments on four islands over the following six years. The second component was designed to provide marine education and training to 11 South Pacific islands affiliated with the University of the South Pacific (USP). A number of local fisheries officers received specialized training in extension techniques and aquaculture development through this program, and several teams of UH scientists and Sea Grant extension agents joined with local USP faculty and their counterparts to carry out on-island projects focusing on locally identified, high priority marine environmental concerns in the regions. The plan was to develop cooperative research programs between UH and USP in subsequent years. The efforts were led by Dr. Phillip Helfrich, Associate Director of the Hawai'i Institute of Marine Biology and Jeremy Harris, then the Kauai Sea Grant Extension Agent.

Congress failed to approve continued funding for the International Sea Grant Program in 1982 and the southern and western Pacific extension and education programs were phased out as resources were depleted. However,



By 1988 the Pacific Program included Coastal Resource Management Program (CRMP), Pacific Aquaculture Development Program (PADP) and Pacific Island Network (PIN) and a marine environmental education component. Prior to 1995 this education unit had made significant contributions to the region's marine environmental awareness. This was accomplished with continued teacher training and development of materials with resources provided by Sea Grant, Office of Territorial and International Affairs (OTIA) and the Pacific Regional Education Laboratory (PREL), and island Department of Education offices. — Pacific Program photo

help to continue a Sea Grant Pacific island program emerged from an unexpected source. Dr. James Maragos, a former Sea Grant graduate student and now an employee of the Army Corps of Engineers (ACE) helped initiate a cooperative Hawai'i Sea Grant-ACE program to inventory coastal resources and conduct ecological assessments for coastal areas targeted for development or for designation as marine protected areas throughout most of the U.S.-affiliated islands. Over a dozen of these projects, with the results presented in a series of coastal atlases, were completed over the next few years. Key Sea Grant people involved in the Coastal Resources Management Program (CRMP) for the U.S.-affiliated Pacific islands included Dr. Bruce Miller, Peter Rappa and Annie Orcutt-Bailey.

Hawai'i Sea Grant and the University of California Sea Grant sponsored Pacific island marine education activities, including teacher workshops and preparation of marine education material. These early efforts were conducted under the leadership of Dr. Deetsie Chave.

Present components of Sea Grant's Pacific Program are:

Pacific Island Network (PIN). In partnership with island governments, PIN's mission is to ensure the longterm health of tropical coastal ecosystems through outreach activities directed at user communities and resources management agencies. PIN uses a network of extension agents and specialists to provide technical assistance and training that builds on-island expertise and disseminates information, shares and leverages available resources, and facilitates communication.

Pacific Aquaculture Development Program (PADP), now called the *Pacific Region Aquaculture Extension Service (PRAES).* PRAES's longterm goal is to assist Pacific island governments in developing sustainable aquaculture enterprises by providing the technical support necessary to ensure their success. This is accomplished

through information dissemination, technical assistance, planning and coordination, and applied research and development funding.

Coastal Resource Management Program (CRMP). This program, an outgrowth of the resource assessment projects funded by the Army Corps of Engineers in the 1980s, works with on-island extension agents and island government to develop, improve, and implement coast management programs with an emphasis on conservation and management of island resources.

Operation Pathfinder—Pacific Island Region. The primary objective of this program was twofold – to implement a national network, inquiry-based, science education effort to increase the awareness and understanding of oceanography and coastal processes and to improve the teaching techniques of elementary and middle school teachers of predominately indigenous students.

Pacific Island Network

In July 1987, in an effort led by the director of Hawai'i Sea Grant and with the help of Margaret Cumisky of Senator Daniel Inouye's staff, several Sea Grant programs sponsored a workshop for U.S. congressional and agency staff with insular responsibilities in Washington, D.C. This workshop was to examine the needs of the island communities and how the regional and national Sea Grant network might facilitate the accomplishment of U.S. goals in these islands.

As a follow-up, a fact finding group headed by NOAA's Chief for International Programs, Thomas Laughlin, visited the U.S.-affiliated islands in September of that year. Subsequent discussions resulted in a planning conference and development of a network of on-island marine extension agents and specialists for the islands.

The Pacific Island Network (PIN) was formalized in 1988. NOAA funds were provided and PIN was to have oversight from a committee of NOAA and OTIA and Hawai'i Sea Grant administrators. Anne Orcutt-Bailey provided on-site management for PIN as well as the Pacific Aquaculture Development Program (PADP) until Sharon Ziegler-Chong could be recruited and brought on board to manage the PIN program.



Sea Grant continues to train local personnel who are indigenous to Pacific island cultures, with on-island agencies as counterparts of extension programs. This cadre of local experts is an asset to management and sustainable use of coastal resources. — Pacific Program photo

PIN presently has two regional extension specialists: Simon Ellis, Aquaculture Specialist and Rob Mullane, coastal processes specialist, and on-site extension agents: Kevin Polloi, Palau; Ahser Edward, Federation States of Micronesia; Mark Brotman, Saipan. In addition, Nancy Daschbach, manager of the Fagatele Bay National Marine Sanctuary acts as the Sea Grant counterpart for projects conducted in American Samoa.

Education and Human Resources



Student Symposium on Marine Affairs

The Student Symposium on Marine Affairs began in 1976 when Hawai'i Sea Grant Associate Director Rose Pfund persuaded the State Legislature to allocate funds for a program to encourage high school students in Hawai'i to study the sea. Students were to write a paper describing their findings on experimental or library research and present the paper before an audience of scientists, teachers and fellow students. Papers were then published in the Symposium's proceedings. Sea Grant continued to sponsor the Symposium until 1982 when the Hawaiian Academy of Science assumed its coordination with funding from the State Department of Education. The Symposium was conducted annually until 1997 when the 22nd Annual Student Symposium on Marine Affairs was held.

In 1998 the Hawaiian Academy of Science received a grant from the Academy of Applied Science and the U.S. Departments of the Army, Navy and Air Force to conduct a regional symposium of the Junior Science and Humanities Symposium Program. The Student Symposium on Marine Affairs has evolved to become the Pacific High School Science Symposium, accepting student papers on a wide variety of science fields. Students continue to write scientific papers and to receive guidance from subject area specialists at the university and the professional community.

Knauss Marine Policy Fellowship

Since 1979 the National Sea Grant Federal Fellows Program has held its national competition for the prestigious Dean John A. Knauss Marine Policy Fellowship. The fellowship provides a unique educational experience for graduate or professional degree students in a marine-related field who are interested in national policy decisions affecting marine resources. Qualified students are matched with hosts in the legislative branch, executive branch or other appropriate institution located in Washington, D.C., for a one-year paid fellowship.

In 1988, when the Knauss Marine Policy Fellowship changed its name from the National Sea Grant Intern Fellowship, University of Hawai'i oceanography graduate student Megan Bailiff was the first Hawai'i student selected for the year-long fellowship. Bailiff worked in Hawai'i Senator Daniel Inouye's office where her pursuit of ocean mining legislation prompted the U.S. Department of Interior to work with Hawai'i on protective legislation concerning ocean mining. Today, Bailiff is the senior program associate for the University of Washington Sea Grant College Program and executive assistant to the dean for policy affairs at UW's College of Ocean and Fishery Sciences.

University of Hawai'i zoology graduate student Stephanie Bailenson, a 1998 Knauss Fellow, is currently working with Senator Olympia Snowe on the Senate Subcommittee on Oceans and Fisheries for the Majority.

Undergraduate Research Fellowship

In 1995 Hawai'i Sea Grant Associate Director Rose Pfund committed funds to further the education and potential careers of University of Hawai'i undergraduates with interests in the sustainable use of the ocean and its resources. Proposals would be solicited from the perspectives of ecology, physical and biological sciences, social sciences, law and public policy. The Undergraduate Research Fellowship Program was modeled after the National Science Foundation's Research Experiences for Undergraduates Program based in the UH Department of Oceanography. Students were provided with a \$3,000 stipend and course credit.

Sea Grant coordinated these efforts with the State Department of Land and Natural Resources. Students would spend a summer completing their research projects and make oral presentations at a final symposium. The Undergraduate Research Fellowship Program is now in its third year.



Youth for Environmental Service



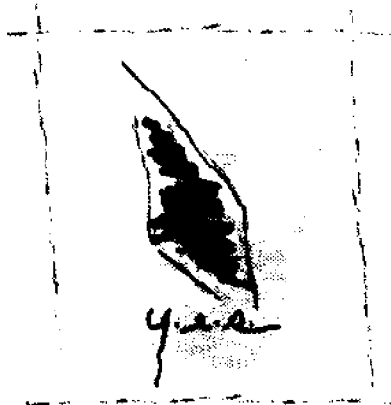
Founded in 1994 by 21-year-old Brian Schatz, Youth for Environmental Service links student volunteers from grades K through 12 with community service projects. In 1997 the Educational Foundation of America awarded a \$56,000 grant to YES to continue its pilot projects in San Francisco and Los Angeles and to establish a YES pilot project in Seattle in partnership with the University of Washington Sea Grant. Today, YES reaches more than 35,000 K-12th grade students in 85 schools across the State of Hawai'i and has established offices in San Francisco, Seattle, and Los Angeles.

Lieutenant Governor Mazie Hirono presented a special commendation to Sea Grant's Youth for Environmental Service (YES) coordinators Brian Schatz and Sean Casey at the 1998 Governor's Kilohana Awards for Outstanding Volunteerism ceremony at Washington Place.

The special commendation recognizes that YES was selected as one of 50 national winners of actor and philanthropist Paul Newman's "Make a Difference Day" special award for its environmental project on October 25, 1997, a national day of community service. The Kilohana commendation states that on that day, more than 400 YES volunteers engaged in a day-long campaign to clean up trails, streams and beaches in the Ala Wai Watershed.

The award further states:

As a result of your outstanding efforts to remove debris and restore the land, our surroundings are healthier and more attractive. Also, your action has helped enormously to raise public consciousness of the need to protect and perpetuate our precious natural resources. The people of Hawaii are proud of you—and the tens of thousands of young people who have been involved with the YES program since its founding in 1994.



Get the Drift and Bag It!

In 1996 divers with National Marine Fisheries Service (NMFS) found 22 entangled seals – the most ever recorded in a single year. NMFS found 16 entangled monk seals in 1997; divers released 13, two seals escaped unaided and one died entangled in fishing net. — Ray Boland photo



Get the Drift and Bag It! is Hawai'i's contribution to the International Coastal Cleanup effort. In 1997, almost 5,000 Hawai'i volunteers gathered at 185 sites, walked a total of 286 miles, and collected 204,278 pounds of debris on land and underwater. Offending debris included Hawai'i's "Dirty Dozen" of picked-up debris items, including cups, straws, paper bags, fishing line, packaging material, utensils and fast food containers.

Hawai'i Sea Grant celebrates Get the Drift and Bag It! throughout the State of Hawai'i every year in September. Sponsors include the Governor's Committee for a

Beautiful Hawai'i, Center for Marine Conservation, State of Hawai'i Coastal Zone Management Program, Hawaii State Department of Land and Natural Resources, City and County of Honolulu Parks and Recreation, City and County of Honolulu Public Works, Ocean Recreation Council of Hawai'i (TORCH), Hawai'i State Department of Health-Solid Waste Branch, County of Kaua'i Office of the Mayor, Keep Hawai'i Beautiful, County of Maui Community Work Day Program, City and County of Hawai'i Department of Parks and Recreation, Sea Life Park, Reynolds Recycling, U.S. Coast Guard —

Hawai'i Marine Safety Office, and KidScience.

Based on these efforts, spearheaded by Sea Grant Extension Agent Christine Woolaway, Hawai'i has been designated a "Model Community" by the national Center for Marine Conservation.

Hawai'i's Dirty Dozen of picked up debris items for 1997 include:

1. cigarette butts	69,044
2. plastic pieces	1,843
3. glass pieces	10,483
4. beverage bottles	9,425
5. foamed plastic pieces	9,390
6. food bags/wrappers	9,301
7. paper pieces	7,620
8. caps, lids	5,479
9. beverage cans	5,312
10. bottle caps	5,273
11. other paper	5,052
12. beverage, soda	4,816



A November 1997 "sweep" of underwater debris yielded more than 5,000 pounds of discarded fishing nets and lines. Twenty-two percent of the weight was entangled broken coral.

— Priscilla Billig photo

Makahiki Kai – Festival of the Sea

From 1974 to 1978, Sea Grant's Makahiki Kai gave more than 50,000 Hawai'i children a marine education experience through exhibits, booths, displays, films and speakers. Funded by the Hawai'i

State Legislature, Makahiki Kai filled the Neal S. Blaisdell Center in Honolulu with all things oceanic.

In 1976, Sea Grant took the festival to neighbor island children aboard the U.S. Navy's *Kaimalino*, a prototype semi-submersible plat-

form. Makahiki Kai served to educate the children of Hawai'i about the ocean that surrounds them and also gave new insights to teachers on how to incorporate marine science into their lesson plans.

Operation Pathfinder

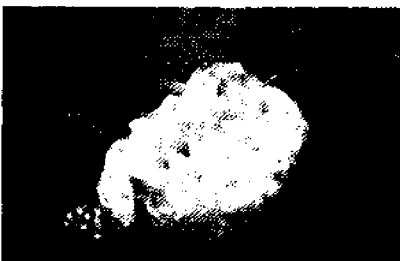
In 1995 Hawai'i Sea Grant successfully sponsored the U.S.-affiliated Pacific islands to become the sixth region under the national Operation Pathfinder.

Coordinated by Elizabeth Kumabe, Pathfinder II sponsored an international teacher institute on Rota in October 1995 for 30 teachers from around the region. This institute was carried out in partnership by the Pacific Island Network (PIN), the Pacific Math and Science Consortium at PREL, and the Division of Fish and Wildlife of the CNMI Department of Land and Natural Resources, and supported in part with funds from the Office of Territorial and International Affairs (OTIA).



Pathfinder III was held on Pohnpei and was again supported by a grant to PIN by OTIA. It was co-sponsored by PIN, PREL, the College of Micronesia-FSM and the Pohnpei State Department of Education. It provided a summer course to dozens of Pacific island science teachers. — Pacific Program photo

Micronesia and American Samoa Student Internship Program



Since its inception in 1994, MASSIP has hosted 42 islanders. In 1997, the Pacific Program began its pilot Hawaiian Internship Program to link Native Hawaiian students with career opportunities in Hawai'i. — Pacific Program photo

Sea Grant has embarked on training initiatives in which it recruits Pacific island and Native Hawaiian undergraduates to enroll them in internships with environmental or resource management organizations on their home islands. Coordinated by Sharon Ziegler-Chong with funding from the Department of Interior's Office of Insular Affairs, Sea Grant's Pacific Program creates training opportunities for Pacific islanders.

The Micronesia and American Samoa Student Internship Program, or MASSIP, places interns on their home islands where they work with host agencies in fields related to the management and sustainable use of island natural resources.

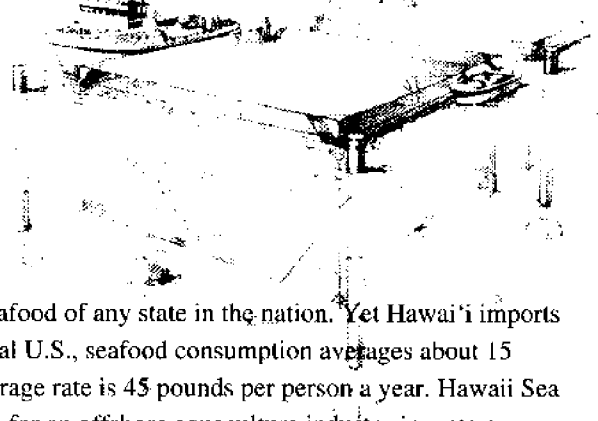
Oil Spills

Oil transport vessels, which carry as much as 10 million gallons each, supply 100 percent of Hawai'i's oil needs. Public concern about the potential impact of oil spills on a tourism-based economy prompted a 1992 Hawai'i Sea Grant report titled *Oil Spills at Sea: Potential Impacts on Hawai'i*, which recommended that the state put more effort into preventing oil spills and that it define the roles of state agencies in managing oil spills. Since publication of the report, the oil industry

has voluntarily rerouted tankers traveling between Indonesia and the U.S. West Coast, from the narrow Kaiwi Channel between O'ahu and Moloka'i to the wider Kaua'i Channel. In 1993 Hawai'i implemented a 5¢-per-barrel tax on oil to fund development of an oil spill prevention plan, research, mitigation of terrestrial oil spills, and public education.

When a corroded pipeline leaked 25,000 gallons of fuel oil into Pearl Harbor on May 14, 1996, it was Hawai'i's worst oil spill in almost a decade. The spill closed Hawai'i's famed Arizona Memorial.

— Clean Islands Council photo



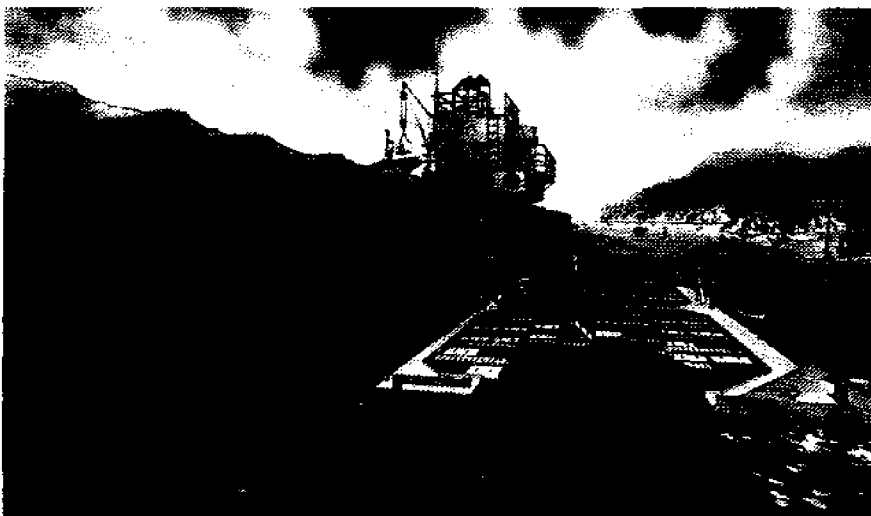
Open Ocean Aquaculture

Hawai'i has the largest per capita consumption of seafood of any state in the nation. Yet Hawai'i imports 75 percent of the fish it consumes. In the continental U.S., seafood consumption averages about 15 pounds per person a year, while in Hawai'i the average rate is 45 pounds per person a year. Hawaii Sea Grant is investigating the economic, biological and mechanical potential for an offshore aquaculture industry in waters

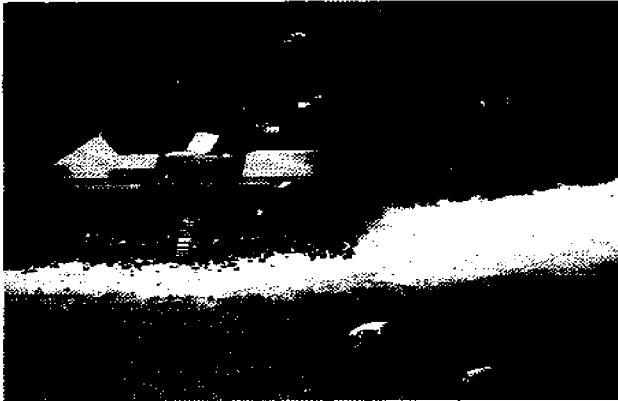
surrounding the Hawaiian Islands. To help chart the future of ocean farming, Sea Grant sponsored the Open Ocean Aquaculture '97 conference on Maui.

The 1998 Hawai'i State Legislature has passed bill HCR114 which gives legislative approval for the State Department of Land and Natural Resources to issue a permit to Hawai'i Sea Grant to conduct a demonstration open ocean aquaculture project in Hawaiian ocean waters.

— JAMSTEC graphic



Coastal Erosion



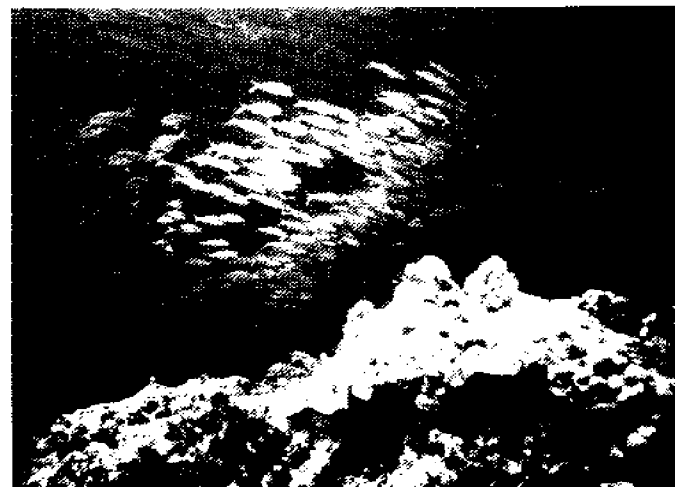
Beach loss in front of a seawall (left) versus the natural landward retreat of a beach (right) can be seen clearly in this aerial shot over Mōkule'ia. — Chip Fletcher photo

transferring technological data from the researchers to the user at the community level remains a priority for Hawai'i Sea Grant as it works toward public awareness of coastal processes and effective shoreline management which will keep those processes in balance. Extension agents distribute reports, pamphlets and conference proceedings to the general public. Certain recommendations in the Beach Management Plan for Maui will be formalized as changes in the rules and regulations of the Maui Planning Commission. Coordinated by coastal processes extension agent Rob Mullane, Sea Grant will co-sponsor a series of workshops on the proposed rule changes with the Maui County Council to formalize other recommendations that will require changes in county ordinances. Sea Grant hosted the Coastal Erosion Management in Hawai'i and Other Pacific Islands conference on Maui in April 1997 and intends to make this an annual event with plans for a July 1999 conference on Majuro Atoll, Republic of the Marshall Islands and a 3rd annual conference on Maui in September 2000.

Fishery Management Areas

Since 1995, Sea Grant Extension Agent for West Hawai'i Sara Peck has acted as a liaison for the community-based management process working with Hawai'i's Department of Land and Natural Resources on the Big Island to set the agenda for the creation of the West Hawai'i Regional Fishery Management Council.

The 1998 Hawai'i State Legislature enacted a bill which requires the West Hawai'i Regional Fishery Management Area Plan to effectively manage fishery activities, enhance nearshore resources and minimize conflicts of use in this coastal area. The bill, now before the Governor for his signature, requires the State Department of Land and Natural Resources to adopt rules to designate a minimum of 30 percent of coastal waters along the Kona coast as fish replenishment areas where fish collecting is prohibited; establish a day-use mooring buoy system along the coastline and designate high-use areas where no anchoring is allowed; establish a portion of fish replenishment areas as fish reserves where no fishing is allowed; and, designate areas where gill nets as set nets will be prohibited.



Conflicts between tropical fish collectors and ocean recreation business operators on the Big Island's Kona coast have been aired through a community-based management process. — Sea Grant photo

Communications

Hawai'i Sea Grant's Communications Program provides access to scientific findings and supports the flow of outreach information. Knowledge and understanding is the keystone to wise stewardship of our marine and coastal environments and dissemination of information to a broad audience for public and private decisions affecting these environments, has evolved from the *Sea Grant Newsletter* of the 70s to today's multimedia efforts.

Sea Grant Communications, coordinated by Priscilla Billig and Diane Nakashima, maintains a library of Sea Grant-funded scientific and technical publications and fills worldwide requests for these publications. An online publication directory, with links to the Sea Grant National Depository, provides better public access to all Sea Grant publications. Sea Grant's monthly newsletter, *Makai*, as well as the full-color version available online as the *Electronic Makai*, has served as the focal point of the Student Writers Project which supports young writers interested in developing skills in the field of science journalism. A media query service fields requests from local and national media through ProfNet, an international cooperative of public information officers linked by the Internet to provide journalists convenient access to expert sources who can provide newsworthy Sea Grant information.

To aid in heightening public awareness, news releases and public service announcements are distributed to media sources on research progress and outreach activities for coverage by local and national press, radio public service announcements and interviews, and television broadcasts and guest appearances. In recognition of 1997's International Year of the Reef, Sea Grant Communications partnered with the Pacific Science Association to publish in *Makai* a monthly series of nine abbreviated reports on coral reef health in nine Pacific regions. The series culminated in a bound volume of full reports titled *Status*

of Coral Reefs in the Pacific, which coincided with the 8th PSA Inter Congress held in Suva, Fiji.

To help celebrate 1998's International Year of the Ocean, Communications staff organized a Spring Seminar Series which featured agents of the Hawai'i Sea Grant Extension Service. The same speakers also participated in a series of live radio interviews on KCCN-KINE, Hawai'i's most popular radio stations. In collaboration with the UH College of Continuing Education, plans are set for a Fall course titled "The Pacific Ocean: Its Ecology and Environment," instructed by Sea Grant-supported researchers which will target Hawai'i science teachers.

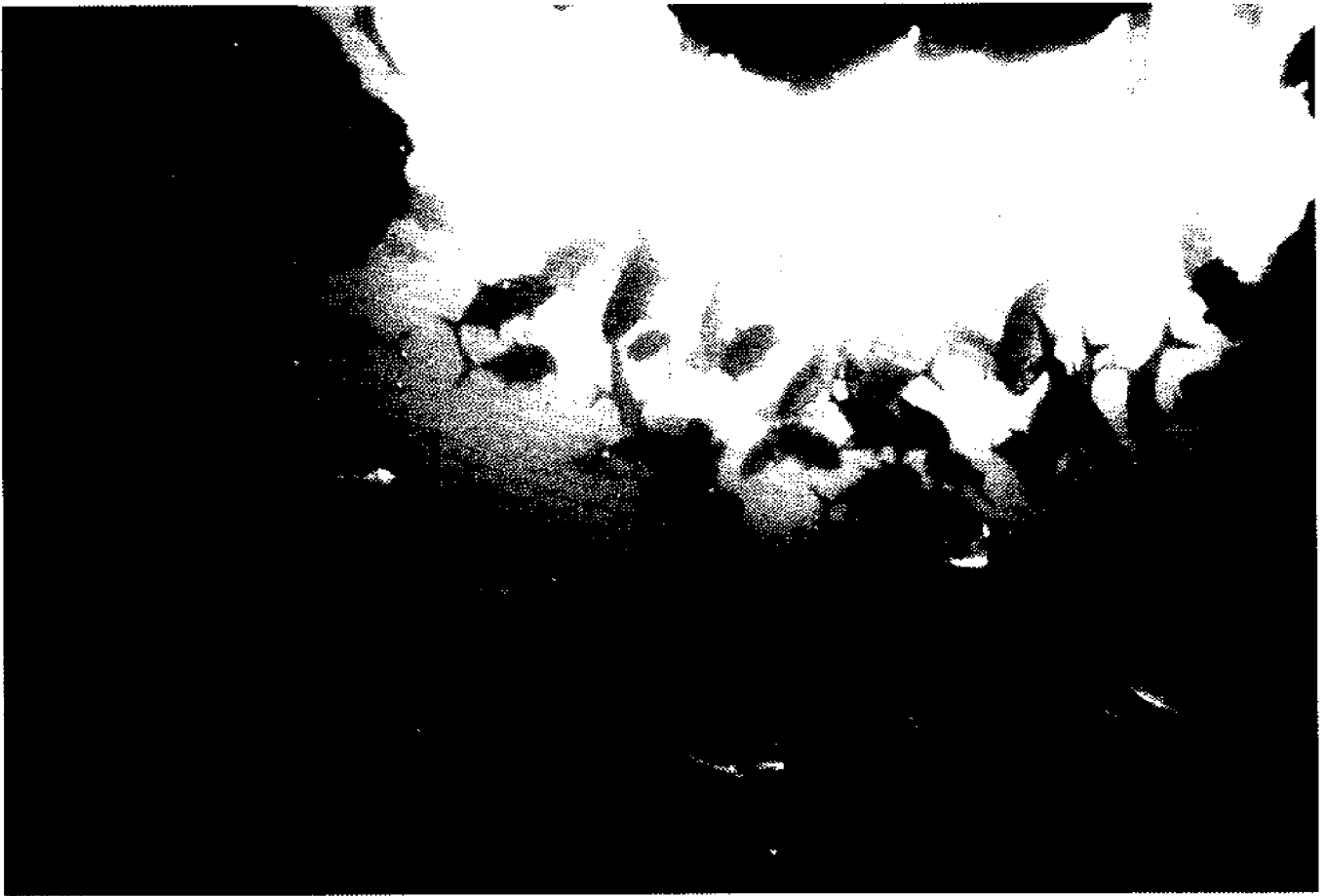


Entering the information age, Sea Grant's website development and its expansion via links to partnering institutions is well underway, including the 1997 debut of Sea Grant online for kids called "Sea Squirt," for which Sea Grant collaborates in curriculum development with local schools and educational projects, such as Castle High School, UH Lab School Summer Science Program, Moanalua Gardens Foundation's Ō'hia Project and the Hawai'i Science Teachers Association.

— Diane Nakashima graphics



Sea Grant Profiles



Aquaculture Specialist Howard Takata

Howard A. Takata, Hawai'i Extension Agent, has retired after 20 years of Sea Grant service. His major role was as a liaison between the general public and the university recently focusing on freshwater aquaculture. Born and raised in Hilo, Takata received his bachelor's degree at Northwestern University and his master's degree in marine zoology at the University of Hawai'i at Mānoa. After graduating, he worked with the Peace Corps, first as a volunteer, then as a training officer in Malaysia and Micronesia.

When Takata first started working with Sea Grant, he was a general agent and covered everything from marine education, coastal ecology, aquaculture and clean-ups of Hilo Bay to organizing workshops for ahi burn and ciguatera. In the 1980s, Takata turned his attention to aquaculture.

"Starting in the 80s, the push on O'ahu had been on Chinese catfish and prawns," Takata said. "Those are warmwater fish, better for O'ahu. I was looking at resources on the Big Island and the possibility of aquaculture development there. We have cool water and cheap land, so I started focusing on what would be better for this island," he added.

At first focusing on the importation and cultivation of rainbow trout, Takata now works primarily on freshwater aquaculture, such as Chinese catfish and tilapia. A high priority item for Takata is his work on the Russian sturgeon (*Acipenser gueldenstaedti*). Traditionally, the best fish eggs we call caviar come from Russian sturgeon breeding in a 1,000-acre area near the mouth of the Volga River where it feeds into the Caspian Sea. Taken from four species of sturgeon, the best of this ancient and prized foodstuff is called Beluga, osetra, sevruga and sterlet caviar. The sturgeon in Russia is rapidly being depleted due to overfishing, pollution, and habitat destruction in the Caspian Sea, where fisheries once supplied up to 80 percent of the world's catch of sturgeon, and 90 percent of the worldwide demand for caviar.

In 1995, Takata and Kevin Hopkins, aquaculture program director at the UH-Hilo College of Agriculture, formed a partnership with the Fisheries Committee of the Russian Federation. The Russians began looking for hatchery facilities in the United States. They shipped 40,000 fertilized Russian sturgeon eggs to Hilo, (via Astrakhan to Moscow to Anchorage to San Francisco to Honolulu to Hilo) where they were placed into spring-fed ponds at three different facilities and hatched the following day.

Comparing statistical data, Takata reports his sturgeon are now more than twice as long and two times heavier than Russian sturgeon from the Volga River. He attributes this growth rate to Hawai'i's year-round warm temperatures and high quality feeds. The Russian sturgeon, which reportedly can live up to 50 years and grow to a length of seven feet, is marketable in three years and is expected to reach sexual maturity in five to seven years.

At present, the sturgeon project shows great promise as a new aquaculture industry for Hawai'i. "I think I've made a positive impact on the community, helping it solve problems," Takata said.



I think I've made a positive impact on the community, helping it solve problems.

Mayor Jeremy Harris

In the 1970s, Jeremy Harris taught marine conservation and Hawaiiana to thousands of island youngsters. These days, as mayor of Honolulu, he's more likely to be in the boardroom than at the beach, but Harris retains his passion for the marine environment.

Harris earned two undergraduate degrees and a master's degree in biology, before going on to teach oceanography and biology at Kaua'i Community College. Then in 1974, he was employed as the new Sea Grant advisory agent on Kauai.



"Sea Grant had a profound effect on my life," explained Harris. "... I will always treasure the hands-on experience that the program provided."

As part of his job, Harris produced a television show called *Sea* for cable television community programming. He also had a biweekly radio program and a local newspaper column. He led school children on reef walks and conducted workshops for commercial fishermen.

In 1975, Harris began a two-year stint as the acting coordinator for the Sea Grant Extension Service. Here he gained management and leadership experience that would later prove valuable in his political career.

"While at Sea Grant, it became apparent to me that there was a great need to strengthen government's commitment to the environment," he said. "I felt that my background would make me an effective advocate for the environment as an elected official."

This was partly what spurred Harris to run for the Kauai County Council in 1980. He was elected, and later chaired the council. The beginning of his political career, however, meant he had to give up his Sea Grant position.

Serving on the council reaffirmed Harris' belief that there was a need for more people with scientific backgrounds in government. "Scientists bring an added dimension to the offices in which they serve as well as a heightened appreciation of the effects of government operations, and change in general, on our ecosystems," he said.

In 1984 Harris ran for mayor of Kauai — he lost, but that loss led to him being hired onto the administration of Honolulu Mayor Frank Fasi. He eventually became the city managing director in 1986. Eight years later, he himself was elected Honolulu mayor, the position he holds today.

Harris has been dubbed the "Environmental Mayor" and the "Everywhere Mayor" because of his willingness to roll up his sleeves and get out on the job. He's gone scuba diving to help clean up our bays. He's ventured into the city's aging wastewater system and, on weekends, he is often seen with the Mayor's Beautification Team creating garden spots around the island. He has also initiated public education programs to fight water pollution and clean-up O'ahu's streams.

Harris says he still enjoys getting into a wetsuit or walking along the shoreline but, with the demands of a city on him, the opportunities to do so are not as frequent as he would like.

State Representative David Tarnas

The marine environment has a strong champion in House Representative David Tarnas. As chair of the House Ocean Recreation and Marine Resource Committee, Tarnas is at the forefront of legislative initiatives dealing with Hawai'i's alien species problem, fisheries management issues and boat harbor management. He says much of what he brings to his political position he learned while serving as the West Hawai'i Sea Grant Extension Service Agent in the early 1990s.

Tarnas gained a B.A. in political science from Kalamazoo College in Michigan, then went on to earn a Master of Marine Affairs degree at the Institute for Marine Studies at the University of Washington.

In 1986 Tarnas moved to the Big Island's Kona coast. He volunteered with several organizations dealing with marine and coastal management and also worked as a coastal resource specialist on projects in Malaysia and Thailand. In 1990 Tarnas landed the newly created Sea Grant West Hawai'i Extension Agent position.

Tarnas helped in the development of coastal management plans for the rapidly developing area and helped establish marine and coastal protected areas. He was involved in the development of a comprehensive coastal zone monitoring program and the establishment of a public education program on marine and coastal environments.

One of his most important roles was acting as a mediator to help resolve disputes over coastal development. This experience had Tarnas aptly prepared for office when he won the House seat for District 6 (North Kona — South Kohala, Hawai'i Island) in November 1994.

"As a Sea Grant agent I also became very aware that many positive initiatives from the university and private industry got stuck when they came to the political arena," he said. "This was partly from a lack of awareness and partly from a lack of organized advocacy."

Now in office himself, Tarnas uses his experience to get things moving in the right direction. If re-elected this year, he has several marine issues at the top of his agenda. "I would like to focus on the continuing effort to get DLNR more rule-making authority, so it can establish technically and scientifically based fishery management rules and regulations without going through the legislature," he says. He is also concentrating on the redesign of Hawai'i's boat harbor management and freeing up the ocean leasing laws so commercial open ocean aquaculture can get off the ground.

Over the years, Tarnas has also continued working as a coastal resource specialist. "It's a passion of mine," he said. He has worked in such far-flung places as Eritrea in East Africa, the Gulf of Aquaba in the Red Sea, the Federated States of Micronesia and Tetouana, Morocco. He also recently began work as a private environmental dispute mediator in Hawai'i and is involved with a new firm applying fluid separation technologies to environmental problems.



As a Sea Grant agent I also became very aware that many positive initiatives from the university and private industry got stuck when they came to the political arena.

In Memoriam



The Distinguished Service Award is presented to

Dr. Maxwell S. Doty

In recognition of his truly superior service to the mission of the National Sea Grant College Program to use and conserve coastal, Great Lakes and marine resources for a sustainable economy and environment through research, education and outreach programs.

– SEA GRANT ASSOCIATION, AUGUST 1997

With more than 20 years of support from the Hawai'i Sea Grant College Program, UH botany professor Maxwell Doty domesticated two species of *Eucheuma*, a red algae, and spread the practice of seaweed cultivation across the Pacific. Doty taught villagers in Zamboanga, Philippine Islands, how to cultivate the commercially valuable *Eucheuma* spp. as a cottage industry. He arranged the sale of all the algae the villagers could cultivate or harvest from wild stocks to Marine Colloid, Inc., the industrial partner in this enterprise. The venture was so successful the population of the small village increased ten-fold, banks established branch offices, and freighters made regular calls at the village.

Doty was a founder of the Phycological Society of America and the International Seaweed Symposium. He received the Shinkishi Hatai Medal by the Japanese Science Council in 1983. In 1989 Doty was given special recognition by the Seaweed Industry Association of Philippines for his vital role in making that country the world's leading *Eucheuma* producer. Doty's expertise in *Gracilaria* was also highly regarded. By 1990, the Philippines was producing one million wet tons of *Eucheuma* a year and earning \$50 million annually from its export.

On August 12, 1997, Meng Sung Doty accepted the Sea Grant Association's Distinguished Service Award on behalf of her late husband at Sea Grant Week in Madison, Wisconsin.

Hawai'i Sea Grant Vision

The focus of Hawai'i Sea Grant's endeavors for the next 10 years will be directed toward the sustainable development of the region's marine environment, its resources, and the training of marine professionals and technicians in ocean-related fields. Within the context of state and national priorities, Hawai'i Sea Grant plans a holistic and integrated approach. Taking fiscal constraints into consideration, the program will maximize funding by collaborating wherever possible with county, state and federal agencies, academia and the private sector. With this strategy in mind, Hawai'i Sea Grant will continue to obtain appropriate matching support and to encourage the participation of the best available scientific minds and educational talent.

Hawai'i Sea Grant, with a broad spectrum of input from the marine and coastal community in Hawai'i and the Pacific islands, is poised to enter the new millenium as an established leader in marine research, education and public service dedicated to the wise use of America's resources. Through its efforts, Hawai'i Sea Grant will continue to contribute to the region's rich tapestry by creating a greater awareness and appreciation for its oceanic environment.



Sea Grant Partners

- U.S. Coast Guard • Keep America Beautiful • Oceanic Institute • Waikiki Aquarium • Palau Bureau of Education • YMCA •
- Center for Tropical and Subtropical Agriculture • Hawaiian Islands Humpback Whale National Marine Sanctuary • SOEST •
- Hawaii Ocean and Marine Resources Council • College of Micronesia-FSM • UH Water Resources Research Center •
- Surfrider Foundation • Friends of Youth for Environmental Service • The Tides Center • Hawaii Department of Health •
- National Marine Fisheries Service • National Park Service • Castle High School • U.S. Army Corps of Engineers •
- Commonwealth of Northern Marianas Public School System • U.S. Geological Survey • Maui Community College •
- National Science Foundation • Governor's Committee for a Beautiful Hawai'i • Center for Marine Conservation •
- University Lab School Summer Science Program • Hawaii Coastal Zone Management • U.S. Fish and Wildlife Service •
- City & County of Honolulu Department of Parks and Recreation • Guam Department of Education • Bishop Museum •
- The Ocean Recreation Council of Hawai'i (TORCH) • Pacific Resources for Education and Learning (PREL) •
- Hawaii Department of Business, Economic Development and Tourism • Southern California Marine Institute •
- Hawaii Visitors and Convention Bureau • Conservation Council of Hawaii • Palau Community College •
- Friends of Hanauma Bay • Robert Reimers Enterprises, Arno Pearl Oyster Giant Clam Farm • Aloha Airlines •
- Atlantis Submarines • University of Washington Sea Grant Extension Service • Yap State Department of Education-FSM •
- Hawaii Institute of Marine Biology • Office of Insular Affairs, U.S. Department of Interior • National Park Service •
- Pacific Business Center • Pohnpei State Department of Education-FSM • Huchue Ranch Associates • GST Hawaii Online •
- Windward Community College • USDA Center for Tropical and Subtropical Aquaculture • Pohnpei Natural Products •
- Division of Boating and Ocean Recreation • Malama Kai Foundation • Black Pearls of Micronesia, Inc. • PEACESAT •
- National Cancer Institute • Kosrae State Department of Education-FSM • Marine Option Program • East-West Center •
- Hawai'i Department of Education • Chuuk State Department of Education • DBEDT Ocean Resources Branch •
- Waikalua-Loko Fishpond Preservation Society • UH Office of Technology Transfer and Economic Development •
- Saltonstall-Kennedy Fishery Development Program • Northwest Marine Technology, Inc. • Pohnpei Natural Products •
- American Samoa Department of Education • The Nature Conservancy • Wahoo Island Giant Clam Farm • Pacific Atlas, Inc. •
- State of Hawaii Natural Area Reserves System • College of the Marshall Islands • Palau Mariculture Demonstration Center •
- Lenger Hatchery, Pohnpei State Government • University of Guam Land Grant College • UH Small Business Development Agency •
- Marshall Islands Marine Resources Authority • National Aquaculture Center, FSM Department of Resources and Development •
- Hawaii Visitors and Convention Bureau • Windward Community College • Honolulu Aquarium Society • County of Maui •
- Anuenue Fisheries Research Center • Hawaii Department of Education • Tropical Fish Breeders of Hawai'i • Moli'i Fishpond •
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