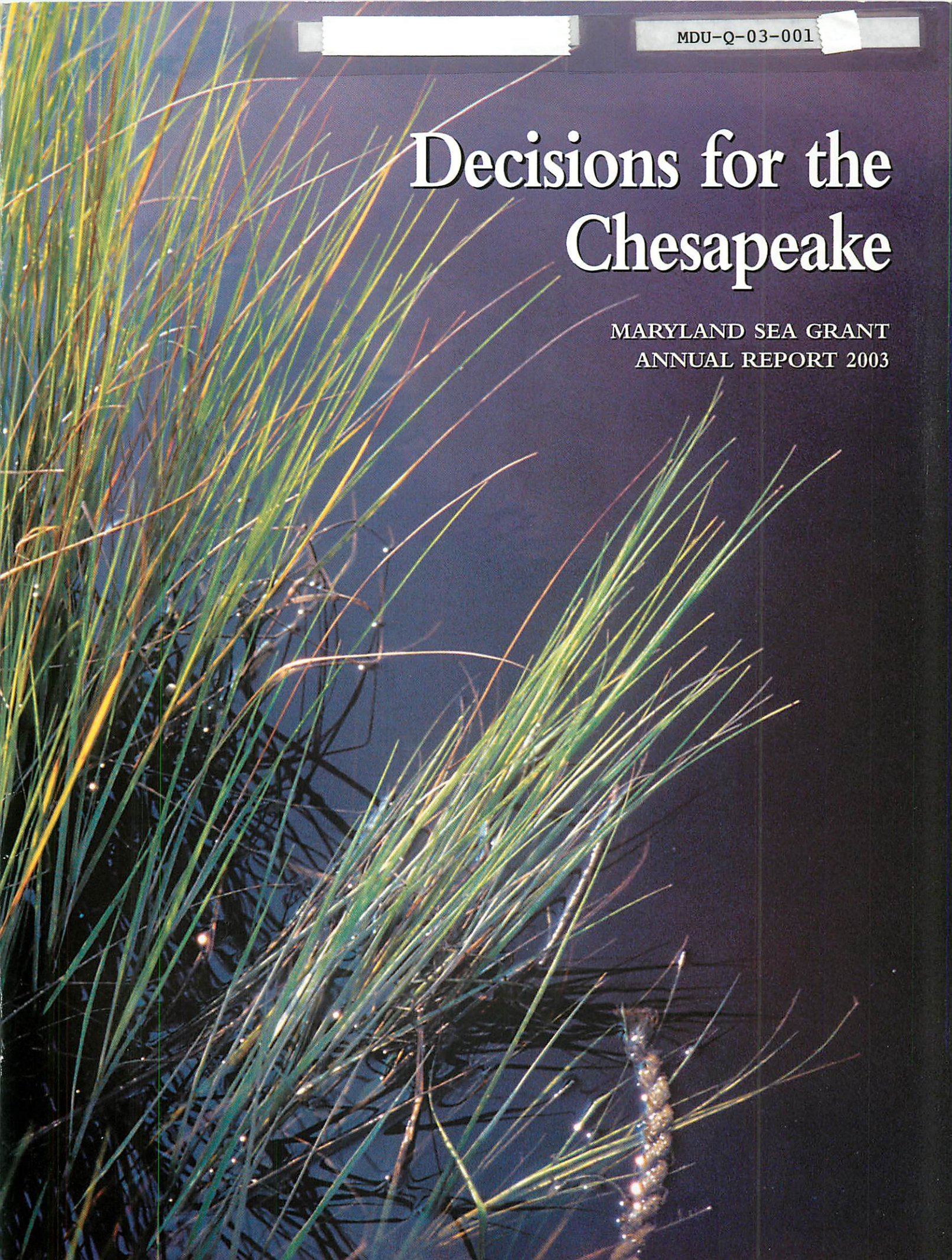
MDU-Q-03-001

Decisions for the Chesapeake

MARYLAND SEA GRANT
ANNUAL REPORT 2003



Sea Grant

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Message from the Director

Over the past year, the Chesapeake Bay and its watershed have confronted a number of pressing concerns. The region emerged from a long period of drought only to face a year of near record rainfall. Then came Hurricane Isabel, whose rapid passage left a distinct mark on the Bay's ecosystem, as well as its human communities. Over the course of 2003, citizens across the region have entered into detailed and at times difficult debates over how best to manage and restore the Chesapeake Bay. Front and center have been discussions about the introduction of the non-native oyster, *Crassostrea ariakensis* — viewed by some as a viable option to restore a depleted fishery and renew an important ecological function, and by others as an unproven if not potentially damaging alteration to the ecosystem. In the past twelve months the Bay has experienced lower oxygen levels over much larger areas than seen in recent years. From many quarters have come renewed calls for definitive actions to lessen the impact on the Bay of urbanization and agriculture in the watershed.

In many respects this past year has been one that has emphasized the importance of difficult choices and the role that science must play in the decision-making process. Throughout this period, Maryland Sea Grant has worked to bring relevant science to critical issues. Program-wide, we have been engaged in activities directly focused on the Chesapeake Bay. By fostering research and synthesis, encouraging and enhancing discussion and working with our many stakeholders through extension and education, our program is addressing Baywide issues — and helping others as they seek unbiased, creditable information to address many of those same issues. Looking forward, the coming year will surely bring more complex challenges to the Chesapeake Bay and its watershed. Maryland Sea Grant will continue to seek new ways to engage and extend the strengths of our university and research partners, to help solve these difficult problems and to create new opportunities for Maryland and its coastal communities.

We are proud to highlight many of our activities from 2003 in this report, and we invite you to learn more about our diverse portfolio. Your comments, questions and insights are essential and always welcome. Our door is open and we encourage you to contact us.

Jonathan Kramer
Director

Integrated Approaches to Complex Challenges

The Chesapeake Bay, like estuaries and coastal waters throughout the country, faces continuing challenges to its health and productivity — challenges that range from the persistence of poor water quality and loss of habitat, to declines in popular fish and shellfish species. These ecological impacts have also affected Bayshore communities that can no longer sustain traditional ways of life. For more than 25 years, Maryland Sea Grant has been working to address these challenges through integrated programs of research, education and outreach. Our primary objectives are to deliver research-based information that can reliably inform decision making at all levels, from policy makers to those in Bay-related trades, to secondary school teachers. Our efforts during 2003 reflect our long-term commitment to scientific discovery and our mission to clarify scientific, policy and restoration issues in service to the citizens of the state and mid-Atlantic.

► The Chesapeake Bay Oyster Crisis

Two entrenched parasitic diseases continue to impede sustainable oyster restoration in the Chesapeake. While the performance of disease-free native oysters (*Crassostrea virginica*) is still being field-tested and disease-tolerant strains are under continuing development, support for introducing an apparently disease-resistant non-native species, *Crassostrea ariakensis*, increased significantly in 2003. As part of coordinated efforts focused on the oyster, we supported a suite of research, education and outreach activities that examined the benefits and risks of introducing *Crassostrea ariakensis* to the Bay and helped to frame the complex scientific and policy issues that underlie efforts to restore oyster populations to the Chesapeake. During this year, Maryland Sea Grant examined both the native and non-native species. With Virginia Sea Grant, we organized "Oyster

Research & Restoration in U.S. Coastal Waters," a national meeting aimed at developing a set of priority recommendations for restoring native populations. In addition to compiling and publishing a comprehensive summary of ten years of scientific support by the Oyster Disease Research Program (www.mdsg.umd.edu/oysters/workshop/), Sea Grant staff worked with conference rapporteurs to facilitate breakout sessions that led to a joint print and web-based publication, "Strategic Priorities for Oyster Research for the Future."

As part of the oyster recovery effort, Maryland Sea Grant Extension Shellfish Aquaculture Specialist and Senior Agent at Horn Point Laboratory Don Meritt produced 130 million disease-free spat, more than three times the 40 million produced in 1999. Most of these oysters have been planted, with the help of the non-profit Oyster Recovery Partnership, in sanctuaries and managed reserves where they are being assessed for growth and disease prevalence by University of Maryland scientist Kennedy Paynter in order to determine optimal conditions for rebuilding populations of the native oyster, *Crassostrea virginica*.

While efforts aimed at restoring the native oyster continue, the states of Maryland and Virginia have requested a federal Environmental Impact Study on importing *C. ariakensis*. The Chesapeake Bay Program's Scientific and Technical Advisory Committee (STAC) moved quickly to convene a workshop of scientists and resource managers to discuss priority research needs so that scientists could better articulate the risks and benefits of introducing an exotic oyster. The Maryland Sea Grant Director served as a co-chair of the workshop and Sea Grant staff helped facilitate breakout sessions on issues related to disease and population and community ecology.

Our continually updated Oyster Research and Restoration website remains an important resource for a diverse community with some 15,000 visits in 2003, as are print and web-based articles in *Chesapeake Quarterly* and *Maryland Aquafarmer* that highlight the status of issues related to the native and non-native oyster.

▶ Blue Crabs

Blue crab harvests have remained below the long-term average, and fisheries independent surveys have documented a worrisome decline in the crab stock. Resource managers and researchers alike are watching for signs of recovery following management actions recommended by the Chesapeake Bay Commission's Bi-State Blue Crab Advisory Committee. When funding for the Advisory Committee ended in 2003, Maryland Sea Grant partnered with Virginia Sea Grant to maintain the Commission's Technical Workgroup (TWG) for the foreseeable future. Sea Grant has worked to support the research and analysis needed to sharpen our understanding of the blue crab's behavior and growth in the estuary. This has required close cooperation with others in the region, from state and federal agencies to research laboratories in Maryland, Virginia, Delaware and beyond. In order to help promote understanding between watermen who catch crabs and scientists who study them, Maryland Sea Grant has supported the work of anthropologist Michael Paolisso, work detailed last year in Sea Grant's magazine, *Chesapeake Quarterly*. In addition, Sea Grant is now completing a long-term goal: the publication of the most comprehensive volume produced to date on the blue crab, *Callinectes sapidus*. This book will bring together current information on the crab's physiology, biology and management.

Regional Sea Grant Collaboration

Fostering regional partnerships received a logistical boost this past year. By shifting its funding cycle, Maryland Sea Grant will now more easily coordinate regional research efforts with neighboring Sea Grant programs. Discussions with the leadership at Delaware and Virginia Sea Grant have led to several issues of joint priority, in particular a focus on understanding how biological resources of the Chesapeake and Delaware Bays are impacted by changes in the coastal ocean.

► Assisting Seafood Processors

In 2003, declining crab fisheries nationwide sparked an emergency response from Congress. Relief funds were allocated to a number of states, including Maryland, which received approximately one million dollars. Maryland crab and crabmeat suppliers and commercial buyers identified a number of uses for these funds, including a series of projects that target quality and marketing needs. Sea Grant Extension specialist Tom Rippen received a special request to submit a research plan to address these needs. The resulting program — with $250,000 of the relief funds — supports not research studies in the usual sense but applied projects to develop necessary processing procedures and infrastructure not currently in place. The projects will be conducted by and with crab and food industry suppliers and will examine innovative ways to reduce shell content, develop value added products, develop new packaging, train and implement procedures to reduce pathogen impacts, and develop new ways to reduce losses due to crab mortalities post-harvest. The program will be conducted at Rippen's UMES laboratory and with processors on Maryland's Eastern Shore.

► Scientific Expertise and Environmental Literacy

Training Future Experts. Equally as important as supporting current researchers and their scientific work is the training of future researchers, scholars and technical experts. This commitment to the next generation is evident in our support of Maryland Sea Grant Research Fellows and our long-standing Research Experiences for Undergraduates (REU) program. These students not only received financial support but also benefited from direct contacts with many of the region's noted marine researchers. Sea Grant brought these students together during the summer to share experiences and to discuss both science and science outreach — instilling in them the importance of conducting rigorous scientific investigation and of communicating that work to others.

Looking Ahead: 2005-2010

In 2003 Maryland Sea Grant initiated its new strategic planning effort, building on the current strategic plan for 2000-2005. We are working within the context of strategic goals set by Sea Grant's primary funder, the National Oceanic and Atmospheric Administration (NOAA), and the national Network of Sea Grant Programs. The planning process commenced with a detailed self-assessment and an analysis of our stakeholders, resulting in the development of an extensive database. We are following this with a series of meetings, surveys and other information-gathering exercises and will begin drafting the plan itself in 2004. Defining defensible benchmarks and supporting metrics of progress will form an important part of this effort, and will depend on insights and observations from our stakeholders.

Research and Discovery

Sea Grant Sponsored Research

Research forms the foundation of our understanding of the Chesapeake Bay and its remarkable ecosystem. While we may focus on the bounty we can see — like blue crabs and striped bass — beneath the surface lies a complex web of interrelation that fuels the Bay's productivity.

This complexity includes the rich diversity of organisms found in bottom sediments, an important factor in an estuary as shallow as the Chesapeake. It also includes tracking the health of tidal marshes and of the Bay's threatened underwater grasses. A better understanding of these and other dimensions of the Bay's physical and biological complexity will help inform decision makers as they assess the difficult management and policy decisions that lie ahead.

As part of an ongoing effort to shape our research programs, Maryland Sea Grant brought together a group of researchers, managers and other stakeholders in December 2003 to help develop a clear vision of the Bay's research needs and a sense of where Maryland Sea Grant could best contribute. The result of this important meeting was a well-articulated focus on research needed to assess and support effective Bay restoration efforts. The participants helped frame a series of insightful questions that we should address if we are to understand which paths the Bay might take as restoration proceeds, the indicators that we will need to understand how best to adaptively manage the restoration process, and the opportunities for building communities and economies along the way. This strategic advice was reflected in the new Request for Proposals issued in 2004 and will have a direct impact on our strategic plan for 2005.

In 2003, research in our core program has focused on fisheries, ecosystem processes and aquaculture. Summaries of selected projects appear below, and Maryland Sea Grant's website (www.mdsg.umd.edu) carries broader descriptions of work underway and recent findings.

Ecosystem Processes

Life Cycles on the Bottom of the Bay

► **Roberta L. Marinelli. Benthic Studies in Chesapeake Bay: Analysis and Synthesis of Faunal Data in Relation to Sediment and Water Column Interactions and Scope for Future Needs.** Bottom-dwelling (benthic) organisms can play significant roles in estuarine ecosystems like the Chesapeake, recycling nutrients and contaminants, modifying water flow and serving as prey for fish and crustaceans. While a good deal of data are available for benthic processes in the Bay, much of that data have not been analyzed and interpreted. In this project, Roberta Marinelli and her team are drawing on nearly 15 years of Baywide data to better quantify the ways in which these communities affect the chemistry of the sediments and overlying waters. They began by first examining the quality of these data, organizing their findings in terms of ecological relationships and likely biogeochemical interactions. One goal is to identify "keystone" species, those organisms that have a significant role in regulating benthic-water column interactions. In detailing chemical cycling or flux, they have so far assessed the spatial overlap of data that describe species composition in terms of life history, biological behavior (such as feeding modes) and likely effects on benthic processes. As a result of these analyses, Sea Grant graduate research fellow George Waldbusser is highlighting the need for modifying some of the current protocols for collecting geochemical data. During the summer of 2004, Marinelli's team will participate in a teacher workshop organized by Maryland Sea Grant Extension Marine Agent Jackie Takacs to discuss the importance of benthic organisms in understanding the functioning of the Bay ecosystem.

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Ecosystem Processes

Tracking Pollutants in Marshes

► **Gerhardt F. Riedel and Richard Osman. The Use of Stable Isotopes to Measure Contaminant Movements in Wetlands.** A major challenge in restoring contaminated wetlands is how to protect bottom-dwelling organisms from exposure to sediment-borne contaminants. A number of remediation techniques have been employed in wetland restoration projects for reducing such risks, among them capping contaminated bottom with clean sediments, and phytoremediation in which aquatic plants are used to sequester toxic compounds. Testing the effectiveness of these techniques, for example by measuring the movement of toxics, is difficult and expensive. In this project, Gerhardt Riedel and Richard Osman are developing an innovative experimental approach that will measure the degree to which each of these techniques reduces the transfer of contaminants to the surrounding environment. In Spring 2003, the researchers collected sediments from a contam-

inated site in Baltimore Harbor and from a relatively clean one in Fishing Bay that would serve as a baseline for comparison. After dividing sediments among five different treatments — a control, contaminated, capped, restored and phytoremediation — they added chemical tracers for several contaminants. The treatments were placed in large experimental tanks that were open to Bay waters and their tidal action; the researchers added marsh plants — cord grass, for example — and organisms — mummichogs, sheepshead minnows, periwinkles and seaweed snails. During the summer, a Maryland Sea Grant Research Experience for Undergraduates fellow Tracy Kroboth participated in this effort and presented the results of the work she conducted with her mentors, "Trace Mercury Uptake by *Spartina Alterniflora* in Mesocosms Simulating Capping, Marsh Restoration and Phytoremediation," in a seminar at the conclusion of the fellowship program.

Fisheries

Tracking Blue Crab Age and Growth

► **David H. Secor and H. Rodger Harvey. Growth and Recruitment of Juvenile Chesapeake Bay Blue Crab.** Baywide management efforts to balance conservation of blue crab stocks with the viability of the harvesting and seafood industries depend on developing regulatory policies that all stakeholders can have confidence in. Such policies, which rely on stock assessments of crab populations, are based on intensive monitoring, the results of which are used in population models — important components of these models are measures of crab longevity and age of sampled crabs. Because there are no direct methods for making such determinations, and because size does not necessarily correlate with age, scientists have had to find indirect measures, none of which have been wholly reliable. In the last several years, however, Dave Secor and Rodger Harvey have adapted a technique that shows some promise. It makes use of lipofuscin, a pigment that results from the breakdown and absorption of damaged blood cells. Lipofuscin accumulates in neural tissues such as the crab's eye stalk and brain; because the cells of neural tissue experience a slow turnover rate, lipofuscin's accumulation is relatively constant — it seems to increase as the crab grows and therefore can serve as an index of age.

In this project, Secor and Harvey are developing a temperature-based growth model for juvenile blue crabs and will apply this model to predict monthly fishery yield patterns. During 2003, their primary efforts focused on rearing wild-caught crabs in brackish water ponds at the UMCES Horn Point Laboratory and comparing their growth with hatchery-spawned juvenile crabs provided by the Center of Marine Biotechnology (COMB). In June, 270 juvenile crabs nearly two months old were released into a single pond, then sampled monthly for growth; in July and September, lipofuscin concentrations were measured in a small sample of crabs. A second batch of juveniles, about 80 days old, were obtained from COMB and released into the second experimental pond in mid-October. The researchers will continue to monitor crabs of known age in both ponds and continue to sample lipofuscin concentrations — in the end, they hope to develop algorithms that will enable them to predict crab age based on lipofuscin concentrations.

Ecosystem Processes

Regional Differences in Bay Grass Restoration

► **Charles Gallegos. Regional Refinement of a Diagnostic Tool for Setting Water Quality Targets for the Protection and Restoration of Submersed Aquatic Vegetation.** Whether or not sufficient levels of sunlight can penetrate bottom waters is critical to the growth and reproduction of submerged aquatic vegetation (SAV). High turbidity, which restricts light penetration, results from suspended particulate matter and may have numbers of causes. These include land and nutrient runoff that can fuel high phytoplankton populations, the recycling of nitrogen and phosphorus in bottom waters, the scouring

of sediments by tidal action, and other mechanical forces. Which condition predominates in any given region may vary depending on a number of factors. For example, phytoplankton (chlorophyll) may dominate in one area and suspended solids may be a secondary factor; in another region, suspended solids may predominate and chlorophyll may be weak. While the multi-state-federal Chesapeake Bay Program has identified scientifically-based water quality criteria that list minimum requirements for promoting SAV growth, there is a widespread recognition that the causes of turbidity vary from one region to another.

To better assess the major contributors to turbidity in a given area, Charles Gallegos has been developing techniques that distinguish the spectral or optical properties of different kinds of organic and inorganic matter. His study sampled four stations to provide a sharp gradient in optical properties between the once-vegetated middle salinity (mesohaline) stations and those in or upstream of the turbidity maximum in the tidal fresh regions. In mid-salinity areas (the mesohaline zone), scattering of light — identified as "scattering coefficients" — was governed principally by algae (phytoplankton chlorophyll) and only weakly by suspended solids. Conversely, in tidal fresh regions these scattering coefficients were controlled by suspended solids and only weakly by algae (chlorophyll). Shapes of the scattering spectra also indicated that large organic particulates governed the scattering of light in mid-salinity regions, while in tidal fresh regions this scattering was governed by small inorganic particulates, such as dirt and clay particles. The primary outcome of this project has been the development of an optical water quality model and diagnostic tool to predict precisely how such scattering limits light (the "diffuse attenuation coefficient") and especially light waves essential for photosynthesis ("photosynthetically important irradiance"). These precise calculations will help managers as they attempt to predict the availability of light to SAV in a given location.

By developing accurate algorithms and models, this effort could assist the Bay Program in its goal of identifying the kinds of management actions that will be required to restore and protect 114,000 acres of SAV by 2010. The Chesapeake Bay Program will incorporate the results of this project into the web version of the diagnostic tool to be used by managers.

Gallegos's effort could assist the Bay Program in its goal of identifying the kinds of management actions required to restore and protect 114,000 acres of SAV by 2010.

Ecosystem Processes

The Role of Sediment Quality in Restoring Bay Grasses

► **W. Michael Kemp and Jeffrey Cornwell. Sediment Biogeochemistry and Seagrass Bed Development: Implications for Restoration and Sustainability.** Underwater grasses in the Chesapeake today cover only 20 percent of the bottom surface they covered 50 years ago — their lack of recovery on a large scale is an index of the Bay's poor water quality conditions, especially the widespread turbidity that prevents light from penetrating to bottom areas. While researchers have identified the conditions that plant species require for promoting growth, only recently have they begun to examine the significance of biochemical processes in the sediments. In this project, Michael Kemp and Jeffrey Cornwell have been focusing on how these processes change as plants develop and spread. They are studying how plant interactions in sediments affect grass bed sustainability, and are applying their findings in outreach efforts to secondary schools, directly involving young students in growing grasses and planting them in test plots. During the spring and summer of 2003, record

high rains and runoff created extremely turbid conditions, which are detrimental for the growth of existing submerged grass beds and the initiation of new or restored ones. Nevertheless, from aerial monitoring surveys, Kemp and Cornwell identified numbers of potential study sites, selecting 30 that provided a representative range of grass bed sizes, plant density, geographic distribution and historical patterns of abundance. They then sampled the sites for plant biomass, nutrients and sediment characteristics. At all sites *Ruppia maritima*, commonly known as widgeon grass, was the dominant species. Analyses of chemical, biological and sedimentological data in these vegetated areas revealed daily patterns of oxygen, ammonia, nitrogen gas and dissolved organic carbon fluxes. In unvegetated areas, these regular patterns were less clear and flux rates were substantially lower. In vegetated areas, rates of ammonia regeneration and denitrification — an important biochemical process that releases excess nitrogen gas — are proportional to *Ruppia* biomass. In addition, rates of nitrification are substantially higher in these vegetated sediments and appear to be related to the distribution of *Ruppia* root biomass. This work has so far shown that existing SAV beds of prolific grasses like *Ruppia maritima* can serve as nursery areas for restoring other native SAV species, for example, sago pondweed (*Stuckenia pectinata*, formerly *Potamogeton pectinatus*) or redhead grass (*Potamogeton perfoliatus*), which have important ecological value.

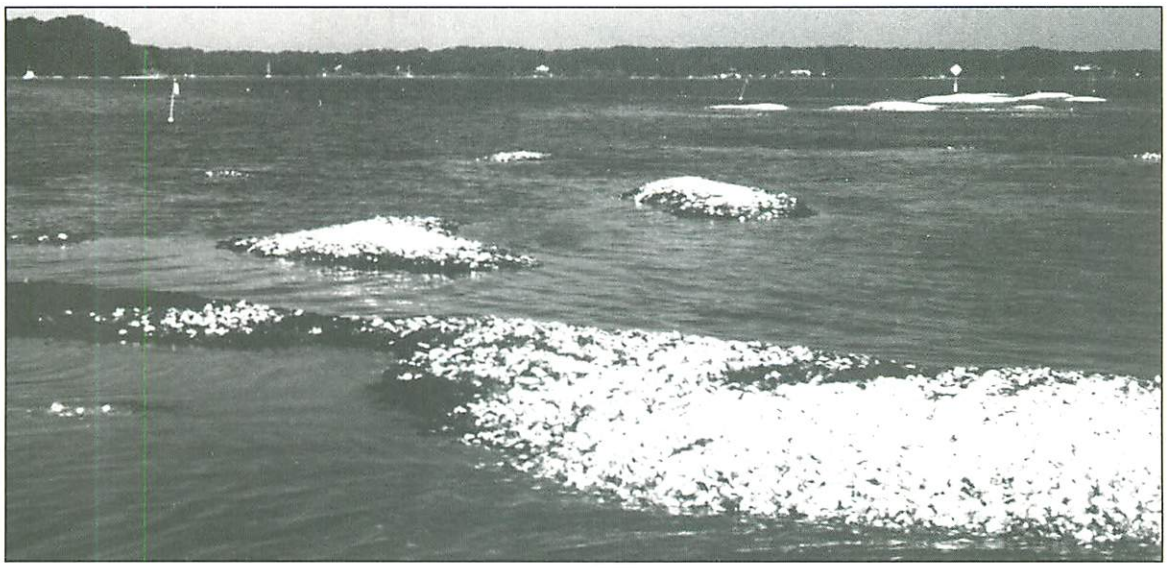
Ecosystem Processes

Tracking the Sources of Jellyfish

► **Denise L. Breitburg. The Role of Small Inlets as Potential Reactor Vessels for Gelatinous Zooplankton in Chesapeake Bay.** Denise Breitburg has been testing a novel hypothesis, namely that small inlets along Chesapeake Bay tributaries act as "reactor vessels" for gelatinous zooplankton species such as the sea nettle (*Chrysaora quinquecirrha*) that feed heavily on plankton and on early life stages of fishes in the mid-region of the Chesapeake Bay system. If her hypothesis is correct, water exchange between these reactor inlets and the mainstem tributaries may strongly influence, and under some circumstances even control, upper trophic level dynamics in Chesapeake Bay tributaries. Depending on the ingress-to-export ratio, the breeder-vessel characteristic of these small inlets may allow them to act as nutrient sinks, reducing nutrient export to mainstem tributaries, or as sites of seed-populations for consumers (e.g., of fish larvae), and strongly influence food web dynamics.

Field sampling that focused on two creeks along the Patuxent River in 2003 partially supports the observation that gelatinous zooplankton are more abundant in small inlets and subtributaries than in the mainstem portion of major tributaries of the Chesapeake Bay. However, the unusually cold winter and high spring and summer rainfall that occurred during the year could have caused significant deviations in this pattern. Densities of comb jellies (ctenophores, *Mnemiopsis leidyi*) were zero or near zero at all sites during May and early June 2003, and it is likely that low winter temperatures may have significantly reduced overwintering populations in much of the system. Earliest appearances were in the mainstem, mid-channel Patuxent River and consisted of medium-to-large-sized adults.

Sea nettle densities peaked much later than is typical, probably reflecting the cool wet spring and wet summer. Densities in October were higher than those in July. Low peak densities (rather than the timing of peak densities) during 2003 may more strongly reflect a long-term decline in sea nettle abundance than interannual variation related to rainfall. Sea nettle densities in recent years are roughly an order of magnitude lower, and ctenophore densities are at least an order of magnitude higher than during the early 1990s, regardless of whether rainfall in particular years was above or below average. Because of unusual weather conditions and low sea nettle densities during 2003, much of the field sampling conducted during the first year of the project will be repeated during 2004.



Ecosystem Processes

Do Oyster Reefs Help Bay Grasses?

► **Raleigh Hood, Evamaria Koch, Roger Newell. Do Oyster Filtration and Wave Attenuation Associated with Oyster Reefs and Breakwaters Improve Seagrass Habitat?** The restoration of oysters and Bay grasses must be a top priority if we are to stimulate and renew ecological function in Chesapeake Bay. Recognizing that synergies exist between these vital components of the ecosystem, a new research project being undertaken by Raleigh Hood and colleagues at the Horn Point Laboratory is evaluating the potential for oyster reefs to create suitable seagrass habitats. The researchers are quantifying the impact of oyster reefs and breakwaters on wave attenuation and water clarity using a combination of numerical modeling and field studies. They will use this same approach to develop a model that can be used by managers to help guide their seagrass and oyster restoration efforts.

The field work from the first summer of observations at a breakwater at Bishop's Head Point confirmed substantial wave attenuation, but also revealed increases in fine organic sediments and epiphytic loading on seagrasses growing in the area protected by the structure. In this case, the high turbidity and nutrient levels coupled with the elevated epiphytic growth made the area protected by the breakwater at Bishop's Head less suitable for seagrass growth than a nearby exposed area. The team hypothesizes that a structure that remains beneath the surface of the water, like an oyster reef, may allow currents to carry away fine organic sediments, providing a better environment for SAV than did the relatively restrictive breakwater at Bishop's Head. Additional experiments at a submersed breakwater will be conducted in 2004.

Fisheries

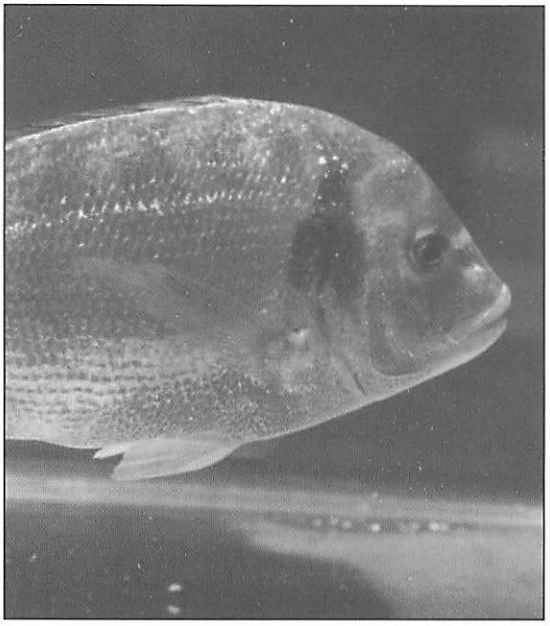
On the Trail of a Deadly Clam Disease

► **Robert S. Anderson. Immunological Approaches to Understanding QPX Disease.** A potential major threat to the hard clam (*Mercenaria mercenaria*) aquaculture industry, the most successful hatchery-based enterprise on the east coast, QPX disease has been responsible for clam mortalities from Canada's Atlantic coast south to Virginia. In this new project, Robert Anderson is carrying out a suite of biochemical tests that will try to uncover the molecular basis of the clam's susceptibility. Hemocytes (blood cells) in clam serum, as in the serum of other bivalves, first recognize an invading parasite like QPX, try to inhibit its replication by engulfing it, and then disable it by releasing a chemical compound.

Anderson is carrying out a suite of biochemical tests that will try to uncover the molecular basis of the clam's susceptibility to QPX disease.

Anderson is focusing on the biochemical basis by which hemocytes move towards QPX (called chemotaxis) and engulf it. These processes are important for understanding the ability of a clam's immune system to face such an attack. New technology is making it possible to rapidly measure such processes with a high degree of accuracy. Analysis of QPX-infected clam tissues has shown changes in the serum — these are characterized by aggregations of hemocytes though there is little indication that they are successfully attacking or engulfing invading parasites (the process is called phagocytosis). While experiments show that the clam experiences inflammation by QPX with a consequent hemocyte activation, there appears to be little actual cellular uptake of the QPX parasite. Anderson believes that this is most likely due to a protective coat of mucus (or mucoid coat) surrounding QPX. He is currently developing a system that will allow him to increase the counting rate for hemocytes by 2000-fold over previous methods. Once optimized, experiments with extracts of QPX mucoid secretions will begin. In order to determine the possible protective role of QPX secretions, Anderson is comparing the rates of immune response (specifically phagocytosis) of mucus-coated and non-coated QPX cells. He has developed a method that uses fluorescence to label coated and uncoated QPX, and is now carrying out the comparative phagocytosis experiments.

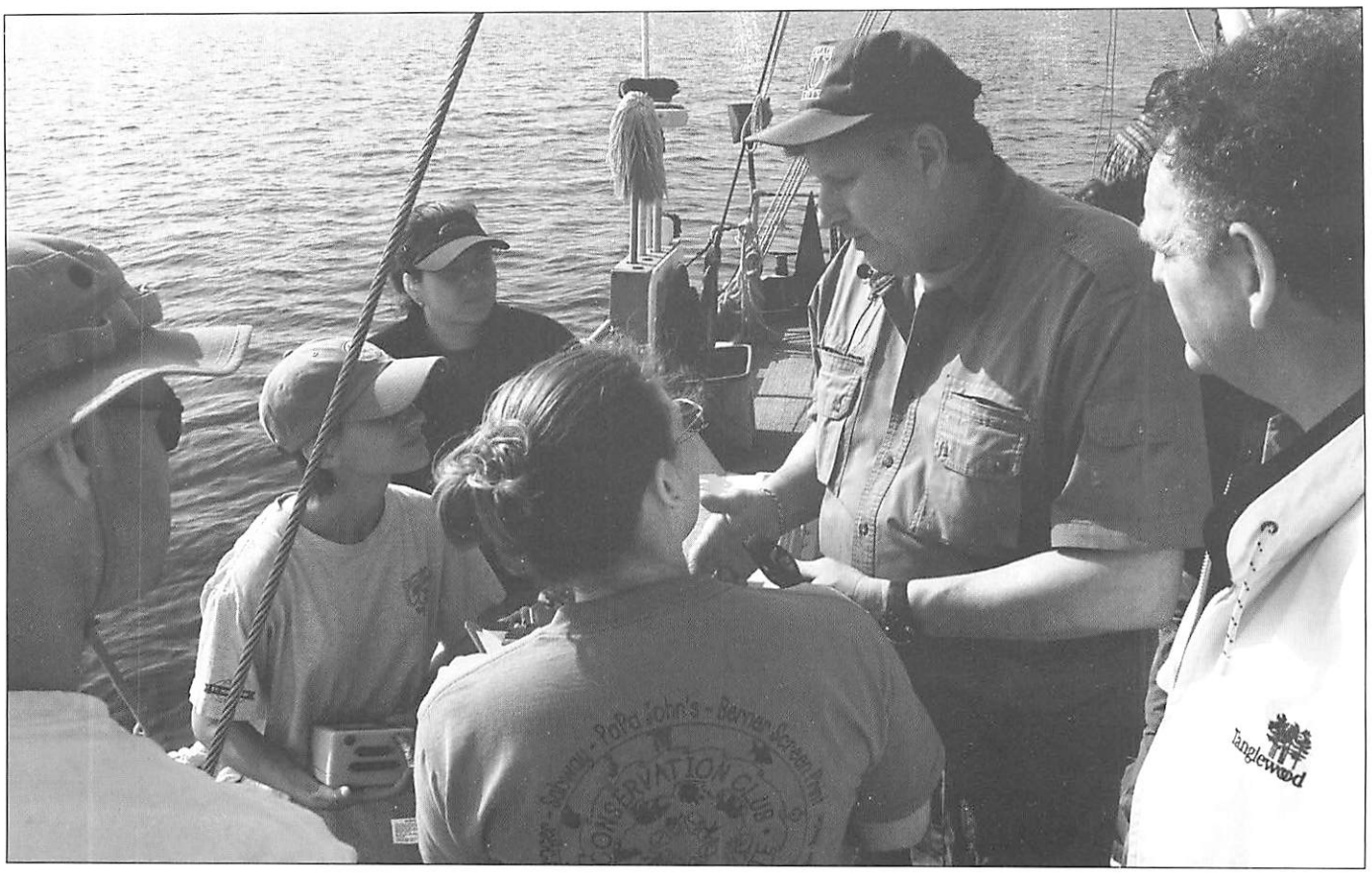
This project builds upon the recently completed study funded by Maryland Sea Grant entitled: "*Mercenaria mercenaria* - QPX: Immunological Characterization of the Host-pathogen Interface."



Aquaculture

Enhancing Fish Growth and Production

► **Yonathan Zohar. A Novel Approach to Inducing Sterility in Farmed Fish: Disrupting the Early Establishment of the GnRH System.** Aquaculturists are continually seeking new ways to minimize the time needed to grow fish to market size. An additional challenge is the fact that farm-raised fish may not be genetically compatible with natural populations. One potential solution to these problems is to grow sterile fish that both grow rapidly and cannot breed in the wild. Yonathan Zohar is working to develop a simple and generic treatment for inducing sterility in farmed fish at the larval stage. Based on altering the migration pattern of gonadotropin releasing hormone (GnRH) neurons during early development using gamma-aminobutyric acid (GABA), this novel technology is currently being studied in two model systems — one using gilthead seabream and another using hybrid striped bass. Over the first phase of this project, several experiments provided preliminary information suggesting that the GnRH system in early development is manipulable. At the heart of these studies are a set of new, extremely sensitive and specific RT-PCR assays that allow the investigators to monitor minute changes in the level of key mRNA's encoding different components of the GnRH system. These initial experiments suggest a window in the GnRH ontogeny during which system perturbation may be possible. Ongoing studies are expected to provide additional information on the degree to which perturbation is possible and the optimum timing of intervention.



Educating Scientists and Specialists

Preparing the Next Generation

Educating those who will become marine researchers, policy experts and technical specialists is a central goal of Maryland Sea Grant. Fulfilling this mission takes several forms:

- Supporting graduate students through an ongoing Research Fellows program

- Staging each summer a Research Experiences for Undergraduates program offering hands-on educational experiences through teacher training and other activities aimed at both students and educators

- Providing invaluable practical experience in government and policy through the Knauss Fellowship program

Maryland Sea Grant Research Fellows

During 2003, Maryland Sea Grant provided support to seven graduate students who worked with their advisors on topics in biotechnology, fisheries, biogeochemistry, molecular biology and benthic ecology. Former fellow Angie Arnold (1999-2002) completed her Ph.D. at Johns Hopkins University; her dissertation, directed by Grace Brush, addressed the long-term history of food web (trophic) conditions in the Chesapeake Bay through the analysis of sediment cores. The research of Grace Brush, including this work by Arnold, was highlighted last year in our magazine, *Chesapeake Quarterly* (www.mdsg.umd.edu/CQ/V01N2/index.html).

In addition to their research, Fellows are also engaged in outreach and education activities. In 2003, the Research Fellows met to discuss the program and to learn more about Sea Grant's community outreach and science communication efforts. To improve communication among graduate students, this past summer eight current and former Research Fellows

Maryland Sea Grant Research Fellows for 2003

George Waldbusser, Chesapeake Biological Laboratory, UMCES (Roberta Marinelli)*

Laurie Bauer, Chesapeake Biological Laboratory, UMCES (Thomas Miller)

Eytan Abraham, Center of Marine Biotechnology, UMBI (Yonathan Zohar)

Jessica Davis, Horn Point Laboratory, UMCES (Michael Kemp)

Brandon Puckett, Chesapeake Biological Laboratory, UMCES (David Secor)

Larry Taylor, Department of Microbiology, UMCP (Ronald Weiner)

Rebecca Holyoke, Horn Point Laboratory, UMCES (Roger Newell)

*Research Advisor in parentheses

presented updates on their research at a Fellows Symposium held at the Chesapeake Biological Laboratory. The audience consisted of University of Maryland faculty, staff and students as well as 14 NSF-sponsored students in Maryland Sea Grant's Research Experience for Undergraduate (REU) program. The meeting provided an excellent means for each Fellow to discuss his or her research project in the context of its potential application.

Research Experience for Undergraduates

Maryland Sea Grant's 15th year as a National Science Foundation site for the Research Experience for Undergraduates Program brought 14 students from around the nation to work in marine laboratories at the University of Maryland Center for Environmental Science and the Philadelphia Academy of Natural Science's Estuarine Research Center. Each student worked with a mentor-scientist in developing a summer research project. Over the years, numbers of students have given presentations of their research at scientific meetings and have served as co-authors on publications. In February 2003, three students, Sarah Bjork, Kelly Kearney and Marissa Yates, from the summer class of 2002, went to the American Society of Limnology and Oceanography meeting in Salt Lake City, Utah. They presented posters, respectively, on: "The Effects of Osmotrophy on Growth and Pigmentation in *Soreatula major,*" "A Model for Nutrient Pathways in the Choptank River," and "Characterizing Suspended Sediments in the Estuarine Turbidity Maximum Zone of the Chesapeake Bay." Laura Rubiano-Gomez, a student from MIT, was selected for the 2004 ASLO meeting in Hawaii to present the results of her project, "Sizes and Settling Speeds of Suspended Particles in the Chesapeake Bay Estuarine Turbidity Maximum." To learn more about the summer fellowship program, the students who have participated in the program, their projects and published papers, visit www.mdsg.umd.edu/Education/REU/index.

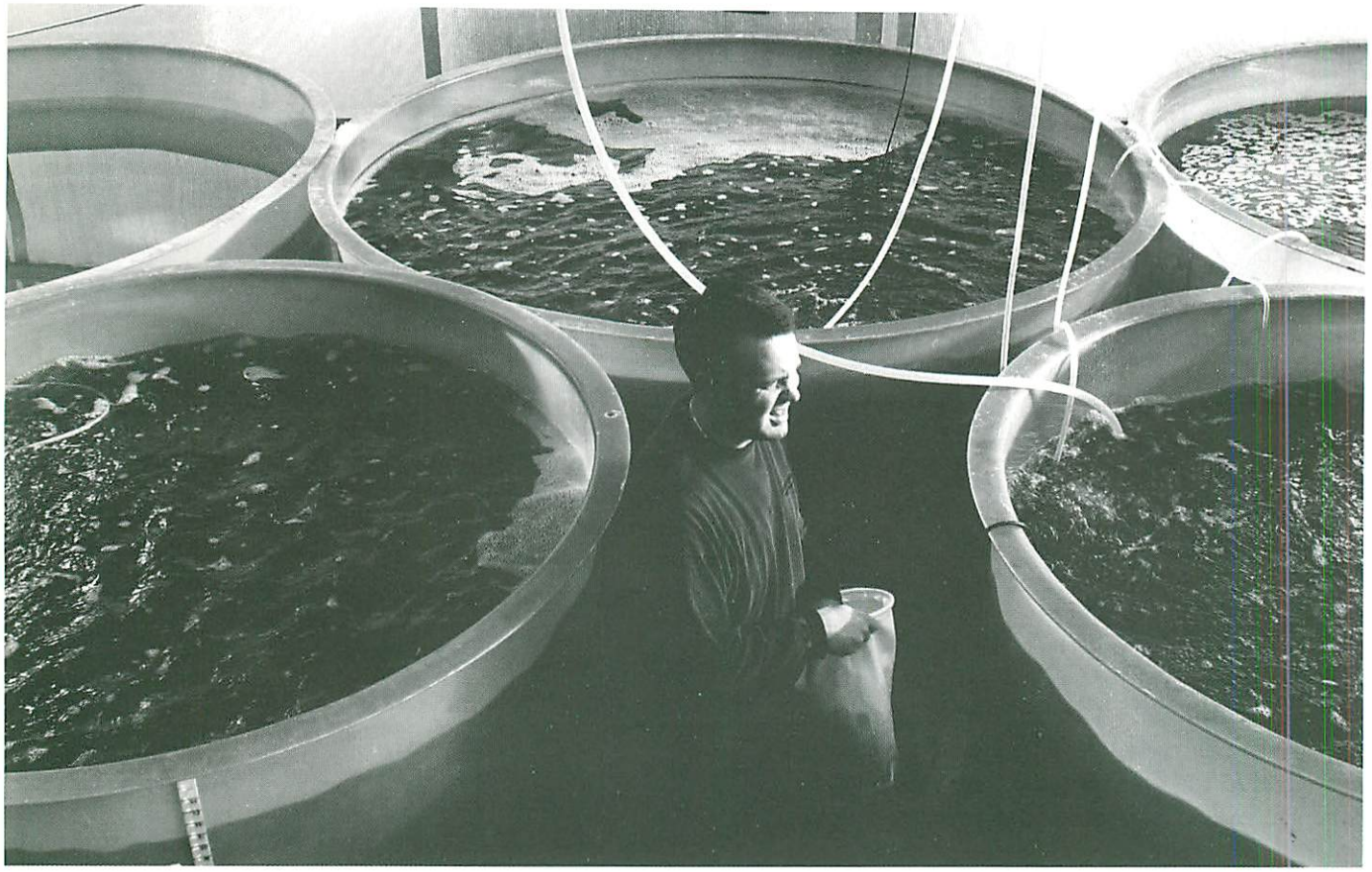
Knauss Fellows, Class of 2003

Two University of Maryland graduate students, Olaf Jensen and Taconya Piper, both in the Marine-Estuarine-Environmental Science (MEES) program, received Knauss Marine Policy Fellowships in 2003.

Olaf Jensen's fellowship placed him in the biogeography program in NOAA's National Ocean Service. His work there focused on biogeographic assessment, including habitat mapping and multi-species modeling of National Marine Sanctuaries. Jensen began work on an M.S. degree in the MEES program in 2000 and received a Maryland Sea Grant Research Fellowship. His thesis research, conducted at the Chesapeake Biological Laboratory and supervised by researcher Thomas Miller, focused on understanding the distribution patterns and spatial ecology of the blue crab in Chesapeake Bay. Jensen is currently writing his thesis and plans to graduate in the spring of 2004.

Taconya Piper spent her fellowship year with NOAA's National Ocean Service in the Office of Ocean Exploration. She organized, coordinated and provided special support to expeditions led by the office. She also focused on the development of education and outreach programs that promoted ocean exploration and stewardship to the public. Her work with education and outreach fulfilled a personal goal to implement programs that expose inner city youth to the many opportunities for careers in ocean and environmental science. Piper enrolled in the MEES program in 2000, under the direction of Roman Jesien, where she investigated the reproductive potential of American shad in the Delaware and Hudson rivers. While in the MEES program, Piper was also a research fishery biologist in the Student Career Experience Program (SCEP) through NOAA's National Marine Fisheries Service, an EPA Graduate Research Fellow, and a summer intern with the Maryland Department of Natural Resources. She received her M.S. degree in May 2003 and will pursue a Ph.D. in Fisheries Science and Management at Auburn University in Alabama.

In marine labs and government agencies, Maryland Sea Grant has provided students and fellows with opportunities to hone their scientific skills.



Building Bridges for Maryland's Citizens

Outreach and Extension

When Congress created the Sea Grant concept in 1966, it envisioned outreach as a central component. This outreach ranges from targeted technology transfer programs to the broad dissemination of information to interested audiences.

Maryland Sea Grant Extension — a joint effort of Maryland Sea Grant and Maryland Cooperative Extension — offers a range of programs in seafood technology, marine aquaculture, water quality and marine education. Through an active communications effort, Maryland Sea Grant also produces award-winning videos, books and other materials, including our new magazine, *Chesapeake Quarterly*.

Through these efforts, Maryland Sea Grant provides a vital link between the research laboratories of the state's universities and those who have a need for new and helpful information.

Education Opportunities for Students and Teachers

▻ **Aquaculture in Action.** Maryland Sea Grant's long-standing effort to bring aquaculture to the classroom continued to grow in 2003. Led by Maryland Sea Grant Extension Education Specialist Adam Frederick, Aquaculture in Action added six more teachers to the growing network of those using aquaculture as a vehicle to teach science concepts. Working in partnership with Garrett College and with funds made available from the college, the program trained teachers in Maryland, West Virginia and Pennsylvania. This partnership with Garrett College illustrates the effectiveness of the training program and the model Sea Grant has developed related to aquaculture education. (See the web at: www.mdsg.umd.edu/Education/AinA/.)

▻ **SciTech Programs in Baltimore.** In order to translate applied microbial research for both teachers and students, our educators created innovative laboratory activities for the Microbes for Hire Workshop at the Center of Marine Biotechnology (COMB) in Baltimore. In the summer of 2003, nine teachers gained applied laboratory skills and enhanced content knowledge on topics presented by Adam Frederick, COMB scientists and graduate students. Lectures provided essential background on new research. Follow-up with "hands-on" laboratory experiences exposed teachers to new techniques, laboratory materials and ideas — all designed to enhance content and pedagogy in their classrooms.

▻ **Environmental Science Education Program.** The Environmental Science Education Program (ESEP) Summer Research Fellowship is an eight-week program that immerses teachers in research focused on the Chesapeake Bay and its watershed. This program helps them advance their understanding of related science concepts, develop classroom applications that build on their research experiences, and structure meaningful Bay and stream experiences. With leadership from Marine Agent Jackie Takacs, Adam Frederick and UMCES educators Laura Murray and Cat Stylinski, and with support from the NOAA Chesapeake Bay Office and program development funds from Maryland Sea Grant, the program oversaw 14 fellowships in 2003. An extensive web-based resource — see the web at: www.esep.umces.edu — contains an interactive section for research experience documentation, classroom lesson development and downloadable lessons for teachers.

Environmental Science Education Program

The Environmental Science Education Program Summer Research Fellowship immerses teachers in research focused on the Chesapeake Bay and its watershed.

▻ **Vertically Integrated Partnership (VIP) — Enhancing Science Education in Maryland.** Maryland Sea Grant is working with a consortium of University System of Maryland institutions to enhance content and pedagogy in high school science classes in Montgomery County. Funded by the National Science Foundation (NSF), VIP links teachers and a broad university community in a collaborative endeavor that will extend for five years. Maryland Sea Grant is developing an innovative web-based learning community for all participants. Scienceinquiry.org is the community website being built for the educators involved in the VIP grant. The website enables community members to post and sign up for events and meetings, correspond through chat and messages, create and post inquiry-based lessons, post and utilize multimedia resources, and participate in peer reviews. The response from the educators about the site has been positive and it is being used extensively. The goal of scienceinquiry.org — collaboration through community and content — is being fulfilled. Kevin Bruce, the educational web designer who joined Sea Grant in 2003, visits the educators who have difficulty with the site to explain how to accomplish their goals, and attends most of the meetings to make himself accessible should they have questions, as well as to better understand their needs. The website can be accessed at: www.scienceinquiry.org/about.php.

Four members of the Sea Grant Extension Program have been appointed to a task force to study and recommend changes to the state's seafood and aquaculture industries.

Water Quality Programs and Outreach

The development of novel biofiltration applications was a priority for Water Quality Specialist Dan Terlizzi in 2003. Work has proceeded along two main lines. First, studies to determine the utility of diatom-impregnated mats for water quality management in juvenile crab aquaculture demonstrated that a commercial product, Aquamats, inoculated with diatoms (*Amphora* species) had limited impacts on water quality, but the availability of diatoms appeared to have a nutritional benefit in growth and survival. Second, studies of the kinetics of nutrient utilization by macroalgae and SAV have enabled Terlizzi to evaluate several species for consideration in the design of novel biofilters.

Linking knowledge on water quality issues to users in the community remains an important part of Jackie Takacs's program. In 2003 she co-founded and co-chaired the Maryland Lake, Pond and Watershed Association, an organization dedicated to better management of these resources in Maryland.

► **Threats from Invasive Species.** The risk of introducing non-native species to local ecosystems via the pet and aquarium trade has led Finfish Aquaculture Specialist Andy Lazur to initiate a cooperative effort with the Maryland Association of Pet Industries (MAPI) and the Maryland DNR Fisheries Service. Aimed at educating pet owners on the harm of releasing exotic animals and plants, this program will include a "rehoming" program utilizing a poster and sticker campaign commencing in 2004. This program will provide a list of pet shops and other contacts (via the MAPI website) that will take unwanted pets and find a new home, thus encouraging more responsible pet ownership and preventing releases into the environment.

► **Ensuring Healthy Seafood.** Federal and state health regulatory agencies continued to revise their expectations for the seafood industry during the year. Seafood Specialist Tom

Rippen implemented projects to assist commercial fishermen and processors with compliance. Model HACCP plans were developed and field tested for controlling scombrotoxin formation on fishing vessels, including alternative methods for monitoring and record keeping. This is part of a National Sea Grant-funded training program, Fisheries Extension Enhancement, led by Maryland Sea Grant. A parallel project identified temperature histories, microorganisms and histamine levels for susceptible fish species as currently handled on small inshore boats. Some modification of U.S. FDA guidance is expected as a result of these efforts. National training is planned for 2004. Maryland Sea Grant also developed a set of HACCP monitoring forms for the U.S. crab processing industry. These materials were adopted by the National Seafood HACCP Alliance for training processors and regulators.

New Paradigms for Aquaculture in Maryland Sea Grant

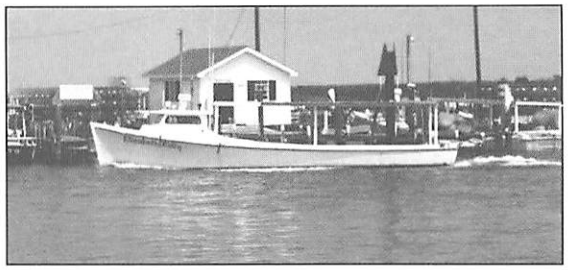
► **Aquaculture Policy Changes.** Increased pressures on traditional fisheries in Chesapeake Bay have sparked renewed debate on the current and future role of aquaculture in Maryland. Over the course of 2003, Maryland Sea Grant has been very heavily engaged in a series of efforts to inform policy development as well as to catalyze practical applications of aquaculture in the state. Four members of the Sea Grant Extension Program (Marine Agent Don Webster, Lazur, Rippen and Doug Lipton) have been appointed to a task force set up by the Maryland State Legislature to study and recommend changes to the state's seafood and aquaculture industries. Two members of the program currently serve on each subunit (aquaculture and seafood, respectively) and provide expertise based on their background and experience. With Maryland harvests of many species at historical lows, major changes are being discussed that would focus on

increasing production and providing processing and distribution expansion in order to rebuild the seafood industry. An interim report released in December 2003 preceded a final report scheduled for legislative distribution in September 2004. As part of this expanded role and in support of the Task Force's activities, Maryland Sea Grant sponsored a two-day Aquaculture Development Conference with the Maryland Agricultural Experiment Station and the Maryland Department of Agriculture. The meeting — organized and facilitated by Webster and Lazur — was held in Annapolis in August 2003.

Coastal Communities and Economies

Over the past 12 months, the program has continued to place priority on outreach and analysis directed to coastal communities and economies. Extension Director Doug Lipton led a group as part of the Maryland Seafood Task Force to examine current fishing regulations in Maryland in an attempt to determine how they might be modified to allow for improvements in watermen's income. Using watermen logbook data obtained from Maryland DNR the group was able to characterize changes to watermen's income over time that resulted from changes in fish populations and regulations. In other efforts, Lipton used data from Maryland DNR, to develop an annual update of the economic impact of boating on the Maryland economy. Interestingly, in 2002, there was little change in boater spending compared with 2001, despite the downturn in the overall economy. Most recently, he has been working with Maryland seafood processors to determine the impact associated with Hurricane Isabel. Specifically, the analysis will help processors develop estimates of the impact of this major storm in terms of lost production, damaged product, and physical plant loss. These analyses may impact emergency legislation in Congress.

In partnership with the Maryland DNR Chesapeake Bay and Watershed Programs, Coastal Communities Specialist Rachael



Smyk-Newton conducted educational programs on the impacts of sea-level rise on Maryland communities. Using high-resolution shoreline mapping to determine elevations, she identified areas in Maryland with high vulnerability to sea-level rise. She conducted an analysis of potential economic losses in some of the vulnerable areas. This information is being developed so that it can be used by local communities in their planning and coastal development processes.

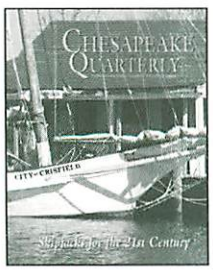
Environmental Finance Center

Over the past 12 months, the Environmental Finance Committee (EFC) held individualized watershed financing workshops for five communities across the state of Maryland who completed Watershed Restoration Action Strategies (WRASs) through a grant from the Maryland DNR. The workshops were conducted to help the communities find ways to move forward toward implementation of particular components of their strategies. Also, in partnership with The Friends of the Potomac, the EFC held a two-day workshop on environmental markets and the applicability of a nutrient trading program to the Potomac River basin. The EFC has continued to work with the towns of Frederick, Maryland, and Berkeley, West Virginia, to complete collaborative source water protection projects in both of these communities. As the year ended, the EFC made plans to work with the Chesapeake Bay Program to help staff the Chesapeake Bay Watershed Blue Ribbon Finance Panel, created to identify new ways to pay for the reduction of nutrient and sediment loads to the Bay and its tributaries. Such reductions will be necessary if the Bay is to be removed from the federal list of impaired waters by the deadline of 2010.

Communicating Science

Many Routes to Reach Stakeholders

Since its inception, Maryland Sea Grant has placed a premium on communicating the results of scientific research and other information critical for education, conservation and wise decision making. During its twenty-six year tenure, Maryland Sea Grant has produced numerous books, documentaries, magazines, newsletters, fact sheets, technical reports, synthesis documents and other products aimed at communicating a broad range of information about marine science and policy. The past year has seen progress on several long-term projects, among them a video series on the Bay's troubled oyster fishery — including the growing interest in introducing a non-native oyster — and a comprehensive reference text on the blue crab, *Callinectes sapidus*, the Bay's most valuable fishery. Of special note was the production of Maryland Sea Grant's new magazine, *Chesapeake Quarterly*.



► **Chesapeake Quarterly.** During its second year, Maryland Sea Grant's banner publication *Chesapeake Quarterly* has developed into a well-respected magazine. Issues of the periodical address and translate critical issues in a format that is readily accessible to readers at many levels. Augmented with handsome photographs, the quarterly seeks to attract a broad audience to the value of marine research. In 2003, the magazine addressed the question of managing Bay fisheries according to new sophisticated models based on ecosystem approaches. An issue dealing with the heavily urbanized and impacted Anacostia River drew attention to complex uses and generated requests for additional copies from individuals and agencies. Two other issues, one focused on the fabled skipjack and the Bay's changing oyster fishery and the other on anthropologist Michael Paolisso's study of watermen on Deal Island, proved popular both with resource managers and watermen. *Chesapeake Quarterly* reaches a targeted audience of some 5,000 subscribers, with hundreds of new readers signing up in 2003.

► **New Uses for the Web.** We continue to seek new means to extend and enhance the impact of our products through the use of technology. For example, while we have traditionally made publications like *Chesapeake Quarterly* available both online and in a downloadable format on our website, in 2003 we embarked on an ambitious effort to provide video enhancements for each issue. Those who access the magazine on the web can now view short (2-5 minutes) Quicktime video clips that provide additional information and interviews with scientists and stakeholders. These enhancements build upon our program's long history of video production and take us into a new era of utilizing the web. Examples can be found at: www.mdsg.umd.edu/CQ/V02N1/videos.html#V02N1_1. Updating and refreshing our web pages was an ongoing task for 2003. We continue to use our site for a myriad of purposes, from administration to meeting planning, to the survey and evaluation of critical documents. With this in mind, the program has embarked on an effort to develop a new "face" for our website. We anticipate that our new splash page and format will be appearing in mid-2004.

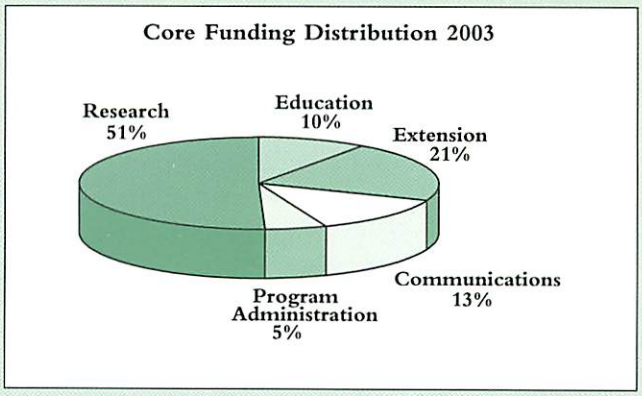
Appendix 1

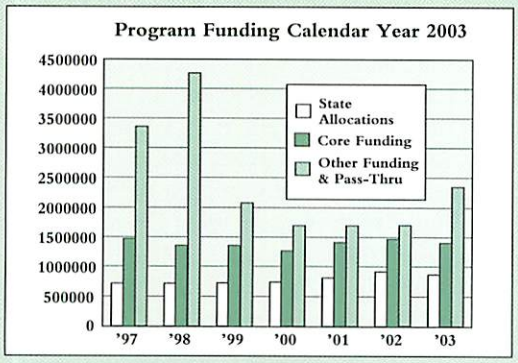
Program Management and Service
Administration in Turbulent Times

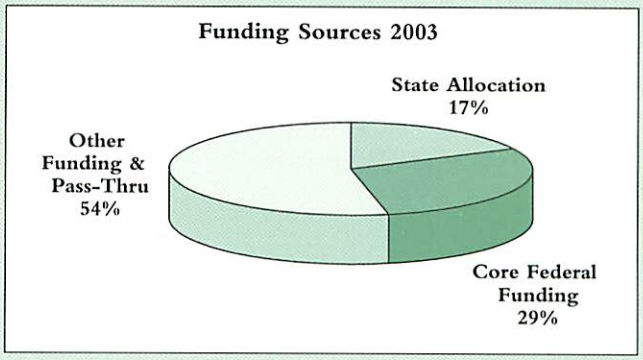
Though Maryland Sea Grant successfully moved its offices to a new building in 2002, 2003 arrived with some fanfare as a major fire in our building early in January caused severe smoke damage and left us without facilities for over a month. The program was able to relocate essential web and e-mail servers within 48 hours and had all staff operational from home or satellite offices within a few days. Accordingly, there was minimal disruption to the research community and other stakeholders and only minor delays with regard to production of publications and other outreach materials. All functions were restored by early February and the program is now fully at home in its new facility. The fiscal climate for our program, and indeed the entire state of Maryland, has remained quite challenging over the past year, however. Budget reductions occurred at virtually all levels of the University System of Maryland — including our program. State support for Maryland Sea Grant dropped in real terms by approximately 8-10%, with additional cuts and unfunded mandates anticipated for FY04. This climate has placed great demands on program management, as we have worked to both mitigate their impacts by implementing a variety of efficiencies and scaling back on all non-essential expenditures. Given that the outlook for the next two fiscal years is not dramatically different, it will be essential for Maryland Sea Grant to actively seek ways to become more entrepreneurial and to form effective partnerships that leverage our resources and build upon our core capabilities.

Maryland Sea Grant College Program
Calendar Year 2003 Core Funding

Program Administration	75,000
Communication	185,000
Extension	295,674
Education	135,670
Research and Scholars	
Coastal and Great Lakes Habitats	253,890
Coastal and Great Lakes Water Quality	155,334
Revitalize the Nation's Fisheries	115,189
Develop Sustainable U.S. Aquaculture	82,994
Commercial Biotechnology	62,000
Program Development	39,249
Total Funds Allocated	**1,400,000**







Leveraging Financial Resources

During 2003 Maryland Sea Grant raised more than $480,000 in external funds to support our overall mission and extend our capabilities. A representative list includes:

- Research Experience for Undergraduates Program Years 14-16, $94,650 (NSF)
- Environmental Finance Center Awards, $222,223 (U.S. EPA)
- Chesapeake Bay Research Fellowships: Professional Development for Maryland Teachers, $88,500 (NOAA Chesapeake Bay Office)
- Vertically Integrated Partnerships; A University System of Maryland/Montgomery County, Maryland School System Initiative to enhance K-12 science education, $76,014. Maryland Sea Grant is one of 8 partners in this 5-year $7.5M effort funded by NSF.

Supporting the Research Community

We continue to seek ways to better serve the research community, both administratively and as a catalyst for creative interaction and the exchange of ideas. Part of this effort entails tracking the progress of research efforts without overburdening busy researchers. To facilitate this process, we now receive virtually all progress reports through a simple on-line system and we are working to extend this on-line option to the submission of pre-proposals. We are also working with research administrators across the state to insure timely financial reporting at all levels. Beyond these administrative efforts, we have made a special effort to inform and engage new researchers this past year. Our intent is to insure that all who are potentially interested in what Sea Grant can provide are aware of and have access to our program.

Activity Highlights

► Robert S. Anderson. Immunological Approaches to Understanding QPX Disease.

Publications

Anderson, R.S., B.S. Kraus, S.E. McGladdery, K.S. Reece, and N.A. Stokes. 2003. A thraustochytrid protist isolated from *Mercenaria mercenaria:* molecular characterization and host defense responses. Fish & Shellfish Immunology 15: 183-194.

Anderson, R.S., B.S. Kraus, S. McGladdery, and R. Smolowitz. 2003. QPX, a pathogen of quahogs (hard clams), employs mucoid secretions to resist host antimicrobial agents. J. Shellfish Research 22: 205-208.

Anderson, R.S., B.S. Kraus, S. McGladdery and R. Smolowitz. 2002. Mucoid secretions protect QPX from antimicrobial agents. J. Shellfish Research 21: 404.

Decker, C.-S. and R.S. Anderson. 2002. Chemotaxis of hemocytes of the hard clam, *Mercenaria mercenaria*, to quahog parasite unknown (QPX) and other microorganisms. J. Shellfish Research 21: 404.

Conferences and Special Programs

Annual Meeting of the National Shellfisheries Association, Mystic, CT, 14-18 April 2002. R.S. Anderson chaired a session on "Parasites and Host Defenses." Papers on the role of mucoid secretions as virulence factors was presented by R.S. Anderson, and chemotaxis toward QPX mucus was given by C.-S. Decker. Abstracts were published.

Anderson, R.S. and B.S. Kraus. 2002. Mucoid secretion is a virulence factor for QPX, a protist pathogenic for the clam, *Mercenaria mercenaria*. VIII International Colloquium on Invertebrate Pathology and Microbial Control, Iguassu Falls, Brazil, 18-23 August 2002.

Annual Meeting of the Society for Invertebrate Pathology, Burlington, VT, 26-30 July 2003. R.S. Anderson was invited to organize and chair a symposium on "Diseases and Pathobiology of Aquatic Invertebrates."

► W. Michael Kemp and Jeffrey Cornwell. Sediment Biogeochemistry and Seagrass Bed Development: Implications for Restoration and Sustainability.

Conferences and Special Programs

Murray, L. Reduction of nutrients from sewage treatment plants: Effects on Chesapeake Bay waters. Seminar presented to Chesapeake Bay Foundation. Port Isobelle, VA. Feb 2003.

Murray, L. and J. Melton. Combining science education and SAV restoration in mesohaline regions of Chesapeake Bay. Seagrass Restoration Conference. Baltimore, MD. Sept 2003.

Davis, J., W.M. Kemp, J. Cornwell. Effect of the seagrass on sediment biogeochemical processes. Estuar. Res. Fed. Meeting. Seattle, WA. September 2003.

Henson, S. The biogeochemistry of plant-sediment interactions in contrasting *Ruppia maritima* beds. Summer REU presentation. August 2003.

Kelley, A., J. Melton and L. Murray. The effect of sediment type, irradiance, and bed persistence on growth of *Potamogeton perfoliatus* (Redhead grass). Presentation to NOAA BWET Conference, Baltimore, MD, July 2003.

Bunnell, J., J. Melton and L. Murray. Effects of SAV bed age, density, and persistence on the survivorship and growth of transplanted *Potamogeton perfoliatus* (Redhead grass). Presentation to NOAA BWET Conference, Baltimore, MD. July 2003.

► Yonathan Zohar. A Novel Approach to Inducing Sterility in Farmed Fish: Disrupting the Early Establishment of the GnRH System.

Students Funded through this Grant

Eytan Abraham is funded as a Maryland Sea Grant Fellow in conjunction with award # R/A03 to Y. Zohar.

Conferences and Special Programs

Zohar, Y., Wong, T.T., Kight, K., Steven, C., Zmora, N., Yashuvi, Y., Klenke, U. and Y. Gothilf. 2003. Early establishment of the gonadotropin releasing hormone (GnRH) system in fish with two and three GnRH forms. International Symposium on Reproductive Physiology of Fish. Mie, Japan. May 19-23, 2003.

Zohar, Y., Kight, K., Wong, T.T. and Y. Gothilf. 2003. Manipulating the GnRH system to induce sterility and fertility in farmed fish. International Marine Biotechnology Conference. September 21-27, 2003. Chiba, Japan. (Conference proceedings will be published in the journal, Fish Physiology and Biochemistry.)

► Raleigh Hood, Evamaria Koch, Roger Newell. Do Oyster Filtration and Wave Attenuation Associated with Oyster Reefs and Breakwaters Improve Seagrass Habitat?

Conferences and Special Programs

E.W. Koch, R. Newell and R. Hood; The effect of a man-made breakwater (and oyster reef) on adjacent seagrasses. Invited Talk. Estuarine Research Federation Meeting. Seattle, WA. 2003.

Publications

Kemp, W.M., R. Batiuk, et al. 2003. Habitat requirements for submerged aquatic vegetation in Chesapeake Bay: Water quality, light regime, and physical-chemical factors. Estuaries (in press).

Bartleson, R.D., W.M. Kemp and J.C. Stevenson. 2003. Use of a simulation model to examine effects of nutrient loading and grazing on *Potamogeton perfoliatus* L. communities in microcosms. Ecol. Model. (in review).

Kemp, W.M. and R. Bartleson. 2003. Epiphyte contributions to light attenuation and availability for submersed plants: Model estimates of water quality effects. Aquatic Botany (in revision).

Conferences and Special Programs

Chesapeake Bay Modeling Workshop (attended by G. Waldbusser). November 2003.

► C. Gallegos. Regional Refinement of a Diagnostic Tool for Setting Water Quality Targets for the Protection and Restoration of Submersed Aquatic Vegetation.

Conferences and Special Programs

Preliminary results were presented at: "New Technologies for Bay and Tributary Monitoring, Maryland Partners Meeting." Annapolis, Maryland. April 8, 2003.

New Publications from Other Research Projects Received by Maryland Sea Grant in 2003

Breitburg, D.L., A. Adamack, K.A. Rose, S.E. Kolesar, M.B. Decker, J.E. Purcell, J.E. Keister and J.H Cowan, Jr.. 2003. The pattern and influence of low dissolved oxygen in the Patuxent River, a seasonally hypoxic estuary. Estuaries 26(2A): 280-297.

D'Elia, C.F., W.R. Boynton and J.G. Sanders. 2003. A watershed perspective on nutrient enrichment, science, and policy in the Patuxent River, Maryland: 1960-2000. Estuaries 26(2A):171-185.

Newell, R.I.E., J.C. Cornwell and M.S. Owens. 2002. Influence of simulated bivalve biodeposition and microphytobenthos on sediment nitrogen dynamics: a laboratory study. Limnol. Oceanogr. 47(5): 1367-1379.

Riedel, G.F., J.G. Sanders and D.L. Breitburg. 2003. Seasonal variability in response of estuarine phytoplankton communities to stress: linkages between toxic trace elements and nutrient enrichment. Estuaries 26(2A): 323-338.

Riedel, G.F. and J.G. Sanders 2003. The interrelationships among trace element cycling, nutrient loading, and system complexity in estuaries: a mesocosm study. Estuaries 26(2A): 339-351.

Stoecker, D.K. and D.E. Gustafson, Jr. 2003. Cell-surface proteolytic activity of photosynthetic dinoflagellates. Aquatic Microbial Ecology 30: 175-183.

Appendix 2

Program Development

Maryland Sea Grant continues to fund a diverse portfolio of small projects through Program Development awards. These targeted projects are designed to initiate new cutting-edge scientific programs, catalyze interactions among scientists, managers and the public and support important education and outreach efforts. A listing of such awards for the 2002-2003 period is found in Table 1.

Table 1. Program Development Awards 2003.

PI	Affiliation	Title
		Education/Outreach
Greer	MDSG	In-service Teacher Training; Enhancement to 2003 NOAA Chesapeake Bay Watershed Research Fellowship Program
Klauda	MD-DNR	Zebra Mussel Fact Sheets for Recreational Boaters in Maryland (Joint Funding with Maryland Department of Natural Resources)
Lorenzen	CORE	Support for 2004 Ocean Science Bowl
		Estuarine Process
Brush	JHU	"Reconstructing the History of *Pfiesteria piscicida* using the Paleoecological Record of Cysts and DNA Preserved in Sediments from Recently-Infested Areas in the Chesapeake and Delaware Estuaries"
		Fisheries/Aquaculture
Gaffney*	University of Delaware	Support for a Fluorescence Polarization Microplate Reader for Regional Oyster Population Genetics Research (Co-funded with Delaware Sea Grant)
Lazur	Horn Point Laboratory	"Feed Training of Atlantic Sturgeon Broodstock and Sex Determination Induced Spawning Technology Transfer"
Swanson*	CBC	Support for Bi-State Blue Crab Advisory Committee Technical Workgroup (Co-funded with Virginia Sea Grant)
		Meetings
Vasta	COMB	Travel for postdoctoral researchers to attend the: "9th ISDI Congress" in St. Andrews, Scotland
Wilson*	NMEA	Sponsorship of the 30th Annual Conference of the National Marine Educators Association "Taking Marine Education by Storm"
Storms*	AERS	Students travel to attend the 2003 Estuarine Research Federation Meeting in Seattle, Washington
Chen	COMB	Students Travel to attend the: "Marine Biotechnology Conference 2003" in Chiba, Japan
Hicks*	DESG	Support for Student Award at 2002 Institute of Food Technologists Meeting
Bates*	RAE	Sponsorship for the Inaugural National Conference on Coastal and Estuarine Habitat Restoration, Baltimore, Maryland
Kucklick*	NOAA CSC	Sponsorship of the Student Reception at the Coastal Zone '03 Meeting, Baltimore, Maryland

* Regional

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This Annual Report summarizes Maryland Sea Grant work for 2003.

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