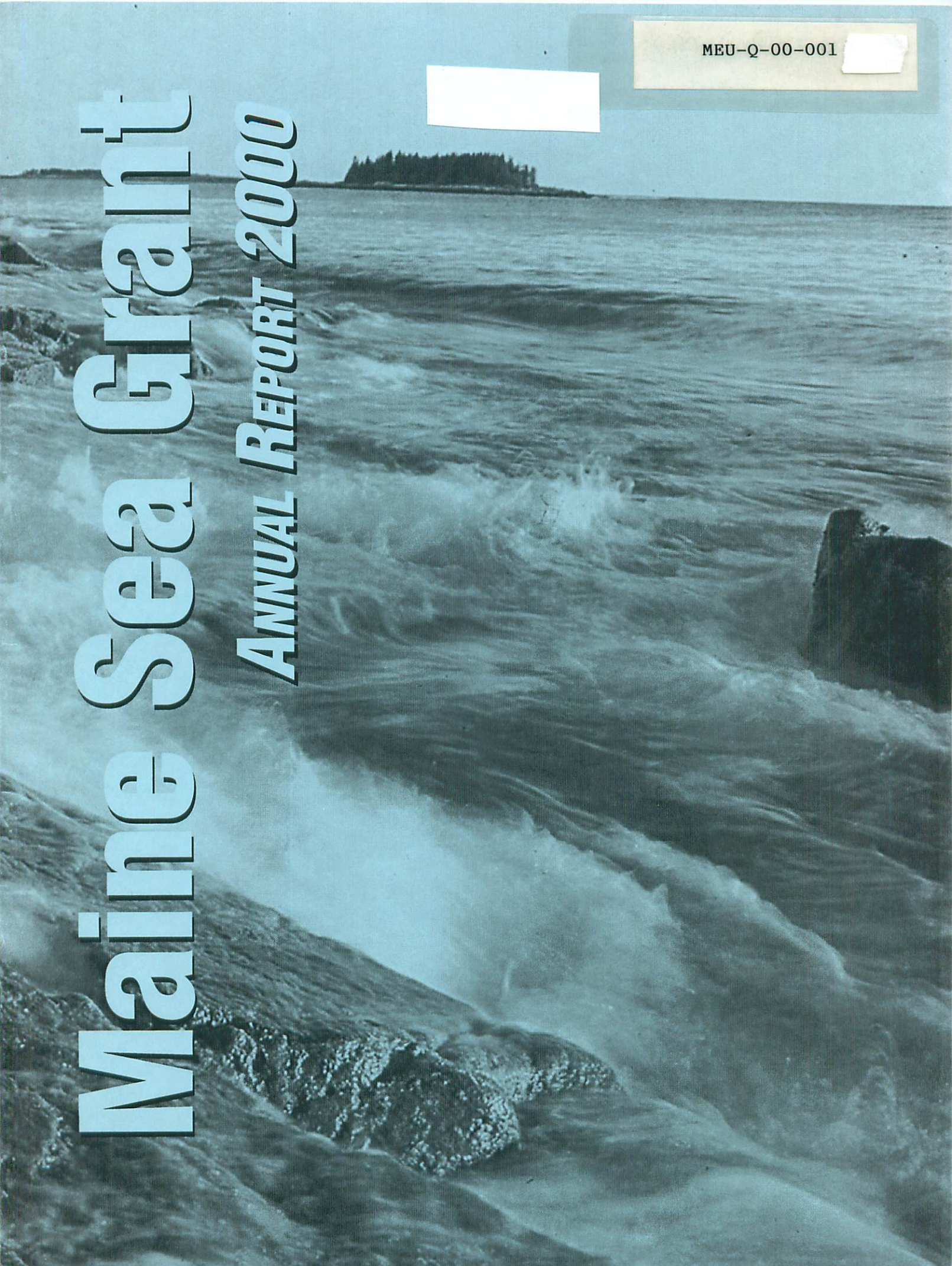


Maine Sea Grant

ANNUAL REPORT 2000



Maine Sea Grant

Annual Report 2000

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INTRODUCTION

This annual report summarizes the accomplishments and activities of the Maine part of the joint Maine/New Hampshire Sea Grant College Program for the period October 1, 1999, to September 30, 2000. Although the independent Maine Sea Grant Program did not officially come into existence until October 1, 2000, the two parts of the program functioned independently for most of 2000 as they prepared for separation.

The organization of the annual report follows that of our forthcoming strategic plan *Marine Science for Maine People*. The majority of our efforts in research, extension, and communications are organized into three *theme areas*: **Ecosystem health, Aquaculture and Fisheries**. In addition to the theme areas, we describe our accomplishments and activities in overarching *program areas* – management, extension, education, and communications – that apply to all of the theme areas.

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PROGRAM AREAS

Management

For the first time in several years, Maine Sea Grant is fully staffed. Ian Davison was appointed Sea Grant Director in September 1999 after serving as Interim Director for two years. In 2000, Paul Anderson was hired as Marine Extension Leader and Associate Director, and Susan White, the Communications Coordinator, assumed the additional responsibilities of Assistant Director. Together, Davison, Anderson, and White form the program's management team and are responsible for providing leadership and decision-making. In order to streamline and rationalize our decision-making process, we have developed a standard form for staff-initiated projects and requests for development funding. The form allows the management team to evaluate projects in the context of the strategic plan and analyze the anticipated costs, as well as impacts and outcomes. Our preliminary experience with this process in 1999/2000 was successful, and this form will be integrated into our new strategic and implementation plans.

A clerical employee, Lynn Wardwell, was promoted and became the program's fiscal officer. Her responsibilities also include helping to develop and maintain a new program database that will be used to track all of the program's activities. Work on the database has begun, and we anticipate it will be completed in 2001. Initially, we considered using the Oregon Sea Grant Program's *Making a Difference* database, but decided to develop our own to ensure it was compatible with other databases used at the University of Maine. Margaret Rocheleau-Shina provides clerical support for the program.

The joint Maine/New Hampshire Sea Grant College Program ceased to exist on

October 1st, 2000, and was replaced by independent Maine and New Hampshire Institutional programs. In preparation for this change, Maine established an independent Policy Advisory Committee in the summer of 2000 and began working with these stakeholders to develop strategic and implementation plans for the periods 2001-2005 and 2001- 2003, respectively.

Marine Extension Team

A 1999 memorandum of understanding (MOU) between the University of Maine Sea Grant and Cooperative Extension programs aligned their coastal extension assets to more effectively serve the public. The Marine Extension Team includes three Sea Grant Extension Associates, the Sea Grant Education Coordinator, four Cooperative Extension Educators, and the Marine Extension Program Leader. The MOU details cost sharing for the Sea Grant Extension associates and the split appointment of the Marine Extension Program Leader. With the recent separation of the Maine/New Hampshire Sea Grant Program into two distinct programs, the Maine Marine Extension Team is able to focus on the unique aspects of the state's coastal issues and the community characteristics that define Maine's coastal heritage.

The Marine Extension Team is involved in formal and informal education activities, community development initiatives, and applied research projects related to fisheries, aquaculture, and ecosystem health issues. Extension expertise ranges from fisheries technology and aquaculture science, to environmental monitoring. Statewide programs in water quality monitoring, phytoplankton monitoring, and beach profiling utilize volunteers and collaborate with coastal communities and state agencies, while aquaculture- and fisheries-related programs include applied

research, demonstration projects, and facilitation efforts.

Extension staff members link University scientists and information users. By providing a balanced approach to facilitation and building collaborations, the extension staff helps decision makers and stakeholders identify critical information needs and helps foster opportunities to fill those data gaps. Based along Maine's coast, extension associates work in local communities to identify the important issues, which helps to determine their plans of work.

The Marine Extension Team:

Paul Anderson, Associate Director,
Maine Sea Grant, and Marine Extension
Team Leader
Chris Bartlett, Marine Extension
Associate: eastern Maine
Dana Morse, Marine Extension Associate:
midcoast Maine
Kristen Whiting-Grant, Marine Extension
Associate: southern Maine
Esperanza Stancioff, Cooperative
Extension Water Quality Biologist:
statewide
Riley Young-Morse, Water Quality &
Phytoplankton Coordinator: statewide
Sherman Hoyt, Fisheries Extension Agent :
statewide
Ron Beard, Cooperative Extension Faculty:
eastern Maine
Sara Lindsay, Maine Sea Grant Education
Coordinator

Education

The Maine Sea Grant education coordinator, Sara Lindsay, holds a position as an assistant research professor of marine sciences at the University of Maine. In the past year, she spent much of her Sea Grant time coordinating the Northern New England Ocean Sciences Bowl held in February 2000 at the University in Orono.

She recruited 16 high school teams from Maine and New Hampshire, representing nearly 100 students and teachers. She also recruited and trained an equivalent number of faculty, staff, and graduate students to run the competition. In addition, she organized fund-raising for the event, obtaining over \$5000 beyond the original grant in support, and coordinated publicity that resulted in news coverage by eight regional newspapers, two local television stations, a radio station, and a national internet news network. According to the surveys returned by participants, the event was a big success.

The education coordinator also made several presentations to groups throughout the state, including the Maine Science Teachers Association, the Gulf of Maine Marine Educators Association, and various school classes. This fall she has been helping to organize the teacher resource room and three panel sessions on aquaculture education for the Northeast Aquaculture Conference and Exposition that Sea Grant is co-sponsoring with the Maine Aquaculture Innovation Center in December 2000. She has also been actively seeking external funding to support teacher education initiatives.

Communications

The communications office hired a new Science Publications Specialist, Natalie Springuel, in the last year. Because the separation from New Hampshire Sea Grant necessitated developing our own web site (the joint Maine/New Hampshire program had a combined web site), Springuel took a three-week University of Maine web design course, as well as workshops in Photoshop, scanning techniques, and graphic design to help her develop our new program web site. The site is going online in November 2000 and can be found at: <http://www.seagrant.umaine.edu>.

In the last year, communications designed a new eight-page folder/ brochure for the Maine Sea Grant Program. Program staff will use this either alone or with fact sheet inserts for their constituents.

Communications staff also designed and produced new exhibits for the Program and for the Marine Extension Team which were used at several events, including the University of Maine Cooperative Extension Day at the state legislature; Maine Fishermen's Forum; University of Maine Research Day with the state's delegation at the Capitol in Washington, D.C.; Maine Environmental Resources Day; the summer OP Sail 2000 celebration in Portland, Maine; National Cooperative Extension Day on the mall in Washington, D.C.; the National Water Quality Monitoring Fair in Austin, Texas; and at various workshops and county fairs.

Communications has produced several informational products for a general audience in the last year.

Collaborating with the Maine Coastal Program (MCP)/ State Planning Office, communications staff produced the "Sea & Shore" radio series and received a \$10,000 grant from the Maine Outdoor Heritage Fund to place 26, one-minute spots on eight commercial radio stations in Maine. In the summer of 2000, Maine Public Radio accepted the spots and began airing them during "Morning Edition." We are now in the process of expanding the spots to fit the public radio format.

Another cooperative project with MCP was the *Did You Know: Maine Coast Fact Cards*. In the last year, we revised the six-card series that contains information on the coast, maritime heritage, wildlife, flora, fish, and beach organisms. Packaged in an envelope with information about Sea Grant

and MCP on the cover, these very popular cards had a total print run of over 5000.

In the fall of 1999, we published the last issue of *Rising Tide*, a newsletter produced over the past two years with the School of Marine Sciences, the Darling Marine center, and the Maine Agricultural and Forest Experiment Station. The eight-page newsletter was distributed to over 2600 people. We have discontinued *Rising Tide* and plan to replace it with several new publications (including an environmental monitoring newsletter, two books, fact sheets, and a newspaper column) in the coming year.

Some other communications projects accomplished in the last year include; the annual Project Directory; 12 press releases distributed to media throughout the state; and articles submitted to the Northeast regional web site monthly and *The Communicator* biannually.

THEME AREAS

ECOSYSTEM HEALTH

Wave Modeling

Ocean waves have an impact on a variety of activities, such as aquaculture, shipping, harbor design, sediment transport and coastal erosion, among others. In spite of the importance of waves, the network of buoys that can provide wave data is extremely sparse. In addition, measurements cannot predict changes that will occur after the construction of, for example, a new breakwater. Numerical models provide the only viable option, and Vijay Panchang's project, *Field validation of a harbor wave prediction model* (R/CE-231), has led to the construction of perhaps the world's most sophisticated model in this context.

Panchang's model can simultaneously model the effects of wave refraction, diffraction, reflection, friction, and breaking in domains with completely arbitrary shapes and bathymetric features for the entire spectrum of waves. This project resulted in three publications in 1999/2000, and the U.S. Army Corp of Engineers and other users have adopted the model. Two other grants were obtained from the Office of Naval Research, allowing the model to be implemented on the Department of Defense's high performance computing center for naval applications and to allow floating structures to be incorporated into the model. Sub-contracts were received from California Sea Grant, the University of Southern California, Laval University, and from Coastal Systems Inc. for specific harbor studies.

Seabed Pockmarks

New seismic reflection profiling, side-scan sonar, and geo-technical probe data were collected on gas pockmarks in Penobscot

Bay, as part of a project, *Seabed pockmarks in Maine embayments* (R/CE-235), by Dan Belknap and Joe Kelley. Pockmarks are steep-walled, dish-shaped craters in soft mud found in many parts of the world's oceans. They are known to result from eruptions of fluids and natural gas over petroleum areas, and also to occur over sources of biogenic gas. One of the world's largest fields of shallow biogenic-gas-induced pockmarks is found in Belfast Bay, northern Penobscot Bay, Maine. Other embayments nearby also contain abundant gas, and at least some have pockmarks.

Belknap and Kelley have determined the extent of these fields, and are attempting to determine processes of origin, evolutionary history, and likelihood of instability of the seafloor in cases of human disturbance (such as fishing, shipping, anchoring, dredging and dredge-spoil disposal, laying of cables and pipes, and construction on the seafloor). Seismic and side-scan interpretations have been confirmed with vibracores, as well as with submersible and Remotely Operated Vehicle (ROV) observations. The research will continue in 2001 with additional ship time support from the National Sea Grant Office.

Beach Monitoring/Planning

Beach erosion is a serious problem in southern Maine and a study by Kelley *et al.* on the *Co-management of beaches through volunteer monitoring and annual state-of-Maine's-beaches meeting* (R/CE-237) is designed to study changes in beach profiles and understand the role of tidal currents and storms in sand movement. Although the results are still being processed and analyzed, excellent progress has been made in organizing 11 groups of volunteers who have collected monthly beach profile data and placed it on a web site.

Extension associate Kristen Whiting-Grant has been overseeing volunteer recruitment for the project, with most of her efforts focused on the Wells, Ogunquit, and York teams. In addition, she has trained volunteers in Scarborough, Saco, Old Orchard, Biddeford and Kennebunk who have been monitoring nine beaches in these towns since early summer 1999. Beach monitoring groups have collected important baseline data of more than 100 profiles to date, and has generated considerable public attention and support.

Last summer, over 200 year-round and summer residents attended the first annual *State-of-Maine's-Beaches* conference at Thornton Academy in Saco, Maine. Attendees represented the target audiences: shorefront property owners, monitoring volunteers, teachers and students, state and municipal officials, scientists and conservation group members. Whiting-Grant coordinated the event, managing all aspects of facility preparation, scheduling, agenda planning, staffing, and event evaluation.

For the conference, communications wrote and distributed press releases; designed the logo; produced the promotional brochure and program; designed the conference folder, banner, and T-shirts; produced signs; and staffed the registration table. The conference was covered/promoted by three major newspapers including the *Portland Press Herald*, the *York County Coast Star*, and the *Journal Tribune*. Maine Public Radio also included a seven-minute segment on the show "Maine Things Considered" which is aired during evening prime time. In addition, an article on the beach profiling project and conference was featured on NOAA's Oceanic and Atmospheric Research (OAR) web site last summer. Outgrowths of the conference include two brochures on

Managing Maine's Beaches: A Regional Approach and *Southern Maine Beach Profile Monitoring: Mapping the State of Maine's Beaches* that have been distributed throughout the state.

The beach monitoring project has brought collaboration from the Maine Coastal Program of the State Planning Office and from the Maine Geological Survey. Several colleagues in other states (NH, MA, NC, GA) have expressed interest in similar work in their states and this may lead to a regional collaboration next year. Additional ship time support from the National Sea Grant Office will allow the collection of further oceanographic data to supplement the ongoing volunteer monitoring effort.

Whiting-Grant, working with Sharon Meeker, Education Coordinator at New Hampshire Sea Grant, and Laura Stone, Program Coordinator at the Wells Reserve, coordinated and hosted a docent workshop on coastal processes and beach profiling called *Where Have All the Beaches Gone?* About 50 docents, beach monitors, and staff attended the workshop.

Additionally, Whiting-Grant serves the Wells Bay Beach Planning Committee – comprised of state, municipal, and community representatives from Kennebunk, Wells, and Ogunquit—as educational support staff. In the past year, she conducted a survey of the 12 members to assess their educational needs and created a plan to address these needs. In May, a contract was developed with the New England Board of Higher Education to hire an undergraduate intern for a 10-week term. The focus of the intern's work was community-level outreach on the progress of the Wells Bay Beach Planning Process and its relationship to beach profile monitoring. After the *State-of-Maine's-*

Beaches conference in July, an outreach segment on the beach planning process was incorporated into the planning committee's agenda.

Circulation Models

Understanding the circulation of Penobscot Bay is the goal of the project on *Real time simulations of the circulation in Penobscot Bay: A study of predictability of a coastal embayment* (R/CE-223) by Huijie Xue.

This project will provide the framework to better understand the role of circulation patterns in influencing biological processes such as the distribution of the larvae of lobsters and other commercially important species. The advantage of the model is that it provides a much greater level of detail than would be possible from direct measurements with current meters. Model simulations were conducted for the spring and summer of 1997 and 1998, and compared with current meter mooring data for this period.

Xue's model reproduced the observed three-layer structure in the outer western bay, with outflows near the surface and the bottom, and inflows in the middle of the water column. In contrast, a two-layer, estuarine-like circulation was found in the outer eastern bay, with outflows in the upper water column and inflows in the lower water column. Furthermore, the model indicates that Penobscot Bay is highly variable at different spatial and temporal scales, especially during severe weather when currents are particularly strong. The model predicts the development of micro-environments in different parts of the Bay, which result from the eddies associated with the complex topography. In addition to the model results, Xue has compiled a physical forcing data set for Penobscot Bay that includes winds, freshwater discharge from the Penobscot River, tides, and topography.

She has also developed an algorithm to incorporate infrequent hydrographic survey data into the model to improve model performance.

Another project by Neal Pettigrew and Maureen Keller on *Exchange processes between the Kennebec estuary, Casco Bay and the inner shelf: implications for contaminant transport and red tide* (R/CE-229) has continued to collect data which will be analyzed over the final 12 months of the project.

Extension associate Chris Bartlett collaborated with the Cobscook Bay Resource Center, Texas A&M University and Shead High School in Eastport, Maine, to study the tidal currents in Cobscook Bay. Students designed and deployed drifting markers and recorded their positions throughout the tide cycle. They then used the data to create graphic images of Cobscook Bay's currents. Bartlett procured funding for purchasing handheld GPS receivers and coordinated the vessels used for five trials thus far. Approximately 25 students have participated in this project.

Volunteer Monitoring

The water quality monitoring program is a collaboration of the Maine Coastal Program, Maine Department of Environmental Protection (DEP), Cooperative Extension, and the Maine Department of Marine Resources (DMR). Marine extension staff provide organizational and technical support in this citizen-based program that assists DMR in classifying clam flats. They coordinate volunteer activities of more than 40 groups along the coast, including priority watershed efforts, and work with the partners to ensure that quality data is being gathered and utilized by decision makers.

The Maine Phytoplankton Monitoring Program is designed to provide an early warning of possible red tide events to the DMR. Cooperative Extension, Sea Grant, and DMR are partners in this statewide program that has 22 groups and dozens of volunteers. This year, local volunteers and scientists from the region collected phytoplankton samples for researchers from Woods Hole Oceanographic Institute (WHOI) who are investigating the presence of *Alexandrium spp* in Casco Bay. WHOI is involved in a regional Gulf of Maine study on harmful algal blooms (ECOHAB – Ecology of Harmful Algal Blooms). With growing interest in harmful algal blooms, this community-based monitoring program is in a position to affect the research being conducted to understand the dynamics of these blooms, and to provide a public education opportunity.

Extension staff worked with the communications office to produce a 10-page booklet on the water quality and phytoplankton monitoring programs that was distributed to nearly 1000 interested parties throughout the state, region, and nation.

The Webhannet Estuary Water Quality Improvement Project was established as part of a long-term estuarine water quality monitoring program in the Webhannet watershed. The goal is to train volunteers to monitor upstream sections of the watershed for fecal coliform bacteria contamination to discover the sources of the pollution problem. Rectifying these non-point source problems will help to reopen closed shellfish harvesting areas in the estuarine sections of the watershed. This project was made possible through grants totaling \$19,000 from the Gulf of Maine Council on the Marine Environment and the Maine Coastal Program's Shore Stewards grants program. The steering committee has representatives from Maine

Sea Grant, Natural Resource Conservation Service, DEP, DMR, Southern Maine Regional Planning Commission, and the towns of Wells and Ogunquit. To date, 34 volunteers have been recruited and trained to take field samples and/or conduct lab processes on the samples. Preliminary results have helped to identify three "hot spots" which will be the focus of further investigations in the spring.

The Spruce Creek Work Group is an effort to unite state, municipal, and community representatives to address non-point source pollution problems on Spruce Creek in Kittery, Maine. Extension staff Whiting-Grant and Riley Young-Morse co-chair the Monitoring and Education subcommittee of the Spruce Creek group. Extension staff are also working to assess the status of watershed education in the public schools of the Spruce Creek watershed, and to determine if local schools are interested in participating in monitoring the Creek.

Extension associate Whiting-Grant is receiving training and orientation from her peers at the Wells National Estuarine Research Reserve on habitat restoration. She will educate communities about the importance of habitat restoration and help facilitate grant writing and implement restoration projects. This activity will be limited to southern Maine for the near future.

Tourism/Recreation Impacts

Communications staff wrote an article on "Planning for Eco-tourism on the Coast of Maine" for the *Maine Policy Review*, a high quality publication sent to state legislators, Maine's delegation in Washington, D.C., school superintendents, libraries, and to hundreds of coastal stakeholders. Extension leader Paul Anderson hosted a panel on recreational impact on the Maine coast and its islands

on WERU community radio and the science publications specialist was a member of the panel.

NEW RESEARCH

A new project in ecosystem health, *Repair of wood pilings through fiber-reinforced composites* (R/CE-239) by Roberto Lopez-Anido and Tom Sandford, was started in February 2000. This project is timely because of recent outbreaks of wood boring shipworms that have caused serious damage in Maine, the only state in the U.S. that does not allow creosote-impregnated wood to be used in the marine environment. Until the summer of 2000, however, damage from these invertebrates had been rare. Lopez-Anido has been working with the affected communities and has enlisted the support of Barry Goodell and Dan Distal who are experts in wood decay and microbiology, respectively.

AQUACULTURE

FISH HEALTH

Infectious pancreatic necrosis is a disease of salmonid fishes and a major problem for Maine's salmon aquaculture industry. A National Strategic Initiative project, *Molecular basis for virulence of infectious pancreatic necrosis virus* (IPNV) (R/FMD-269) by John Singer *et al*, focused on the mechanism that explains why some strains of the IPN virus are more pathogenic than others. The long-term objective of this research is to better understand the disease and hence develop preventative measures, or cures, such as vaccines. Although this group has not resolved all of the questions about virulence, they have significantly increased our understanding of infectivity in fish viruses. Their research suggests that single amino acid changes in viral proteins may account for the difference between virulent and non-virulent strains. Research is continuing to show the effect of the

amino acid changes on protein structure and their role in conferring virulence. Infectious strains of IPNV lose their virulence when grown in cell cultures, although this can be maintained if the cell culture media are supplemented with trout serum. The virulent strain of IPNV is resistant to a component of trout serum, whereas avirulent or low virulent strains are not.

In April 2000, extension associate Chris Bartlett assisted Dr. Mike Opitz, University of Maine Cooperative Extension veterinarian, to organize the eighth New England Farmed Fish Health Management Workshop, a conference held each spring to address salmon aquaculture industry concerns. Bartlett's responsibilities included: facilitating a hatchery manager's roundtable, coordinating facility arrangements, and conducting a salmon farm tour. Communications staff wrote and distributed press releases for the workshop which attracted approximately 160 participants.

Bartlett also serves on the eight-member Maine Fish Health Technical Committee that counsels the commissioners of Department of Marine Resource and U.S. Department of Inland Fish and Wildlife on fish health-related issues. Discussions and recommendations have included issues such as Swim Bladder Sarcoma virus found at the Craig Brook National Fish Hatchery and Infectious Salmon Anemia, currently found in neighboring New Brunswick, Canada.

Bartlett is participating in the implementation of an FDA Investigational New Animal Drug (INAD) study for the use of EXCIS cypermethrin in controlling sea lice on all Maine salmon farms in Washington County. Bartlett's activities have included: conducting training on the

safe handling, distribution, and storage of EXCIS cypermethrin for 40 participants; coordinating the distribution, usage, and disposal of EXCIS Cypermethrin with all trained participants and associated company employees; coordinating research to assess the effects of EXCIS cypermethrin use on the marine environment and target species; and coordinating all record keeping in accordance with FDA INAD protocols.

Salmon Cage Cleanup

Bartlett obtained \$5000 through DMR to coordinate the removal and disposal of abandoned salmon cages in the Cobscook Bay area. Bartlett hired local contractors and organized volunteer services from area salmon aquaculture companies to tow 17 discarded cages to a central location and have them disassembled. Emphasis was placed on salvaging all materials possible and disposing of the remainder through appropriate methods. Sixteen people were involved in this effort. Press coverage included articles in the *Quoddy Tides* and *Fish Farming News*.

SHELLFISH AQUACULTURE

Setting a Research Agenda

Several extension staff members were involved in organizing, facilitating, and documenting a January 2000 meeting of shellfish aquaculturists, researchers, and agency members to discuss the data gaps and research needs for shellfish aquaculture in Maine. The meeting was sponsored by Sea Grant, the Maine Aquaculture Association, and DMR. Approximately 40 people attended the meeting, and the resulting 20-page document on *Priorities for Maine Shellfish Growers: Research and Other Needs* was produced by the communications office and distributed to about 150 interested parties. This product will serve as a rationale for future RFPs and grant development related to shellfish aquaculture.

Technology Transfer

Nursery culture for shellfish is perhaps the most labor- and equipment-intensive segment of the growout process for most shellfish farmers, requiring great investment in time and financial resources. Though rigorous economic analyses are lacking, the industry has generally accepted that upwellers lower the costs associated with shellfish nursery production. Shellfish aquaculturists are acutely interested in using upwellers in Maine, where cold water temperatures mean shortened growing seasons. Extension associate Dana Morse is providing the extension link to research, funded by the Maine Aquaculture Innovation Center, which is providing information specific to tidal upwellers. Morse will present research results at the Aquaculture 2001 conference in Orlando, Florida, and will hold workshops in Maine during 2001-2002.

Shellfish Health

During the past year, extension staff member Dana Morse helped organize a five-session seminar series at the University of Maine's Darling Marine Center on shellfish aquaculture and disease management. About 30 industry members attended each of these workshops. An outgrowth of the series was the 12-page *Guide to Bivalve Diseases for Aquaculturists in the Northeastern U.S.* produced by the communications office. Morse also hosted and organized an emergency gathering of shellfish growers and researchers to discuss a recent episode of Juvenile Oyster Disease (JOD) in two farms in Maine. The outcome of this meeting was that the research community made a commitment to increase work on JOD. Maine Sea Grant program development funds are being used to jump-start a larger research project that MSG will fund in 2001. Additional support is being sought in Washington, D.C. to address this problem.

New Species

Extension staff member Chris Bartlett assisted Tom Pottle of Cobscook Bay Aquaculture in sea scallop aquaculture trials, including cage development and density, growth, and mortality studies. Other collaborators include the Cobscook Bay Resource Center, University of Maine at Machias, Beals Island Regional Shellfish Hatchery, and DMR.

The market for cultured eels worldwide continues to increase, while supplies of eel seed stock fluctuates year to year. Culture efforts in northern climates focus on expensive re-circulating aquaculture systems, and are generally regarded as risky ventures, especially in North America. Extension associate Dana Morse is working with a client who has extensive experience in the eel harvesting industry and who approached Maine Sea Grant for support to try a different method in raising eels. Morse is helping to assess the feasibility of this method and will develop a project proposal for MSG management.

Board Representation

Chris Bartlett and Paul Anderson serve on the board of directors of the Beals Island Regional Shellfish Hatchery. This facility provides shellfish seed to many coastal communities and conducts scientific research on various species of shellfish and other marine organisms. The board is in the process of developing a proposal to more formally link the facility with the University of Maine at Machias under a new initiative to be called the Downeast Institute for Applied Research & Education. Sea Grant and Cooperative Extension participation is critical during this transition period.

Aquaculture Education

Several extension program staff members are addressing the conflicts arising from

shellfish aquaculture leases in Maine, and helping the concerned parties to make decisions based on factual and current information. Other coastal resource users, such as fishermen, homeowners, and recreational groups, frequently raise objections that are often based on inaccurate information. By facilitating a discussion between the parties involved, accurate information about aquaculture and plans for specific leases are brought to light, thus enabling all parties to make better-informed decisions. This project involves hosting meetings in public venues, such as a town hall or other community building. Three sessions were held this year that allowed staff to determine the best format and timing for future sessions. Maine DMR is very interested in continuing these sessions with future lease proposals.

Extension staff Chris Bartlett and Dana Morse and education coordinator Sara Lindsay are working with the Maine Aquaculture Innovation Center and other organizers to present the second annual Northeast Aquaculture Conference & Expo (NACE 2000) on December 8-9, 2000, in Portland, Maine. Morse and Bartlett staffed a technology transfer room at the 1999 NACE conference. This year's event promises to be another comprehensive conference with technology transfer, general and formal education sessions, and a trade show.

NEW RESEARCH

Two new aquaculture research projects were started in February, 2000. These are *Molecular genetic characterization of blue mussel populations in the Gulf of Maine* (R/RMD-279) by Paul Rawson, and *Genetic signatures of Atlantic salmon: assisting aquaculture and restoration* (R/FMD-227) by Irv Kornfield. Both projects are in their preliminary stages of data

collection. Rawson has presented some of his preliminary findings at meetings, and Kornfield has developed an assay to determine the continent of origin of an Atlantic salmon. This will be used by industry to determine whether European strain salmon alleles exist in aquaculture gene pools. Kornfield's research is critical at this juncture due to the federal government's proposal to list Atlantic salmon as an endangered species, which is opposed by the state of Maine. Regardless of the outcome of the endangered species listing proposal, it is clear that the genetic information provided by Kornfield will be critical not only to restore river-specific stocks of Atlantic salmon (assuming these still exist) to Maine rivers and to develop improved strains for aquaculture.

FISHERIES

Marine Research Agenda

Collaborating with the Maine Department of Marine Resources, Sea Grant co-sponsored a series of research priority workshops that addressed the needs of the whole state for key marine species. Sessions were held in several locations throughout the state on lobsters, soft-shell clams, urchins, shrimp and scallops. Several members of the Marine Extension Team helped organize and facilitate the discussions in these sessions. The outcome is the creation of a Marine Research Agenda for Maine that is now being written by a contractor hired by DMR. Maine Sea Grant program development funds helped cover meeting costs and hire the contractor to design the process and produce the report.

Fisheries Management

Jim Acheson *et al.* have continued to make excellent progress with their project on *Case studies in co-management of marine fisheries* (R/FMD-225), publishing two

papers in 2000, with three others in press. This project is important because it documents the rapid changes occurring in Maine's most valuable fishery in response to newly introduced legislation. The focus of the research has been on implementing Lobster Zone Management law, and some of the key issues that have faced the industry over the past year, including caps on the number of trap tags and limited entry into the management zones. Researchers have also studied the changes in the traditional territorial system with a view toward understanding zone boundary problems. Their research suggests that the territorial system has not broken down, as was first suggested, but rather that the establishment of formal boundaries sets up a set of perverse incentives motivating people to aggressively push into waters traditionally fished by others and artfully construct new "traditional boundaries," giving themselves more prime fishing bottom. This suggests that establishing zones with different rules can cause conflict by giving people incentives to claim additional territory.

Extension staff Dana Morse, Sherm Hoyt, and Chris Bartlett and extension leader Paul Anderson are working with the DMR to help improve the participation in and effectiveness of the Lobster Zone Management process. Sea Grant program development funds were used to hire Patrice Farrey to work part time with the extension team on facilitating and coordinating lobster zone meetings. Each of the participating staff members has been assigned two regions along the coast where they attend regular meetings, assist with facilitation, and help to encourage greater participation by the industry. Presently, discussions with DMR are focused on designing and implementing a training program for the zone and district leaders explaining the regulations and how to conduct effective meetings.

Another continuing research project on lobsters is *Developing predictive tools for the American lobster fishery: differentiating mortality and emigration in open populations* by Rick Wahle (R/FMD-271). The long-term goal of this research is to develop a predictive capability for the American lobster fishery. At the heart of the current debate over the status of the fishery is a poor understanding of processes influencing recruitment to harvestable adult stocks. Previous research has indicated that annual fluctuations in larval production determine cohort strength during the first two years of benthic life in cobble nursery habitats. This is followed by a dramatic attrition as lobsters grow and emerge from shelter, and expand their range of movement. However, the relative importance of mortality and emigration to this attrition is unclear.

Wahle's research is designed to differentiate mortality and emigration during the transition from cryptic to emergent phases of lobster life, by using a multiple mark-recapture technique, in experiments at sites in Maine, New Hampshire, and Rhode Island. The project has reached its midway point and the major emphasis has been on conducting experiments and collecting data which will be analyzed during the final phase of the project. Preliminary analysis of the results indicate the mark-recapture method is a valid technique for obtaining information on population size, gains, and losses on lobster nursery grounds.

Unlike the lobster fishery, which has enjoyed record catches over the past three years, Maine's second most valuable industry, green sea urchins, has declined. Identifying possible new ways to manage this fishery is the rationale for the project on *Non-harvest conservation areas for sea urchins in Maine: exploring new tools for*

sustaining the fishery (R/FMD-273) by Bob Steneck. This project involves comparing sites before and after closing them to sea urchin harvesting. The project is still in the data collection phase and it is too early to draw even preliminary conclusions because the experimental areas have only been closed to fishing for a year.

Industry Assistance

Chris Bartlett assisted with organizing the Cobscook Bay Fishermen's Association, an industry group set up to locally manage harvested marine species. Duties included coordinating meeting locations and assisting with administrative tasks. About 70 participants have attended these meetings.

Sherm Hoyt participates on the Soft-shell Clam Advisory Council that provides a forum for industry discussion and brings issues to the attention of DMR. The communications office also produced a brochure entitled *Why Are Clam Flats Closed?* with DMR that was distributed to nearly 5000 shellfish harvesters, town shellfish committees, and others.

Bartlett provides ongoing assistance to the Eastport Marine Resources Committee for Soft-shell Clam Management with administrative services and impromptu facilitation, as they work to implement an effective clam conservation ordinance under the DMR regulations. This involves several communities, requiring Bartlett to use conflict resolution skills to facilitate this diverse group with occasionally disparate attitudes.

Dana Morse has helped the Boothbay Area Clam Aquaculture Co-op, developed with a \$30,000 grant from the U.S. Department of Agriculture, find information resources, locate appropriate material and vendors for the anticipated seeding projects, and secure a permit for seeding activities.

Industry-Scientist Partnerships

Extension associate Dana Morse is working with the Northwest Atlantic Marine Alliance (NAMA) to develop programs that enhance the productivity of research projects that are based on partnerships between industry members and scientists. There is recent interest (and funding available) in linking these groups together to design and implement scientific studies. The extension role is to help identify effective partnerships and orient the potential partners to each other's behavioral patterns and assumptions. Classes are being organized to show researchers how the industry works and to show fishermen how scientific research is conducted.

Extension staff is involving the industry in applied research to investigate the use of clam "tents" as spat collection devices for soft-shell clams. The information about this collaborative project will be provided to other industry users, scientists, managers, and the general public. To date, this project has been successful in involving clam harvesters in several towns. The clam tents were deployed in May, and diggers have assisted in sampling, monitoring, and maintaining them. A final evaluation will be conducted late this fall.

Dana Morse and Chris Bartlett have provided organizational support to several harvesters and community programs that are collecting scallop spat for stock enhancement. The rationale of this project is to collect the juvenile scallops, while they are suspended and vulnerable to predation, on net bags that will provide refuge from predation until the animals are large enough to settle. The spat can then be used in growout facilities and/or for enhancing wild scallop harvest areas. Extension activities include: organizing groups of harvesters to participate, linking

this project with the research community and the agency staff, and ensuring that useful scientific data is collected.

Bartlett assisted Paul Rawson, Sea Grant-funded researcher at the University of Maine, with a survey to identify the distribution of *Mytilus edulus* and *Mytilus trossulus* in Cobscook Bay. *M. edulus* is preferred for wild harvest and culture purposes, yet *M. trossulus* appears to be quite prevalent in the Cobscook Bay area. Bartlett linked Rawson with area aquaculturists to identify study sites, and assisted with deployment and collection of spat collection ropes.

Bartlett also worked with Tim Linley at Washington County Technical College to collect live flounder that will be used in an experiment to assess the cause of embolisms in fish caught in deep water. Bartlett trained participants in live capture techniques for winter flounder.

GRADUATE STUDENTS

These graduate students are not necessarily supported by Sea Grant (i.e., they may not receive salary from Sea Grant), but they are involved in Sea Grant-funded projects in some way.

Jennifer Brewer (Acheson *et al.*)
Bill Brennan (Acheson *et al.*)
Li Dongcheng (Panchang)
Allen Gontz (Belknap and Kelley)
Susan Hayhurst (Rawson)
Heather Heinze (Kelley *et al.*)
Teresa Johnson (Acheson *et al.*)
Dorothea Kistner (Pettigrew)
Christopher Lage (Kornfield)
Karl Schlenker (Panchang)
John Vavrinec (Steneck)
Mali Wirotasangthong (Nicholson *et al.*)
Luizhi Zhao (Panchang)

M.S. and Ph.D. theses:

Mali Wirotasangthong, *Genomic characterization of monoclonal antibody neutralization-resistant escape variants of aquatic birnavirus*, Ph.D., University of Maine (1999).

LEGISLATIVE FELLOWSHIP PROGRAM

We created a new graduate student opportunity in the area of marine policy, a Legislative Fellowship program, where a graduate student works with the joint House and Senate Marine Resources Committee in the Maine legislature. The 1999/2000 Fellow was Jill Fegley, a graduate student at the University of Maine whose thesis research on the ecological impacts of seaweed harvesting is funded by Sea Grant. Fegley worked closely with the co-chairs of the Committee, Senator Jill Goldthwaite and Representative David Etnier, as well as with other committee members, and also maintained contact with

staff at the Maine Department of Marine Resources (DMR). She worked on several important issues facing the Committee, including: determining whether to establish lobster hatcheries and close areas to dragging, and addressing management concerns of sea cucumber and seaweed harvesting, both rapidly developing fisheries in Maine. Fegley's performance was rated very highly by both the Committee and by DMR, and it is clear that she provided an invaluable service and gained considerable experience. The program will be continued in 2001, and we are currently searching for a new Fellow.

SCIENTIFIC PUBLICATIONS

Twenty peer-reviewed publications were produced in 1999-2000. As anticipated, because of the delays inherent in writing and publishing papers, several of these are from projects that ended prior to 1999. Sea Grant support also resulted in several published abstracts and technical reports.

A. *Peer-reviewed publications:*

1. Acheson, J.M., 2000, With blinders and hobbles: management of the Maine lobster industry, pp. 151-168. In: Durrenberger, E.P. and T.D. King (eds.), *State and Community in Fisheries Management: Power, Policy and Practice*, Westport, CT: Bergin and Garvey.
2. Acheson, J.M. and J. Knight, 2000, Distribution, fights, coordination games and lobster management, *Comparative Studies in Society and History* 42: 209-238.
3. Ames, T., S. Watson and J. Wilson, 2000, Rethinking overfishing. In: Neis, B. and L. Felt (eds.), *Finding our sea legs: Linking fishery people and their knowledge with science and management*, St. John's: ISER Press, (in press).
4. Boettcher, K.J., B.J. Barber and J.T. Singer, 1999, Use of antibacterial agents to elucidate the etiology of juvenile oyster disease (JOD) in *Crassostrea virginica* and numerical dominance of an α -proteobacterium in JOD-affected animals, *Applied Environmental Microbiology* 65: 2534-2539.
5. Cobb, J.S., M. Clancy and R.A. Wahle, 1999, Fish habitat: essential fish habitat and rehabilitation, pp. 285-298. In: L.R. Benaka (ed.), *Habitat-based assessment of lobster abundance: a case study of an oil spill*, Proceedings of the Sea Grant symposium on fish habitat, Hartford, CT 26-27 Aug. 1998, *American Fisheries Society Symposium*, v. 22.
6. Incze, L.S., P. Aas, T. Ainaire, and M. Bowen, 2000, Neustonic postlarval lobsters in the western Gulf of Maine: Spatial and interannual variations, *Canadian Journal of Fisheries and Aquatic Science* 57: 755-765.
7. Incze, L.S., R.A. Wahle and A.T. Palma, 2000, Advection and settlement in a benthic invertebrate: Recruitment to first benthic stage in *Homarus americanus*, *ICES Journal of Marine Science* 57: 430-437.
8. Lage, C and I Kornfield. 1999. Isolation and characterization of microsatellite loci in Atlantic Haddock (*Melanogrammus aeglefinus*). *Molecular Ecology*. 8: 1355-1356.
9. Mayer, L.M., L.L. Schick and T.C. Loder, 1999, Dissolved protein fluorescence in two Maine estuaries, *Marine Chemistry* 64: 171-179.
10. Palma, A.T., R.S. Steneck and C. Wilson, 1999, Settlement-driven, multiscale demographic patterns of large benthic decapods in the Gulf of Maine, *Journal of Experimental Marine Biology and Ecology* 241: 107-136.
11. Panchang, V.G., B. Xu, and Z. Demirebilek. 1999, Wave prediction models for coastal engineering applications. In: Ed. Herbich, J.B. (ed) *Developments in Offshore Engineering*, Gulf Publish, Houston, pp 163-194.

12. Panchang, V.G., B. Xu, Z. Demirbilek, K. Schlenker, and M. Okihiro. 2000, Effects of exterior bathymetry in elliptic harbor wave models. *Waterway, Port, Coastal & Ocean Engineering*, ASCE. 126: 71-78.
13. Steneck, R.S., 2000, Are we overfishing the American lobster? Some biological perspectives. In: Buchsbaum, R., W. Robinson and J. Peterson (eds.), *Decline of fisheries resources in New England: evaluating the impact of overfishing, contamination and habitat degradation*, MIT press, (in press).
14. Steneck, R.S. and J.T. Carlton, 2000, Human alterations of marine communities: *Caveat studium*. In: Bertness, M, S. Gaines and M. Hay (eds.), *Marine Community Ecology*, (in press).
15. Steward, D.R. and V. G. Panchang. 2000, Improved coastal boundary conditions for water wave simulation models. *Ocean Engineering*, (in press).
16. Vadas, R.L., B. Beal, T. Dowling, and J. Fegley, 2000, Experimental field tests of natural algal diets on gonad index and quality in green sea urchin, *Strongylocentrotus droebachiensis* : a case for rapid summer production in post-spawned animals, *Aquaculture* 182: 115-135.
17. Wahle, R.A., 2000, Fisheries in a sea of change: ecology and oceanography of New England's fishing grounds, *Proceeding of the Sea Grant symposium on the history and future of New England's offshore fishing grounds*, Connecticut College, April, 1999, *Northeast Naturalist* 7, (in press).
18. Williams, K., S. Blake, A. Sweeney, J.T. Singer, and B.L. Nicholson, 1999, Multiplex reverse transcriptase PCR assay for simultaneous detection of three fish viruses, *Journal of Clinical Microbiology* 37: 4139-4141.
19. Wilson, J.A., E. Ostrom, B. Low, and R. Costanza, 1999, Scale misperceptions and the spatial dynamics of a social-ecological system, *Ecological Economics* 31: 243-57.
20. Xue, H., Y. Xu, D. Brooks, N.R. Pettigrew, and J. Wallinga, 2000, Modeling the circulation in Penobscot Bay, Maine, *Proceedings of the 6th International Conference on Estuarine and Coastal Modeling*.

B. Published abstracts:

1. Boettcher, K.J., B.J. Barber and J.T. Singer, 1999, The potential involvement of two species of a-proteobacteria in the susceptibility of the Eastern oyster (*Crassostrea virginica*) to juvenile oyster disease (JOD), C29, p. 66, *American Society for Microbiology Conference on Microbial Biodiversity*, August 5-8, Chicago, IL
2. Carnegie, R. B., B. J. Barber, D. L. Distel, and S. C. Culloty, 1999, Development of PCR and *in situ* hybridization assays for detection of *Bonamia ostreae* in flat oysters, *Ostrea edulis*, *Journal of Shellfish Research* 18: 711-712.
- 18 3. Dickson, S.M., D.F. Belknap and J.T. Kelley, 1999, The shoreface ravinement process and inner shelf

sedimentation, coastal Maine, *Geological Society of America Abstracts with Programs* 31: A12.

4. Rogers, J.N., J.T. Kelley, D.F. Belknap, K. Beard-Tisdale, and P. Agouris, 1999, Study of pockmark evolution using seafloor imaging, Belfast Bay, Maine, *Geological Society of America Abstracts with Programs* 31: A-64.
5. Sinson, D.A., D.F. Belknap and J.T. Kelley, 1999, Sea-floor sediments of Penobscot Bay, Maine: scratching the surface of a Quaternary record, *Geological Society of America Abstracts with Programs* 31: A-68.
6. Zhao, L., V. Panchang, W. Chen, Z. Demirbilek, and N. Chhabbra. 2000, Simulation of wave breaking in two-dimensional harbor wave models, Abstract OS51c, 2000 AGU Spring Meeting, published as supplement to EOS.
7. Xue, H., Y. Xu and D. Brooks, 1999, Simulation of Penobscot Bay circulation: April-September 1998. In: *Proceedings of the Sigma Coordinate Ocean Model Users Meeting '99*. p. 42.

C. Other publications and technical reports:

1. Kelley, J.T., D.F. Belknap and S.M. Dickson, 1999, "Measuring the shape of a beach: a beach-profiling training video", 20 min.
2. Steneck, R.S., 2000, Task force report to Maine Department of Marine Resources on the efficacy of hatchery reared lobsters (December 1999), Hollowell, ME.
3. Steneck, R.S. plus 16 other authors (listed alphabetically), 2000, American lobster stock assessment report, *Atlantic States Marine Fisheries Commission*, 350 pp.
4. Steneck, R.S., C.J. Wilson and E. Annis, 2000, Lobster research: a progress report for 1999, Submitted to *Maine's Department of Marine Resources*.
5. Vadas, R.L. and B.F. Beal, 1999, Temporal and spatial variability in the relations between adult size, maturity and fecundity in green urchins: the potential use of a roe-yield index as a conservation tool, *Report to the Maine Department of Marine Resources*, 47 pp.
6. Vadas, R.L., B. Beal, T. Dowling, and J. Fegley, 1997, Production of sea urchin roe: rapid summer enhancement in green sea urchins, In: *Proceedings of Information Session on Green Sea Urchin, Strongylocentrotus droebachiensis*, New Brunswick Department of Fisheries & Aquaculture, Moncton, Canada. pp. 157-162.
7. Vadas, R.L. and L.C.N. Seward, 2000, Sea urchin spawning and population structure in Maine, *Report to the Island Institute*, 11 pp.
8. Zhao, L., V. Panchang, W. Chen, Z. Demirbilek, and N. Chhabbra. 2000, Simulation of wave breaking in two-dimensional harbor wave models, Abstract OS51c, 2000 AGU Spring Meeting, published as supplement to EOS.

SEA GRANT DEVELOPMENT PROJECTS

1. Sea Grant Staff Projects: 7 projects for a total of \$21,454.

1. Anderson, P. *Facilitating the lobster zone co-management process in Maine.* \$9,214.

Working in collaboration with the Maine Department of Marine Resources and the Maine Lobstermen's Association, we hired Ms. Patrice Farrey as a temporary professional employee to help lobster fishermen institute the new lobster zone process.

2. Bartlett, C. *Cooperative state of Maine survey of Atlantic halibut in groundfish closed areas in the eastern Gulf of Maine.* \$1000.

A collaborative project with the Maine Department of Marine Resources to train fishermen to collect data in an experimental halibut fishery allowed under a National Marine Fisheries Service permit. Some halibut were captured alive and transferred to the University of Maine's Franklin Aquaculture Facility as broodstock for aquaculture research.

3. Bartlett, C. *Cobscook Bay Drift Bottle Project.* \$5,000.

Provided drift bottles and GPS units to allow Shead High School students to participate in an experiment to study circulation patterns in Cobscook Bay and test a circulation model developed by Dr. David Brooks of Texas A&M University.

4. Lindsay, S. *Northeast regional competition of National Ocean Sciences Bowl.* \$1,600

Allowed Sea Grant to hire Abigail Deitz, a temporary employee, as Assistant Coordinator of the National Ocean Sciences Bowl competition held in Orono in February, 2000.

5. Morse, D. *Scallop spat collection and stock enhancement.* \$3,000

Purchased supplies and equipment for a collaborative project with fishermen to collect scallop spat for stock enhancement of the wild fishery.

6. Whiting-Grant, K. *State-of-Maine's-Beaches conference.* \$650

Provided, brochures and supplies for the first *State-of-Maine's-Beaches conference* held in July 2000.

7. Whiting-Grant, K., R. Young-Morse, and E. Stancioff. *Learning results-aligned non-point source pollution curriculum guide.* \$990

Allowed the development of a curriculum guide for middle school teachers about non-point source pollution in the Spruce Creek watershed. The curriculum guide is consistent with Maine's learning results.

2. Research Projects: 9 projects for a total of \$43,208.

1. Chai, F. (University of Maine) *Georges Bank in the Gulf of Maine and Zhejing Coastal Upwelling Zone in East China Sea; a comparative study of oceanography and fisheries.* \$5,000.

This provided partial funding to allow Professor Maochong Shi of the Ocean University of Qingdao to visit Maine to initiate a collaboration with Dr. Chai.

2. Cowan, D. (Lobster Conservancy) *Tagging juvenile lobsters in the intertidal zone.* \$2,200.

This project was jointly funded with the Lobster Institute at the University of Maine, and was designed to investigate the abundance, survival, and movement of juvenile lobsters in intertidal habitats.

3. Fegley, J.C. (University of Maine) *A quantitative assessment of the rockweed (*Ascophyllum nodosum*) resources at selected sites along the coast of Maine.* \$5,000.

A jointly funded project with the Maine Department of Marine Resources to measure the standing crop of a seaweed species that is the target of a rapidly developing harvesting industry.

4. Hurst, J. (Maine Department of Marine Resources) *Parallel trials of the MIST Alert™ for paralytic shellfish poisoning at the Maine Department of Marine Resources.* \$10,000.

Supported trials of a new technique to detect paralytic shellfish poisoning that could potentially save considerable time and money in routine monitoring of shellfish for human safety.

5. Mageean, D.M and K. Hunt (University of Maine) *Maine Policy Review, summer 2000.* \$5,000.

Partial funding for the summer 2000 issue of the *Maine Policy Review* which features coastal issues.

6. Mercer, L. (Maine Department of Marine Resources) *Development of a marine research agenda for Maine.* \$5,000.

Working with the Maine Department of Marine Resources, Sea Grant co-sponsored a series of workshops to establish research priorities for several of the most important commercially harvested species.

7. Poor, J. (University of Maine) *Economic valuation of beach erosion control and benefit transfer.* \$5,000.

This funding allowed Poor to collaborate with a colleague at the University of New Hampshire to initiate an analysis of the economic value of southern Maine and New Hampshire beaches.

8. Reiss, W. (University of Maine) *High precision sub-bottom profiling of the Defense site.* \$1,000.

A collaborative project with Dr. Mindell of MIT Sea Grant to use acoustic 3-D imaging to study the site of the *Defense*, a revolutionary war privateer, which sank in Stockton Harbor in 1779.

9. Steneck, R.S. *Pilot study of subsurface lobster larvae*. \$5,500.

Augmented a project funded by the National Underwater Research Program to allow Dr. Steneck to study the vertical distribution of larval lobster and hence better understand how they are transported by ocean currents.

3. Conference Support: 3 projects for a total of \$2,412

1. Gregory, C.J. (Southern Maine Technical College). \$700. To attend the *Aquaculture America Conference* in New Orleans in February, 2000. Gregory presented a paper on "Industry's Role in Designing an Aquaculture Curriculum."
2. Kim, C. H. \$1,212. To attend a workshop on *Interactions Among the Environment, the Endocrine and Immune Systems, and Resistance to Disease in Marine Organisms*. Honolulu, Hawaii, June 2000.
3. South Carolina Sea Grant. \$500. To support the *Fourth International Conference on Shellfish Restoration* in Hilton Head, South Carolina.

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