CALIFORNIA
SEA GRANT

COLLEGE PROGRAM ANNUAL SUMMARY 1981-82

REPORT NO.
R-CSGCP-012

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SEA GRANT

Editor: Kelly E. Anderson

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This report was produced by the California Sea Grant College Program, a statewide, multiuniversity program of marine research, advisory services, and education activities administered by the University of California Institute of Marine Resources. Through the research it sponsors, Sea Grant contributes to the growing body of knowledge about our coastal and oceanic resources and helps solve contemporary problems in the marine sphere. Through its Marine Advisory Program, Sea Grant transfers information and technology developed in its research efforts to a wide community of users in California, the Pacific region, and the nation. Sea Grant also supports a range of educational programs for students, teachers, and the general public to promote the wise use of our coastal and oceanic resources by this and future generations.

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THE PROGRAM MANAGER'S PERSPECTIVE

The California Sea Grant College Program has traditionally been the "silent supporter" of valuable marine research projects, educational programs, and marine advisory activities throughout the state. With an administration committed to revitalizing our nation's economy, Sea Grant has "gone public" with its research accomplishments and results to stimulate innovative and imaginative solutions to marine and coastal problems. This year we again offer you our summary in a newsmagazine format to tell you about the activities of the California Sea Grant College Program.

Sea Grant is in a strong position to aid the nation's economy because it was designed with the nation's economy in mind. Created in the mid-1960s, Sea Grant promotes the wise use and development of our ocean resources by supporting responsive research, education, and advisory services. The program was patterned somewhat after the successful Land Grant College Program, established in 1865, which has been instrumental in helping the U.S. become the world's leading agricultural nation. Following Land Grant's lead, Sea Grant brings together researchers, educators, industries, and government agencies into a problem-solving milieu that generates research information and new technology to help the nation develop its marine economy.

Since its inception, Sea Grant — in California and 28 other states — has been an important influence on the nation's economic and social well-being. It develops new and innovative scientific and engineering techniques that increase the contribution of marine resources to the nation's economy. It analyzes the allocation and distribution of marine resources and marine products to aid public policymaking. It provides scientific and technical training for productive use and management of marine resources. And it communicates the results of university research efforts to all segments of the marine community, to the public, and to government agencies charged with managing the nation's marine and coastal resources.

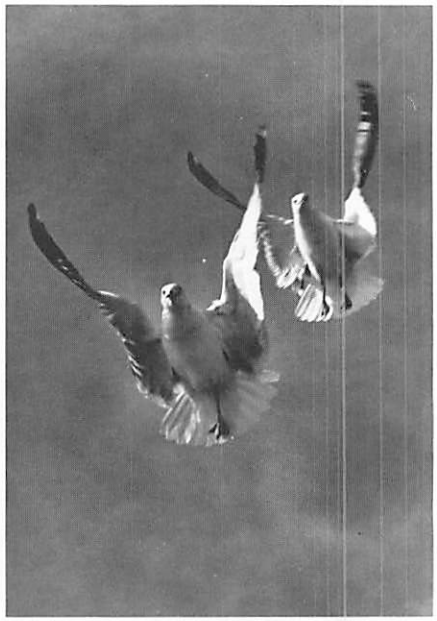
What does this mean to you and me? It means increased supplies of marketable protein from marine sources for human and animal consumption. It means wiser expenditure of public capital on ports, harbors, and beaches. It means improved understanding of defense against the marine environment's destructive forces. And it means new and better technology to increase the contribution of marine resources to the production, transportation, and distribution of energy supplies.

Sea Grant provides scientific and technical training to students who will become the next generation of entrepreneurs, scientists, engineers, and managers responsible for developing the nation's ocean resources. It supports important research in many marine and coastal areas, including coastal resources, aquaculture, fisheries, ocean technology, and marine affairs. It also provides marine advisory assistance to fishermen, industries, and government agencies that are using, developing, and protecting California's valuable marine resources.

This summary informs Californians of Sea Grant's contribution to their lives. It shows state and federal agencies the level of coordination and cooperation existing between Sea Grant and the groups charged with developing and managing the nation's coastal resources. University officials, researchers, and specialists also need the results of Sea Grant's research, as do governmental officials who must keep informed on Sea Grant's contributions to wise ocean development for the state and the nation. This summary is provided for those uses.

I welcome your comments and suggestions.

James J. Sullivan
Program Manager



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THE NATIONAL SEA GRANT COLLEGE PROGRAM

The development of marine resources potentially represents a major segment of our nation's economy. In 1966 Congress created the National Sea Grant College Program to accelerate marine resource development by supporting application-oriented marine research at the nation's leading universities. Sea Grant also must communicate the results of that research to government agencies, industry, scientists, fishermen, and consumers — people who can directly use the research results to socially and economically benefit the nation and its coastal regions.

California Program Remains the Largest

California's Sea Grant College Program is the largest of 29 Sea Grant programs currently underway in more than half of the nation's states. Since 1968 California's program has supported a unique combination of marine research, education, and advisory activities at more than 30 California universities and colleges to address marine problems of national, regional, and local importance. California Sea Grant activities directly benefited more than 100 private sector organizations and government agencies in 1982.

The Nation, the West, and the State Benefit

Many of the research activities supported by the California Sea Grant College Program have national, regional, and local benefits. For example, California Sea Grant has

- identified 10 potential anticancer drugs currently under development by several major pharmaceutical corporations and identified chemicals from the sea that are potential pain killers and topical anti-inflammatory agents
- increased the potential for U.S. export of herring eggs-on-seaweed valued to $20,000 per wet ton by integrating the economically valuable seaweed *Gracilaria* and the herring fishery
- trained salmon and albacore fishermen to use remote sensing data to locate fish schools, which could save an estimated $500,000 in fuel and fishing costs
- developed techniques that can save shellfish fishermen 50% in bait costs through improved baiting techniques
- increased potential food yield from the sea by developing new hatchery techniques for salmon, abalone, and lobster
- developed storage techniques that keep fish fresh 7 to 9 days longer than conventional methods
- developed techniques that reduce water use by 43% in shrimp processing
- designed a free-moving fish filleting knife that runs on air instead of electricity
- developed a prototype squid-cleaning machine that cleans a pound of squid in seconds, a job that can take 20 minutes to do by hand. Commercial development improved the machine's capacity so that it now cleans and skins 120 squid per minute. Some researchers have estimated that the Pacific's current 48,000-ton annual squid catch, presently worth about $5 million, could be increased many times that amount, thus providing the west coast and the nation with a new source of protein.

Much of the research supported by California Sea Grant results in increased awareness and understanding of marine resources and improves the nation's capability for technological development of those resources. For example, California Sea Grant has

- improved the safety of marine transportation and operations through modeling of safety techniques and through the development of more efficient equipment for assessing underwater construction sites and for exploring the sea floor
- trained nearly 400 graduate students since 1972 in the marine-related technical aspects of biology, chemistry, economics, engineering, geology, oceanography, and political science. Most of these students are now putting their newly acquired skills and knowledge to work in government, industry, and university positions throughout the United States
- educated more than 500,000 people annually on fisheries management and economics, salmon and abalone enhancement, trawling and gear development, alternative fisheries development, and the use of remote sensing data through public displays, outreach programs, and consumer workshops
- assisted the government's abalone-restocking efforts by providing research support for seeding experiments on artificial reefs adjacent to power plants, by providing Sea Grant-developed seeding techniques, and by providing Sea Grant research results on the natural history of abalones
- aided marshland restoration efforts by providing coastal wetlands information and advice based on California Sea Grant investigations to port districts, residential development organizations, planning agencies, and the federal government
- published a coastal erosion manual and conducted erosion research investigations to help coastal planners and property owners better plan and control coastal development to reduce property losses.

The California Sea Grant College Program, in cooperation with Sea Grant college programs in Alaska, Hawaii, Oregon, and Washington, is working to develop, use, and conserve the vast resources of the Pacific Ocean — a largely undeveloped wilderness that occupies nearly one-half of the globe.

For more than a decade the Sea Grant college programs in these states provided advisory education and services to Pacific fishermen and mariners through the Pacific Area Sea Grant Advisory Program (PASGAP). PASGAP's success led the five Pacific Sea Grant colleges — University of Alaska, University of California, University of Hawaii, Oregon State University, and University of Washington — to form a closely coordinated research, advisory, and education collegium called the Pacific Sea Grant College Program (PSGCP).

To benefit from a coordinated Sea Grant research base in the West, the collegium is promoting the wise use, development, and management of the Pacific's resources by supporting research to

- increase food yield from the sea
- develop new marine-related industries
- improve marine management techniques and policies
- improve harvest methods and conservation practices
- identify and develop pharmaceuticals and other new marine products from the sea
- improve the handling, processing, and marketing of Pacific seafoods
- develop ocean technology to allow more efficient marine operations and to confront special marine transportation problems in the Pacific.
- develop marine aquaculture in the Pacific, particularly of salmon and commercially valuable shellfish

In 1981-82 Sea Grant invested more than $3.1 million of federal funds and $1.6 million of state matching and other nonfederal funds in California's marine and coastal management and development. The benefits accrued to the nation, the region, and the state resulted from the efforts of about 500 individuals involved in the research, education, and advisory services provided by the California Sea Grant College Program.

California's Sea Grant Institutions Since 1977

California Academy of Sciences
California Institute of Technology
California State University, Long Beach
California State University, Northridge
Claremont College
Humboldt State University
Loyola Marymount University
Moss Landing Marine Laboratories, a consortium of
- California State University, Fresno
- California State University, Hayward
- California State University, Sacramento
- San Francisco State University
- San Jose State University
- California State University, Stanislaus

Occidental College
San Diego State University
San Francisco State University
San Jose State University
Scripps Institution of Oceanography
Southern California Ocean Studies Consortium
- California State University, Dominguez Hills
- California State University, Fullerton
- California State University, Long Beach
- California State University, Los Angeles
- California State University, Northridge
- California State University, Pomona

Stanford University
University of California, Berkeley
University of California, Davis
University of California, Irvine
University of California, Los Angeles
University of California, Riverside
University of California, San Diego
University of California, Santa Barbara
University of California, Santa Cruz
University of San Diego
University of Southern California

MARINE EDUCATION AND TRAINING

As the nation's technology continues to advance at an almost incomprehensible speed, the scientific education and training of our future scientists becomes vitally important. The California Sea Grant College Program has continued to provide students with scientific and technological training to aid the nation's continued economic growth. Since 1973 Sea Grant has trained more than 400 California graduate students in technical aspects of biology, chemistry, economics, engineering, geology, oceanography, and political science. Most of these students are now using their new skills and knowledge working for related industries, government agencies, and universities in California and throughout the United States.

Young Scientists Groomed for Real World

STATEWIDE — In 1981-82, 74 Sea Grant trainees conducted practical marine research with project leaders at 11 California universities and colleges. Each student worked on or completed an M.S. or Ph.D. during the traineeship. The students learned how to identify and solve marine-related problems, and acquired training in new research techniques transferable to their professional careers in industry, government, and academia.

Susan Cooper-Smith, a trainee who worked on Sea Grant vegetative propagation research at UC Santa Barbara, says the techniques she learned "are essential to all tissue culture operations and should prove an important asset in my future studies and career." She is currently the research director of a private orchid firm in Santa Barbara, California.

Two Sea Grant trainees from UC Berkeley who studied earthquake effects on offshore structures report that their trainee experiences are directly linked with their present positions in private industry. Rabi Sankar De completed an M.S. during his Sea Grant traineeship, which he says provided "vital financial support...and an excellent opportunity to work with Sea Grant researcher Dr. William Webster." He has qualified for his Ph.D. program and says he is taking a year off to gain industrial experience. Currently he is employed as an engineer at a marine structures and naval architecture firm in Houston, Texas. Wen-Gen Liao, who completed his Ph.D. as a Sea Grant trainee, says the traineeship experience "was of excellent value in my academic career, and in preparing me for my present position." Liao is currently a project engineer at a structural engineering firm in San Francisco. (E/G-2)

Santa Maria Student Awarded Isaacs Scholarship

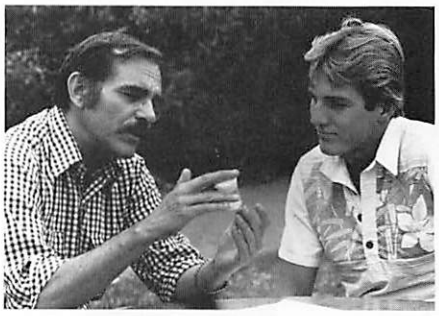
SANTA MARIA — John David Wikert of Santa Maria High School received the 1982 John D. Isaacs Memorial Scholarship for his marine science project, "A Study of Nudibranchs, Focusing on the Developmental and Structural Differences," at the 1982 California State Science Fair.

Wikert said he chose to study nudibranchs, commonly called "sea slugs," because he wanted "to help destroy the concept that slugs are slimy, dirty, brown things that leave shiny mucus trails...nudibranchs are beautiful like butterflies, land slugs are like cockroaches."

Wikert's project was one of more than 200 state science fair projects developed by high school and junior high school students who won awards at local science fairs.

Hoping to dispel the "ugly slug" myth, Wikert displayed many nudibranch species in a 10-gallon saltwater aquarium and prepared a report on the way these unusual creatures defend themselves. Because adult nudibranchs lose their original protective shells, they develop other defenses to protect them from predators. By observing nudibranchs in an aquarium environment, Wikert was able to gather observational data and combine it with research information he collected on nudibranch defenses. Wikert is currently majoring in aquatic biology at UC Santa Barbara.

The John D. Isaacs Memorial Scholarship, a $10,000 award consisting of four $2500 stipends, is the largest award presented at the statewide fair. The award, established in 1980 by the California Sea Grant College Program, is given annually to a high school senior with the best marine science project at the state fair. The award recognizes excellent marine-related research conducted by California high school seniors, and it encourages these students to pursue a marine science education at California's colleges and universities.



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The scholarship is named in honor of the late John D. Isaacs, a professor of oceanography at Scripps Institution of Oceanography at UC San Diego for more than 30 years. Isaacs was also director of the UC Institute of Marine Resources (IMR), which oversees the California Sea Grant College Program. (E/UG-4)

First Isaacs Scholar Still Gung Ho on Marine Science

SANTA CRUZ/LA JOLLA — Amy Kimball, the first recipient of the John D. Isaacs Memorial Scholarship, is having a year-round love affair with science as she pursues her goal to become a marine biologist.

For 9 months of the year, Kimball undergoes a rigorous academic schedule at UC Santa Cruz, where she majors in chemistry. During the summer she spends most of her time cooped up in a laboratory in La Jolla, while her pals spend the days in southern California's sun and surf.

This kind of life hardly sounds romantic, but for Kimball, the knowledge and experience she's gaining are more than worth the sacrifice of a few summers in the sun.

K. Anderson

Kimball was already leaning toward a scientific academic career when she heard about the Isaacs Scholarship as a student at Point Loma High School. The Sea Grant-sponsored Isaacs Scholarship was the only one of its kind available to her as a graduating high school senior. According to Kimball, she almost didn't enter a project in the science fair, a requirement for qualifying for the Scholarship. "At my high school," she said, "hardly anybody did projects, and I was all ready not to do one either. But the summer before twelfth grade I took a course at the Scripps (Institution of Oceanography) Aquarium which gave me incentive to do a project."

Kimball's project, a study of environmental impacts on tidepool limpets, won her the 1981 John D. Isaacs Scholarship. Kimball also received the Southwest Fisheries Center's (SWFC) Junior Fellowship, a 4-year summer research fellowship awarded annually to a high school senior who shows interest and talent in marine science.

Last summer Kimball worked with Dr. Gail Theilacker of the SWFC on a project to determine the growth rate and caloric requirements of anchovies. Anchovies are not only important commercially; they are also scientifically interesting because they are filter feeders — they get nourishment by filtering plankton from the water that surrounds them — and little is known about their development requirements. In Kimball's research, she cultured, filtered, and weighed plankton — specifically rotifers and copepods, the kind of plankton that anchovies like to eat. By determining the weight of individual plankton, Kimball is helping Theilacker calculate how much the anchovies need to eat as they grow.

"Weighing plankton sounded so straightforward," Kimball said, "but I've found there's a great deal of work involved. It took us about 3 or 4 weeks to work out the filtering technique for rotifers, but once we worked it out it only took a week to get the data.

"When you read the research paper, all that work will probably end up as one short statement: 'The plankton was filtered.' But even though the result I get in the end is just a number, I still get really excited by it."

— Amanda Iles

California Course Networks Nation's Marine Policy Educators

LA JOLLA — A unique marine policy course developed and offered by a Sea Grant researcher at UC San Diego has opened a line of communication among professors at 10 universities nationwide where similar marine science courses are taught.

Professor Roger Revelle, a founder of the UC San Diego campus and director emeritus of Scripps Institution of Oceanography (SIO), organized and taught an advanced course in marine policy to promote national interest in the impact our ocean environment has on socioeconomic issues and scientific inquiry.

The course, based on a marine policy seminar Revelle taught with Sea Grant staff in 1979, examines the current status of international, national, and state marine issues.

In proposing the new course for Sea Grant support, Revelle said, "With the election of a president with a new approach toward the management of national marine affairs, the examination of federal marine policy issues must be completely restructured. Significant developments at the Third United Nations Conference on the Law of the Sea (UNCLOS III) have forced a reorganizing of the current marine affairs issues of international interest. Marine policy issues of state concern...have diminished in significance in comparison to increased activities at the national and international levels. There is growing recognition that the world ocean is a global environment that cuts across national boundaries, and, consequently, the international issues are of paramount importance."

According to Revelle, the class was "the most direct approach" to furthering Sea Grant's aim to provide greater awareness of the future role of the oceans through education of college students.

"It is not an understatement," Revelle said, "to claim that the oceans are playing an ever increasing role in the course of human affairs. The world ocean will pose serious questions for social, economic, and political advancements over the near and long term. The National Sea Grant College Program is a product of these realizations."

Dr. Revelle has established a cooperative national network among universities currently offering marine policy courses, including the University of Miami, Woods Hole Oceanographic Institution, the University of Delaware, Louisiana State University, Texas A&M University, Massachusetts Institute of Technology, the University of Southern California, the University of Virginia, the University of Washington, and the University of Rhode Island.

The course was funded through California Sea Grant's Rapid Response Program, which supports short-term projects that respond quickly to unanticipated or immediate marine or coastal needs. (R/NP-1-11E)

Humboldt Student Wins Internship on Capitol Hill

ARCATA — Robert H. Deibel, a 26-year-old graduate student at Humboldt State University, is one of 10 new faces on Capitol Hill in 1983. Deibel was the only California student selected in 1982

for an internship from the National Sea Grant College Program.

The internship program matches highly motivated graduate students with "hosts" in Washington, D.C. for paid 1-year internships. In his internship Deibel will serve on the staff of the Subcommittee on Oceanography in the House Merchant Marine and Fisheries Committee (on the minority side).

This committee presides over issues related to merchant marines; oceanography and marine affairs, including coastal zone management; the Coast Guard; fisheries and wildlife; the Panama Canal; and international fishing agreements.

California's Sea Grant College Program nominated Deibel for the national internship in 1982 because of his educational and practical experience in fisheries management. He has a B.S. in Natural Resources Management (fisheries concentration) from the California Polytechnic State University at San Luis Obispo, and he is presently completing his M.S. in fisheries at Humboldt State University.

Deibel was president of the Humboldt chapter of the American Fisheries Society and has been actively involved in policy formulation and decision making affecting California's fisheries resources. He has worked as a research assistant on Sea Grant-supported projects and as a fisheries biologist for the U.S. Forest Service. His graduate work at Humboldt concerns the rehabilitation of juvenile salmonid habitats in Trinity County.

Deibel said he is excited about the "hands-on" experience the year-long internship will give him. He plans to focus on Title III of the Marine Protection, Research, and Sanctuaries Act, which he feels will allow him to play an active role in maintaining the wise use and development of the nation's fisheries and marine resources.

The National Sea Grant College Program offers this educational experience each year to 10 graduate students who have an academic interest in the marine sciences and in marine resource policy decision making.

Women in Science Honor California Sea Grant Trainee

SANTA BARBARA — A Sea Grant trainee conducting abalone culturing research at Santa Barbara was one of three women in the U.S. to receive the prestigious 1982 Predoctoral Research Award from The Association for Women in Science Education Foundation.

Andrea J. Baloun, a second year Ph.D. student, won the award for her research proposal to conduct Sea Grant research on red abalone development. Her proposal was based on 2 years of research she conducted as a Sea Grant trainee in the research project "Biochemical Engineering for Improved Production of Commercially Valuable Marine Shellfish," conducted by Dr. Daniel E. Morse from the Marine Science Institute at UC Santa Barbara.

Since 1976 Dr. Morse and his colleagues have studied the biological processes that control development of abalones and other important commercial shellfish. They have devised simple, safe, and inexpensive techniques that help control reproduction, survival, and growth in species of molluscs that are important sources of food.

Baloun joined the Sea Grant research team 2 years ago as an undergraduate interested in advanced research training. According to Morse, Baloun's research was critical in the team's discovery of the mechanism by which a naturally occurring chemical causes minute, swimming abalones to settle to the bottom of the ocean and grow rapidly into adult abalones. Her research significantly extends the group's earlier finding that small charged molecules known as "ions" are an essential link in the chain of events that controls abalone settling.

"Andrea's experiments are a model of scientific creativity and precision," Morse said. "We're very excited by her results because they open the possibility for practical cultivation of many other shellfish."

The researchers originally developed their production techniques using abalones and have since shown that the techniques work with numerous other commercially valuable shellfish, including scallops and oysters.

A number of sea-farming firms in the Santa Barbara area and elsewhere are using the techniques developed by this Sea Grant research. "The production of nearly a dozen different species of abalones and of many other species of scallops, oysters, clams, and other shellfish has been improved by the use of these techniques in California, other states, and abroad," according to Morse.

Public Learns Marine Ps and Qs

STATEWIDE — The general public is exposed to a wealth of marine science information and education materials through a variety of Sea Grant-supported outreach programs. One such vehicle is the Ocean Education for the Public Program, in which Sea Grant supports public advisory services at five university-based marine institutions in the state. The ocean education program and other public advisory programs are described under "Marine Advisory Services."

Marine Education	**FY80**	**FY81**	**FY82**
Sea Grant Trainees (E/G-2, Sullivan)	O	O	O
Ocean Engineering and the Future: Long-Range Planning: A Graduate Seminar (E/G-8, Webster/Tulin)	N/C	—	—
A History of the Santa Barbara Channel (E/UG-2, Talbott)	N	O	O
John D. Isaacs Memorial Scholarship (E/UG-4, Sullivan)	—	N	O
Reorganizing and Updating an Advanced Course in Marine Policy (R/NP-1-11E, Revelle)	—	—	N/C

C = Completed; N = New; O = Ongoing

MARINE ADVISORY SERVICES

Sea Grant's marine advisory services bring university resources, research techniques, and information about wise ocean and coastal development to people in the Pacific rim who enjoy the ocean as a source of employment, recreation, and pleasure. Sea Grant's marine advisory activities are frequently coordinated with the National Oceanic and Atmospheric Administration (NOAA) and other federal and state agencies, creating a three-way information flow among marine resource users, the scientific community, and government agencies that monitor and regulate ocean and coastal resource use.

The Marine Advisory Program (MAP), headquartered at UC Davis, provides most of California Sea Grant's marine advisory services. Two additional programs provide Californians with important advisory information and activities: Sea Grant's Ocean Education for the Public Program at marine institutions throughout the state and the Sea Grant communications office in La Jolla.

Throughout the year, California Sea Grant marine advisors and subject area specialists worked closely with more than 200 cooperating organizations in government, industry, and academia to provide information about new marine technologies to thousands of commercial fishermen and seafood processors, coastal planners, consumers, aquaculturists, and California residents who use the ocean for profit or fun.

Since the program's inception, marine advisors and specialists have actively encouraged the adoption and implementation of new technologies by providing valuable information and support in such areas as seafood processing, ocean transportation, port development, retail handling, fishing methods, organization of fishermen's associations and cooperatives, aquaculture development, coastal planning, marine recreation, and public education. A brief overview of the Marine Advisory Program's 1981-82 activities follows. (A/EA-1)

Classes Help Fishermen Make A+ Catches

STATEWIDE — Each year, marine advisors and specialists offer a series of workshops, minicourses, and training sessions to share technical information with fishermen and other user groups. In 1981-82 nearly 3000 commercial fishermen attended workshops to learn how lure speed, currents, and water temperature affect fishing efficiency. In other workshops they learned about Pacific whiting utilization, abalone fishery enhancement, fisheries management, hydraulics, trawling and other gear development, salmon stream enhancement, refrigeration, antitrust laws, fisheries economics, federal assistance programs, and fishing cooperatives.

More than 600 seafood processors, food processors, food canners, and NMFS inspectors attended sanitation and seafood quality workshops in 1981-82. The seafood canning workshops satisfied FDA training requirements for supervisors of seafood canning operators and canning inspectors.

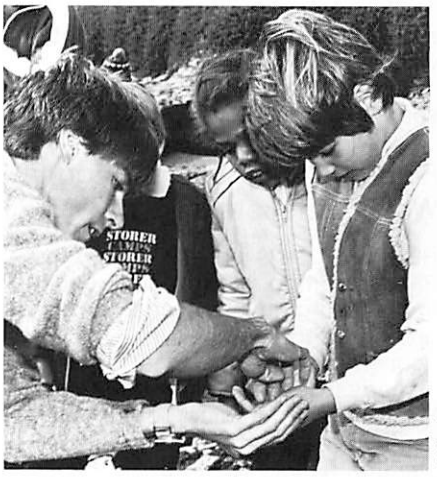
Alternative Fisheries Net Profit and Protein

STATEWIDE — Economic conditions and resource limitations in traditional fisheries have forced many fishermen to consider alternative fisheries in the off season. Several fishermen's groups learned how to develop alternative fisheries such as shark, octopus, scallops, sea cucumbers, sablefish, Pacific whiting, rockfish, squid, and rock crab; more than 300 fishermen participated in five MAP workshops on shark and octopus fishing. Following the workshops, several vessels longlined for shark in San Francisco Bay and landed more than $10,000 worth of shark.

Training and T.V.s Help Fishermen Find Fish Faster

REGIONAL — Fishermen can spend less time searching for fish and saving money on fuel costs, thanks to the remote-sensing training they've received from Sea Grant marine advisors. Using charts that indicate sea surface temperature and ocean color, fishermen are able to locate fishing grounds more efficiently. The marine advisors not only trained the fishermen, they successfully adapted the charts for televised broadcasting with cooperation from a local television station. Fishermen in northern California and southern Oregon can trace the charts from their home television screens before leaving port in the morning, and they can receive the charts on televisions aboard their vessels.

Swordfish fishermen in southern California and albacore and salmon fishermen in central and northern California report that the ocean color charts are extremely valuable. Estimates have shown that west coast salmon and albacore fishermen could save $500,000 yearly in fuel using this data to locate fishing grounds.



C. Foote

Cooperation Improves Shrimp and Prawn Fisheries Management

SANTA BARBARA — In 1981-82 marine advisors, Sea Grant researchers, commercial fishermen, and shrimp processors worked with California Department of Fish and Game biologists to assess ridgeback shrimp and prawn fisheries in the Santa Barbara area. With MAP's assistance, a biologically sound and reasonable management plan for these species was developed and is subsequently being supported by the fishing industry.

Aquaculture Gets Boost from Marine Advisory Participation

NATIONAL — The Marine Advisory Program was actively involved in several national and international programs and projects last year to disseminate state-of-the-art information about aquaculture. The MAP aquaculture specialist, Dr. Fred Conte, gave a keynote address on U.S. aquaculture to representatives of the South Carolina State Legislature and members of the banking community, and he co-chaired both the Big Island Aquaculture Conference in Hawaii and the World Mariculture Society aquaculture functions in Washington, D.C. At the request of the California Department of Fish

and Game and the California Aquaculture Association, Dr. Conte helped develop the most comprehensive aquaculture legislation in the state's history. The changes in California's aquaculture laws and regulations will save the state aquaculture industry an estimated $150,000 a year.

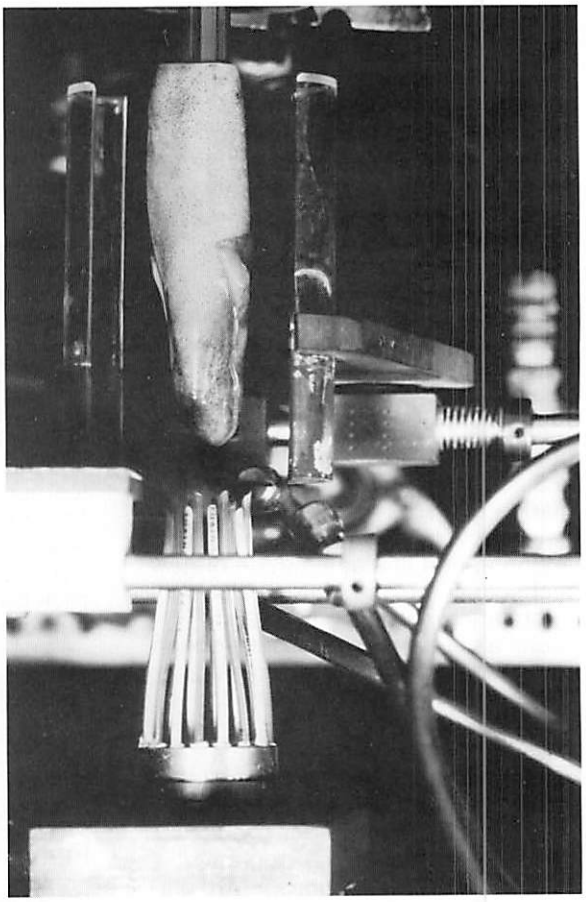
Future is Bright for California Whiting Industry

REGIONAL — A project to develop Pacific whiting markets has resulted in promising developments of this underutilized species. In cooperation with the West Coast Fisheries Development Foundation, MAP advisors studied potential markets for Pacific whiting — a plentiful fishery resource in the Pacific. Industry marketing specialists made presentations to restaurant chains and seafood processors, and the results are encouraging. Beverly Enterprises, a nursing home chain, agreed to test 9000 pounds of whiting products per month; Meredith Fish Company agreed to provide the monthly whiting supply; and Mannings' Cafeterias, Sizzler Steak House, and H. Salt are all interested in using whiting.

In addition, Eureka Fisheries has submitted whiting samples to the Armed Forces Product Evaluation Committee. If whiting is accepted by the Armed Forces, domestic processing of Pacific whiting will be greatly stimulated. Estimates show that 100-200 million pounds of Pacific whiting could be harvested and processed on the west coast. Increased utilization of this fishery could mean an additional $50-$100 million annually for the west coast economy.

Squid Cleaning Machine Means More Protein from the Sea

STATEWIDE — Researchers estimate that squid is potentially one of the largest sources of animal protein in the marine environment, yet the squid fishery remains underutilized because there is insufficient technology available to process squid efficiently for commercial marketing.



Because squid is low in fat, high in protein, and plentiful along the west coast, the California seafood industry expressed interest in developing the squid fishery and testing squid's potential marketability with restaurants, fast-food chains, and general consumers. Industry representatives asked members of the California Sea Grant Marine Advisory Program (MAP) if a machine could be designed to clean squid quickly and easily, thus replacing the labor-intensive, time-consuming method of cleaning squid by hand. MAP staff outlined the problem to a group of agricultural engineers at UC Davis, who in turn acquired California Sea Grant support for 2 years to develop a prototype squid cleaning machine.

The Sea Grant engineers succeeded in developing a prototype machine that beheads squid, then skins and eviscerates it using powerful water jets. The machine's design vastly improved the speed and efficiency of the squid cleaning process: it skins and cleans a pound of squid in seconds — a job that takes 15 minutes to do by hand. The machine was patented by the University of California, and it has been commercially developed by the Squid Machine Corporation in Santa Cruz, California. The commercial model, which skins and cleans 120 squid per minute, was demonstrated to industry, government, and academic audiences in June 1983. With a commercial squid cleaning machine available, researchers estimate that the Pacific's current annual squid catch, which is 24,000 tons and worth about $5 million, could be increased many times that amount, thus providing the west and the nation with a new source of protein for human consumption.

Marine Labs Reveal Ocean's Mysteries with Sea Grant Support

Sea Grant's Ocean Education for the Public Program supports educational and interpretive activities at five university-based marine facilities located along California's 3400-mile coastline. The laboratories and museums currently involved in the program provide displays, tours, workshops, and field trips to students, residents, and tourists who want to learn more about California's rich coastal and marine life. (A/PE-1)

ARCATA — The Fred Telonicher Marine Laboratory at Humboldt State University provides the public with interpretive materials and activities related to marine environments in the Trinidad Bay area and in northern California. During 1981-82 the laboratory staff developed marine science displays simulating local marine environments, and they helped develop interpretive programs for the Redwood National Park by providing photographs and micrographs of marine organisms in their natural environments. Laboratory staff helped the California Department of Parks and Recreation construct an interpretive display for the Trinidad Beach State Park, and they conducted a workshop on marine interpretation last year for local state park rangers. Classes in interpretation at Humboldt State University continued to use information and materials developed by laboratory staff as a result of this program.

The lab's automated audiovisual presentation on local seashore life enhanced the educational experiences of more than 1000 annual open house attendees and summer and weekend visitors last year. In 1981-82 the lab continued to offer outreach presentations to clubs, service organizations, and elementary and secondary schools in the area.

SANTA CRUZ — The Center for Coastal Marine Studies (CCMS) at UC Santa Cruz supplements its traditional interpretive program with unique activities that provide academic training to student interns working at Natural Bridges State Park, Long Marine Laboratory, Elkhorn Slough, and Año Nuevo Park.

CCMS offers an unconventional seminar series in which UC faculty share their current research and field techniques with student interns. Two new slide shows on the elephant seals at Año Nuevo and the addition of a second intern training handbook have helped the center's growing interpretive and public information programs attract more than 11,000 people each year.

MOSS LANDING — In 1981-82 more than 14,000 people participated in the educational programs offered at Moss Landing Marine Laboratories (MLML), a research-teaching facility operated by a consortium of six state universities. People from all age groups and diverse ethnic and economic backgrounds attended MLML's annual Visitor Days Program and 2-day Open House, and participated in tours and field trips to nearby habitats. MLML expanded its outreach program in response to an ever-increasing demand for public awareness about marine resources. The program reached 6000 students last year with its slide shows, marine research lectures, and marine career opportunity days.

For the fourth year in a row MLML offered marine science minicourses to students at a local continuation school and a 2-week marine science summer workshop for highly motivated children in grades 5 through 8. Additional MLML-sponsored activities include weekly ad hoc tours, scheduled outreach presentations and a student intern program. In 1981-82 four high school students served as interns with MLML scientists conducting plankton, heavy metal, and salt marsh ecology research.

SANTA BARBARA — Each quarter the Marine Science Institute at UC Santa Barbara offers a marine science public education program for visitors and residents interested in learning more about the marine resources of southern California. Special diving collections provide samples of organisms that live in the Santa Barbara Channel area; tanks and aquaria display local plants and animals; and microscope stations, "touch" tanks, and field research displays provide the public with a closer look at ocean life.

More than 3700 scheduled visitors toured the UCSB marine laboratory in 1981-82, viewing the displays and sample research projects and discussing the lab's research activities.

LA JOLLA — The Thomas Wayland Vaughan Aquarium-Museum at Scripps Institution of Oceanography at UC San Diego is open year-round to residents and visitors interested in learning about California's marine life. The aquarium-museum had more than 280,000 visitors last year; more than 37,000 preschool-through college-level students took part in its organized education programs. Last year's programs included 11 summer minicourses for high school students and 14 1-week courses in area schools as part of the state-mandated Gifted and Talented Education Program.

Docents in the aquarium's outreach program made presentations to nearly 6000 school students unable to visit the aquarium last year, and monthly lectures and field trips were held for students participating in the Junior Oceanographer Corps.

In 1981-82 the aquarium hosted the National Marine Education Association Conference, drawing 240 teachers and environmental educators nationwide to participate in marine-related workshops and activities conducted by 70 speakers.

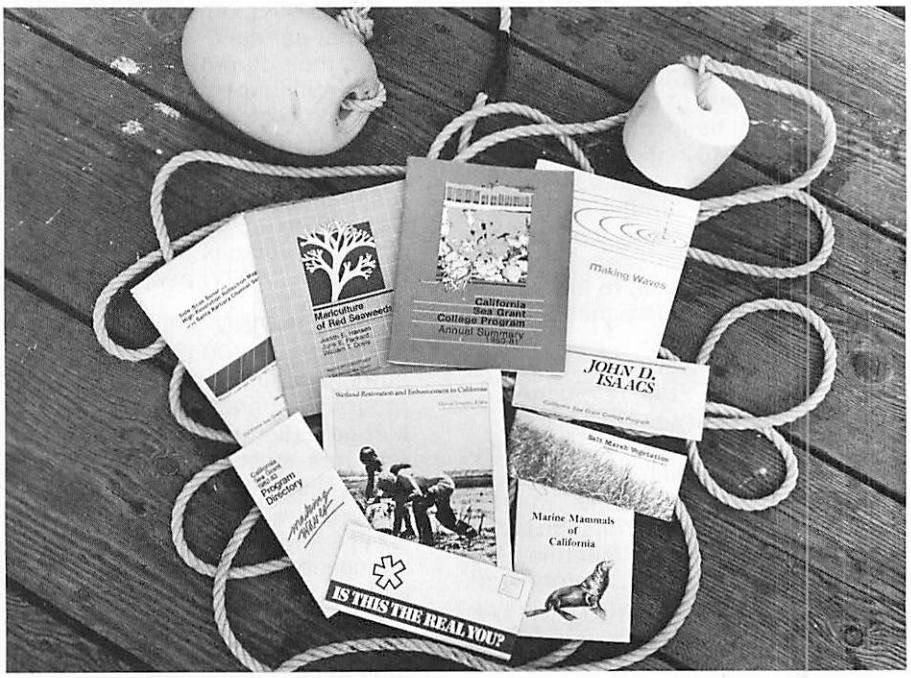
Knowledge Breeds Interest: Public Requests More Marine Information

Through the research it supports, Sea Grant generates new information concerning the nation's ocean and coastal resources. Sea Grant disseminates this information to fishermen, industries, nonprofit organizations, elected officials, government agencies, schools, the scientific community, the general public, members of Sea Grant's statewide and national programs, and other individuals who can put the information to use promptly and productively.

Sea Grant's dissemination efforts are now paying off in terms of increased requests for information, increased awareness of Sea Grant as an ocean information resource, and increased use of research findings. In 1981-82, requests for information from California Sea Grant rose 71%, due in part to a more vigorous effort to make known the results of Sea Grant research by

- publishing Sea Grant project results in publications aimed at technical and lay audiences
- providing the public with information about Sea Grant's projects, services, products, and activities
- distributing books, reprints, technical reports, and activity announcements produced or sponsored by Sea Grant
- advising project leaders, administrators, and advisory personnel about effective techniques for communicating with user groups, the scientific community, and the general public.

The Sea Grant communications office receives more than 10,000 information requests each year from industries, government agencies, special interest groups, legislators and congressmen, schools, nonprofit organizations, and the general public.



Requests were up substantially in 1981-82, due primarily to more assertive dissemination of Sea Grant program information utilizing publication announcements, press releases, and public displays. For example, in 1981-82 the communications office:

- distributed 13,000 fliers announcing availability of Sea Grant publications
- answered more than 12,000 requests for information on Sea Grant project results and activities
- distributed press releases to more than 7000 people announcing several Sea Grant research accomplishments in 1981-82
- distributed 44 journal reprints and proceedings
- presented Sea Grant program information and products at 20 local, state, regional, and national marine events
- added 9 new publications to the report series.

California Sea Grant's communications activities will continue to grow as new information is generated on the wise management of our ocean and coastal resources. (A/P-1)

Abalone Venture Viable Thanks to Sea Grant

A year ago Steve Mullenniex knew next to nothing about abalones, except that he liked to eat them. Now he and his business partner, Ted Maschao, are well on their way to becoming commercial abalone aquaculturists.

The two men had tried gold mining for two summers, but, said Mullenniex, "the gold mining just didn't pan out." They got the idea to culture abalone by way of Maschao's 10-year interest in diving.

"The first thing we did," said Mullenniex, "was to go to the UC Berkeley library and look up 'abalone.' The references we found included a paper by Dr. Daniel E. Morse (a California Sea Grant researcher at UC Santa Barbara) in the *Proceedings of the World Mariculture Society*. After we talked to Morse we contacted other researchers, and we found that they were also Sea Grant-funded."

In January 1982 Mullenniex began requesting additional information from Sea Grant including publications, reprints of journal articles, and additional references that enabled Mullenniex to learn about abalones, how they grow, and how best to raise them commercially.

With the information Sea Grant provided, Mullenniex discovered he needed to learn about kelp mariculture as well, since kelp is an important food for abalones and is cheaper to grow than buy. Mullenniex also found that there are different markets for different sized abalones, an important consideration for a new business venture.

For instance, Americans consume abalones primarily in the form of abalone "steaks," a term referring to abalone meat that is at least 7 inches in diameter. In Japan, smaller abalones are more popular; 2-inch abalones are a standard ingredient for sushi. It takes only 2 years for abalones to reach sushi size, and Mullenniex plans to grow abalones to this size and sell them in Japan.

If all goes as planned, Mullenniex will begin exporting sushi-size abalones by 1985. "At first we plan to export all the abalones to Japan," he said, "because they pay the most. The Japanese eat a lot of abalones — consumption there far exceeds production. Later on, we plan to build up and satisfy the U.S. market. The potential for the growth of the abalone market in this country is amazing."

Mullenniex and Maschao are smart to think ahead to the U.S. market for their sushi-size abalones. Although the market is still small nationwide, interest in Japanese sushi and sashimi is growing rapidly; in San Diego County alone there are as many as 20 Japanese restaurants, many featuring "sushi bars," where abalones are popular.

Abalone is a declining resource worldwide, and its commercial cultivation presents many challenges. "Clean water is very important," said Mullenniex, "and it used to be hard to get the animals to spawn. Also, there was high mortality at each stage of the growth cycle. But Dr. Morse developed in his research a safe, simple, and inexpensive technique for raising abalones through their first 6 months of life."

Before construction of the abalone facility can begin, however, Mullenniex needs to get approval from such agencies as the California Coastal Commission, the Department of Fish and Game, the Army Corps of Engineers, and the U.S. Coast Guard. Negotiations are underway to lease land on the east tip of Santa Cruz Island, in the Santa Barbara Channel.

"In order to get financial backers," said Mullenniex, "we need to be sure this will be a moneymaking venture. But we're also intensely aware of environmental considerations. Santa Cruz Island is like a little island in time — there are species of birds and plants endemic to the island that aren't found anywhere else in the world. We must tread carefully before putting up a single building."

Now, according to Mullenniex, "our major hurdles are leasing land, getting all the permits and approvals we need, and so on. But Sea Grant took care of the technological hurdles, and made us sure that we could raise abalones in the hatcheries to an appropriate size (about 1/2 inch) before transferring them to the grow-out facility.

"All along," he said, "there's been a serendipity factor involved in this venture, and an intimate part of this factor has been Sea Grant."

— Amanda Iles

Marine Advisory	**FY80**	**FY81**	**FY82**
Marine Advisory Program (A/EA-1, Price)	O	O	O
Publications and Public Advisory Services (A/P-1, Frautschy)	R	—	—
Communications, Publications, and Public Advisory Services (A/P-1, Sullivan)	R	O	O
Ocean Education for the Public (A/PE-1, Wilkie et al.)	O	O	O
The Golden Gate Marine Center (R/NP-1-9D, Caya)	N/C	—	—
Mobile Marine Science Outreach Program (R/NP-1-9J, Bauer)	N	C	—

C = Completed; N = New; O = Ongoing; R = Restructured

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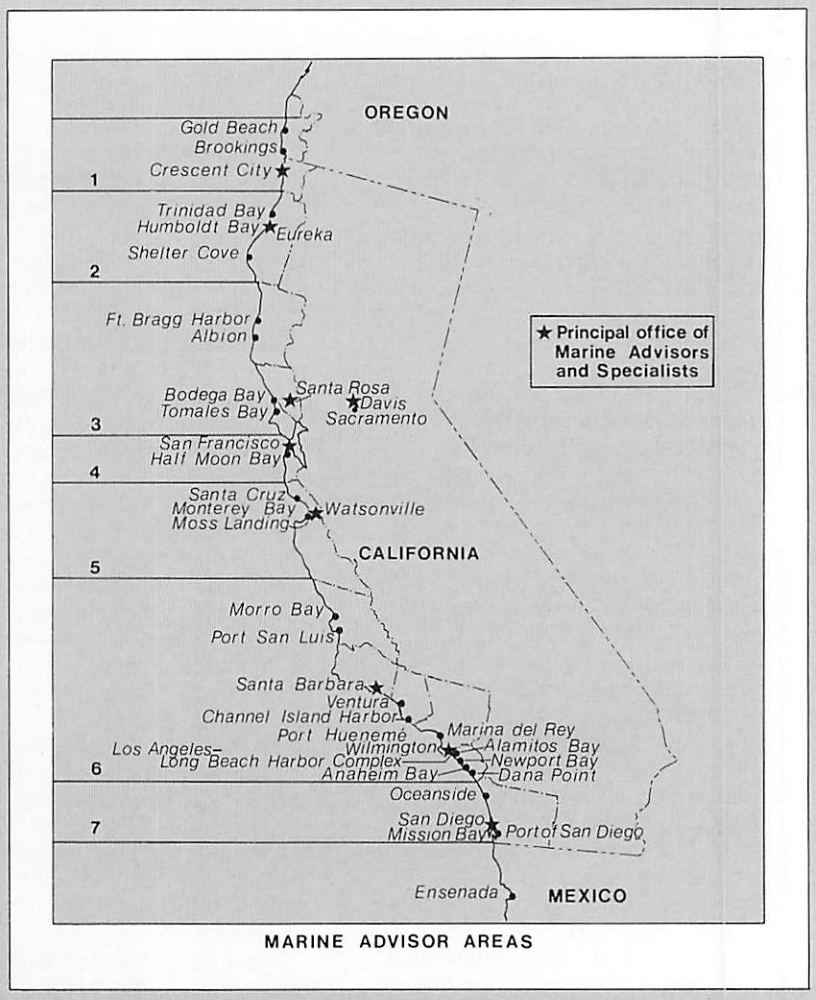

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Extreme dryness, intermittent runoff, and catastrophic flooding all affect California's coastal wetlands, but the extent to which these changes affect ecosystems is just now being understood. In the late 1970s Sea Grant researchers began investigating three major wetland ecosystems: the Tijuana Estuary, Mugu Lagoon, and Elkhorn Slough. In 1978, Mother Nature flooded the areas with fresh water laden with silt and nutrients, allowing ecologists to determine the effects of flooding on the wetland ecosystem. Normal rainfall and runoff followed for a brief period, then a second catastrophic flood occurred in 1980 — almost as if to provide the necessary scientific replication!

Since then Sea Grant researchers have had many opportunities to study coastal wetlands during normal and catastrophic conditions. Their work has resulted in substantial new insights about the role of major disturbances in controlling coastal ecosystems. The dynamic nature of these systems is now well documented, and the important linkages between coastal wetlands and upstream watersheds are clear.

Vegetation Can't Survive Nature's Spring Cleaning

SANTA BARBARA — The impact of siltation on birds, fish, and invertebrates has been documented by Dr. Christopher Onuf and his associates at UC Santa Barbara through long-term studies at Mugu Lagoon. The researchers assembled 5 years of data from permanent sampling stations and assessed the biological changes in wetland ecosystems that resulted from two floods. They compared the effects of the floods and found that the area responded very differently to each episode.

Further analysis indicated that siltation events have a cumulative effect when floods occur frequently. The first flood dumped silt in the lagoon's central basin, reducing its capacity to absorb siltation during a second flood. The second flood subsequently influenced a much larger area of the lagoon and caused greater change to the estuarine fauna. Together the floods reduced nearly 40% the lagoon's depth and volume at low water.

Flood flows and siltation greatly reduce or eliminate populations of many species and trigger increases in some others. An eelgrass bed, smothered by nearly 20 cm of silt in the 1978 flood, will probably never recover now that its subtidal habitat has become intertidal. Benthic invertebrates changed dramatically as areas of sand became covered with silt. Abundances of most species declined after the 1978 flood. Sand dollars began to recover after the 1980 flood, only to be decimated after heavy rains in 1983. Topsmelt and shiner surfperch, dominant in the fish community in 1977, are now only a minor fraction of their preflood densities. Birds showed little change overall, but surface-feeding shorebirds increased each year because siltation created a suitable habitat for surface-feeders.

Dr. Onuf is now assembling his 5-year data base into an estuarine profile to be published by the U.S. Fish and Wildlife Service. His profile, the most comprehensive summary of long-term research in a single southern California lagoon, will complement the regional community profile on southern California coastal salt marshes prepared last year by Dr. Joy Zedler. (R/CZ-52)

Upstream Water Management Imperils Estuary Life

SAN DIEGO — Flood effects on vegetation have been the focus of Sea Grant studies in San Diego County wetlands for many years. As with Mugu Lagoon, a long-term data base was essential for understanding the importance of disturbance events in the region's coastal ecosystems.

In a comparative study of the San Diego River and Tijuana Estuary salt marshes, Dr. Joy Zedler from San

Diego State University showed that floods can have dramatically different effects if upstream dams modify stream discharge patterns. Dams, designed to protect valuable property from flooding, can destroy coastal wetlands if floodwaters are released well after the normal rainy season. Prolonged periods of fresh water flowing into the San Diego River marsh during Dr. Zedler's study killed vegetation, leached soil of its salts, and allowed freshwater cattails to invade the area.

Dr. Zedler expected the "cattail invasion of 1980" to be repelled as marine waters again resumed their influence. But the species proved more tolerant of salt than expected. Although stressed by saline soils in recent years, the cattail population persisted and again flourished with the heavy rainfall and long period of freshwater runoff in 1983. A single catastrophic event can allow a species to establish itself when it otherwise would not be able to tolerate the environmental conditions. Once established, the species can persist.

The patterns of stream discharge at the Tijuana Estuary were less catastrophic than at the San Diego River marsh because upstream dams are managed differently. Flood flows, restricted to the normal wet season, allowed the coastal marsh to keep much of its soil salts. The soils briefly became brackish (15 ppt), and cordgrass populations increased 40%. With these findings, Dr. Zedler advised salt marsh managers on ways to encourage cordgrass growth. Cordgrass is important because it provides habitat for the endangered clapper rail. Several wetlands restoration plans call for artificial establishment of cordgrass to restore degraded wetland areas. (R/CZ-51)

Degraded Wetlands Revived through Research

The long history of man-made and natural disturbances in California's coastal wetlands has led to Sea Grant's involvement in several restoration efforts. Restoration of degraded habitats, now mandated by the state's Coastal Act, is an effective way to mitigate losses brought about by wetland-dependent developments.

SAN FRANCISCO BAY — In February 1982, nearly 250 scientists, managers, and commercial representatives convened in Hayward, California to assess the "state of the art" of restoring and enhancing coastal ecosystems in a Sea Grant-sponsored workshop. Dr. Michael Josselyn from the Tiburon Center for Environmental Studies at San Francisco State University organized and conducted the workshop. The workshop proceedings provides a current summary of goals, methods, problems, and concerns for wetland restoration. (R/NP-1-10H)

SANTA BARBARA — Sea Grant researchers Dr. Christopher Onuf and Dr. M. L. Quammen from UC Santa Barbara teamed up with the California Coastal Conservancy and Dr. Zedler from San Diego State University to develop wetland restoration plans for a major degraded wetland, the Los Cerritos Wetland, in the Los Angeles region. Results of the Santa Barbara team's research on increased tidal flushing, after an artificial dike had been removed, proved valuable in making recommendations for enhanced tidal flow at the degraded site. (R/CZ-51, -52)

SAN DIEGO — To meet a growing demand for information on restoration techniques, Dr. Joy Zedler from San Diego State University has prepared a restoration guidebook for southern California salt marshes. The book, now in press as a Sea Grant Technical Report, resulted from a cooperative effort among marshland users and Sea Grant coastal resource scientists. A draft of the guidebook has been distributed to government agencies and consulting firms. The book provides general advice on restoration planning as well as specific methods and approaches for reestablishing key coastal marsh species. Several government agencies involved in the book's development are now implementing the book's guidelines in their restoration efforts. (R/CZ-51)

Coastal Agencies Seek Sea Grant Guidance

The State Coastal Conservancy and the Coastal Commission rely heavily on Sea Grant researchers for advice on wetland management and restoration. For example, the Conservancy provided additional

Coastal Resources	FY80	FY81	FY82
Wetlands Management in Coastal Zone Planning: A Prototype Framework for Relating Natural Science and Land-Use Planning (R/CZ-45, Dickert/Nybakken)	C	—	—
An Experimental Program to Develop Methods for Kelp Bed Expansion and Enhancement (R/CZ-46, Neushul/Coon)	C	—	—
A Study of the Entrance Problems at Humboldt Bay (R/CZ-47, Isaacs/Kerstetter)	C	—	—
Analysis of Coastal Ocean Mixing Models (R/CZ-48, List/Morgan)	N	C	—
Coastal Wetlands Management: Restoration and Establishment (R/CZ-51, Zedler)	N	O	O
Coastal Wetlands Management: Application of Biological Criteria (R/CZ-52, Onuf et al.)	N	O	C
Investigation of Coastal Bluff Retreat for the Trinidad Headland Area of Northern California (R/CZ-53, Carver)	N/C	—	—
Phosphorites Along the Central California Continental Margin (R/CZ-54, Mullins)	—	N	C

support to Sea Grant researchers to restore transitional areas between the Tijuana Estuary and surrounding upland and urban habitats. Sea Grant trainees surveyed areas previously compacted by extensive off-road vehicle use and made recommendations for reestablishing vegetation on bare sites in conjunction with Dr. Zedler's Sea Grant project on wetland restoration and establishment. (R/CZ-51)

Estuarine Sanctuaries Get Big Boost from Sea Grant

With the recent designation of the Tijuana River Estuary and Elkhorn Slough as National Estuarine Sanctuaries, California has an important role in preserving these unique ecosystems for education and research. Recognized for their past contributions to science and teaching, the Tijuana Estuary and Elkhorn Slough join eight other U.S. estuaries presently being managed for future use by investigators and instructors.

To be recognized as National Estuarine Sanctuaries by the Office of Coastal Zone Management, both estuaries had to meet stringent criteria, including a sound record of research use. Sea Grant research at these sites contributed substantially toward that recognition.

Today Sea Grant scientists continue to help managers carry out sanctuary goals. At Elkhorn Slough, Sea Grant researcher Dr. Greg Cailliet from the Moss Landing Marine Laboratories serves as an advisor to the Sanctuary Advisory Committee. At the Tijuana Estuary, Dr. Joy Zedler from San Diego State University chairs the Management Authority's Research and Education Subcommittee.

Now that the Tijuana Estuary and Elkhorn Slough are designated sanctuaries, both areas are available for long-term research. With the aid of sanctuary managers, research will greatly improve conditions for field work and provide a direct line of communication with public users. Much of the wetland research conducted in these areas is being incorporated directly into interpretive information already. For example, Sea Grant recently worked with the Southwest Wetlands Interpretive Association to publish a pocket field guide *Salt Marsh Vegetation: Examples from the Tijuana Estuary*, written by Dr. Joy Zedler. The guide is used by visitors of all ages who want to learn about the valuable resources and habitats in the Tijuana Estuary. (R/CZ-51)

M. Josselyn

Coastal Resources (continued)	FY80	FY81	FY82
Salt Marsh Restoration: An Ecological Evaluation of an Estuarine Mitigation Project (R/CZ-56, Barnhart/Boyd)	—	N/C	—
Planning Methods for California's Coastal Wetland Watersheds (R/CZ-57, Dickert)	—	N	O
Sea Urchin Diseases (R/CZ-58, Hinegardner et al.)	—	N	C
Water Currents and Mixing Rates in Kelp Beds (R/CZ-59, Jackson/Winant)	—	N	O
Liquefaction Potential of Coastal Fills (R/CZ-61, Noorany)	—	N/C	—
Evaluation of the Mad River Estuary (R/NP-1-9C, Crandell)	N/C	—	—
The Role of Nutrients in Supporting Phytoplankton Productivity in Humboldt Bay (R/NP-1-9E, Pequegnat)	N/C	—	—
Sea Cliff Erosion and Beach Accretion Along San Onofre State Park and Camp Pendleton, San Diego County, California (R/NP-1-9G, Shepard)	N/C	—	—
Aerial Survey of Humboldt Bay, California (R/NP-1-9I, Stork/Costa)	N/C	—	—
Studies of Light and Life in Natural Waters (R/NP-1-10C, Tyler)	—	N/C	—
Coastal Zone Geology and Related Sea Cliff and Bluff Erosion: Oceanside South to Batiquitos Lagoon, Carlsbad, Oceanside Littoral Cell, San Diego County, California (R/NP-1-10E, Shepard)	—	N/C	—
Investigation of Coastline Retreat, Humboldt County, Northern California (R/NP-1-10F, Rust)	—	N	C
Longard Tube Survey and Documentation, Del Mar, California (R/NP-1-10G, Flick)	—	N/C	—
Workshop on Coastal Wetland Restoration and Enhancement (R/NP-1-10H, Josselyn)	—	N	O
Use of Underwater Habitat as Coral Reef Research Tools (A/C-P-1, Neudecker)	—	N/C	—

C = Completed; N = New; O = Ongoing

AQUACULTURE RESEARCH AND DEVELOPMENT

Aquaculture — the controlled cultivation and harvest of aquatic plants and animals — has not yet realized its full economic potential in the United States. With the help of major research advances, however, aquaculture offers the possibility of meeting the nation's increasing demand for useable protein from the sea and reducing the nation's reliance on imported fishery products.

Aquaculture is a major component of California's Sea Grant research. In 1981-82, aquaculture research addressed problems that hinder aquaculture development of many commercially valuable marine species native to California's waters.

Pest Control Means Brighter Future for U.S. Seaweed Industry

PACIFIC GROVE — Red seaweeds have been relished as a food for hundreds of years by people in Asia, Polynesia, and Europe; it is only within the last century that edible red seaweeds have begun to interest North Americans as a marketable resource.

Dr. Isabella Abbott from Hopkins Marine Station at Stanford University concluded a 1-year study investigating physiological aspects of *Porphyra* mariculture. *Porphyra* is the seaweed most preferred in seaweed-consuming nations, and it is commonly found growing along California's coast, particularly San Francisco Bay. However, red seaweed productivity has been impaired by marine pests.

Dr. Abbott has made substantial progress toward understanding the effects pathogens and epiphytes have on *Porphyra* growth. The manipulation of environmental factors to control the growth of these "pests" will result in reduced costs and handling time for intertidal algae culture systems, thus enhancing the potential for developing a red seaweed industry in the U.S. (R/A-49)

Seaweed Mariculture Research Reaps Bonus for Orchid Growers

PACIFIC GROVE — Seaweed, often considered an ugly duckling of the plant world, has become an improbable character in a story of one of the plant kingdom's most glamorous stars, the orchid.

Orchid growers in Hawaii, tipped off by Dr. Isabella Abbott, California Sea Grant's plant aquaculture specialist from Stanford University, have begun experimenting with the seaweed extract kappa-carrageenan as a material for germinating orchid seeds.

"Orchid seeds are very small — about the same size as vanilla seeds," said Dr. Abbott. The orchid seeds need to be germinated on a medium strong enough to support them and pliable enough to allow the roots to grow. For many years, orchid growers have used bacteriological grade agar -- a seaweed extract — as the germination medium. This grade of agar is best known for its biomedical use as a medium on which bacterial cultures are grown for disease diagnosis and research. Agar is a good medium for growing orchid seeds; but because it comes from fluctuating foreign seaweed stocks, agar is expensive.

Not all seaweed species yield agar as an extract. Some species yield a similar substance called kappa-carrageenan. "Carrageenan is known as the poor relation of agar," said Abbott. "Its gel strength is not as high and it is not used in sophisticated research. But there are more plants that contain carrageenan, so the resource is more abundant."

Abbott discovered the extract's potential as an orchid "soil" while conducting her Sea Grant seaweed extract experiments at the University of Hawaii at Manoa. On the same floor as Abbott's lab, Dr. H. Kamemoto and his associates were researching orchid growth. "I had some kappa-carrageenan left over from my research," said Abbott, "and I happened to have it in my little hot hand when I encountered my cronies who do orchid research. I said, 'Hey, have you ever tried

kappa-carrageenan instead of agar?' They said no, so I gave them some of my left-over material."

Kamemoto tried some of Abbott's "cheap stuff" in a side-by-side experiment with agar. "For our dendrobium orchids," said Kamemoto, "there was no difference for growth between the two." According to Abbott, "The upshot of the experiment was that the orchids not only did as well, but some did better on the carrageenan than on the agar."

Abbott estimates that the retail price of average carrageenan is about one-fourth that of agar. Abbott's fine grade carrageenan, which Kamemoto used in his tests, is more expensive to produce than most other carrageenans and costs about the same as agar. Now Kamemoto has begun testing some less expensive grades, and results from these tests will determine whether or not the Hawaiian orchid growers will switch from agar to inexpensive carrageenan. "It all depends on price," he said. "If we see that the less expensive kappa-carrageenan works as well as the fine kappa-carrageenan, then there will be no reason to use agar for orchids anymore."

— Amanda Iles

H. Kamemoto

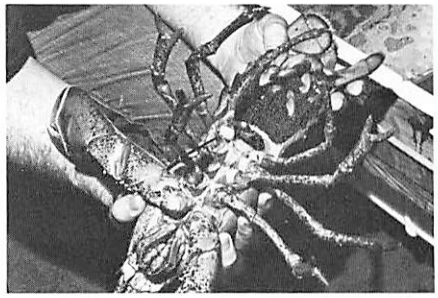
Lobsters Breed, Ready or Not

RIVERSIDE — Lobster aquaculturists no longer have to wait for their lobsters to mate, thanks to the efforts of Sea Grant researcher Dr. Prudence Talbot at UC Riverside. Dr. Talbot has explored the basic mechanisms involved in lobster fertilization, and she and her staff have developed a technique for collecting viable sperm from live male lobsters that should be directly applicable to aquaculture technology for lobsters and other crustaceans.

The technique, electrically induced extrusion of lobster spermatophores, provides a source of sperm in its natural packet for further experimentation, artificial insemination, and genetic crossing. Dr. Talbot's techniques are now being used with great success by aquaculture firms in Monterey and Oxnard. Freshly molted female lobsters have been artificially inseminated with the electrically induced sperm, and several of these females have successfully spawned. Most of the females' eggs appeared normal and were fertilized.

The researchers also began testing a technique they developed for long-term storage of sperm. Dr. Talbot reported that spermatophores stored more than 8 months still show viable sperm, thus laying the groundwork for future "lobster sperm banks."

In related work at UC Riverside, Dr. Prudence Talbot, in conjunction with Dr. Dennis Hedgecock of the Bodega Marine Laboratory, is determining if sperm production in laboratory male lobsters is seasonal, and they are determining if epibiotic bacteria on spawned lobster eggs cause eggs to drop off pleopods before larvae have a chance to hatch. The research on sperm production is ongoing and will be completed in about a year. The studies on bacteria-egg interactions showed that *H. gammarus* eggs are coated with fewer epibiotic bacteria than are *H. americanus* eggs, which, the researchers feel, is cause for further investigation. It is possible that controlled growth of surface bacteria may alleviate the egg drop problem. (R/A-46)



Rock Scallops Ready for Commercial Development

SAN DIEGO — Survival and healthy growth — not weight control — are the reasons rock scallops at Scripps Institution of Oceanography (SIO) are still dieting today. Using a specially-designed laboratory at SIO, Drs. Charles Phleger and David Leighton from San Diego State University continue to refine and develop aquaculture technology for the purple-hinge rock scallop.

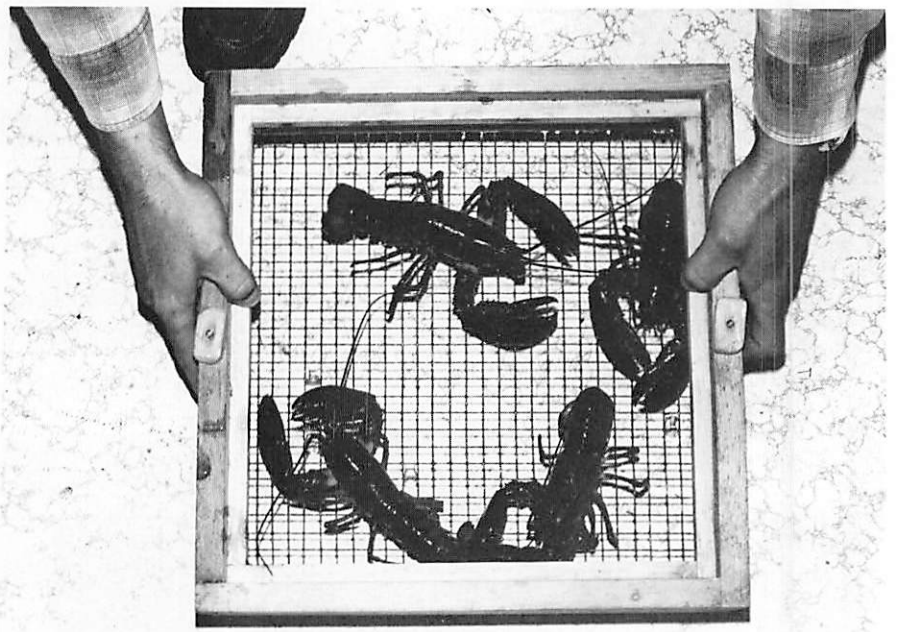
Drs. Phleger and Leighton have successfully maintained and conditioned broodstock rock scallops in the laboratory. They spawned scallops from experimental groups to produce viable larvae, which means that hatcheries may no longer have to depend on wild gravid adults. The researchers also developed techniques for collecting rock scallop juveniles in the ocean. Spat collector bags packed with gill nets were effective juvenile collectors when placed in the ocean for 3-4 months during the rock scallop spawning periods.

In addition, Drs. Phleger and Leighton obtained a U.S. patent on the plastic rearing panel they invented in the first years of their Sea Grant research. The tools and techniques developed in this project will allow the development of valuable alternate sources of scallop seed stock and should stimulate the commercial development of rock scallop aquaculture. (R/A-44)

New Techniques Improve Shellfish Production

SANTA BARBARA — New techniques for improved production of commercially valuable shellfish have been developed by Sea Grant researchers at the Marine Science Institute at UC Santa Barbara. With the cooperation of commercial shellfish producers, Dr. Daniel E. Morse and his staff have developed and extended techniques for economically efficient control of reproduction, larval development, settlement, and metamorphosis in a number of commercially valuable species of abalones, oysters, scallops, mussels, clams, and other molluscs.

One biomedical technique they developed for inducing larval settlement and metamorphosis is less expensive and more useful than current methods and may prove applicable to other species of valuable shellfish. The researchers have also identified principal factors responsible for the slow growth rate of cultivated abalones and subsequently identified two natural hormones that safely accelerate abalone growth rate. The results of Morse's research increase the economic efficiency of shellfish production, increase the number of mollusc species that can be profitably cultivated, and extend geographical areas where cultivation can occur. (R/A-43)



Lobster Farms and Sturgeon Ranches: The Future is Now

DAVIS — The development of a diversified and economically viable sturgeon and crustacean aquaculture industry in California is the goal of UC Davis researchers at Bodega Marine Laboratory. Drs. Wallis Clark and Douglas Conklin are leading an interdisciplinary Sea Grant team of researchers conducting projects dealing with the aquaculture of sturgeon, shrimp, lobster, and brine shrimp. Their research attacks the problem in six related areas: broodstock development, endocrinology, larval biology, nutrition, engineering, and pathology.

By 1981, the research team had 1) successfully raised juvenile lobsters to 1-pound market size exclusively on an artificial diet, 2) determined optimum levels of nutrients to begin formulation of cost-effective rations, 3) supplied artificial diets to industry and researchers for raising prawns and lobsters, 4) developed techniques for totally controlled reproduction in the marine shrimp *Sicyonia ingentis* (Penaeidae), 5) developed a flow chart identifying pathogenic marine bacteria that will help mariculturists treat diseases more rapidly and effectively, and 6) provided disease diagnosis to several California fish hatcheries.

In 1981-82 the researchers refined control of lobster reproduction; with Dr. Gall, developed techniques to determine sturgeon genetic structure; with Dr. Crowe, developed cryopreservation techniques suitable for sturgeon sperm; with Dr. Hedgecock, established broodstock for controlled spawning and development of molluscs; with Dr. D'Abramo, determined the American lobster's nutritional requirements; with Dr. Chang, investigated hormonal regulation of growth, development, and metamorphosis in crustaceans and molluscs; and with Dr. Hedrick prevented, detected, and controlled diseases observed in cultured crustaceans.

Last year Dr. Hedgecock developed an operational broodstock husbandry management plan which allows calculation of the size and economics of maintaining broodstock for a commercial lobster farm. Drs. Clark and Crowe developed a technique for storing sturgeon seminal plasm in an oxygen atmosphere for a minimum of 10 days, offering immediate advantages for hatchery operations. (R/A-45)

Oysters' Nutritional Needs Assessed

IRVINE — Amino acids, vital in maintaining the health of human beings, may have an important role in the nutrition of oysters and other marine bivalves. Dr. Grover Stephens from UC Irvine is assessing the role of amino acids and organic solutes in marine bivalve nutrition. He has found that amino acid concentrations are substantially affected by commercial mariculture procedures such as filtration and the inadvertent addition of dissolved organic solutes in particulate food. In his research, Dr. Stephens has developed bacteria-free suspensions of larvae for use as experimental material, and he has refined analytical techniques of analyzing free amino acids in seawater. He is using refined HPLC techniques to test the feasibility of supplementing mariculture diets to improve animal survival and product quality. (R/A-48)

Santa Barbara and Davis Researchers Honored by World Mariculture Society

SANTA BARBARA — Sea Grant marine biologists from UC Santa Barbara won first prize at the 1981 International Symposium of the World Mariculture Society in Venice, Italy for their revolutionary new techniques that improve production of abalones and other important commercial shellfish.

UCSB's Dr. Daniel E. Morse, professor of molecular genetics and biochemistry, and research specialists Neal Hooker and Aileen Morse devised simple, safe, and inexpensive techniques that help control reproduction, larval development, metamorphosis, survival, and growth in species of molluscs that provide important sources of food.

One biochemical technique they developed allows abalones to spawn reliably at any given time. They also learned how to culture the larvae in a way that improves the larvae's survival rate and encourages them to grow quickly.

Most exciting, according to Morse, is their discovery of a naturally occurring chemical that causes abalones to metamorphose — the change that causes minute, swimming abalones to settle to the bottom of the ocean to grow rapidly into adult abalones.

The researchers originally developed their production techniques using abalones, but now they have shown the techniques work with numerous other commercially valuable shellfish, including scallops and oysters.

"The production of nearly a dozen different species of abalone and of many other species of valuable scallops, oysters, clams, and other shellfish has been improved by the use of these techniques in California, other states, and abroad," Morse stated in a February 1982 *Genetic Engineering News* article announcing the award.

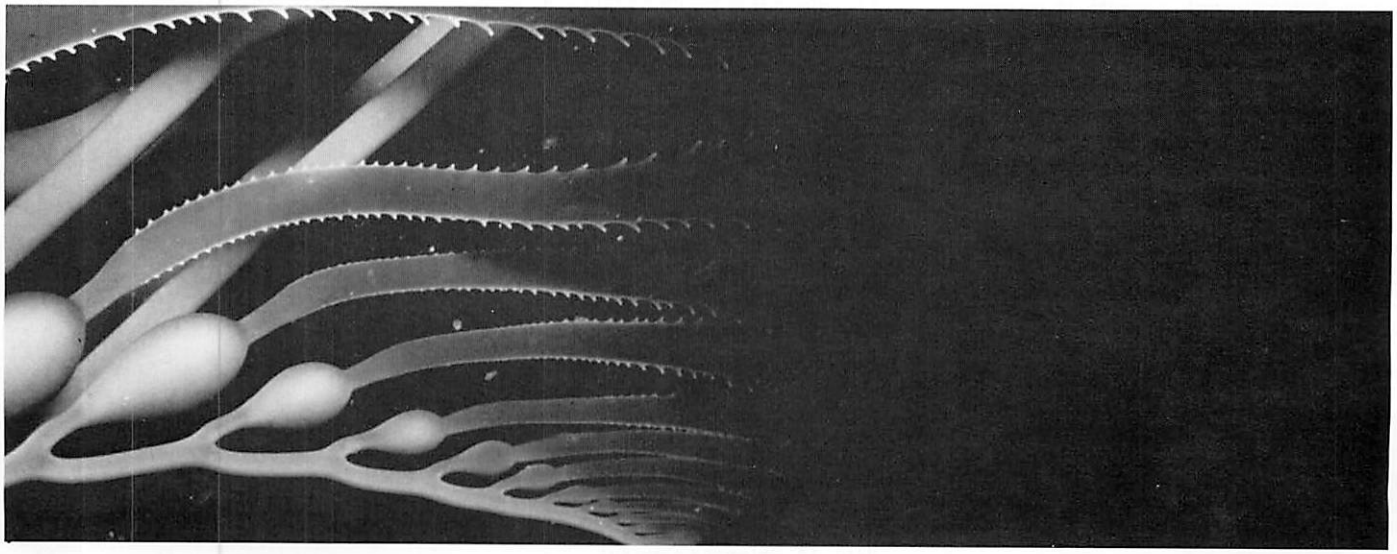
Morse's award-winning paper, entitled "Biochemical Engineering for Improved Production of Abalone and Other Valuable Shellfish," describes research funded since 1976 by the California Sea Grant College Program.

The UCSB Sea Grant research team developed the new production techniques after first identifying the underlying biochemical and genetic processes that normally regulate reproduction, development, and growth in commercially valuable molluscs. The findings described at the Venice meeting have opened the door for the next step in Morse's Sea Grant research: genetic engineering aimed at cloning specific genes to enhance the growth of abalones and other valuable shellfish.

This is the second time the researchers have received kudos from their peers in the World Mariculture Society. Morse *et al.* won first prize in 1979 for earlier Sea Grant research in the same subject area.

DAVIS — Top awards for best papers were won by Sea Grant researchers from UC Davis in May 1982 at the annual meeting of the World Mariculture Society in Charleston, S.C.

The society's "Best Paper" award went to UCD's Randal K. Buddington and Serge I. Doroshov for their paper "Early Growth of White Sturgeon (*Acipenser transmontanus*) Fed Manufactured Feeds."



The "Second Best Paper" award went to UCD researchers Louis D'Abramo, Clark E. Bordner, Douglas E. Conklin, and Nancy A. Baum for "The Effect of Various Dietary Carotenoids on Pigmentation of Lobsters Fed a Purified Diet."

The Davis sturgeon research was still in its fledgling stages when Drs. Wallis Clark and Serge Doroshov first requested Sea Grant support for the project in 1979. Sea Grant invested in the project through its Rapid Response capability, giving the researchers funds to procure wildstock sturgeon. Sea Grant uses rapid response funds to respond quickly to unanticipated or immediate marine or coastal needs.

That initial Sea Grant seed funding prompted further support for the sturgeon research program from the United States Fish and Wildlife Service of the Department of the Interior and the National Marine Fisheries Service. Since then, Sea Grant has also provided additional funding for projects investigating specific bottlenecks in sturgeon hatchery technology.

This Sea Grant sturgeon work is part of a large Sea Grant project in Aquatic Animal Production, a project in which researchers are finding answers to questions that presently restrict the culture and domestication of not only sturgeon, but lobster, shrimp, and oysters — animals important to the development of California's aquaculture and fisheries industries.

In their first-prize paper, Buddington and Doroshov describe and discuss the survival, growth, and development of white sturgeon larvae reared on various commercially produced pelleted diets. The artificial diets differ in moisture and protein content. The researchers compared the growth and development of larvae raised on these diets with those of fish raised on live foods. They emphasized the imprinting of young sturgeon on the various diets and the use of commercial diets for fingerling production.

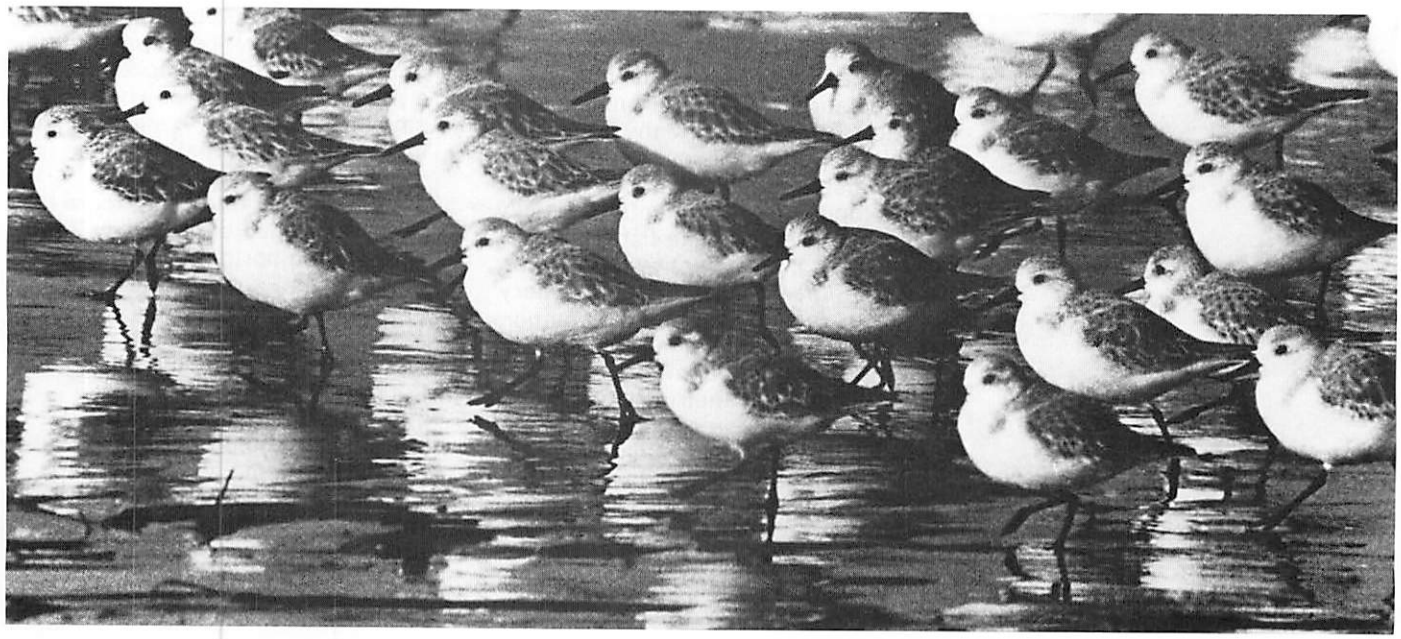
Also in the "Aquatic Animal Production" project, UCD researchers D'Abramo, Bordner, Conklin, and Baum have been conducting their award-winning lobster research at Bodega Marine Laboratory with Sea Grant support since 1978. In their second-place paper, the authors outline controlled experiments in which they looked at the metabolism, effectiveness, and cost of potential sources of carotenoids for use in commercially prepared feed. Carotenoids are pigments present in the natural diet of wild lobsters and are responsible for turning the lobster shell brick red when boiled. Use of formulated diets lacking appropriate carotenoids results in cultured lobsters that turn only slightly pink when boiled.

Because consumer acceptance of commercially cultivated lobsters will undoubtedly depend on the presence of the traditional red shell color, the Sea Grant researchers explored the use of inexpensive carotenoids in formulated lobster diets to achieve normal shell pigmentation. With this important aspect under control, the researchers are focusing on other present and potential problems that hinder the commercial production of lobsters. (R/A-28, -32, -43, -45)

Aquaculture	**FY80**	**FY81**	**FY82**
Development of the Science and Technology of Crustacean Aquaculture (R/A-28, Clark/Hand et al.)	O	C	—
Control of Reproduction in the Decapod Crustaceans (R/A-29, Talbot)	O	C	—
Studies to Refine Hatchery and Ocean Rearing Methods for the Purple-Hinge Rock Scallop (R/A-31, Phleger/Leighton)	C	—	—
Biochemical and Genetic Control of Critical Physiological Processes in Molluscan Life-Cycles: Basic Mechanisms, Water-Quality Requirements, and Sensitivities to Pollutants (R/A-32, Morse)	C	—	—
Culture of Marine Bivalves: Effects of the Uptake of Amino Acids (R/A-33, Stephens)	O	C	—
Aquaculture of Red Algae (R/A-34, Abbott)	C	—	—
An Exploratory Study of the Vegetative Propagation of Benthic Marine Algae (R/A-37, Gibor/Neushul)	O	C	—
Protective Measures Against *Fusarium* Disease in Shrimp (R/A-38, Steenbergen/Lightner)	N	C	—
Assessment of Sperm-Egg Interactions During Fertilization and Hybrid Formation of California Abalones (R/A-39, Vacquier)	N	C	—
Regulation of the Production of Dormant Cysts by the Brine Shrimp, *Artemia salina*, and Factors Influencing the Viability of Such Cysts (R/A-41, Crowe)	N	C	—
Food and Fiber from Seawater, Sand, and Solar Energy (R/A-42, Epstein)	N	C	—
Biochemical Engineering for Improved Production of Commercially Valuable Marine Shellfish (R/A-43, Morse)	—	N	O
Artificial Control of Gametogenesis, Spawning, and Larval Production in the Purple-Hinge Rock Scallop (R/A-44, Phleger/Leighton)	—	N	O

Aquaculture Projects (continued)	FY80	FY81	FY82
Aquatic Animal Production (R/A-45, Clark/Conklin)	—	—	N
Development of Procedures for Artificial Insemination and Sperm Storage in Lobsters (R/A-46, Talbot)	—	—	N
Variation in Intracellular pH and Its Effect on Hatchability of Cysts of the Brine Shrimp *Artemia salina* (R/A-47, Crowe)	—	—	N
Culture of Marine Bivalves; Nutritional Role of Dissolved Organic Solutes (R/A-48, Stephens)	—	—	N
Physiological Aspects of *Porphyra perforata* Mariculture: The Effect of Desiccation on Photosynthesis and on the Control of Epiphytes (R/A-49, Abbott)	—	—	N/C
Pathology and Bacteriology of a Disease of Crustaceans Caused by a Marine Bacterium (R/NP-1-9H, Baumann/Bowser)	N/C	—	—
Ova Development Success as a Function of Temperature and Delay in Fertilization Post Spawning (R/NP-1-9L, DeMartini)	N/C	—	—
Seasonal Growth Responses of Vegetative Axes and Spores of an Agar-Producing Marine Alga (R/NP-1-10B, Stewart)	—	N/C	—
Vegetative Propagation of Commercially Important Benthic Algae (R/NP-1-11A, Gibor)	—	—	N
The Effects of Environmental Factors on the Ability of Chemical Cues to Trigger Settlement and Metamorphoses of Bivalve Larvae (R/NP-1-11F, Shaw)	—	—	N
Control of Egg Drop in the Lobster, *Homarus americanus* (R/NP-1-11G, Talbot/Hedgecock)	—	—	N/C

C = Completed; N = New; O = Ongoing



FISHERIES RESEARCH AND DEVELOPMENT

The Sea Grant fisheries research program takes a four-way approach to increase supplies of marine protein for human consumption. Projects are designed to enhance traditional fisheries such as salmon and abalone; develop fisheries of underutilized species through biological, technological, and public policy studies; develop wise utilization and management approaches for all fisheries; and increase the use of current catch through product development.

Abalone

LA JOLLA — Enhancing California's abalone population is the aim of Sea Grant's fisheries specialist, Dr. Mia Tegner of Scripps Institution of Oceanography at UC San Diego.

Dr. Tegner tested four abalone enhancement approaches: seeding, broodstock transplantation, habitat modification, and closure. She studied the effects of habitat, looked at size-specific survivorship, and monitored changes in abalone populations resulting from previous seeding experiments and the closure at Palos Verdes. In 1981 she completed experimental plants of red and green abalone seed at Palos Verdes Peninsula and at Santa Cruz and San Miguel Islands. At Santa Rosa Island she conducted a drift-bottle experiment to study green abalone larval dispersal and continued her life table studies.

Her conclusions indicate that the growth of native abalone populations is currently limited by predation, largely by *Octopus* spp. Recruitment does not seem to be a major factor in the decrease of abalone populations.

Additional studies at Palos Verdes Peninsula indicate that green abalone recruitment is very poor despite excellent conditions for growth. A drift-bottle experiment to determine larvae dispersal showed that recruitment from distant populations is slow for animals with short-lived larvae. Many larvae released in the Palos Verdes Peninsula are likely to stay there.

Broodstock transplantation is being tested to make fishery closures more effective for species with short-lived larvae. Preliminary results indicate that transplantation mortality is low and that the animals are growing and spawning successfully in their new habitat. Because of these encouraging research results, the California Department of Fish and Game (DFG) is transplanting broodstock in Orange County where drift-bottle results suggest that larvae will remain confined to limited target areas. In addition, the DFG is using techniques developed in this research project for handling and seeding hatchery-reared juveniles in planting operations on Catalina Island. (R/F-73)

SIO

Salmon

BERKELEY — Timing the release of hatchery-reared coho salmon into seawater is a difficult problem for California salmon hatcheries. At UC Berkeley, Dr. Howard Bern and his associates are studying ways to minimize losses caused by abnormal smoltification or "stunting" that occurs when hatchery-reared salmon are released prematurely into seawater.

When the researchers looked for a developmental indicator to make sure the salmon enter the seawater at an appropriate stage, they discovered a link between a surge in salmon thyroid hormone levels — a probable indicator of when smolting will occur — and the new moon after the vernal equinox. In 1981-82 the researchers supervised the release of more than 350,000 tagged coho salmon from cooperating northern California hatcheries. Each hatchery used release dates based on the researchers' lunar hypothesis of the smoltification-associated thyroid hormone surge.

Coho salmon normally spend 2-3 years at sea before returning to their freshwater home at the hatchery. Until then, Dr. Bern is studying early returnees as indicators of the major group's migratory success and seawater survival.

The researchers also conducted tests at the Pacific Biological Station in Nanaimo, British Columbia, to identify the aspect of the lunar phase that is responsible for the thyroxin surge. Their studies indicate that moonlight does not appear to be the timing factor. The researchers are expanding their studies to determine the possible causes of poor returns of steelhead and king salmon. (R/F-45)

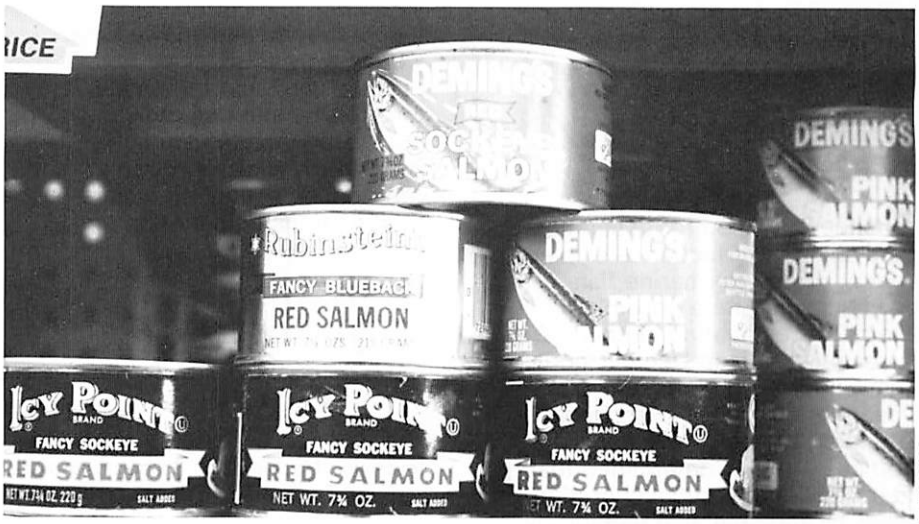
More Salmon

DAVIS — In a cooperative study between UC Davis and NMFS in Seattle, Washington, Drs. Graham Gall and Fred Utter used gel electrophoresis techniques to identify genetic variability in several populations of coho salmon in the Pacific northwest. By quantifying genetic variation in both natural and hatchery stocks, and by identifying accurate genetic markers, Drs. Gall and Utter will be able to assess the impact of hatchery-reared coho salmon on natural populations. (R/F-76)

HUMBOLDT — To control when salmon smolt, researchers need to understand the physiological changes fish undergo during the smolting process. Drs. Theodore Kerstetter and William Allen from Humboldt State University have determined that fat depletion, which occurs in salmonids during the smolting process, may be caused by endocrine mechanisms similar to those in mammals. Dr. Kerstetter identified several fat storage organs in steelhead trout, and he discovered that blood serum and the tissues surrounding the organs diminished in triglyceride content during the smolting season.

Drs. Kerstetter and Allen purified a key enzyme of triglyceride breakdown from mesenteric fat; the enzyme was then identified in dark muscle, where its activity seems to increase during smoltification. This information on fat metabolism changes in smolting salmon supplements ongoing salmon research at UC Berkeley. (R/F-79)

In a related salmon project at Humboldt State University, Dr. Thomas Hassler has determined that morpholine is an effective imprint compound for coho salmon. Coho salmon imprinted with morpholine in two separate experiments returned to the hatchery fish ladder in significantly greater numbers than nonimprinted fish. There was no difference in returns of imprinted and nonimprinted chinook salmon, but this may have been due to disease, a late release date, and low river flows on the release and return dates. (R/F-77)



T. Morgan

Crab and Lobster

SANTA BARBARA — To improve the efficiency of commercial shellfish fishing, Dr. James Case from the Marine Science Institute at UC Santa Barbara analyzed bait and trap functions and 1) demonstrated for the first time that different species prefer different baits, 2) determined the rate of bait dissolution necessary for efficient trapping, 3) established the odorant 4) concentration field around traps, determined the contribution of vision 5) to bait localization, and determined that there exists a societal factor in search behavior. Dr. Case developed a theoretical model of the role of odorants in foraging behavior, based on data collected in this study.

A large behavior tank allows the researchers to observe directly the lobster's orientation behavior in the presence of baits and traps. Preliminary results from this project demonstrate that some baits are being inefficiently used by commercial fishermen and seafood industries.

For example, most shellfish fishermen prefer to use abalone bait — a potent, expensive bait that is in short supply. The UCSB researchers have shown that fishermen can cut in half the amount of abalone bait they presently use and still maintain the same catch yields. They have also shown that mackerel bait, a less expensive and less potent bait, increases in effectiveness when it is ground. The potential cost savings of these two findings should have a substantial impact on the economy of shellfish fishing. (R/F-67)

More Crab

ARCATA — To determine the vital statistics of northern California's female dungeness crab stock, Dr. David Hankin at Humboldt State University marked and released 5,000 adult females in 1980-81 in an ocean mark-recovery program to generate molt increment data. Dr. Hankin is investigating the hypothesis that variations in the abundance of female crabs, which are not currently fished, may be

involved in the cyclic nature of crab landings. Cooperating fishermen returned the released crabs, which the researchers studied for changes in size.

With this data, Dr. Hankin has described the vital demographic statistics of female dungeness crab stock in northern California, including a female growth curve, a fecundity-size relationship, female age composition and abundance, and female survival rates. This information, though primarily biological in nature, will help the Department of Fish and Game evaluate present fishery management practices. (R/F-72)

Zooplankton

LA JOLLA — A new weight-dependent method for estimating zooplankton production — a major energy source for marine fish — has been shown to be a possible alternative estimating method. Drs. Michael Mullin and Daniel Goodman from Scripps Institution of Oceanography at UC San Diego evaluated the new estimation method. They've determined that their studies of vertical migration behavior and selective feeding by zooplankton may need to be considered in estimates of secondary production. Vertical migration is important because it has the effect of moving zooplankton in and out of regions where food is, hence affecting zooplankton feeding and growth. Zooplankton reject some types of particulate matter; thus one cannot estimate their feeding rates simply by estimating total particulate matter present, an approach that was previously considered correct. (R/F-62)

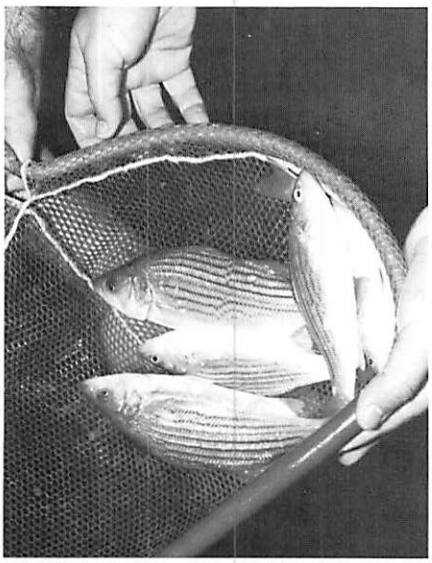
Still More Crab

SANTA BARBARA — To determine the effect of nemertean egg predators on the dungeness crab fishery, Dr. Armand Kuris from the Marine Science Institute at UC Santa Barbara monitored densities of egg-predator worms in populations of dungeness crab from central California to Alaska. He discovered epidemic levels of worm infestation in crabs from central California to Washington and low worm densities in Alaska. His laboratory studies showed that worms were transferred to soft crabs at molt and from male to female crabs during copulation. Laboratory feeding studies showed that worms grew more rapidly and reproduced sooner on isolated eggs than on eggs held by the female crab. (R/F-75)

Anchovy

IRVINE — In a long-term study of the relationship between anchovy availability and gull reproductive biology in southern California, Dr. Hunt from UC Irvine collected and analyzed data on the reproductive and eating habits of western gulls and murrelets on Santa Barbara and Anacapa Islands. The Fishery Conservation and Management Act of 1976 requires that environmental consequences as well as biological and economic concerns are considered in fisheries management — the kind of information this assessment of seabird and anchovy relationships is designed to provide. Changes in the northern anchovy population in southern California has directly affected the production of young western gulls, and it may also have altered the survivorship of the fledglings, thus explaining why overall recruitment has dropped. (R/F-64)

Fisheries	FY80	FY81	FY82
Improved Marine Food Products and Marine Food Technology (R/F-32, Brown)	C	—	—
Design and Development of a Squid Processing Machine (R/NP-1J, R/F-33, Singh)	C	—	—
Bioconversion of Chitin Wastes (R/F-34, Carroad)	C	—	—
Development of Multispecies Management for Kelp Bed Resources with an Emphasis on Sea Urchins (R/F-36, Tegner)	O	C	—
The Effects of Food Availability on the Growth and Survival of California Jack Mackerel Larvae (R/F-44, Mullin/Lasker)	C	—	—
Endocrinology of Normal and Abnormal Salmon Smoltification and Adaptation to Seawater (R/F-45, Bern)	O	C	—
Artificial Imprinting of Chinook Salmon in a Multispecies Hatchery (R/F-46, Hassler)	C	—	—
Experimental Abalone Enhancement Program (R/F-47A, Tegner)	O	C	—
Experimental Abalone Enhancement Program (R/F-47B, Connell)	C	—	—
Sensory and Behavioral Effects of Pollutants on the Crab and Lobster Fishery (R/F-48, Case)	C	—	—
Genetic Improvement of a Chitinase-Producing Microorganism (R/F-50, Ogrydziak)	C	—	—
Coordination of Federal, Regional, and State Policies for Managing Marine Fisheries (R/F-51, Moore/Wyner/Cicin-Sain)	C	—	—
Economics of Fisheries and Aquaculture Development (R/F-52, Johnston/Hand)	O	O	C



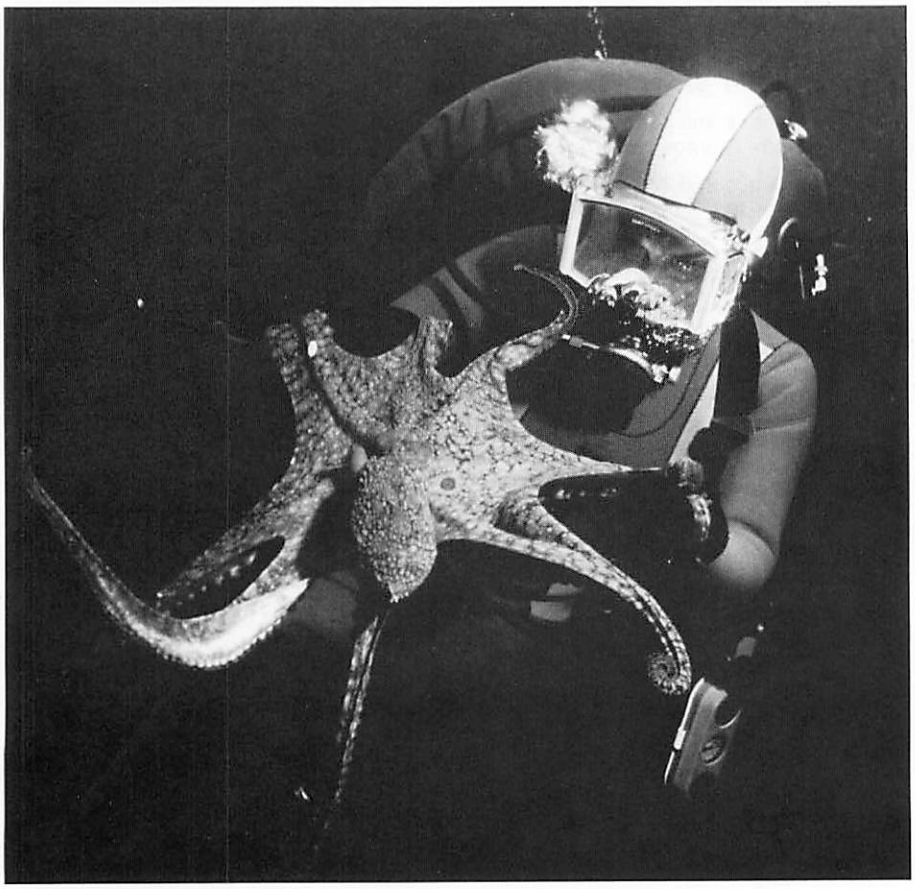
J. Carlberg

Fisheries Projects (continued)	FY80	FY81	FY82
An Economic Analysis of the California Abalone Fishery and the Experimental Enhancement Program (R/F-53, Deacon)	O	C	–
Assessment of Aging Techniques and Their Application to Elasmobranch Fisheries (R/F-57, Cailliet)	N	C	–
Multiple Species Utilization of the Herring Eggs-on-Seaweed Fishery (R/F-58, Abbott)	N	C	–
Storage Stability of the Purple-Hinge Rock Scallop, *Hinnites multirugosus* (R/F-59, Josephson)	N/C	–	–
Demographic Analysis of Porpoise Populations Subject to Time-Varying Tuna-Net Mortality (R/F-56, Goodman)	N	C	–
Economics of Multipurpose Fishing Vessels: Assessment and Policy (R/F-61, Holt)	N	C	–
A New Method for Estimating the Energy Available to Fisheries (R/F-62, Mullin/Goodman)	–	N	C
Functional Structure of Fish Assemblages of the Southern California Sublittoral Soft-Bottom Habitat (R/F-63, Rosenblatt)	–	N/C	–
Anchovy Management and Stock Assessment: Seabird Reproduction as an Indicator (R/F-64, Hunt)	–	N	C
Parasites as Biological Tags for Pacific Herring Stock Identification (R/F-65, Moser)	–	N/C	–
Improving Efficiency of Commercial Shellfishing by Analysis of Bait and Trap Functions (R/F-67, Case)	–	N	O
Seafood Science and Technology: Modified Atmosphere Storage (R/F-68, Brown)	–	N	C
Seafood Science and Technology: Microbiology of Fish (R/F-69, Barrett/Ogrydziak)	–	N	C
Chitin Waste Utilization (R/F-70, Carroad/Ogrydziak)	–	N/C	–
Water Conservation and Pollution Abatement in Seafood Processing Through Water Recycling (R/F-71, Carroad/Price)	–	N	C
Vital Statistics of the Female Stock of Dungeness Crab (*Cancer magister*) in Northern California (R/F-72, Hankin)	–	N	O
Evaluation of the Experimental Abalone Enhancement Program (R/F-73, Tegner)	–	–	N
Field Evaluation of An Abalone Enhancement Test Plant (R/F-74, Schmitt)	–	–	N/C
Effect of Nemertean Egg Predators on the Dungeness Crab Fishery (R/F-75, Kuris)	–	–	N
Genetic Structure of Coho Salmon Populations on the Pacific Coast (R/F-76, Gall/Utter)	–	–	N
Artificial Imprinting of Chinook and Coho Salmon in a Multispecies Hatchery (R/F-77, Hassler)	–	–	N
Endocrine Control of Salmonid Development and Seawater Adaptation (R/F-78, Bern/Nicoll)	–	–	N

(continued on next page)

Fisheries Projects (continued)	FY80	FY81	FY82
Biochemistry of Fat Depletion During Salmonid Smolt Transformation (R/F-79, Kerstetter/Allen)	—	—	N/C
An Economic Analysis of the Gains from Joint Management of Fishery Stocks (R/NP-1-9A, Johnston/Howitt)	N/C	—	—
Feasibility of Mechanical Skinning of Blue Shark (R/NP-1-9B, Singh/Katz)	N/C	—	—
Multispecies Aspects of CalCOFI 1955-59 Ichthyoplankton Data: A Source of Information for Variations in California Current Fisheries Resources (R/NP-1-9F, Loeb)	N	C	—
An Isotopic Aragonite-Water Temperature Scale Determined From Selected Shell-Bearing Marine Organisms (R/NP-1-10D, Shull)	—	N/C	—
Aquarium Energetics and Growth Rates of *Anoplopoma fimbria* (R/NP-1-10I, Somero)	—	—	N/C
Age and Growth of Pelagic Sharks: Management Information for California's Emerging Fisheries (R/NP-1-11C, Cailliet)	—	—	N/C
Vitamin and Mineral Methods Development and Standardization for Assessing the Nutritional Value of Cooked Fish (R/NP-1-11J, Josephson/Spindler)	—	—	N

C = Completed; N = New



E. Hanauer

Sea Grant researcher Dr. Mia Tegner grapples with an octopus — a major abalone predator.

FISHERIES PRODUCT DEVELOPMENT

Less Fishy Fish With Modified Atmospheres

DAVIS — The shelf life of fresh fish has been doubled by researchers at UC Davis who are testing the use of modified atmospheres (MA) in storing various fish products, including round fish, fish fillets, and minced fish.

In this long-term study, Dr. W. Duane Brown has shown that high carbon dioxide levels (80%) in modified atmospheres prevent fish spoilage, extend shelf life from 5-7 days to 14 days, and lessen skin color fading on Pacific red snapper.

In 1981-82 Dr. Brown and his associates 1) tested MA use with crustacea, molluscs, and fishery byproducts; 2) tested MA use in retail packaging; 3) evaluated MA effectiveness in preserving precooked tuna during long-term refrigerated storage; 4) continued their basic work on myoglobin oxidation; and 5) started work on a mode of action of carbon dioxide as a preservative. Results of this year's work show that MA may be used with dungeness crab and crayfish in addition to finfish.

The researchers demonstrated that nutritional quality of proteins in fish fillets stored in MA is not impaired. The researchers successfully used the Computed Protein Efficiency Ratio (C-PER) assay to test protein quality, an application which may interest pet food manufacturers who need an accurate tool for measuring food protein. The researchers also isolated an enzyme from tuna muscle, metmyoglobin reductase, which might prevent discoloration of darker fish stored in MA.

The results of this project could substantially influence the handling, distribution, and cost of a variety of seafood products. Three major seafood industries are providing technical support and fish products for this study; one firm has already used the results of this study for commercial shipping of seafood products. (R/F-68)

Also at UC Davis, Drs. Ericka Barrett and David Ogrydziak conducted microbiological assessments of fish stored in MA. They established optimum conditions for microbial analysis of MA-stored fish and identified predominant bacteria present after 21 days of MA storage. They showed that pathogenic microorganisms are not present in rockfish stored in MA at 4°C, and that predominant spoilage bacteria grew more slowly in MA than in air. (R/F-69)

Shrimp Processor Recycles Water for Double Savings

DAVIS — To conserve water and reduce water pollution in seafood processing, Drs. Paul Carroad and Robert Price from UC Davis designed and tested alternative water recycling methods at a cooperating shrimp processing plant in Sacramento. They tested the recycling system under standard operating conditions and collected data on product quality, water flows, and water quality. Their results showed that certain mechanical shrimp peelers can be operated with 42% less water without affecting efficiency, yield, or shrimp quality.

Shrimp peeling requires 20-40 gallons of water per pound of finished product, or more than 90 million gallons of water annually. The modifications proposed in this study could save 39 million gallons of water annually — a 43% savings — and could reduce the amount of wastewater generated by the same amount. A plant that processes one million pounds of shrimp in a 6-month period could save a total of $1400-$4500 with these conservation and recycling modifications, depending on municipal water and sewer rates. The shrimp processing plant selected for the study is now using the water reduction and recycling methods developed in this Sea Grant research project. (R/F-71)

Fish Knife Uses Air, not Juice

DAVIS — In a unique cooperative project among the Marine Advisory Program staff, UC Davis researchers, and the seafood industry, Sea Grant marine advisors have designed a fish filleting knife that runs on air instead of electricity. The air-powered fish processing knife tested well in filleting, steaking, skinning, butchering, and splitting operations. The knife requires less physical effort than other hand-knife operations. A Report of Invention for the knife has been filed with the UC Patent Office. (A/EA-1)

(Fisheries product development projects are incorporated in the fisheries projects list.)

NEW MARINE PRODUCTS

Since the discovery of morphine in the early 1800s, the pharmaceutical industry has developed potent substances from natural sources for new drugs to combat infection and disease. For many years Sea Grant has supported the exploration and development of marine biomedicinal resources, emphasizing the development of unused marine resources through the close collaboration of university researchers with industry scientists. Although several important medical areas are being investigated in this program, a major emphasis is placed on the investigation of marine plants and animals to isolate new medicinal agents useful in the treatment of human disease. As searches for cures for cancer, cardiovascular disease, and resistant bacterial and viral infections increase in importance, the necessity to explore new sources of safe and effective drugs cannot be overemphasized.

UC, Industry Research New Cures

LA JOLLA/SANTA BARBARA/ SANTA CRUZ — Six years ago, Sea Grant brought together researchers from UC San Diego, Santa Barbara, and Santa Cruz in an uncommon collaborative effort with several pharmaceutical industries to explore marine sources of new and useful chemicals. The Marine Chemistry and Pharmacology Program grew out of this initial collaboration, and today Sea Grant researchers in the program are defining the biological properties and therapeutic value of chemicals derived from soft corals, algae, sponges, and nudibranchs collected from the California coast, the Gulf of California, and tropical regions including Honduras, the Tonga Islands, and Palau.

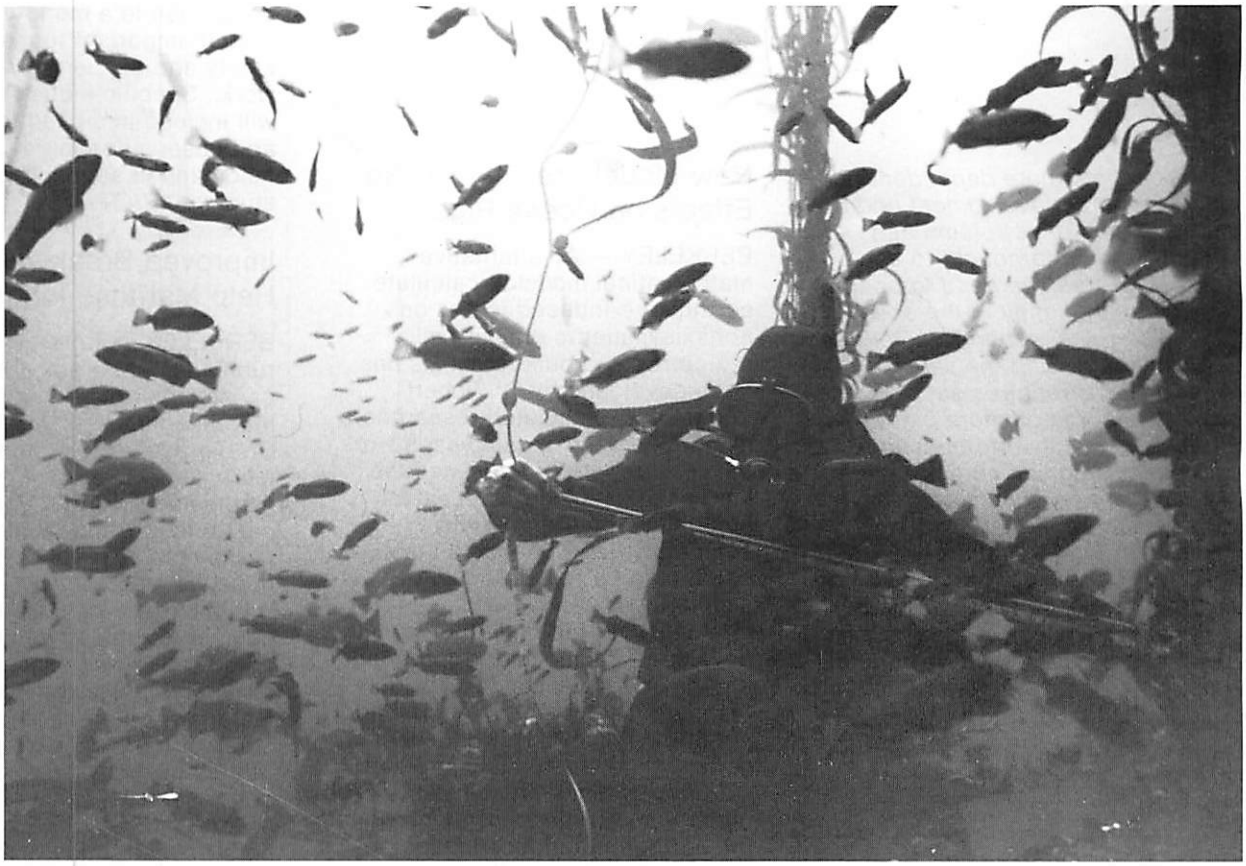
During 1981-82, researchers at UC Santa Cruz and Scripps Institution of Oceanography at UC San Diego continued to isolate and purify potential drug candidates for researchers at UC Santa Barbara, who identify and document the compounds' pharmacological properties.

In 1981-82 Dr. Phillip Crews from UC Santa Cruz and Drs. William Fenical and John Faulkner from Scripps Institution of Oceanography, UC San Diego, continued to isolate and purify structurally defined compounds for their UCSB colleague, Dr. Robert Jacobs, who identified the compounds' pharmacological properties.

Drs. Fenical and Faulkner from UCSD collected 20 new species of gorgonians along Baja California and the Bahama Islands; Dr. Crews at UCSC collected 17 toxic organisms in French Polynesia, including seaweeds, sponges, and soft corals.

A majority of the crude extracts and compounds supplied to UCSB have shown interesting pharmacological activities. In particular, lophotoxin, pseudopterolide, and stypoldione are scheduled for advanced testing and additional compound isolation. Because lophotoxin possesses potent toxicity and lacks the classical chemical structure usually found in this kind of compound, lophotoxin was consistently requested by numerous research laboratories interested in investigating neuromuscular physiology. Sufficient quantities of lophotoxin were provided to four major pharmacological laboratories for further studies. Once initial discoveries are made, substances

W. Fenical



are transferred to the proper collaborating industry for further testing and possible development; the National Cancer Institute in Washington, D.C. provides additional testing.

Stypoldione, a potent inhibitor of cell division, appears to be useful in cancer chemotherapy. In collaboration with Dr. Jacobs at UCSB, Drs. Fenical and Faulkner at UCSD discovered a new group of anti-inflammatory agents, and they found a new source of quinone antibiotics related to antitumor antibiotics.

Several industries including Syntex Laboratories, Inc. in California and Lilly Laboratories in Indiana are collaborating with the researchers to translate the results of this research into new products. Once initial discoveries are made, substances are transferred to the proper collaborating industry for more costly testing and possible development. The National Cancer Institute in Washington is providing particularly important support for the biotesting of potential anticancer drugs. (R/MP-21,-22,-23,-24)

New Marine Products	FY80	FY81	FY82
Marine Plants as a Source of Insect Growth Inhibitors (R/MP-14, Crews)	C	—	—
Pharmacological Evaluation Program (R/MP-15, Jacobs)	C	—	—
Marine Natural Products for Pharmacological Evaluation (R/MP-16, Faulkner)	C	—	—
New Agricultural Chemicals from Marine Organisms (R/MP-18, Fenical)	C	—	—
Antiviral Compounds from Algae (R/MP-20, Vedros)	C	—	—
Marine Chemistry and Pharmacology Program: Pharmacological Screening and Evaluation (R/MP-21, Jacobs)	—	N	O
Marine Chemistry and Pharmacology Program: Chemical Studies of Tropical Marine Algae and Coelenterates (R/MP-22, Fenical)	—	N	O
Marine Chemistry and Pharmacology Program: Chemistry of Sponges and Opisthobranch Molluscs (R/MP-23, Faulkner)	—	N	O
Marine Chemistry and Pharmacology Program: Natural Products from Toxic Marine Organisms (R/MP-24, Crews)	—	N	O

C = Completed; N = New; O = Ongoing

OCEAN TECHNOLOGY

As we become more dependent on marine mineral development and the transportation of petroleum and other hazardous products to and from our shores, the need to operate safely and efficiently in the ocean becomes critical. There are serious questions regarding the safety of major ocean structures such as breakwaters and offshore platforms. Ship casualties lead to questions about vessel design and operating characteristics. Continued deep-sea exploration and construction of ocean structures require advanced remote visual imagery, which can be severely limited by water turbidity. These are just a few of the issues addressed by Sea Grant researchers in the increasingly important field of Ocean Technology.

C. Cary

New Model Predicts Quake Effects on Ocean Rigs

BERKELEY — An alternative mathematical model to calculate earthquake-induced forces on nonaxisymmetric offshore oil structures and bulk terminals has been developed by Dr. Robert Wiegel and associated researchers at UC Berkeley. In last year's work, the researchers programmed the mathematical model on a digital computer, and their results compared well with model tests conducted on the earthquake simulator.

In 1981-82 the researchers developed the model for both rigid and flexible columns. So far the tests are yielding much information about the magnitude, frequency dependence, and coupling related to submerged tanks and caissons. The numeric model successfully predicts the earthquake-induced loads on axisymmetric large offshore structures. The computer program developed in this project is now available for use. It should be extremely valuable in the design of ocean structures subject to seismic loadings, especially structures that are nonaxisymmetric. (R/OT-1)

TV Improves Underwater Work, Safety, Efficiency

LA JOLLA — A TV-sonar display to improve underwater observation and manipulator control is being developed by Dr. Victor Anderson at UC San Diego. Preliminary development of the system occurred in the first year, with a fabrication of both the TV interface and the 2-dimensional scanning sonar system.

In 1981-82 the researchers debugged the sonar and TV display software and evaluated tests on the composite TV/sonar display. Once the display system is operational, the researchers will evaluate the effectiveness and manipulator control of the composite display. The display should improve perception of underwater objects in turbid water and add depth perception to a mono-view TV image — both important to maintaining safety and efficiency in underwater work. Specific industry applications will include improved remote work and observation in deep offshore oil fields and in seabed disposal studies. (R/OT-3)

Improved Breakwaters Will Help Maritime Industry

BERKELEY — Core deficiencies in rubble mound breakwaters can cause major problems for the maritime industry. At UC Berkeley, Dr. Ben Gerwick is developing a more comprehensive and thorough methodology for the design, construction, and quality assurance of the core of rubble mound breakwaters.

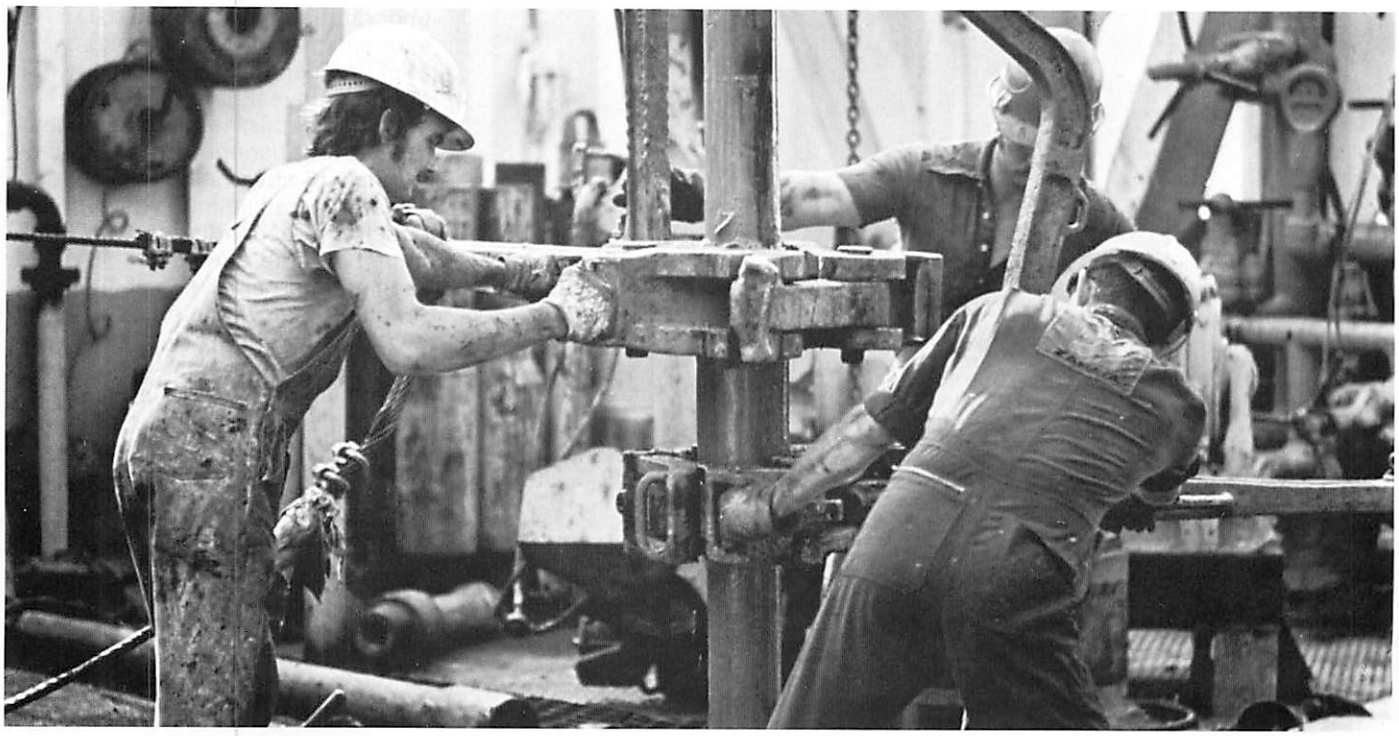
In his research Dr. Gerwick compared rubble mound breakwaters and similar aquatic structures, reviewed criteria for core material, and prepared a detailed study of foundation preparations. The results of this project will allow better selection of durable and sound materials and will lead to better construction procedures. (R/OT-5)

New Computerized System Will Allow Work on Seafloor

LA JOLLA — A seafloor work system is in its first design stages at the Marine Physical Laboratory of Scripps Institution of Oceanography, UC San Diego. Dr. Victor Anderson has made design decisions on basic component configurations, and software development is proceeding as planned. The shipboard development computer hardware has been delivered, and Dr. Anderson estimates the vehicle will be completed in 1984. (R/OT-6)

Ocean Technology	FY80	FY81	FY82
Earthquake Loading on Large Offshore Structures: An Application of Experimental Data to Practical Structure Forms (R/E-14, Penzien)	C	—	—
Side-Scan Sonar Mapping and Computer-Aided Interpretation of the Geology of the Santa Barbara Channel (R/E-18, Luyendyk/Simonett)	C	—	—
A Condensing Turbine for the Distillation of Seawater (R/E-22, Manalis/Lee)	C	—	—
Temperature Tolerances of Benthic Marine Invertebrates and Their Relationship to Regulatory Requirements for Thermal Effluent (R/E-23, Ford/Van Olst)	C	—	—
Earthquake-Induced Forces on Nonaxisymmetric Offshore Structures (R/OT-1, Wiegel)	—	N	O
Hydrodynamics of Harbor Entrances and the Maneuverability of Ships Moving Through Entrances (R/OT-2, Webster)	—	N	O
TV/Sonar Imaging System (R/OT-3, Anderson)	—	N	O
Development of a Methodology for the Design, Construction, and Quality Assurance of the Core of Rubble-Mound Breakwaters (R/OT-5, Gerwick)	—	—	N
Design of a Sea-Floor Work System (R/OT-6, Anderson)	—	—	N
Bioelectric Toxicity Assaying (Phase I) (R/NP-1-9M, Anderson)	N	O	C
Application of Advanced Methods of Magnetic Reconnaissance (R/NP-1-10A, Macdonald/Miller)	—	N	C

C = Completed; N = New; O = Ongoing;

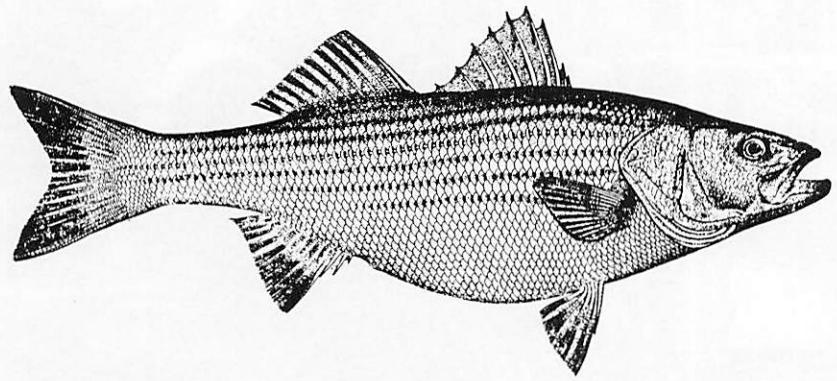


MARINE AFFAIRS

Sea Grant activities in Marine Affairs recognize both the increasing importance of research in marine resource policy making and the need to better coordinate broad policy research in other subject areas. Marine Affairs research brings together public-policy projects associated with coastal resources, aquaculture, fisheries development, and ocean technology. It brings to light the socioeconomic implications of new scientific and technological research information and makes this information available to policy makers who must respond to marine issues.

Behavior Predictions Help Fishery Management

DAVIS — Statistical forecasting models have been developed by Sea Grant researchers Drs. James Wilen and Richard Howitt at UC Davis to help managers make regulatory decisions affecting fisheries. Using the pink shrimp fishery as an example, the researchers developed a theory of fisherman behavior by developing a data set, related computer programs, and conceptual models incorporating geographical search decisions made by fishermen, and by testing the models statistically. When the work is completed, Drs. Howitt and Wilen will have a statistically estimated set of probabilities which will 1) allow managers to predict fishermen destinations, 2) yield an organizational picture of information exchanges and some welfare and policy statements, such as an estimate of producer's surplus, and 3) allow managers to predict expected catch. (R/MA-1)



Whiting and Shrimp Fisheries Affected by Management Decisions

LA JOLLA — Dr. Daniel Goodman and Mr. Payson Stevens at Scripps Institution of Oceanography, UC San Diego, are producing a multispecies model that focuses on the ecological and social consequences of management decisions regarding the Pacific whiting (also known as Pacific hake) fishery. The researchers prepared background material for their model which analyzes the history of the fishery, policy options in the fishery's development, and interactions between the whiting and pink shrimp fisheries. To complete the model, the researchers will also examine marine mammal predation on whiting and shrimp and incidental catch of other related species during whiting fishing. The model and its analyses will serve as a test case for application of multispecies management criteria. (R/MA-2)

Historical Model Analyzes Fishery Management

BERKELEY — An investigation underway by Dr. Harry Scheiber at UC Berkeley may lead to a more systematic analysis and understanding of the political, economic, and legal variables affecting fisheries public policy. Dr. Scheiber investigated the ways scientific expertise has been used to deal with fisheries problems; the interplay of government, the research establishment, and industry in responding to fisheries crises; and the effects of fragmentation of responsibility. Dr. Scheiber is moving methodically toward his goal of providing a historical model for analyzing law and public policy affecting the management and exploitation of California's fishery resources. (R/MA-13)

Fish Prices Vary With Market Supply

DAVIS — Dr. Leon Garoyan at UC Davis analyzed the industrial organization of commercial Pacific marine fisheries in California, Oregon, and Washington to determine the existence of price differences paid to fishermen. Their preliminary analysis showed that prices fishermen receive for the same species during the same week vary among nearby ports. Using regression analyses applied to Dover, Rex sole, and sablefish prices in ports where the price differential was statistically significant, Dr. Garoyan showed that price differences between ports were due to differences in market supply. Price differences for sablefish were due to differences in buyer concentration. Both these facts offer important information to industry representatives and research economists. (R/MA-4)

History Helps Predict Fishery Policy Impacts

SANTA BARBARA — How have commercial fishermen in Monterey Bay responded to policy decisions that have affected their livelihood throughout history? UC Santa Barbara researcher Dr. W. Elliot Brownlee has nearly finished his research to answer this question by studying problems of social mobility and their relation to the fishing community, the demise of the sardine industry, and the early history of Oriental fishermen in Monterey Bay. In 1981-82 he documented and interpreted material collected in the first year of this project. The publication from this project — a complete history of the commercial sardine fishing industry in Monterey Bay — will show the historic role Monterey has played in the development of California's sardine industry and should aid predictions of the socioeconomic impacts of future changes in fishery public policy. (R/MA-7)

Transit Study Improves Coastal Access Planning

SAN DIEGO — The first comprehensive study of transit services accessing coastal recreation areas in the San Diego area has been conducted by Drs. James Banks and Frederick Stutz of San Diego State University. The two researchers, concerned with coastal transit options and policy, conducted transit planning case studies at four coastal sites in the San Diego area. They revised tentative planning guidelines for coastal transit services, and they prepared a coastal transit planning manual for transit operators, coastal zone planners, recreation agencies, and transportation planners. Using information provided by 50 organizations in the state, including the park service, local departments of transportation, park agencies, local governments, planning agencies, and transit operators, the researchers have drafted planning guidelines that provide the first comprehensive guidance to coastal zone planners related to their roles, environments, and design and operating features. (R/MA-10)

J. Sorensen

Marine Affairs	FY80	FY81	FY82
Statistical Forecasting Methods for Fisheries Management (R/MA-1, Wilen/Howitt)	—	N	C
Management of Multispecies Systems: The Pacific Hake Example (R/MA-2, Goodman)	—	N	O
Improved Procedures for Salmon Management in California: Bioeconomic Approaches (R/MA-3, Wilen/Botsford)	—	N/C	—
Analysis of Industrial Organization of Commercial Pacific Marine Fishery Markets (R/MA-4, Garoyan)	—	N	O
A Study of Direct and Indirect Economic Linkages Associated with the California Seafood Industry and an Analysis of Their Impacts on the Employment, Income, and Level of Economic Activity in California (R/MA-5, King)	—	N	C
Technological Change in the Salmon Canning Industry: Blaine, Washington, 1890-1930 (R/MA-6, Scheiber)	—	N/C	—
A History of the Commercial Fishermen of Monterey Bay—The Role of Public Policy (R/MA-7, Brownlee)	—	N	C
The Role of Individual Perception and Structural Position in the Development of Fishery Management Policy (R/MA-8, Orbach)	—	N	C
Marine Mammals/Fisheries Conflicts: Emphasis on Sea Otter/Shellfish Fisheries Conflicts in California (R/MA-9, Cicin-Sain)	—	N/C	—
Coastal Transit Service Options and Policy (R/MA-10, Banks/Stutz)	—	N	O
Law, Ecology, and Economic Change: The California Fisheries, 1850-1980 (R/MA-13, Scheiber)	—	—	N
The Politics and Policy Implications of Deep Seabed Mining: U.S. Options (R/NP-1-8I Mann)	N	C	—
A Preliminary Survey of the Impact of Limited Entry Regulations upon California Fishermen (R/NP-1-9K, Petterson/Bailey)	N/C	—	—
A Preliminary Investigation of Indochinese Refugee Adaptation to the Monterey Bay Fishing Industry (R/NP-1-9N, Orbach)	N	C	—
The Deep Seabed Hard Mineral Resources Act: Was There a Need to Precede the Development of International Law Through U.S. Unilateral Action? (R/NP-1-9"O", Lynch)	N/C	—	—
Economic Analysis of the Impact of Aquaculture on Commercial Fisheries (R/NP-1-11B, Johnston/Wilen)	—	—	N
The Distribution and Interpretation of the 1980 CIF Model and the Refinement of User-Oriented Computer Programs (R/NP-1-11D, King)	—	—	N
Exploring Conflicts Between Offshore Oil Development and Commercial Fishing in California (R/NP-1-IIH, Mann)	—	—	N/C

C = Completed; N = New; O = Ongoing

RAPID RESPONSE

Sea Grant's rapid response project supports short-term research and activities that respond to unanticipated or immediate marine or coastal problems, thus avoiding the long lead time required of projects submitted for funding in the annual proposal. A summary of representative rapid response projects funded in 1981-82 follows. (Rapid response projects are included in the appropriate project lists by subject area at the end of each section.)

Sablefish Eat Less and Stay Healthy, Even in Lab

LA JOLLA — The energetics of the sablefish, *Anoplopoma fimbria*, were studied by Dr. George Somero from Scripps Institution of Oceanography, UC San Diego. This species is a large, benthopelagic fish found in a region that extends from the Bering Sea, Alaska, to Baja California. (A substantial fishery exists north of Monterey Bay.) The researchers collected the fish off the San Diego coast at a depth of 500 meters and maintained them in a laboratory on varying amounts of food for 6 months. According to Dr. Somero, this is the first time fish have been recovered from such depths and healthily maintained in a laboratory. The fish exhibited a high tolerance for food deprivation, suggesting that wild sablefish may exist on seasonal or very limited prey, and they appear to be slow growers. This type of information will lead to improved fisheries management plans for the geographically extensive sablefish fishery. (R/NP-1-10I)

Stubborn Oyster Larvae Resist Chemicals

ARCATA — At Humboldt State University, Dr. William Shaw studied the effects of environmental factors on chemical cues that trigger settlement and metamorphosis of bivalve larvae. Dr. Shaw found that chemical inducers encourage attachment and metamorphosis in setting systems where no preferred setting substrate is used, such as in the setting of clams and cultchless oysters. The data at this point suggests that chemical inducers are not effective in settling hatchery-reared eyed oyster larvae onto cultch. (R/NP-1-11F)

Fisheries Economic Model Put to Good Use

SAN DIEGO — *The California Interindustry Fisheries (CIF) Model*, developed by Dr. Dennis King at San Diego State University, has been used to evaluate four situations on the west coast. The CIF model, which allows economic assessment of California's fishery and seafood industries, has been used by government and industry officials to interpret the true values of the commercial fisheries in relation to proposed bans on gill net fishing, closure of a portion of the salmon season, a plan to translocate the sea otter, and a proposal for a fish off-loading facility for the Port of Santa Cruz.

In 1981-82 the researchers updated and expanded their original model, making full use of all available survey data. The revised model provides essential input into fishery management decisions made by state and federal agencies. (R/NP-1-11D)

Workshop Encourages Wetlands Restoration, Enhancement

SAN FRANCISCO — Nearly 6,000 years ago, California's wetlands spanned 381,000 acres and supported exotic fish and wildlife. In the last 50 years, the state's wetlands have been almost completely destroyed by rapid and uncontrolled development.

Destruction of valuable wetlands is not unique to California, but in no other state has the loss been as great. In some regions as much as 95% of our wetlands have been destroyed.

Public alarm over uncontrolled bay and coastal development has led to changes in governmental attitudes concerning the value of wetlands as a habitat for the state's wildlife populations. A workshop on coastal wetland restoration and enhancement, conducted last year by Dr. Michael Josselyn from the Tiburon Center for Environmental

Studies at San Francisco State University, brought together 250 university researchers, government officials, nonprofit conservation organizations, and interested citizens to discuss issues relevant to coastal wetland restoration and enhancement in California.

The workshop, sponsored by the California Sea Grant College Program and the California Coastal Commission, had a twofold purpose: 1) to summarize what we currently know about wetland restoration and enhancement in California and, 2) to address current problems and constraints that limit our ability to successfully restore wetland systems. The workshop proceedings, *Wetland Restoration and Enhancement in California*, is being disseminated to provide technical information on wetland restoration and to develop recommendations for future research in this area. (R/NP-1-10H)

How Nutritious is Fish?

SAN DIEGO — In a project to assess the nutritional value of cooked fish, Dr. Ronald Josephson and his associates from San Diego State University have refined and modified HPLC procedures to analyze the vitamin content of fish. With the proper procedures, the researchers should be able to provide valuable new information on improved assays of nutrients in fish. (R/NP-1-11J)

Economic Models Predict Fisherman and Aquaculturist Behavior

DAVIS — A series of models to determine the economic impact of commercial aquaculture development on commercial fishery operations have been developed by Drs. Warren Johnston and James Wilen from UC Davis. The models provide valuable insight into the behavior of fishermen and aquaculturists. One model evaluates price and production dynamics when competitive aquaculturists and cartel aquaculturists enter the market. Other models can be used when optimal behavior of a cooperatively managed fishery is threatened by competing aquaculturists. The third set of models includes market and biological interactions. (R/NP-1-11B)

Techniques Developed for Commercial Algae Production

SANTA BARBARA — In a project to develop techniques for propagating commercially important marine algae, Dr. Aaron Gibor from UC Santa Barbara has successfully maintained sterile cultures of nori tissues isolated during the previous year. Dr. Gibor is growing masses of cells, which he is attempting to dissociate to individual cells. By utilizing the techniques of tissue culture and cell suspension culture widely used for propagation of higher plants, Dr. Gibor hopes to develop economically viable propagation techniques for red and brown algae. (R/NP-1-11A)

Rapid Response

Rapid Response Capability (R/NP-1, Sullivan)

O = Ongoing

O *O* *O*

ACTIVITY BUDGET 1981-1982

	NOAA Grant Funds	Matching Funds
Marine Resources Development		
Aquaculture	$ 387,105	$ 385,228
Living Resources, other than Aquaculture	266,216	194,508
Marine Biomedicinals and Extracts	177,661	113,688
Socioeconomic and Legal Studies		
Ocean Law	22,294	25,931
Marine Recreation	30,505	26,680
Sociopolitical Studies	12,771	10,413
Marine Technology Research and Development		
Ocean Engineering	139,348	174,900
Resources Recovery and Utilization	89,784	87,474
Transportation Systems	57,757	16,084
Marine Environmental Research		
Research and Studies in Direct Support of Coastal Management	32,037	26,233
Ecosystems Research	89,736	52,125
Environmental Models	89,743	31,795
Marine Education and Training		
Other Education	481,174	18,069
Advisory Services		
Extension Programs	555,809	160,912
Other Advisory Services	198,244	87,759
Program Management and Development		
Program Administration	270,657	194,439
Program Development	249,159	27,494
TOTAL	**$3,150,000**	**$1,633,732**

MATCHING FUNDS SOURCES 1981-1982

State of California:	
California Resources Agency	$ 196,250
Department of Fish and Game	99,146
State of Washington:	
Department of Fish and Game	2,400
Bristol-Meyers	8,000
Canadian Fisheries Research Board	2,400
Donations	9,497
Hydro Products	12,160
Johnson Oyster Company	1,500
Meredith Fish Company	3,000
Program and Remote Systems	10,000
Santa Barbara County Parks	7,247
Syntex Corporation	34,500
Humboldt State University	18,383
San Diego State University	74,985
San Jose State University	5,222
Stanford University	23,476
University of California	1,123,166
University of Oregon	2,400
TOTAL	$1,633,732

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