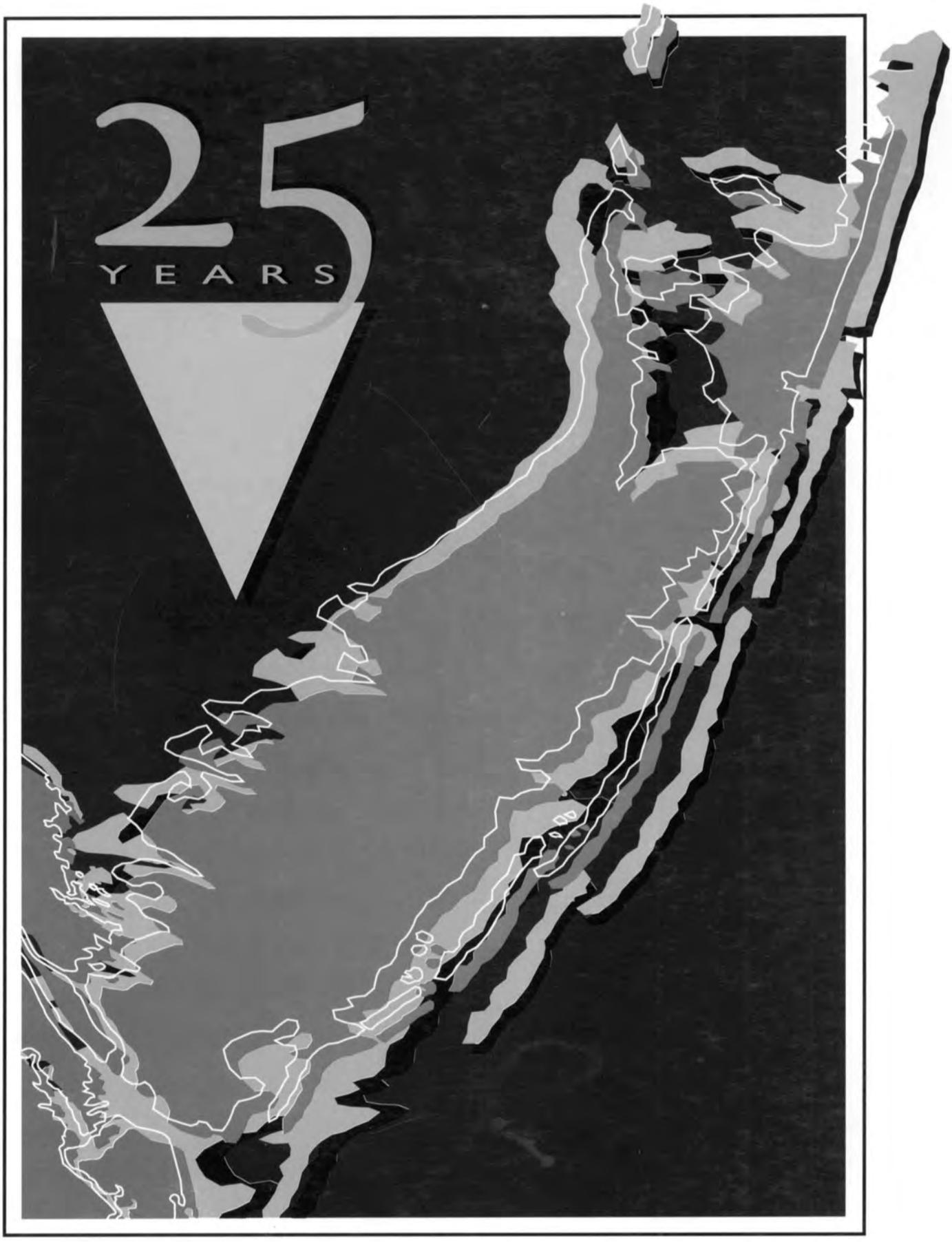

Report of the Marine Sciences Research Center

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Editor
Trudy M. Bell

Design and Cover Art
Lori J. Palmer

Editorial Contributions
Josephine Aller
Henry Bokuniewicz
Christine B. Campbell
Edward Carpenter
George Carroll
J. Kirk Cochran
David Conover
Marvin Geller
Sultan Hameed
Roger Kelly
Glenn Lopez
Kamazima Lwiza
James Mackin
Charles Nittrouer
Lori Palmer
Jeri Schoof
R. L. Swanson
Dong-Ping Wang
Thomas Wilson
William Wise
Randy Young

Photographic Contributions
Leslie Adler
Byron Boekhoudt
Jeng Chang
Brian Connolly
Susan Dooley
Roger Flood
Frank Greenfield
NASA
R.G. Rowland
Ian Stupakoff
Jeanette Yen
Chongle Zhang
Bret Zielenski

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DEDICATION

This biennial report is dedicated to John H. Marburger III, who after 14 years as University at Stony Brook's President stepped down on 1 September 1994 to teach and conduct research.

Dr. Marburger's tenure as President spans more than half of MSRC's history, and it was during this period that the Center experienced its greatest growth in size, diversity of mission, and stature. Without his leadership and commitment, MSRC would be far different and less impressive than it is today.

All of us wish President Marburger fair winds and following seas as he sets out on his new journey of exploration.

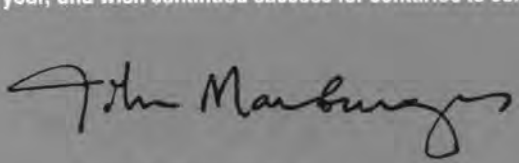
Message from the President

No other program at Stony Brook can match the success of the Marine Sciences Research Center in linking academic research and teaching with attempts to solve the real problems of our Long Island region. From the early emphasis on coastal zone marine science to later extensions into more general issues of environmental management and policy, MSRC's history is distinguished by an insistence on applicability. While it may seem a natural course to those of us who live on Long Island and see its problems and opportunities every day, concern for regional issues does not evolve automatically within research universities like Stony Brook. One reason for this is that we select our faculty from among the world's best, and they tend to bring their interests with them. Another reason is that research has costs that regional communities may not be willing or able to pay.

The insistence on regional applicability of MSRC programs, and the successes to which it has led, owes much to the vision of MSRC's leadership during its first quarter century. I was particularly fortunate to serve my term as Stony Brook's President during the reign of Dean Jerry Schubel, the most visionary and energetic of MSRC's distinguished leaders. Jerry's consistent emphasis on regional affairs, and his frequent participation in them, has not prevented the Center from achieving international recognition. Jerry has frequently pointed out that Long Island's problems are problems that the entire world is struggling with. The collapse of the Soviet Union and the red-hot economic development of Asia during the past decade have revealed enormous environmental and coastal zone problems that have confirmed these judgments.

Today MSRC is leading Stony Brook and other universities throughout the world as a model for how to capture the benefits of research for the solution of regional problems. And MSRC is leading too in the application of these resources to our primary mission of education. Long before Dean Schubel accepted the challenge of steering Stony Brook's Undergraduate Initiative, the Marine Sciences Research Center was providing one of the most exciting undergraduate educational experiences available in higher education.

On every front, MSRC today is fulfilling the promise of its founders. Its people carry out the missions of education, research, and regional service with an enthusiasm and a professionalism that is highly infectious. I salute the Center in its twenty-fifth year, and wish continued success for centuries to come.



John H. Marburger III
President

Message from the Provost

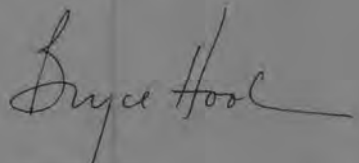
The Marine Sciences Research Center (MSRC) is a University at Stony Brook success story! The Center has become a distinctive and distinguished coastal oceanographic institution with a superb reputation both in the United States and throughout the world.

Two themes have guided the development of the Center since its inception in 1968: a concentrated attention to the Coastal Ocean itself; and applying the results of its research to solving the problems that arise from the use and misuse of that Coastal Ocean.

The problems are worldwide and the figures are frightening! Currently one-half of the earth's population of 5.6 billion lives in coastal areas. It is predicted that within 30 years, the world population will double again with 95 percent of the growth occurring in the so-called developing nations, most of which lack the infrastructure needed to cope with the resultant human impact on highly sensitive coastal regions. MSRC research is helping to address this lack.

From the beginning, the excellence of its basic research has been the foundation of MSRC's success. However, it is the ability of its faculty to translate advances in knowledge into innovative technology and strategies that sets the Center apart from other oceanographic institutions today. In short, the Center's work is integral to enabling us all to live in greater harmony with our coastal environments.

The work of the Marine Sciences Research Center has the enthusiastic support of the Provost's office, and I look forward to working with MSRC to ensure its continuing success.



Bryce Hool
Provost and
Academic Vice President

QUOTABLES

For 25 years the Marine Sciences Research Center has been a Center of excellence within a great and developing State University of New York at Stony Brook. MSRC has also been a leader in the worldwide development of marine sciences and in applying research results to enhanced protection of marine resources, aquaculture, disposal of waste, and planning for optimal utilization of the environment.

But MSRC's work will be much more important in the future. We are approaching the limits of what can be achieved on land to support society. The great majority of the Earth's surface is covered with water; in the next century most of our increase in supplying food and other human requirements will be from proper utilization of our marine environment. Stony Brook's MSRC must continue to guide our policy for sustainable development.

The marine environment offers many frontiers not only geographically but scientifically, such as high temperatures and high pressures available at great depths, which can lead to discovery of greatly enhanced chemical reactions for biologically based industry of the future. Learning to enhance and to share our marine resources among all humankind will help us to diminish national rivalries and to build a cooperative, free, and supportive world society. MSRC will bring advances in the physical sciences, biological sciences, engineering, and policy sciences to guide us to an exciting future. We owe a great debt to Director Jerry Schubel and the MSRC faculty, students, and staff for their leadership.

John Toll
President, 1965-1978

On the one hand, MSRC has been so long at the head of its league that it is surprising to be reminded it is only 25 years old. On the other, its launching seems like yesterday.

Stony Brook's intentions for the Center at the outset, beyond canonical excellence for faculty and students, were a four-fer: an exemplar for our ambitions in interdisciplinary research; a curricular example of the applicability of scientific substance to preparation for new professional paths within an otherwise deliberately austere department design; a contemporary rereading of the land grant notion, to show in New York the utility of world-class faculty in responding to a region's particular needs; and, finally, establishment of a pattern of assigning SUNY-wide responsibility for appropriate public service missions at Stony Brook.

That this complex mix has been carried to such splendid realization is an enormous tribute to all hands at the Center.

T. Alexander Pond
Executive Vice President, 1965-1978
Acting President, 1978-1979

The Many Missions of MSRC

I am delighted to present this report which summarizes some of the highlights of MSRC's programs in research, education, and public service for the past two years, 1992-1993. Last year, MSRC celebrated its 25th anniversary. For 20 of those years, I have had the honor and the pleasure of being the Director of MSRC.

Throughout its history, MSRC has pursued distinction through distinctiveness. The same two themes have guided the development of MSRC almost from the outset—excellence in coastal oceanography and commitment to the use of science to serve society.

Over the years MSRC also has developed programs of excellence in carefully selected areas of blue water oceanography. In 1992 in a singular move, MSRC added a new and powerful capability to study ocean-atmosphere-earth interactions with the addition of the Institute for Terrestrial and Planetary Atmospheres. Commitment to the distinguishing themes remains strong.

The Cornerstone of MSRC is Excellence in Basic Research.

While everything MSRC does begins with basic research, little ends there. It is *not* excellence in basic research that sets MSRC apart from all other oceanographic institutions. It is how MSRC leverages that position of leadership in fundamental research. It is this excellence across the broad spectrum of MSRC's many missions that sets it apart: excellence in education at all levels, the richness and diversity of MSRC's public service missions, and the innovation and the effectiveness in the ways it pursues these missions. These are the qualities of MSRC that make it distinctive and that make it a center of distinction.

It is because MSRC's reputation is rooted so deeply and anchored so securely in its fundamental research that it is able to take chances that few other oceanographic institutes could take. Whenever one takes chances, there are risks; risks of failure, risks of criticism. MSRC has not been immune from these assaults, but the risks of not taking chances are even greater.

Many of the planet's coastal environments are in peril. They are already being lost at a rate that rivals the loss of tropical rain forests, and the worst may be yet to come. The loss of biodiversity associated with the degradation of coastal marine ecosystems ranks second only to the loss of biodiversity associated with deforestation of tropical rain forests. The loss of coastal biodiversity has not captured the public's attention but unless bold steps are taken promptly, many important coastal environments and their living resources could be severely damaged, some even irretrievably lost.

The planet's present population is 5.6 billion. Fifty percent live in coastal regions. In less then 30 years the planet's population will double. Ninety-five percent of the growth will come in developing countries, none of which has the infrastructure needed to deal with the enormous surges in wastes they will experience. Fifty percent of the more than 11 billion will live in coastal regions. That is equivalent to moving the planet's present population to within 50 miles of the coast! Many of the countries with the most rapidly growing populations are in tropical and semi-tropical areas, areas rich in coastal biodiversity and which are particularly sensitive to anthropogenic disturbances.

Most of the countries where the greatest population growth will occur are known. Those that also have rich and diverse coastal ecosystems can be identified. The time to act is now. The first step is to raise awareness. This is not done through publications in peer-reviewed journals, regardless of the quality of the articles and regardless of the quality and circulation of the journals. It is done through the mass media, through mass entertainment mechanisms and through major informal science educational institutions—museums and aquaria.

This fall MSRC will form a partnership with the New England Aquarium in Boston: Kenny Young, writer of "Under The Boardwalk" and producer of "Earthrise;" and Ronald Oehl, co-founder of *The Earth Times*. We will announce a bold new joint venture entitled "Coastal Rhythms."

"Coastal Rhythms" will consist of a CD, a video, a CD-ROM and we hope an IMAX film—all focused on the importance of the coastal ocean, on the impending threats—the loomings—and on the development of strategies to allow humans to live in harmony with their coastal environments.

The CD will have songs about the sea and the coast and people's interactions with these environments. About half will be in English, the other half in native languages sung and performed by indigenous peoples from around the world.

The CD-ROM will allow people of all ages to hear the music, to see the beauty and the threats, and to explore "what if..." scenarios for the world's coastal oceans. The video and the IMAX film will capture the beauty and diversity of the world's coastal ecosystems, their importance to living marine resources and to people, and explore the threats and the strategies to allow people to live in harmony with these environments. The project will involve celebrities, scientists, policy makers, environmentalists, and ordinary people from all walks of life who love the sea.

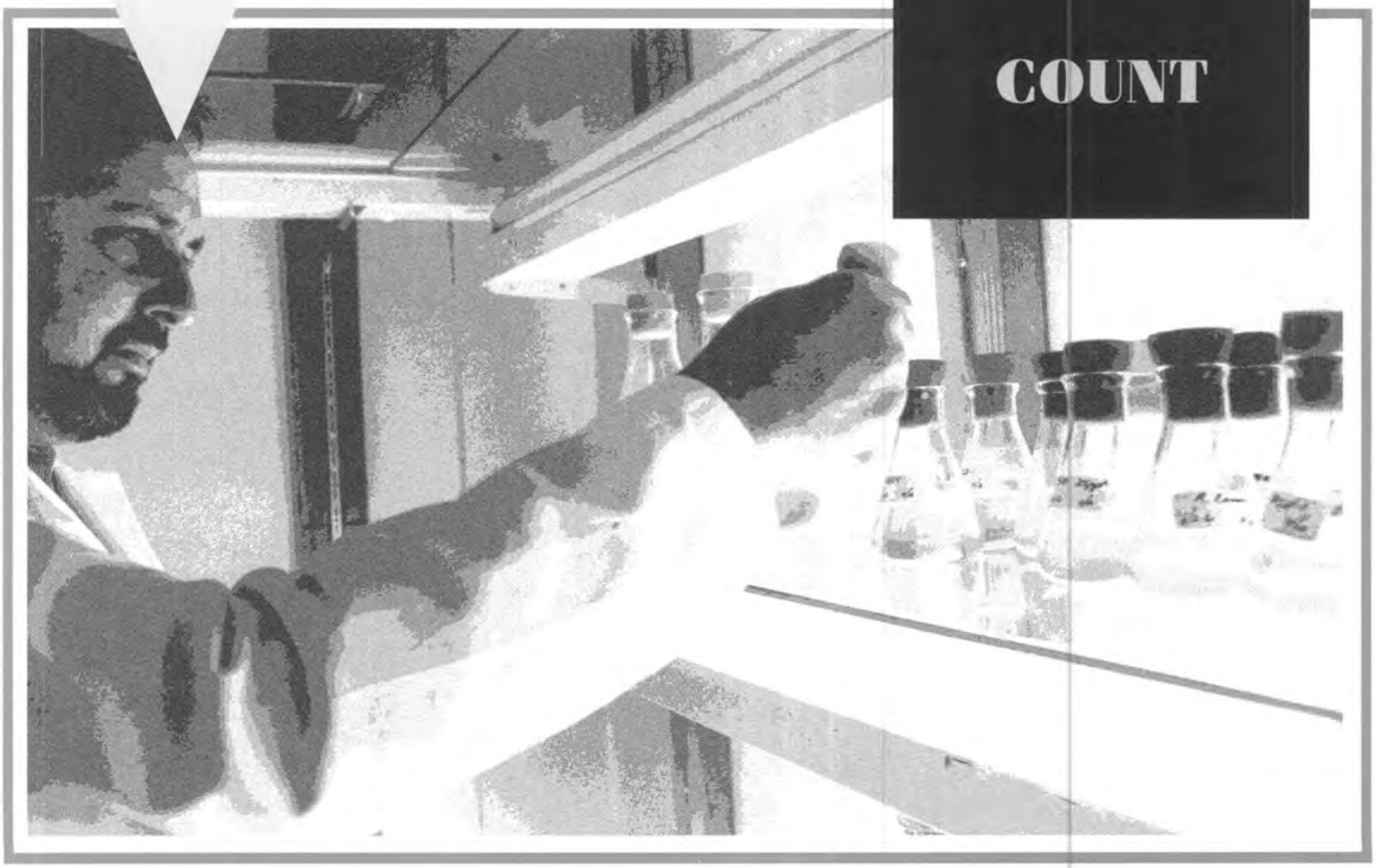
On 1 November 1994 I become the President of the New England Aquarium. I want to take this opportunity to thank all those inside and outside of MSRC who have contributed so much to the development of this remarkable Center. I shall miss you.

J. R. Schubel
15 September, 1994

The Marine Sciences Research Center

25 YEARS

MAKING SCIENTIFIC RESEARCH COUNT



The Marine Sciences Research Center

Pathfinder, innovator, risk taker ... all are phrases that can be used to describe the Marine Sciences Research Center. Over its brief history, celebrating its 25th anniversary in 1993, MSRC has emerged as one of the world's leading coastal oceanographic institutions. It has been a leader in research on unusual and sometimes controversial issues. In one major area, in particular, MSRC took a leading role from the very beginning—translating scientific research results into informational formats usable by decision makers, planners, managers, and the general public.

The Center has also been a leader in achieving a rich diversity of its faculty, staff, and students; a leader in building consensus among diverse constituents to find solutions to intransigent environmental problems; and a leader in promoting and offering marine education to schools, teachers, and the general public. With this report, MSRC re-examines its 25 years, not as an exercise in informing the status quo, but with an eye to growing, and even restructuring, over the next 25 years.

A history of leadership built on solid science

The cornerstone of MSRC has been a strong basic research commitment. The Center's 55 full-time faculty have built a solid reputation, placing MSRC as the top coastal oceanographic institute in the world. This pre-eminence in research and the flexibility and opportunities afforded by the Center s five

institutes, have enabled MSRC to take risks to develop innovative solutions to regional, national and global problems. (see section on institutes, page 39). For example, MSRC's Waste Management Institute (WMI) constructed the first fishing reefs out of coal ash blocks. Some years later, WMI built the first artificial reefs as well as the first building out of concrete blocks made from incinerator ash, a substitute for aggregate, mixed with cement. The goal of both projects was to test the utility and safety of products created from unwanted wastes. From these, a number of similar projects have emerged.

MSRC researchers were among the very first to probe the sources, transport, and fate of sediments in New York Harbor estuary, and to use that knowledge to develop new ways of managing dredged material. Today, through the WMI and Institute for Urban Ports and Harbors, many more MSRC scientists conduct research programs on the complex dynamics of this harbor estuary, and much of their work will be used to control pollutants and understand the needs of its living resources.

Multidisciplinary approach to study systems

Understanding systems—how many different environmental components are related to each other—often takes many years of study by researchers in many different disciplines. Long before multidisciplinary research became a buzzword, MSRC scientists were collaborating with colleagues in neighboring disciplines on comprehensive research programs all over the world's coastal oceans. One of this Center's greatest strengths is its faculty's ability to collaborate among the disciplines.

One of the largest and longest running programs of this type involving several MSRC researchers is a joint Brazilian and North American multi-institutional effort to examine sedimentation on the continental margin near the mouth of the Amazon River. Over the project's five years of study and four cruises, much has been learned about the geologic history of that region by examining cores of sediment deposited over an extended range of time in conjunction with studies of current physical, chemical, and biological processes.

MSRC is typically a part of regional multidisciplinary projects. Our researchers' combination of skills and experience with regional problems put them on the inside track in understanding the many complex coastal marine systems nearby and surrounding Long Island. The five-year EPA study of Long Island Sound, part of the National Estuary Program, brought together six MSRC faculty and a number of their graduate students with other universities, industries, environmental agencies, and citizens' groups around the Sound. These diverse groups joined together in a concerted effort to understand and control the causes of summer hypoxia in the Sound.

In an extension of this project with the Long Island Sound Study Office, located at the Center, MSRC is currently designing a novel monitoring program that may serve as a model for all others. It will combine advances in sensor and information technology and in remote sensing strategies to provide better coverage at lower cost, and to make information available quicker and in a wide variety of formats tailored specifically to the needs of different user groups.

Another new EPA National Estuary Program study in which MSRC is involved is to learn more about the Peconic Bay system, a series of bays inside the forks of Long Island's eastern end.

Building consensus among researchers, policy makers, and environmental managers

During the past few years, MSRC has become well-known for its leadership in building consensus among diverse, and often divergent, environmental viewpoints. After many years of finding no resolution, the EPA asked MSRC to help with their National Estuary Program in San Francisco Bay. The San Francisco estuary can now claim back some of the fresh water, previously diverted to agricultural and urban concerns, in order to maintain low salinity habitats critical to many estuarine plants and animals.

Now, consensus-building will be easier with MSRC's new Interactive Decision and Environmental Analysis

25 YEARS

MSRC Highlighted in Forbes Magazine

MSRC was a featured contributor to a Forbes Magazine supplement titled, "Clean Air, Clean Water" in the October 25, 1993 issue. The supplement included a half-page description of the Center's philosophy, goals, and achievements, in celebration of its 25-year history.


Forbes

Businesses turn waste into profits as part of new environmental initiatives for preserving . . .

Clean Water, Clean Air

A Special Report to Management prepared by the Marine Sciences Research Center of the State University

Laboratory (IDEAL). This facility boasts 12 networked computers, installed around a conference table, which allow users to enter ideas anonymously with a facilitator to integrate all entries into one listing or graph on one main screen.

IDEAL was first used at the Center's 25th Anniversary Coastal Summit in December 1993. At this meeting 25 top leaders in coastal ocean problems from around the world converged to assemble a report of the major threats to the coastal ocean and to suggest remediation strategies. The facility allowed for an easier flow of ideas, as well as freer acceptance of the ideas presented by participants, since authors remained unidentified. The end result was a much smoother road to consensus than ever before.

The make-up of MSRC's faculty

MSRC has had a long commitment to asembling a faculty of many cultures and more women than most other oceanographic institutes in the world. Its 150 graduate students studying for their Masters or Ph.D. degrees are also diverse, coming from countries around the world in response to the Center's global reputation and the reputations of multiple generations of MSRC graduates who have taken leadership positions in academia, business, and government throughout the world.

Taking a broader educational role

MSRC offers a rich array of undergraduate and graduate educational programs and specialized certificate programs that respond to the specific needs of professional groups. Every year more than 500 undergraduate students enroll in oceanography courses that take them into wetlands and onto open water for first-hand experiences.

Public education for the Center is continuously evolving and expanding. Recent highlights include special Center-community-school partnership programs, teachers' workshops, and educational software, videos and publications for all ages (see Public Outreach, page 9). Many of these programs, products, and publications are produced jointly with New York Sea Grant Institute, located at the MSRC campus.

The MSRC institutes

Its institutes bring MSRC an array of resources for research and education that would otherwise not be available. They enable institute researchers to focus their attention and efforts on important problems and opportunities. These problems and opportunities are national and global in extent, but often arise with clarity and urgency first in the New York metropolitan region, where the institutes' research can be tested in practical applications in the field.

Most recently, the Institute for Terrestrial and Planetary Atmospheres, along with the atmospheric sciences faculty, joined MSRC. This union now allows the Center to focus on ocean-atmosphere interactions, an important area of interdisciplinary study.

The Center's Waste Management Institute has, in its nine years of existence, tackled an array of regional waste issues, such as aiding in the formulation of a regional floatable waste management action plan to keep the region's beaches free of wastes; testing degradable plastics in various natural environments; and developing and testing uses for composted municipal waste, recycled plastic products, and municipal incineration ash.

By providing a major source of talent to explore the fundamental requirements of important native species of aquatic plants and animals, the Living Marine Resources Institute (LIMRI) has aided environmental managers, local and regional planners, and entrepreneurs dependent on marine resources, such as aquaculture companies. The LIMRI faculty are involved in projects that probe the life history and migratory patterns of bluefish, predation on striped bass, and the invigoration of Long Island's shellfish industries. LIMRI has for a number of years conducted research on the "brown tide," a mysterious alga that periodically blooms in the bays of Long Island, causing a severe decline in shellfish. While the difficult question, What causes the alga to bloom? has not been satisfactorily answered, in the process of studying the causes, LIMRI scientists have begun exploring several new, important avenues for further research.

Achieving consensus to solve difficult environmental problems has been the speciality of the Coastal Ocean Action Strategies (COAST) Institute. To manage group problem solving more efficiently, the Institute's most recent venture into uncharted waters exploits advances in computer hardware and software. The creation of IDEAL, the first computerized coastal ocean problem-solving facility, has extended MSRC's capabilities, not only for problem solving, but for training the next generation of problem solvers.

The Center's two themes

From the Center's outset, two themes have guided its development. The first is to achieve excellence in basic research in coastal oceanography. The second is the timely transformation of advances in scientific understanding and technology into innovative strategies to allow humans to live in greater harmony with their coastal environments.

The greater New York-Long Island region is perhaps the world's greatest coastal laboratory to put these themes into practice. No other area of comparable size can match it in terms of diversity of coastal environments and population size and density. The gradient in population and environmental impacts from the New York City region to the pristine east end of Long Island Sound is steep.

Such range and diversity makes this region an ideal laboratory for developing and testing management strategies to accommodate multiple and conflicting uses. And MSRC has used this laboratory well over the past 25 years, becoming a key information source for many regional and local environmental managers.

EXCELLENCE IN RESEARCH

SOLVING SOCIETAL PROBLEMS

SCUBA 1

Disguised as a seal by technology,
rubber flesh scarred by neoprene,
I slip into the pressure
which triples every hundred feet,
a strict and lethal rule.

Now, free of allegiance to the vertical,
nearly happy but for the guages,
I hunt where no saints have gazed
except for the statues in shipwrecks.

If the tank on my back is a lung,
then what is this gun in my hand?
A hypodermic for civilized poisons,
a retired caveman's totem,
a twisted secret no straighter in steel?

Those are land questions. Here,
where everything is sidelong and saline,
life eats life alive
and I worship God as Zero Mercy.

Richard Lourie

QUOTABLES

I want to extend my heartiest congratulations to Jerry Schubel and to the faculty and staff of the Marine Sciences Research Center on this occasion of the Center's 25th Anniversary. You have accomplished in this short period the enormous feat of creating one of the world's top research institutions in coastal oceanography. The Center has simultaneously advanced basic science at a rapid pace and has developed myriad applications of these scientific advancements to critical problems in the real world. It is with a sense of great pride that I look back on my former association with the Center, and I extend to each one of you my best wishes for the decades ahead.

Homer A. Neal
Provost,
1981-1986

Education

The graduate program

Although our 1992-1993 full-time graduate population numbered 120, MSRC has managed to keep the student to faculty ratio low (2.9) to insure that each student receives the individual attention needed to become active professionals and leaders. Because of this individualized attention and MSRC's growing involvement with environmental agencies and institutions of every stripe, our graduate students are often given unique opportunities to work on real problems, both regional and global in scope.

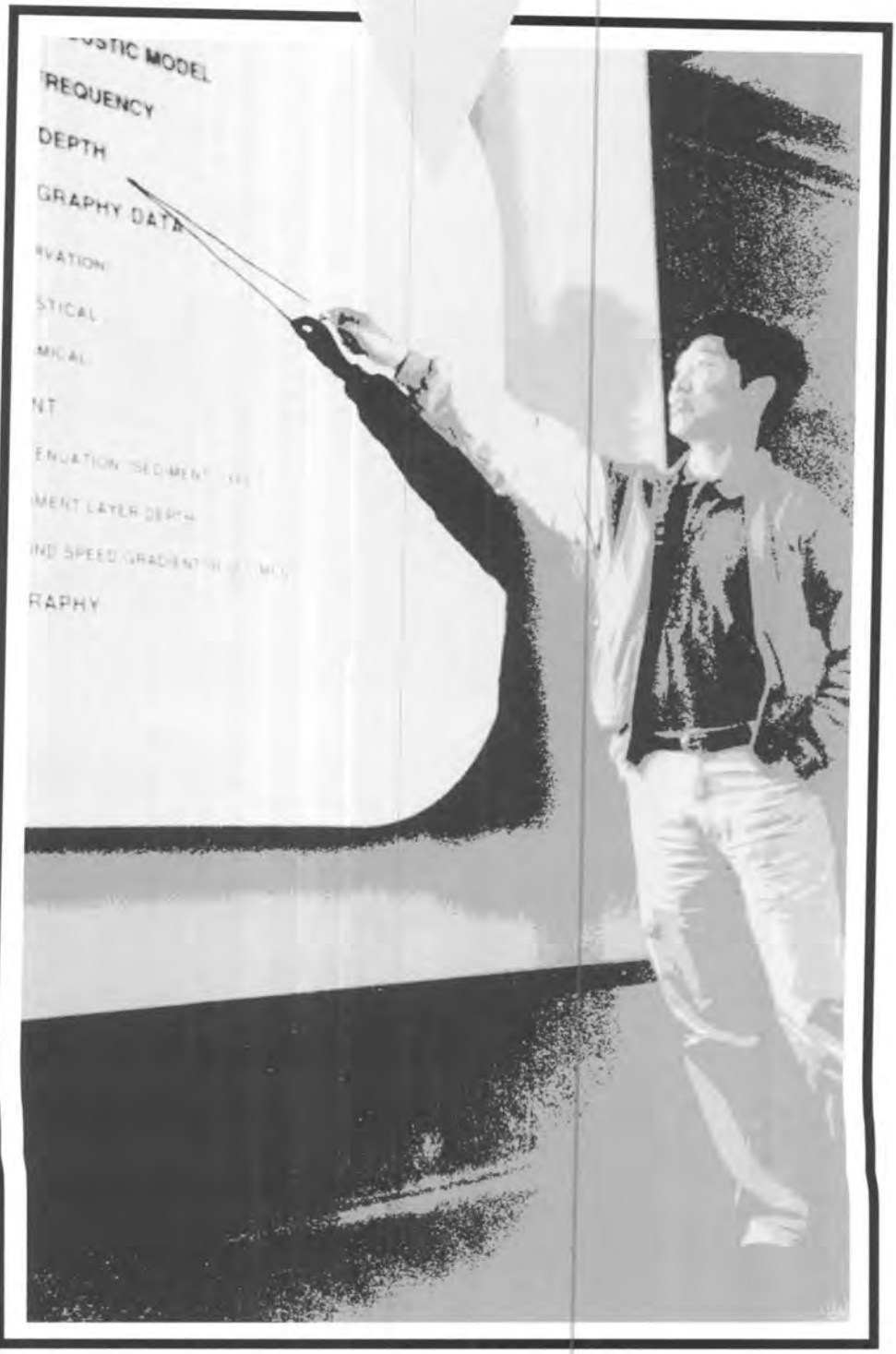
Their experiences range from formal internships to informal participation on projects that attempt to answer pressing questions or solve existing problems. This combination of academics and experience has given MSRC graduate students a distinct advantage in finding job opportunities in the fields of their choice. Today our graduate students are found in academic and government institutions and environmental agencies throughout the world.

INDIVIDUAL ATTENTION

Undergraduate education

The undergraduate component of the marine sciences curriculum has evolved with the educational mission of MSRC. From the first four undergraduate courses offered through MSRC in 1982 to the 28 courses offered by the end of 1993, the enrollment has grown from less than 100 students to nearly 800 today.

Many undergraduates have availed themselves of the opportunity to undertake independent studies with the supervision



LEADER IN ENVRONMENTAL STUDIES

MSRC HIGHLIGHTS

MSRC Brings Environmental Sciences to Undergraduates

Combining residential and academic activities, the Environmental Studies Living-Learning Center, spearheaded by MSRC, is the newest of five such programs at the University at Stony Brook. The Center opened in the Fall of 1994 and a student exchange program involving Lancaster University of the United Kingdom will begin in the Fall of 1995.

With MSRC leadership in the design and coordination, the Environmental Living-Learning Center, provides the nucleus for a series of new courses and a minor in environmental science. An MSRC faculty member serves as master of this living-learning center, coordinating programs, teaching, and otherwise maintaining close contact to guide and assist the students.

The concept of the living-learning centers was developed and put into action at USB in the mid-1970s, with the intent of integrating the student's residence hall experience with special academic interests.

of MSRC faculty. The Center continues to run its own competitive program of summer fellowships for deserving undergraduates to participate in research projects, as well as to play an important role in the University-wide summer research programs for minority students.

In 1988, MSRC created its first marine sciences minor, through which undergraduates can take lecture, laboratory, and field courses taught at both introductory and advanced levels. Research opportunities are also available to qualified undergraduates, both on-campus and in off-campus internships.

In 1992 MSRC began a cooperative effort with the Multidisciplinary Studies program at USB, crafting Oceanography and Environmental Studies tracks in the Multidisciplinary Studies major.

The addition of the Institute for Terrestrial and Planetary Atmospheres (ITPA) in 1992, brought to MSRC a major in Atmospheric Sciences/Meteorology, as well as a suite of undergraduate atmospheric science courses. We are now in the process of establishing an undergraduate meteorology laboratory at the Center.

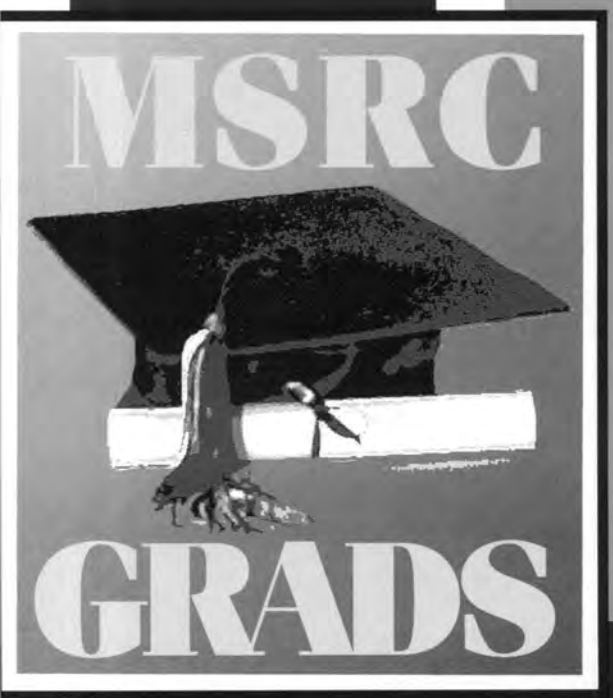
MSRC has become the University-wide leader in development and refinement of the undergraduate programs in the broad area of Environmental Studies. MSRC played a major role in the establishment of the Office of Environmental Studies on west campus in the Fall of 1993. In the Fall of 1994, the Environmental Studies Living/Learning Center opened, with a student exchange program involving Lancaster University of the United Kingdom. The Living/Learning Center pro-vides the nucleus for a series of new courses and a minor in environmental science.

In the future, MSRC will remain active in the environmental studies arena. The Center has just begun a comprehensive review of MSRC undergraduate programs, with the goal of improving existing programs and eventually developing an undergraduate major in the marine sciences.

OUR STORY

25 YEARS

▲ *Director of Graduate Studies, Henry Bokuniewicz with degree recipients.*



The Graduate Program

In 1970, MSRC had eight full-time graduate students. Today, our full-time graduate population numbers 120, with scholars from 20 countries, including students from realigned countries in eastern Europe, Romania, and Russia.

Both the numbers and quality of the graduate students continue to increase. We are receiving more applications for admissions than ever before—nearly 200 for 28 openings. The Graduate Record Examination scores of MSRC students are now the highest of any division in the University.

In 1992 the Institute for Terrestrial and Planetary Atmospheres joined the Center. As a result, our graduate program leading to the Ph.D. degree now has two tracks—one in oceanography and one in atmospheric sciences. The Center currently has 19 students pursuing a Ph.D. focused on atmospheric sciences.

A list of our graduates over the past 25 years is on page 89.

Undergraduate Mission

From four initial courses in 1982-83 enrolling fewer than 100 students, to 28 courses in 1993 enrolling nearly 800 students, MSRC's undergraduate component has evolved substantially over the years.

Program highlights include: five-year BS-MS options developed in 1986 in conjunction with Earth and Space Sciences and Engineering Sciences; creation of marine sciences minor and establishment of an undergraduate director position to coordinate the growing constellation of programs in 1988; creation of an Oceanography and Environmental Studies track in the Multidisciplinary Studies major in 1992; and a major in Atmospheric Sciences/Meteorology, as well as a suite of undergraduate atmospheric science courses.

QUOTABLES

The Marine Sciences Research Center has become one of the truly brilliant achievements nurtured at Stony Brook. It has forged unique degree programs in coastal oceanography, pioneering in fields of study related to the vital problems confronting the coastal environments around the world. Its research has become an exemplar in terms of the continuous support it has attracted from external sources, as well as the ultimate contribution it has made to its diverse regions — local, state-wide, and national. I salute its remarkable and imaginative leadership, its outstanding faculty, and its talented students.

Sidney Gelber
Academic Vice President,
1971-1981

Public Outreach

Living on Long Island—where the coast is no more than a 15-minute drive from all points—offers rich opportunities to be close to the sea. It also carries responsibilities. As a citizen of the Island, MSRC is committed to nurturing and promoting a sense of stewardship of the coastal ocean. The Center fulfills this responsibility through a diverse variety of public outreach programs, each tailored to the special interests and needs of a particular group. These activities range from informal science programs for youngsters to formal courses designed specifically for school teachers at all levels; from breakfast discussion groups for citizens groups to film festivals for retirees; from formal partnerships with school systems to environmental writers' festivals for the general public.

For society to live in harmony with the coastal ocean, citizens must know it better—they must cultivate an understanding and deep appreciation for its changeable and complex nature. They also must develop a strong sense of stewardship. People take care of things they care about.

Since publication of its first Biennial Report for 1988-1989, MSRC has explored many new avenues to reach as many sectors of the public as possible with information about the coastal ocean. The methods and means used have varied, but the results have been uniformly successful. The following are some of the events, programs, and products MSRC has made available to the public over the past years.

Groundwater flow demonstration

PROMOTING STEWARDSHIP

Tools for teachers

Our series of Science Bulletins for teachers tackled topics such as junk mail, food webs in estuaries, the state of marine fisheries after the Magnuson Act, hypoxia in Long Island Sound, the effects of population growth on the coastal ocean, and floatable wastes in our coastal waters. Nearly 1,000 are now on this mailing list.

Delving into a new medium, MSRC collaborated with John Stevens Productions to produce a video on the health of New York harbor ("Alive in an Urban Harbor") and a series of four videos on the chemistry, biology, geology, and physics of Long Island Sound ("Science of Long Island Sound: Exploration of an Estuary"). As the word has spread, the demand for these videos from libraries, schools, and environmental groups has continued to grow. Other videos are in the planning stage.

Environmental stewardship conferences with New York Sea Grant

During the past two years, MSRC has co-sponsored with the New York Sea Grant Extension Program two workshops to promote environmental stewardship. One was developed for teachers; the

MSRC HIGHLIGHTS

other for religious leaders. Living on Long Island with its extraordinary array of natural coastal environments combined with the pressures of a large population crystallized the importance of environmental stewardship. Some of the ideas and ideals that evolved from these sessions were encapsulated in program coordinator Bob Kent's opening remarks:

> *We hope we are at the dawn of a new age, where people will take seriously the impact of their daily life on the natural environment around them. In older cultures, the natural world was often considered sacred and people treated the Earth gently. In our modern life, we have become separated from the natural world, and no longer realize our connection to it, nor consider our impacts on it.*

watershed to the north includes portions of New York City and Westchester County and stretches all the way to Canada, following the Connecticut River. To the south of the Sound, the watershed includes roughly the northern half of Long Island.

Participants in a MSRC-Sea Grant workshop on Environmental Stewardship learned that daily activities throughout a watershed can impact the receiving body of water. Runoff from lawns — the fertilizers and herbicides we use — and chemicals from household cleaners that we flush down our drains may all end up in these coastal water bodies.

At the end of the conference, teachers left with their own stewardship creed and lists of ideas and activities to bring these messages into their classrooms.

photo by R.G. Rowland

Coastal Breakfast Discussions

The Sunday Breakfast Series, sponsored by the MSRC Associates, began in response to local citizens' frustrations with conflicts and conflicting information about coastal issues. On several Sundays every semester, a group of concerned citizens gather at the Center's conference room over bagels and coffee to listen to experts on issues about the regional environment and to discuss what they have learned.

The topics chosen are suggested by participants, and in the past have included "Wetlands and Their Management," "The Natural History of Long Island," "Living with the Law and the Long Island Shoreline," and "Environmental Journalism."

Living in a watershed

Each of us lives in a watershed—a geographic area that drains into a body of water. This is a critical principle for students of the marine environment to understand and is an important theme running through much of the teaching and activities of MSRC and the Stewardship Conference.

Everyone lives "downstream" from someone else. Long Island Sound's

Environmental writers' festival

In October 1993 the Center sponsored its first annual Environmental Writers' Festival. Bringing together several award-winning writers from across the country — including many of Long Island's most distinguished environmental writers — the festival attracted a large turn-out of aspiring writers. The outstanding poets, nature writers, journalists, photo essayists, and environmental story tellers participated in plenary sessions and workshops to celebrate the rich diversity of Long Island's coastal environments, to elevate the public's awareness of the importance of these environments and their vulnerability, and to stimulate the region's aspiring environmental writers. With "Environmental Exposures," the juried

photo exhibition and a reading and slide-show on a work in progress, the festival appealed to artists of all crafts.

The award winning writers included Peter Matthiessen, Louis Simpson, Tom Horton, William Warner, Helen Cooper, Donald E. Axinn, Nick Karas, Roger Stone, Dennis Puleston, Donald Squires, Lawrence Taylor, Karen Blumer, Jeff Richards, Stan Brodsky, and Claire Nicolas White.

Alumni's mission to planet Earth

April 1993 marks a cataclysmic event in MSRC's history. It marks the day when MSRC hosted Stony Brook alumni and their families for a mission to planet Earth. It marks the day when the President of the Alumni Association, Sheldon Cohen, called an emergency town meeting to announce that the group's home planet—Stoneiper—was in the path of a large meteorite that would strike in two weeks. Another hospitable planet must be found. The only other planet known to have the conditions needed to support human life. Cohen explained, was Earth. Everyone would have to evacuate Stoneiper and depart on a mission to planet Earth. This was their only chance for survival.

The group from Stoneiper formed a plan. They would set their spaceship down in three locations—China, Africa and Long Island—and send out parties to obtain information on the natural and human resources of each place. The objective was to use this information to develop strategies that would allow them to live in greater harmony with the planet than present Earthlings.

Each person was issued a passport, complete with a photo ID, and, after official processing, boarded the MSRC spaceship—the conference center that had been transformed into a spaceship, with sounds, lights, and control panels. On the trip to planet Earth, the crew was given descriptions of the Earth's support systems, complete with satellite imagery. The realism was vivid. About 30 minutes into the trip one youngster exclaimed loudly, "Mommy, we really are in space! Look at the Earth!"

Once the spaceship landed, scouting parties were sent out to the three locations and youngsters were given the responsibility of gathering the critical information which was to be reported back to the full group at the end of the day. Classrooms had been transformed into Africa, China, and Long Island, complete with appropriate furnishings and plants. In each simlulated country, MSRC faculty and their children, staff, and graduate students from the three areas dressed in their native clothes and served food of the region.

Everyone enjoyed the day and learned important lessons, which were reported by the youngsters when the group reassembled in the spaceship at the end of the day. All left determined to be better environmental stewards for Earth.

MSRC HIGHLIGHTS

Alumni Journey to Planet Earth

Stony Brook alumni arrived at MSRC, and —with a bit of virtual reality provided by MSRC's graphics, instruments, and computer specialists and inventive staff — landed their space ship on planet Earth to explore it as a possible new home. Taking advantage of MSRC's multicultural make-up, the alumni-Earth visitors were able to compare present-day environments and societies of Africa, China, and Long Island, U.S.A.

MSRC HIGHLIGHTS

Open House

For the second year, MSRC has opened its doors and rolled out its research equipment and researchers so the public could learn about us and meet us. Outside in the cool October sun, MSRC students, staff, and faculty assisted the youngest—and sometimes oldest— guests who wanted to touch or hold a starfish or a clam in the "touch tank." Displays lined the hallways of Endeavour, Discovery, and Challenger Halls and flowed out onto the courtyard.

Professors and their graduate students displayed films of waves destroying the coast in the Nor'easter of '92 and discussed the opening of a new inlet in the barrier beach. Others laid out dissected cores of sediments and explained how they could learn the histories of the sea beds where the cores came from.

Throughout the day, guests took field trips to Flax Pond to see the laboratory with running sea water. Videos and computer displays were up and running in MSRC's information center and video viewing room.

The day draws an enormous creative capacity from the MSRC researchers and staff that captures the imaginations of the hundreds of guests that stroll through our open doors.

photo by Lori Palmer

Writers' Festival

Augmenting the theme of stewardship, MSRC sponsored, for the first time in October 1993, a gathering of environmental poets, nature writers, journalists, photo essayists, story-tellers, and an interested public to discuss Long Island's unique environment as a source of artistic inspiration.

▲ *Peter Matthiessen talks to* Writers' Festival *participants.*

photo by Lori Palmer

Open house

For the second consecutive year, in October 1993 MSRC opened its doors to the public, providing an exciting opportunity to experience and explore many of the activities of their Marine Sciences Research Center. The annual event inspires the best in the enormous creative capacity of our faculty, staff, and graduate students. Each year they create activities that convey the excitement and importance of their work in ways that will capture the imaginations of the hundreds of guests that stroll through the open doors to see what MSRC is all about.

More than 800 children of all ages were able to see, touch, and explore a variety of displays, demonstrations, experiments, and interactive exhibits. The most popular activities were those that involved the young explorers directly: the tidal "touch tank," the computerized Earth quiz, the scavenger hunt, the oceanographic sampling opportunities, and the environmental mural painting.

Sunday breakfast discussion series

With newspapers and the press sensationalizing environmental problems, accurate, responsible information is often hard to come by. Responding to this need and requests from local citizens for realistic and informed portraits of environmental issues, MSRC

MSRC graduate student demonstrates waves and beach erosion at open house.

photo by Byron Boekhoudt

inaugurated its Sunday Breakfast Series. Sponsored by the MSRC Associates, the Sunday breakfasts bring together a panel of experts and concerned citizens for bagels, coffee, and a lively, often heated, discussion. Perhaps, most importantly, the breakfast discussions provide a rare, interactive forum where citizens can question experts drawn from across the University, from state and local environmental management agencies, environmental groups, and the private sector, to probe different coastal and environmental issues. Each panel is chosen to have a balancing of biases so that all points of view can be heard.

Based on participant requests and suggestions, past topics have included: environmental health and human health, environmental journalism, environmentally friendly gardening and lawn care, biodiversity, and living in harmony with Mother Nature.

Education programs for communities, schools

In response to repeated requests for environmental education materials, ranging from pamphlets and videos to complete classroom units, the Center has invigorated and expanded its commitment to this area by developing new products and new services. Walking tours of the south campus and Flax Pond has evolved into structured educational programs offering hands-on laboratory and field sessions, using multimedia educational aids.

Teachers' workshops

MSRC's Teachers' Workshops in Environmental Sciences are open to teachers at all levels. MSRC invited a select group of teacher-advisors in November 1993 to choose topics and design the structure for the series that began in 1994. This first group has just completed the topic, "Coastal Processes." Remaining topics chosen by the teachers range from marine wetlands to air pollution.

Each topic is explored over the course of three meetings, the first of which is a presentation of the issues by MSRC faculty. The remaining two sessions are devoted to the collaborative assembly of an activities guide and demonstrations of field trips or classroom activities. The end products will be better informed teachers and guidebooks of classroom activities and field trips designed by the participating teachers and made available to all other teachers.

photo by Chongle Zhang

Stony Brook Community Fund-MSRC partnership

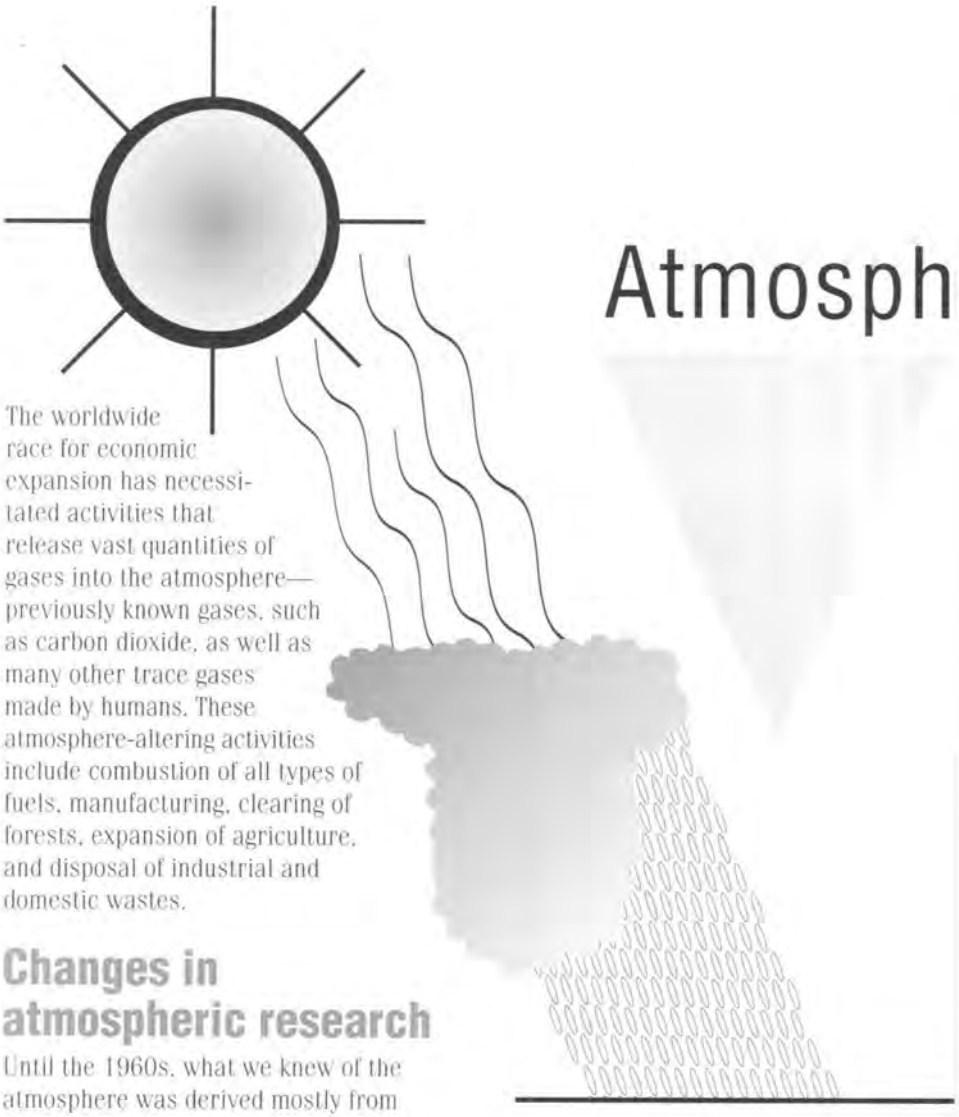
Partnerships between MSRC and towns and community groups are becoming increasingly common as the Center is sought out to consult on various activities and projects. One such partnership has been formed between MSRC and the Stony Brook Community Fund (SBCF), a non-profit corporation established in 1939 to preserve and restore historic properties and to protect sensitive environmental properties in the Village of Stony Brook. Part of this heritage is an 83-acre wetland between the Stony Brook Harbor and West Meadow Beach. On this wetland alongside West Meadow Creek is the Marine Conservation Center, a building with conference room and laboratory space.

Through joint fundraising efforts of MSRC and SBCF, the building is in the process of being refurbished after severe storm damage. The Community Fund and MSRC plan to expand and improve the facilities, offering programs and special events for Long Island school children as well as for adults. The partnership already has produced a successful lecture series at the Conservation Center. When completely refurbished, the SBCF Center will house a busy schedule of lectures, summer educational programs and tours for students and families.

◀ Teachers examining materials for curriculum development.

The Disciplines

Atmospheric Sciences



The worldwide race for economic expansion has necessitated activities that release vast quantities of gases into the atmosphere—previously known gases, such as carbon dioxide, as well as many other trace gases made by humans. These atmosphere-altering activities include combustion of all types of fuels, manufacturing, clearing of forests, expansion of agriculture, and disposal of industrial and domestic wastes.

Changes in atmospheric research

Until the 1960s, what we knew of the atmosphere was derived mostly from instrumental observations at selected locations at the Earth's surface. In general, theoretical ideas could not be tested because of the complexity of the equations that govern atmospheric and oceanic flows.

This picture has changed dramatically in the last 25 years, as Earth-circling satellites now monitor the atmosphere globally, as well as continuously. A parallel rapid increase in computational power has made numerical solutions of atmospheric and oceanic equations of motion possible, resulting in simulations of global climate in three dimensions, with computer generated continents and oceans, mountains and valleys, clouds and storms, winds and ocean currents.

In the models we can investigate the full range of atmospheric physical and chemical processes and make comparisons with observations. The models also give us the capability of simulating scenarios of anticipated events. For example, we can seek answers to the question, What is going to be the consequence of the continuous increase in the emissions of carbon dioxide into the atmosphere?

This question, and others like it, have assumed urgency because of the exponential rate of increase in the human intervention in the atmosphere. This increase is remarkable both for its size and its pace, leading to a worldwide investment of a large effort to study its consequences.

Coupled with the question of what changes are in the air, are questions about likely changes in physical and chemical processes in the atmosphere and their impact on climate and the environment. Possible scenarios associated with the greenhouse effect and ozone depletion have been given wide attention. But because atmospheric models are new and still evolving, there are so many unknowns in the implicated processes that the determination of the size and the timing of the impacts was not immediately possible. First, significant progress has to be achieved in our knowledge of the fundamental processes.

Many processes are poorly understood and are treated in the models with approximations developed from limited observational data. Furthermore, some processes cannot be resolved by model grids—their effects have to be approximated by ad hoc formulas. Data sets used to define the initial and boundary conditions of the models are not complete. As a result, the current models disagree among themselves in simulation of processes that control the predicted warming in response to increased concentration of carbon dioxide and other gases in the atmosphere.

Climate studies

A major theme of climate research at MSRC is to help improve climate models. One approach is to study feedback mechanisms in the climate system which can either amplify or suppress forces of climate change. One important example of feedback is the role played by clouds. If the climate warms up, do we get more or fewer clouds, and how does the change in cloudiness impact climate?

A quantitative understanding of important feedback mechanisms is necessary to get a reliable estimation of projected climate change. One example of research in this direction at MSRC is the investigation of cumulus convection in several general circulation models. Cumulus convection is the very rapid, vertical movement that acts as a pump to lift moisture and heat in small funnels from near the surface to the upper troposphere. In a simulated warmer climate, cumulus convection becomes stronger, and more moisture and heat is pumped into the upper atmosphere. The extra moisture produces a stronger greenhouse effect, a positive feedback. The extra heat warms up the upper

IMPROVING CLIMATE MODELS

troposphere to make it emit more radiation to outer space, a negative feedback. The increased moisture and temperature cause a change in relative humidity that controls distributions of high clouds, producing a subtle cloud feedback. This feedback turns out to be different in different models, depending on the convection scheme used. Such modeling discrepancies can hopefully be reduced by use of radiation and cloud data obtained by satellites.

Another phenomenon being investigated at MSRC that has important implications for the understanding of the Earth's climate is the observation from current and historical data that sea surface temperatures have upper limits; that is, there are processes that keep the temperature of the ocean surface below 32°C, even in the warmest tropical regions. As of now, there are two primary candidates for regulating these warm temperatures: evaporative cooling from the ocean surface and cloud shielding of incoming solar radiation. Both play important roles in regulating surface temperatures in many climates of the world; however, at the highest observed temperatures, the relative behavior of these two mechanisms is not clear. A recent field experiment known as the Coupled Ocean Atmosphere Response Experiment (COARE) was designed to obtain important data that will help answer some of these questions.

Ozone hole research

Since attention became focused on Antarctica following discovery of the seasonal "ozone hole" which develops over that continent, it has been increasingly recognized that the dynamics and chemistry of polar regions play an important, and heretofore neglected, role in influencing the stratosphere on a global scale. More must also be known about the chemistry and dynamics within the polar regions themselves.

As part of this effort, one of MSRC's faculty members and several students have traveled a number of times since 1986 to the Antarctica and the Arctic to make field measurements of chlorine monoxide, the telltale catalytic agent acting to destroy ozone. This group was the first to gather positive evidence that a build-up of **anthropogenic** chlorine was causing the seasonal ozone hole.

To gain further knowledge of conditions within the polar stratosphere, the group also set up a millimeter-wave remote sensing spectrometer at the South Pole in February 1993, for a year-long study of atmospheric trace gases at the heart of the southern polar vortex. Chemical species involved in important chemical cycles, including O_3, ClO, HNO_2, and NO_2 were measured, as well as N_2O, an inert tracer useful for measuring effects of vertical transport.

This experiment, the first ever to gather data on ozone above 30 km throughout the Antarctic winter or to study other trace gas behavior throughout a year-long period at an extreme polar latitude, has resulted in a large amount of unique data. MSRC researchers are also analyzing observations of stratospheric ozone by NASA's Upper Atmosphere Research Satellite (UARS) and global general circulation models to understand the variations of ozone in the upper atmosphere. UARS obtains data also on solar radiation, energetic particle fluxes, and winds, and analysis of their observed variations, together with three-dimensional global modeling, yields important clues to understanding dynamical and chemical processes in the stratosphere.

NASA's Upper Atmosphere Research Satellite (UARS) was launched on September 12, 1991, from Cape Canaveral, Florida, on the Space Shuttle Discovery. It is obtaining the most complete set of measaurements on the energetics, composition, and dynamics of the stratosphere and mesosphere that have ever been available. ▼

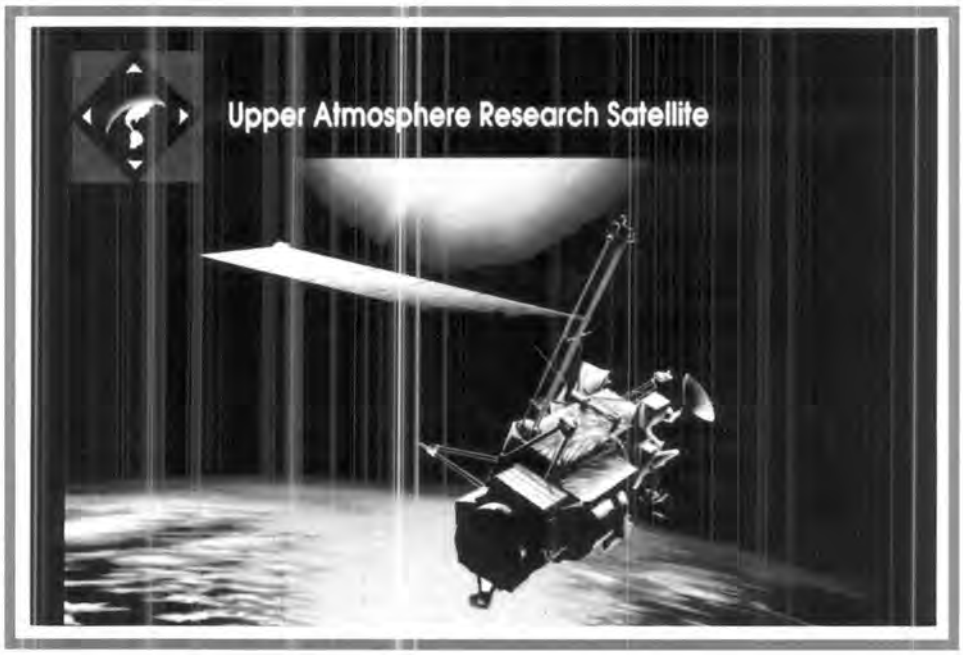


photo courtesy of NASA

Natural vs. anthropogenic variability

Because the atmosphere is a naturally varying system, often giving rise to large fluctuations in natural phenomena, an important challenge in climate research is to distinguish between natural and anthropogenic effects. For example, it is not intuitively clear if the widespread droughts experienced in the United States in 1988 and the major flood in the Mississippi Basin in 1993 were parts of natural atmospheric rhythms or consequences of modification of climate by anthropogenic emissions. This question requires quantification of the natural variability of atmosphere and climate, by investigation of historical data and use of theoretical models of the atmosphere.

Study of atmospheric variability is also a major theme of research at MSRC. A complementary approach to clarifying our knowledge of fundamental atmospheric processes, also being pursued at MSRC, is to realize that the atmosphere of planet Earth is but one of the many planetary atmospheres, and the rich data base obtained by NASA's space missions to other planets can be exploited to enhance our knowledge of

anthropogenic-
originating from humans

atmospheric processes. A focus in this approach at MSRC has been the nightside ionosphere of Venus and the ultraviolet emissions observed there by the Pioneer Venus spacecraft. Our faculty also conducts research on the Jovian ionosphere, and the chemistry and evolution of the Martian atmosphere.

Infrared spectroscopy

Calculations of heating in the terrestrial and planetary atmospheres requires accurate knowledge of the absorption properties of atmospheric gases in the infrared part of the spectrum. MSRC houses a state-of-the-art infrared spectroscopy laboratory where spectra of water vapor, carbon dioxide, methane, chlorofluorocarbons, and other important gases have been accurately measured. A large number of modeling groups use the measurements from this lab to improve their radiation calculations. These areas of MSRC atmospheric research are primarily carried out by faculty associated with the Institute for Terrestrial and Planetary Atmospheres (see page 49 for section on this institute).

Future challenges

Now that society recognizes the importance of climatic change, the future challenge in atmospheric research is to come up with more reliable assessments and predictions that would help in economic forecasting and planning. Uncertainties in climatic assessments can be reduced by progress in quantitative understanding of atmospheric physical and chemical processes and their links to oceanic and geological phenomena. This need is likely to define the theme of atmospheric research at MSRC in the coming years, requiring not only the maintenance of high standards of atmospheric research, but also increasing interactions with colleagues in marine sciences and learning new skills. This will be needed to continuously adapt to the modern scientific environment characterized by rapid progress in techniques and availability of unprec-

OUR STORY 25 YEARS

Institute Joins MSRC to Enhance Studies of Oceans — Atmosphere Interactions

In January 1992, University at Stony Brook's Provost, Tilden Edelstein, announced the transfer of the Institute for Terrestrial and Planetary Atmospheres and all of the atmospheric sciences faculty from the College of Engineering and Applied Sciences to MSRC. This union offers graduates in either marine or atmospheric sciences a greater range of studies involving the interaction of the atmosphere with the ocean.

This reorganization is also consistent with plans to assign the leadership role for further development of the University's environmental research, education, and service programs to MSRC.
With atmospheric and marine sciences combined, Stony Brook will be able to make even greater contributions to understanding how society is affecting the climate of the planet.

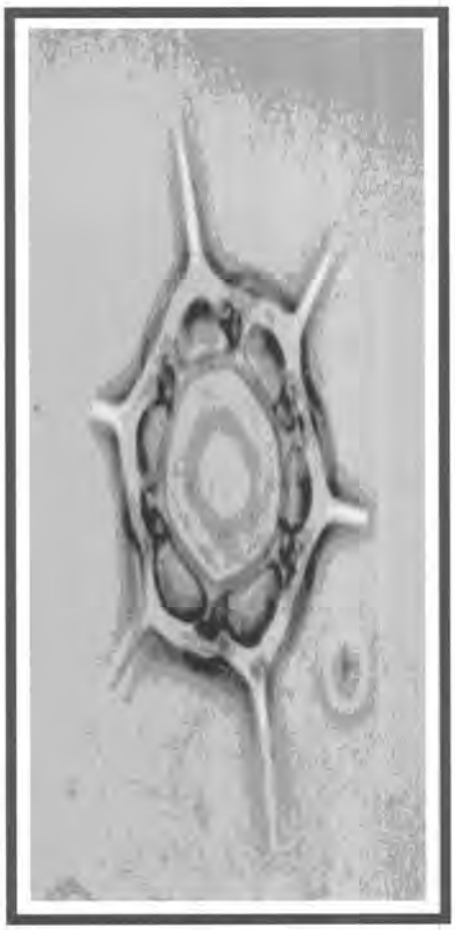
Biological Oceanography

Biological research at MSRC concentrates on the life of two main groups of organisms, those living in the water column (pelagic) and those associated with the sea bottom (benthic). Research over the past 25 years at Stony Brook has involved understanding the relationships of these marine organisms to their physical, chemical, and biological environments, and increasingly, their relationship to humans. Over the past two decades the biological faculty at MSRC has grown to a world-class group of ten, and their research has spanned the range from the smallest (viruses) to some of the largest (macroalgae) organisms in the sea.

Major discoveries at MSRC

MSRC marine biologists have made several discoveries that have revolutionized our view of marine pelagic ecosystems. For example, the discovery that viruses were much more abundant and important in infecting marine life originated in research done by an MSRC graduate student and professor. Now, scientists worldwide are involved in the study of the specificity of marine viruses and their effects on bacteria and phytoplankton. We now know that there is a tremendous diversity of viruses in the sea and that they are usually specific to the organisms they infect.

DIVERSITY OF VIRUSES IN THE SEA



A silicoflagellate

Current research is continuing at MSRC on the role of viruses in controlling local blooms of a **chrysophyte** phytoplankter, known locally as the "brown tide" which has impacted the commercial scallop harvest.

Another major discovery in which our faculty were instrumental concerns the concept of the "microbial loop." It was learned that marine bacteria have high growth rates in the sea, and that they accomplish this by utilizing dissolved organic carbon (DOC). These planktonic bacteria are thus important as producers of particulate organic carbon (POC).

This POC was then shown to be readily grazed by microflagellates (single cell protozoa with a flagellum). In the microbial loop concept, much of the carbon taken up by the microflagellates is recycled back into the dissolved (DOC) fraction, then utilized again. Measurements indicate that a surprisingly large fraction of the carbon in the sea cycles through the microbial loop and that little of this energy is cycled to commercially valuable species or exported from surface waters.

Marine pelagic ecosystems studies

Photosynthetic phytoplankton (microscopic algae), consisting of very small (about 1 μm) primitive bacteria-like cells in the genus *Synechococcus*, have been shown to be major primary producers throughout near-surface waters of the world's oceans. Research done by MSRC investigators has shown that there is high genetic diversity within the genus, that their productivity and growth rates are high, and that they are grazed significantly by protozoa (single cell animals).

Phytoplankton in local waters are the base of the food chain and are essential for Long Island's rich harvest of finfish and shellfish. Hundreds of species of phytoplankton are present in local waters. While most are good food for higher trophic levels, unfortunately, some produce toxins and others may form destructive blooms or may not be suitable food for grazers. MSRC marine scientists have been able to determine which waters have unfavorable phytoplankton populations, and are currently conducting research on causes of blooms and their destructive effects. Most notably, research has involved causes of brown and red tides and the transfer mechanisms of paralytic shellfish poisoning (PSP) toxins to shellfish.

Fundamental research on the fluid mechanics of grazing copepods is revealing how they detect and capture their prey. This research relies on fixed-frame laser-illuminated video photography

to study the mechanics of feeding. This research is important at a basic level to understand how ecosystems function. Other basic research on copepods concerns their life histories and the role that photoperiod and temperature play in signaling the animal to either overwinter in a resting stage or to reproduce. By examining the life histories of copepods from Maine to Florida, environmental effects can be discerned on the life cycle of these important secondary producers.

On a global level, it has become important for marine scientists to determine how marine biota fit into global **biogeochemical cycles**. For example, phytoplankton play a key role in removing the greenhouse gas CO_2 from the atmosphere and replacing it as particulate matter, which sinks into the deep waters of the world's ocean, no longer able to fuel global warming. Research by MSRC scientists on carbon (C) and nitrogen (N) cycling in tropical seas has shown that large colonial cyanobacteria (blue green algae) are much more instrumental in converting these elements from either their gaseous or dissolved forms into the particulate phase than was previously thought. This research is also important because the pathway of N_2 fixation by these cyanobacteria introduces "new" nitrogen into the **euphotic zone**.

Nitrogen is an element which is typically present in limiting concentrations in marine surface waters; that is, it is in low enough concentrations such that growth of an organism—in this case, phytoplankton—is retarded. The typical source of new N is dissolved N which originates in deep water and gradually seeps into surface waters where phytoplankton occur.

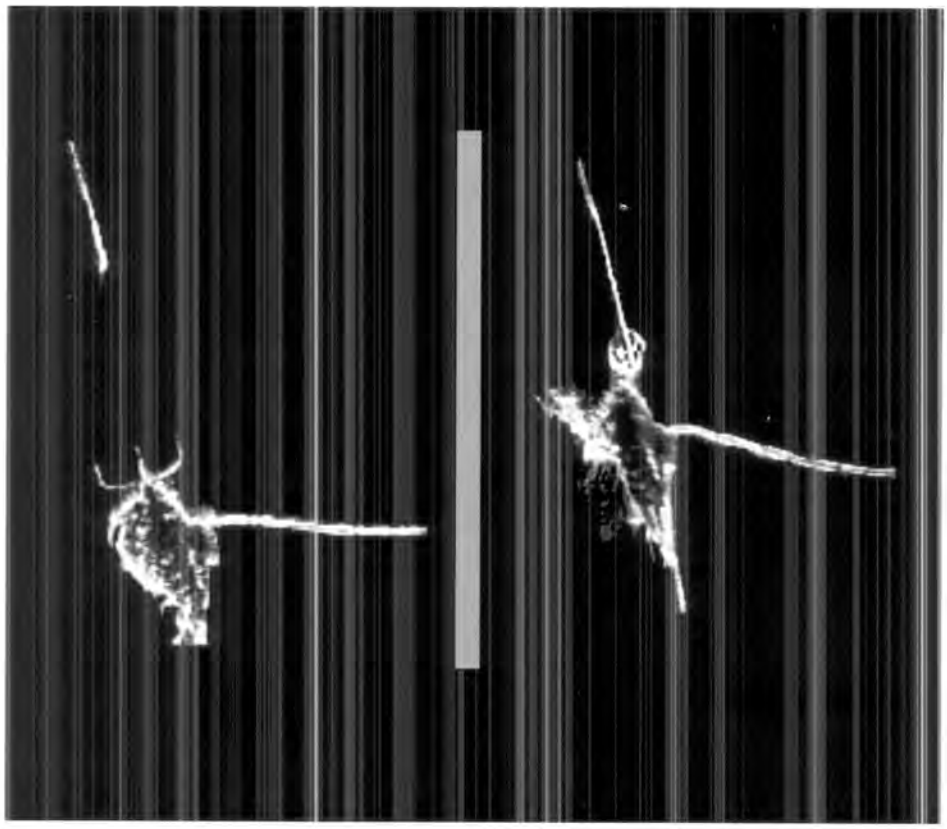
MSRC research on the cycling of metals in the sea has shown that marine phytoplankton concentrate some metals up to a million-fold out of seawater and planktonic fecal and detrital material are instrumental in transporting metals within the marine ecosystem. Studies have also quantified the **remineralization** rates and mechanisms of many elements associated with decomposing organisms.

chrysophyte -
golden brown alga

biogeochemical cycles -
the cycling of an element between the land, water, and the atmosphere, as mediated by biological, chemical and geochemical processes

euphotic zone -
the surface waters of the oceans which receive sufficient light to support photosynthesis

remineralization -
the transfer of a chemical element from the organic to inorganic state



▲ A small marine crustacean, called a copepod, tethered to a wire in an experiment to record movements on video during prey capture. Left panel shows copepod at rest; upper streak is a water jet mimicking prey movement. Right panel shows copepod jumping up to attack prey mimic.

Benthic ecosystems studies

Several of our faculty are interested in understanding how the smaller benthic organisms (meiofauna) within the sediments influence the oxygen content of sediment pore waters. They compare bioturbation (mixing of bottom sediments) by these animals as well as by large benthic organisms (macrofauna). The larger benthic deposit feeding species have been shown to exert a major influence on sediments through ingesting sediments to extract food. To obtain enough food from marine sediments, these organisms must eat as much as a hundred times their body weight daily. Thus, they are important not only as the main food source for bottom feeding fish, but as bioturbators of the sediments.

Temperature is the major determinant of geographic distribution in most

organisms—benthic or planktonic, aquatic or terrestrial, plant or animal. Research comparing the physiological and biochemical characteristics of kelps (large brown seaweeds) collected from Long Island Sound, the Atlantic Coast, and the Arctic will help us understand the mechanisms by which organisms adapt to high temperature.

Multidisciplinary projects

Because benthic community distributions and characteristics often mirror the physical regime, they can be used as indicators of physical processes. Biologists involved in multidisciplinary projects in locations such as the Amazon continental shelf have been examining seasonal and spatial population patterns of the benthos to help document large scale diagenic transport processes and time-scales of physical disturbance within the seabed.

The future of marine biology at MSRC

What does the future hold for marine research in the biological arena? It is clear that there will be need for an increasingly sophisticated approach to the field. It will require, for example, remote sensing to study the onset and fate of blooms of phytoplankton. New satellites and receiving stations will allow real time following of blooms, and this should help in understanding causes and fates of blooms and the siting of aquaculture operations. Several MSRC scientists are involved in remote sensing, and we see it as becoming increasingly important in the biological field.

Another growing area is that of molecular biology. Research in this area ranges from genetic recombination, use of probes to detect organisms with specific genes, and the study of genetic diversity. MSRC has recently added a molecular biologist to the faculty. Besides delving into these new research areas, it is important for the marine biology faculty to continue using new and appropriate technology, as well as to develop traditional research themes in the areas of physiological ecology, ecosystem dynamics, behavior, and taxonomy. There is still so little known about the biology of marine organisms that it is essential to continue research on a broad front in local tidepools, harbors, bays, and in the open seas on a global basis.

Creation

In the pueblo, Kantokan bent to her work.

She decided

For the form, I will use husk

For the hair, corn-silk

For the eyes, dark beans

For cheeks and lips, crushed berries

For clothing, a strip of skin

For ornament, this bright feather

And, so she did.

Singing softly,

swaying gently,

offering doll to east, to west, to north, to south—

to sky, to sun, to air, to Spirit.

She saw that it was good:

Made of the earth

Made of the harvest

Made of the Spirit.

Clapping her hands, Kantokan laughed.

—Max Mobley
First Place Winner
MSRC - Taproot
Poetry Contest, 1993

Fishery Science

MSRC's teaching and research programs in fisheries biology have enjoyed explosive growth over the past 20 years. Back in the 1970s when New York State was the number one producer of hard clams, and coastal stocks of finfishes were still plentiful, MSRC's research effort in fisheries science was modest. But as shellfish stocks began to collapse and a number of key finfish species such as striped bass and weakfish began to decline, MSRC's lone fishery scientist at the time was among the first to sound a warning. Soon thereafter, MSRC took swift and decisive action to begin the research necessary to restore these valuable resources.

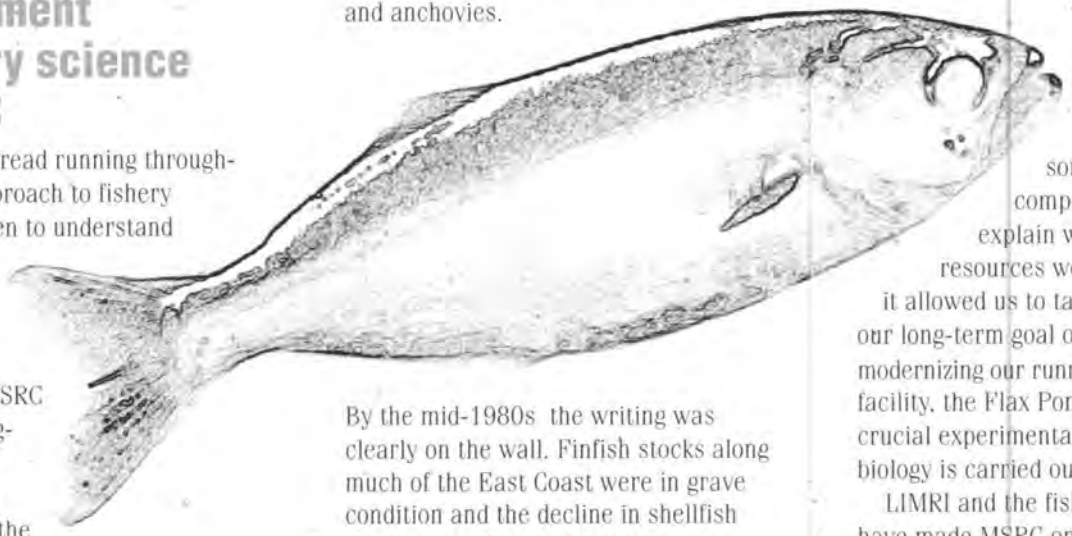
Development of fishery science at MSRC

The common thread running throughout MSRC's approach to fishery science has been to understand the factors that limit **recruitment** of young into adult stocks. MSRC scientists recognized correctly that the key to understanding the collapse of adult stocks was to study the factors affecting both production and survival of the early life stages—eggs, larvae, and juveniles—which are most susceptible to declining habitat quality and quantity.

When hard clams began a precipitous decline in 1977, MSRC created the first research position in New York dedicated to understanding the causes for loss of shellfish stocks. The Center initiated studies to evaluate changes in age structure, growth, mortality, and reproductive rate; determined habitat requirements of different life stages; and evaluated a variety of management options, such as planting hatchery-reared seed clams, establishing spawner sanctuaries, and controlling predator populations.

Around 1980 new concerns about the health of finfish stocks emerged, and MSRC responded by hiring a fish biologist whose chief concern was the decline in abundance of near-shore fishes that all depend on estuaries as a critical nursery ground for the early life stages: striped bass, bluefish, weakfish, summer flounder, and winter flounder and their forage base, silversides and anchovies.

Juvenile bluefish



By the mid-1980s the writing was clearly on the wall. Finfish stocks along much of the East Coast were in grave condition and the decline in shellfish stocks spread beyond hard clams to include other species such as surf clams and bay scallops. Moreover, Long Island's eastern bays were besieged by a series of devastating algal blooms that became known as the "brown tide." Many believed these blooms to be a sure sign that New York's coastal marine ecosystems were on the verge of collapse: the brown tide virtually eliminated the entire harvestable population of bay scallops and diminished eelgrass beds over a large area.

New institute formed

At this point MSRC made a major leap forward. In 1985, with financial support from the New York State Legislature, MSRC created the Living Marine Resources Institute (LIMRI—see page 41). This initiative accomplished two major goals. First, it added three new members to our faculty who immediately rolled up their sleeves and began the difficult task of sorting out the competing hypotheses to explain why our marine resources were eroding. Second, it allowed us to take the first step in our long-term goal of refurbishing and modernizing our running seawater facility, the Flax Pond Laboratory, where crucial experimental research in fishery biology is carried out.

LIMRI and the fishery science faculty have made MSRC one of the strongest institutes in the United States, combining comprehensive knowledge of the marine sciences with that of fishery science. Seven faculty now devote their efforts to understanding the biology and aquaculture of various resource species. Over 25 graduate students are engaged in fisheries research and training at any one time at the Center, and a total of over 90 students have been awarded advanced degrees (M.S. or Ph.D.) while specializing in fishery science.

Major accomplishments over the last 10 years are numerous. With its firm commitment to the study of recruitment, MSRC has become one of the primary centers of knowledge on the early life history stages of both finfish and

recruitment -
the number of juvenile organisms arriving at a habitat where they will grow and live for an extended period of time

shellfish species. Research topics span a wide range of important issues: for example, physical mechanisms by which larvae are transported from spawning sites to nurseries; use of estuaries and artificial reefs as habitat; factors affecting survival after settlement; mechanisms and rates of survival during winter conditions. A sign of MSRC's rapid emergence in larval ecology was our leadership in organizing and hosting the Larval Ecology Meetings in 1993, the first time that larval ecologists working with a wide variety of invertebrate and vertebrate animals had ever come together to compare findings.

Aquaculture research

MSRC continues to conduct research in support of aquaculture as a long-term alternative to the harvesting of free-ranging stocks, working primarily with oysters, scallops, hard clams, and striped bass. Causes and affects of the brown tide and other harmful algal blooms on major resource species is another area where MSRC has a distinguished record of achievement.

Bluefish studies

MSRC is the only marine institute in the world with research focused on bluefish. For the Center, this is a natural consequence of the fact that bluefish are generally the number one landed species in the marine recreational fishery along the U.S. East Coast, as well as in many other parts of the world. Yet before MSRC began its work, very little was known about the biology and life history of bluefish. MSRC's fishery scientists also extend their research expertise well beyond the borders of New York. Projects are underway throughout the U.S. East Coast and in the Caribbean, Antarctica, Central America, Namibia, and the Galapagos Islands.

photo by Frank Greenfield

▲ Clamming in Great South Bay, 1973.

Sustainability of living marine resources will require a better balance between harvesting pressure and maintenance of habitat suitability.

Habitat requirements

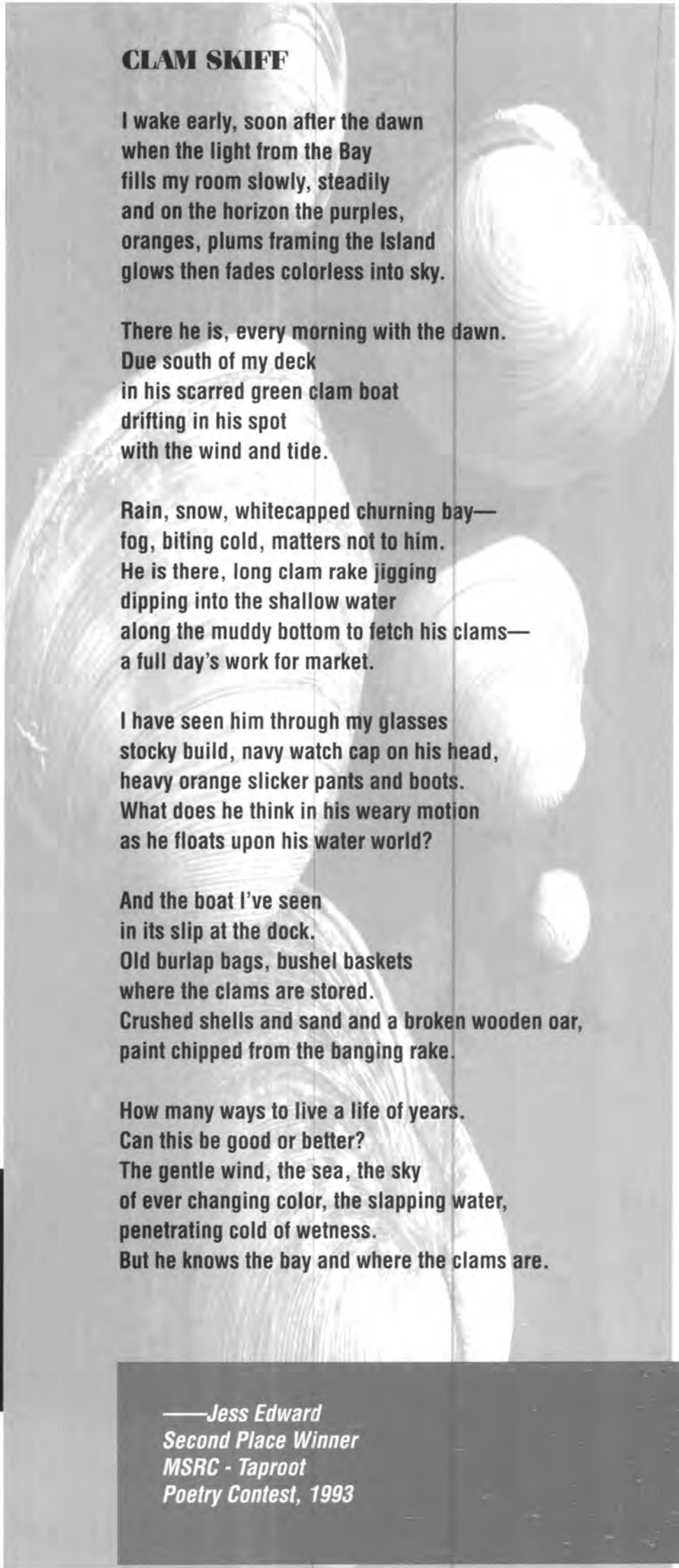
As the future unfolds, we predict the path that MSRC fishery scientists have taken will pay rich dividends. As pressures to further develop the coastal zone increase, the importance of understanding habitat requirements of resource species, particularly the larval and juvenile stages, will increase.

Much of the declines in various resource species are now known to be due largely to overfishing, but stocks will not rebound when fishing is relaxed unless the quality of the habitat for all life stages is suitable for optimal growth, survival, and reproduction. Remote sensing will become an extremely valuable tool in assessing the quantity and quality of available habitat, as well as assessing directly the abundance of harvested stocks.

The continued occurrence of brown tide blooms is a vivid reminder that fishery management is as much about maintaining habitat quality as it is about restricting the level of fishing effort. Our difficulty in identifying the causes of algal blooms indicates that we have much to learn about how to maintain ecosystem function.

Future demands

Amid the overall decline in fisheries stocks, there is a growing demand for sources of protein such as seafood that are low in fat. Aquaculture will be needed to replace much of the burden on wild stocks to provide seafood to consumers who will turn more and more to fish products as a source of protein. But there are many problems that need to be solved before aquaculture can reach its vast potential. These problems include development of improved domestic strains, improved disease resistance, better nutrition, and techniques for controlling water quality. MSRC's fisheries scientists are committed to meet these and other challenges head-on in the coming decades.



CLAM SKIFF

I wake early, soon after the dawn
when the light from the Bay
fills my room slowly, steadily
and on the horizon the purples,
oranges, plums framing the Island
glows then fades colorless into sky.

There he is, every morning with the dawn.
Due south of my deck
in his scarred green clam boat
drifting in his spot
with the wind and tide.

Rain, snow, whitecapped churning bay—
fog, biting cold, matters not to him.
He is there, long clam rake jigging
dipping into the shallow water
along the muddy bottom to fetch his clams—
a full day's work for market.

I have seen him through my glasses
stocky build, navy watch cap on his head,
heavy orange slicker pants and boots.
What does he think in his weary motion
as he floats upon his water world?

And the boat I've seen
in its slip at the dock.
Old burlap bags, bushel baskets
where the clams are stored.
Crushed shells and sand and a broken wooden oar,
paint chipped from the banging rake.

How many ways to live a life of years.
Can this be good or better?
The gentle wind, the sea, the sky
of ever changing color, the slapping water,
penetrating cold of wetness.
But he knows the bay and where the clams are.

——Jess Edward
Second Place Winner
MSRC - Taproot
Poetry Contest, 1993

Chemical Oceanography

In the last 25 years, chemical oceanography has developed from a discipline concerned chiefly with documenting spatial variations of chemical species in the oceans to one which addresses the processes—not only chemical, but also physical and biological—that interact to produce the observed distributions. The transition to this process-oriented approach has made chemical oceanography the most interdisciplinary of the marine sciences.

Process-oriented approach to understanding distributions

Along with the increasing emphasis on understanding how oceanic processes produce the observed oceanic distributions of chemical species (for example, nutrients, trace elements, dissolved gases, radionuclides, and organic compounds) chemical oceanographers have developed the use of tracers, gaining insights into the processes themselves and the rates at which they operate. Because most oceanic processes operate in both the nearshore and open ocean, coastal waters have become a readily accessible natural laboratory for the study of ocean chemistry on a larger scale. At MSRC the chemical oceanography faculty and students take advantage of this fact to extend the results of their research in coastal chemical oceanography to other parts of the ocean.

Evaluating chemical fluxes

Recent insights gained from an understanding of chemical distributions in the oceans and the processes controlling them have led to an emphasis on evaluating chemical fluxes in the oceans. Indeed, the distributions of chemical species in the oceans are heavily influenced by fluxes across interfaces such as the air-sea interface, the sediment-water interface and the river water-sea water interface, and chemical oceanographers have often focused on these interfaces in their work.

Answering interdisciplinary questions

The emphasis on fluxes in chemical oceanographic studies has resulted from the need to answer broad, interdisciplinary questions, such as, What is the fate of dissolved CO_2 in the oceans? What controls the dissolved oxygen levels in estuaries? How are toxic contaminants cycled in coastal waters? These questions are linked to major societal problems such as the consequences of increasing CO_2 in the atmosphere (global warming) or eutrophication of coastal waters (hypoxia). Chemical oceanographers are uniquely well suited to take the lead in answering such questions.

One broad area of current interest that either directly or indirectly involves the research of all chemical oceanography faculty and students at MSRC is that of organic matter cycling in the oceans. Plants living in the surface ocean take up dissolved inorganic carbon and nutrients to produce organic matter. Eventually, much of this organic matter decomposes, consuming oxygen and releasing nutrients to solution. In the open ocean, most of this recycling takes place in the water column, but in the coastal ocean a significant amount of organic matter is deposited at the sea floor and is decomposed in the sediments.

International program studies organic matter cycling

Production and cycling of organic matter influence a great many chemical cycles, including those of the nutrient elements (nitrogen, phosphorus, carbon, silicon); dissolved oxygen, and many trace elements. The fate of organic matter in the oceans is the focus of a major international program, the Joint Global Ocean Flux Study (JGOFS) and several MSRC chemical oceanography faculty are involved in this program.

Other programs in progress

Other major ongoing areas of chemical oceanographic study at MSRC include

- using specific organic compounds to decipher how organic aggregates decompose and break up during sinking;
- developing innovative approaches to trap and preserve sinking particles in the oceans;
- using naturally occurring radioactive chemicals in sea water to estimate the rates of particulate organic carbon and nitrogen removal from the surface ocean

photo by Leslie Adler

▲ *MSRC graduate student analyzing for total CO_2 in the pore waters of Long Island Sound sediments.*

and the rates at which particles aggregate and disaggregate during sinking;

• characterizing the reactions that occur in the water column and sediments as organic matter is decomposed there;

• investigating microbiological controls on the production and consumption of organic compounds in seawater; and

• developing ways to measure reaction rates in sediments and fluxes of chemical species across the sediment-water interface.

Scientific research for effective coastal management

Throughout its history, MSRC has had a tradition of making the link between scientific research results and effective management of the coastal ocean. The chemical oceanography faculty have been active in these efforts through the leadership roles they have played in the recently completed Long Island Sound Study and in their involvement in the Waste Management Institute.

An example of an area of interdisciplinary research that is strongly linked to management concerns, and one in which MSRC chemical oceanographers have played a leading role, is the fate of contaminants. The environments at the ocean's margin — estuary, continental shelf and slope — are important in this context because it is this zone of transition that receives most of the contaminants introduced by human activities.

Many contaminants, both organic and inorganic, associate with particles when they enter coastal waters, so their transport is mediated by that of the particles. Moreover, chemical reactions taking place in sediments after they are deposited can lead to the release of contaminants back to the overlying water column.

LEADERSHIP ROLE IN SOUND STUDY

Contaminant cycling: measuring distributions and governing processes

MSRC chemical oceanographers are studying contaminant cycling in the oceans from the dual perspectives of measuring both the contaminant distributions and the processes that

affect them. Our scientists are able to measure low concentrations of organic contaminants, such as polychlorinated biphenyls, polyaromatic hydrocarbons, and pesticides; heavy metals; and anthropogenic radionuclides in marine samples. But it is the combination of this ability with a process-oriented approach which leads to an understanding of the causes of these distributions and the eventual fate of the contaminants. And it is the combination of these approaches that distinguishes MSRC research from that of other institutions.

Ongoing areas of research linked to contaminant behavior in the coastal ocean include measurements of the rates of particle transport, accumulation, and mixing by the benthic fauna; measurements of the chemical cycles of iron and manganese — elements which play a key role in scavenging both inorganic and organic contaminants in seawater; measurements of the fates of organic contaminants in sediments and their release back to the overlying water; measurements of contaminant chronologies and fluxes from point and non-point sources; and studies of the importance of colloids (particles less than 0.2 μm in diameter) in the scavenging and transport of contaminant and trace metals.

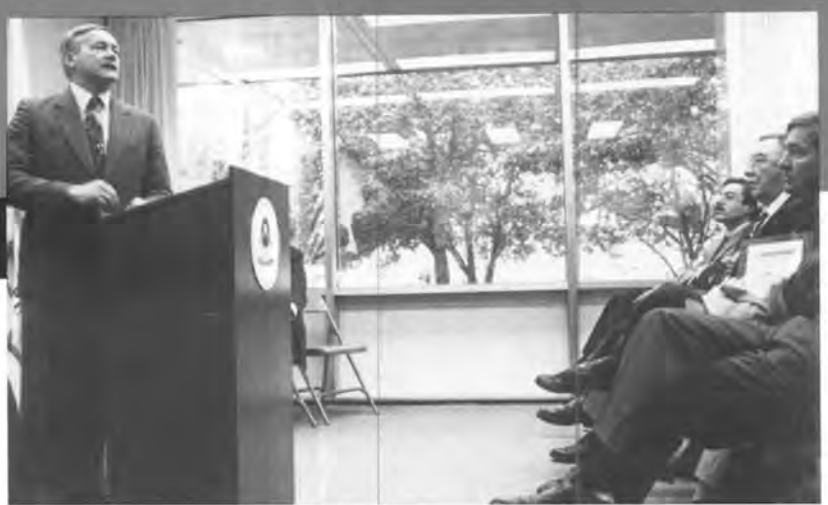
MSRC's chemical oceanographers expect that future growth in this area of research will enhance their ability to understand the effect of ocean processes on chemical cycles and the measurement of fluxes at oceanic interfaces.

OUR STORY 25 YEARS

Long Island Sound Study Office Opens at MSRC

A ribbon-cutting ceremony marked the official opening of the U.S. Environmental Protection Agency's (EPA) Long Island Sound Study Office at MSRC in May 1992. EPA's Constantine Sidamon-Eristoff, New York State Representative James H. Scheuer, New York State Senator Owen H. Johnson, United States Congressman George Hochbreuckner — all long-term supporters of making Long Island Sound part of the National Estuary Program — were just a few of the many who took part in the celebration.

The Sound Study Office, under the direction of EPA's Mark A. Tedesco, an alumnus of MSRC, plays a central role in coordinating the joint federal, state, and local effort to clean up the Sound, according to recommendations of the Comprehensive Conservation and Management Plan. The office serves as the repository for public access to this document, as well as an outreach center aided by New York Sea Grant Institute.



U.S. Congressman George Hochbreuckner at opening ceremonies of the Long Island Sound Study office at MSRC.

turbidity maximum - where fresh and salt water converge and maintain high levels of suspended sediment

Geological Oceanography

MSRC scientists have investigated geological oceanographic processes in coastal environments both in the waters surrounding Long Island and much farther from home.

New York estuaries

Some of the first research projects conducted by MSRC 25 years ago were studies of Long Island Sound, especially the western Sound. Geological, chemical, and physical oceanographic observations made in the early years of the Center have formed the foundation for many studies conducted in the Sound since. These investigations were applied to pressing practical problems, including the disposal of dredged sediment, the use of Sound waters by power plants, and the assessment of proposals to build a bridge over the Sound (or a tunnel under it), or to build tidal locks in the East River, which borders Manhattan's east side.

MSRC geologists have examined the bedrock foundation of the Sound to search for faults and fractures potentially associated with earthquake activity. These studies are done using acoustic or seismic reflection equipment, which work much like high powered echo sounders. Center geologists also have used this same equipment to identify fossil beaches, now buried deep beneath the sediments in the Sound. Peconic Bay, Port Jefferson and Stony Brook Harbors, Moriches Bay, Huntington Harbor, Hempstead Harbor, Jamaica Bay, and many others have all come under the scrutiny of MSRC scientists at one time or another. These ancient beaches provide clues to help decipher how changes in sea level occur and what we might expect in the years to come.

Fate of sediments

Geologists at the Center played an important role in the studies recently completed for the U.S. Environmental Protection Agency as part of its National Estuary Program. This research developed the most comprehensive picture to date of the clouds of particles that are in constant motion in the Sound. MSRC scientists constructed theoretical models to help explain how the Sound waters move these particles, and their associated contaminants, from place to place.

ANCIENT BEACHES PROVIDE CLUES

X-radiograph of a sediment core from Hudson River estuary

Similar work was done by MSRC in the Hudson River estuary. The **turbidity maximum** in the Hudson was first identified by MSRC scientists over a decade ago. Today, as a result of recent MSRC studies, the turbidity maximum is the topic of new hypotheses concerning its formation. In the Hudson, patterns of turbidity are controlled by dynamic flows of salt water along the estuary floor. Undetectable on the surface, these flows sweep across the estuary's sediments when the tides relax, suspending sediment and moving it far upstream. This has already changed the way we view the estuary's behavior and may alter our basic ideas about other estuaries.

The products of these studies have often been applied to the most serious problems facing New York Harbor. Among these are problems associated with the fate of contaminants and the issues surrounding the management of these sediments in beneficial ways—undersea mining, beach renourishment, or the clean-up of contaminated sediments.

Groundwater seepage

The Center has also been at work in the quieter waters of Long Island's bays and harbors. The sediment maps used today for Great South Bay were compiled years ago by investigators from the Center. And some of the first studies of the impacts of groundwater seepage on the coastal ocean were conducted here in Great South Bay by professors and students from the Center. Scientists at the Center have recently joined with others at SUNY to form the Groundwater Institute, dedicated to fostering new studies and providing additional educational opportunities.

Long Island beaches

The geological oceanography project with the longest history at MSRC has been one to monitor beach profiles on Fire Island and other beaches of the South Shore. This project was designed and coordinated by Center geologists, and the field work was performed by student volunteers, for the dual purpose of developing a historical data base for quantifying the changes in the South Shore beaches as well as to alert the public to changes that occurred on the local beaches.

One portion of the original studies, recording beach profiles at East Hampton, now in its 15th year, represents the longest continuous time series of beach profiles in the country. Over the years, MSRC scientists have built upon the techniques developed in this project to obtain an increasingly comprehensive view of our coastline. MSRC researchers have undertaken studies to extract detailed information on the behavior of

the shoreline, using techniques that range from analyses of individual sand grains to determination of the **fractal character** of the shoreline.

Sediment budgets

Center geologists calculated some of the first estimates of cliff erosion and shoreline retreat on the North Shore in the mid-1980s. This work was originally geared towards understanding the contribution to suspended sediment in Long Island Sound — estimates of erosion and shoreline retreat are essential elements in a regional sediment budget.

***The JOIDES* Resolution loads supplies for Leg 155 of the international Ocean Drilling Program. MSRC's Roger Flood served as co-chief scientist for 56 days of the expedition, which produced 4,000 m of core samples from 34 holes at 17 sites at the Amazon River basin.** ▶

Sediment budgets are of critical importance to geologists, engineers and government regulatory agencies. And one of the most difficult steps in developing such a budget is identifying the various sources of sediment in a region. MSRC geologists have, however, been able to perform sophisticated analyses on the characteristics of sediment in dunes along the South Shore in order to determine what the various sources are and how much of the sediment came from each source.

Managing sand as a resource

The Center's geologists, working with New York Sea Grant Institute, have been very active in developing a management plan for the precious resource represented by the South Shore beaches. Throughout the second half of the 1980s a series of workshops was held in which experts from around the country convened to identify areas of the shoreline subject to erosion and to determine management options for these areas. They collected existing information necessary for such management and identified what information was missing. This work highlighted the need for a monitoring plan for the shoreline, and such a plan was developed in one of the workshops. Center geologists have continued this work by taking an advisory role in state and local government bodies.

photo by Roger Flood

The interactions between barrier islands and the bays behind them have long been of interest to Center scientists. Following the 1980 breach at Moriches Inlet, MSRC scientists performed a modeling study to look at how the dimensions of the inlet control the hydrodynamics of the back bay. Later in the decade, MSRC geologists performed a similar study to assess the effects of dredging in Fire Island Inlet on circulation in Great South Bay. Presently,

Department of State Staff at MSRC

Over the past five years, MSRC has made a concerted effort to attract various environmental agencies to locate their offices at the Center to promote interactions. One of the 1991 Recommendations of the Governor's Task Force on Coastal Resources stated that the New York State Department of State's Division of Coastal Resources and Waterfront Revitalization begin to refine the Statewide Coastal Management Program by developing regional elements.

Because of MSRC's leadership roles in coastal marine research and coastal management and policy analysis as a potential aid to development of the CMP, the Department of State opened an office at MSRC in 1992. Their location at MSRC has fostered a synergistic relationship between their staff and MSRC faculty and students.

Barrier Beach

The beach is a vigilant guardian,
Great arms spread out, protecting all behind.
November sits on the sand, taking its turn;
The people have returned to the mainland.

The ocean is chafed by the wind and
Bares an angry face of white waves.
A handful of gulls are bounced around
So much they finally jump up and leave.

A small trawler plows a section off
The sand bar, dragging for blues and weaks.
Sometimes it drops into farmer furrows, the rigging
Appears like broken crosses on a battlefield.

White-necked scoters fly low and fast, oblivious
To the wind that is ceaseless, that pushes
The water out of the sea up onto the beach.
It does until the November moon, no longer

Amused by the wind, pulls the water back
Down into the sea, back off the beach that's
Left only with marks and remnants,
Like a lover who has come and gone.

——Donald Everett Axinn
from *The Hawk's Dream and Other Poems*

fractal character - measurement that describes the underlying patterns in irregularity of a shoreline

MSRC is conducting research on the effects of the 1992 breach at Westhampton Beach as well as efforts to determine the susceptibility of the barrier islands to future overwash and breaching.

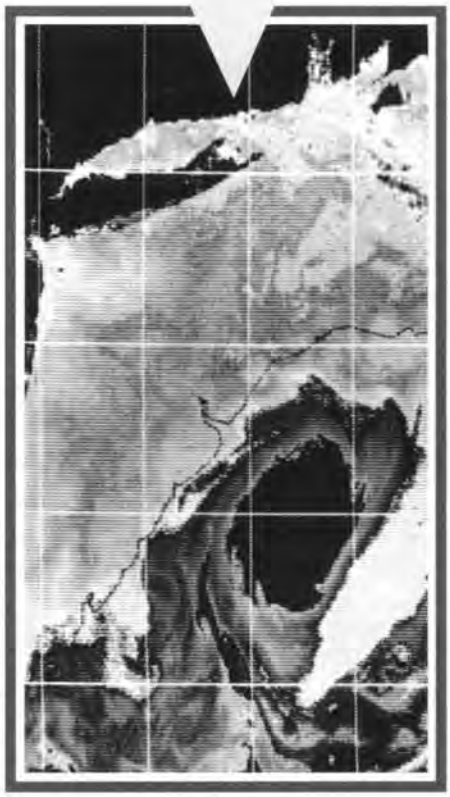
Other coastal areas of the world

An academic institution specializing in marine sciences must present students with an understanding of the full breadth of processes active in the world. For this reason and to maintain its place among the international community of geological oceanography institutions, MSRC has conducted research in many coastal areas around the world. The tropical region near the mouth of the Amazon River has been a region of especially intensive studies investigating the fate of sediment discharged to the ocean. Research has extended from the shoreline to the shelf break. More recently, our scientists have participated in a cruise associated with the Ocean Drilling Program to examine the Amazon Fan at the base of the continental slope and the history locked within its sedimentary deposits.

MSRC has extended its international research to polar settings also, with studies of glacial-marine sedimentation in the Ross Sea of Antarctica. The Center was responsible for instrument deployments that lasted throughout two austral winters and collected oceanographic data regarding sediment transport below the sea ice.

MSRC geologists are now studying the southern coast of Alaska to contrast polar sedimentation in Arctic and Antarctic settings. They have conducted much work in distant temperate locations as well, including those of Asia (Yellow Sea and East China Sea), Europe (Baltic Sea, Adriatic Sea and Black Sea), and North America (U.S. Pacific Northwest). These studies are particularly relevant, because they allow comparisons with the sedimentation processes on the temperate coast of New York State.

Physical Oceanography



Satelite image of the New York Bight

Physical oceanographic research at MSRC concentrates on the coastal ocean, particularly, the inner shelf and estuaries. Over the years, MSRC's physical oceanographers' studies have spanned all major U.S. coastal waters, from Long Island Sound to San Francisco Bay and from the Great Lakes to the Mississippi River, as well as international research programs in the U.K., Canada, New Zealand, and the Mediterranean Sea. While vigorously pursuing fundamental research of coastal processes, this faculty has also been effectively applying research results to the solution of problems that result from society's uses and misuses of the coastal ocean.

Net motion in estuaries

The coastal ocean receives large amounts of runoff from the land, and is constantly subject to vigorous tide and storm actions. In estuaries, river water meets the ocean. The force that drives the intrusion of ocean water is the longitudinal salinity difference. This fundamental process, the gravitational circulation, was first analyzed in the 1950s using the then novel drogue current measuring device and inductive conductivity sensor. The mean motion in estuaries is characterized by a two-layered flow: a seaward flow of fresh water on the surface and a landward ocean water flow on the bottom. The mean flow, while relatively slow compared to the tidal currents, because of its persistence, is responsible for the transport of salt through estuaries.

In the late 1970s, with the successful deployment of continuously recording current meters in estuaries, it became clear that there were strong, rapidly changing currents superposed on the two-layered mean flow. MSRC scientists identified such motions as being driven by the storms. In particular, they found that the coastal longshore wind could drive large transports in and out of estuaries. By recognizing the importance of this non-local effect, that is, motions inside estuaries could be driven by the coastal wind, they brought new appreciation in the 1980's for the coupling between estuaries and the inner shelf.

Dye tracer studies determine horizontal dispersion

Dispersion of plumes in estuaries is controlled by horizontal turbulence. In the early 1960s, the fluorescent dye, rhodamine B (or WT), was identified to be a useful tracer of water movement. In the 1970s, MSRC's physical oceanographers developed an innovative field sampling technique that interfaced seamlessly between an underway pumping fluorometer and a high-precision Mini-Ranger navigation system.

This dye tracer study proved an important application for the resolution of a pressing environmental problem — the impact of nuclear power plants. The dye tracer was ideal for determination of the transport and fate of thermal effluents. In the 1970s and early 1980s, the researchers mapped virtually every nuclear plant outflow in the United States.

Model analyses of transport processes

The physical oceanographers' research always strikes a balance between observation and theory. In the 1970s, they arrived at a landmark theory on the horizontal turbulence from analysis of a large number of dye tracer studies, formulating the relationship between the intensity of horizontal diffusion and the size of the dye patch. This "universal" law was shown to be valid for lengths from as small as 1 m to as large as 10,000 km. In recent years, the horizontal turbulence theory has proved very useful in explaining the patchy distribution of marine microorganisms.

In the 1980s, seizing the opportunities of exploding supercomputer technology, these researchers have succeeded in establishing a vigorous coastal ocean modeling research program. Their studies emphasize model-data verification. For example, their Peconic Bay hydrodynamic model was verified with a dense observation network of current meters and tide gauges that literally covered the entire bay. This model in recent years has been used to find solutions to a damaging environmental problem in the Peconics—the "brown tide."

A BALANCE BETWEEN OBSERVATION AND THEORY

A look to the future

Vertical mixing

It was recognized early that vertical mixing between fresh surface water and salty bottom water ultimately controls the two-layered flow. But it was not possible to measure the small-scale mixing processes in estuaries. The need to fully understand vertical mixing now has an added significance because summer hypoxia (or anoxia) conditions are becoming a widespread environmental problem in most urban estuaries like the Long Island Sound and Chesapeake Bay. Since oxygen in the bottom water is supplied from surface water by vertical mixing, a solution to the hypoxia

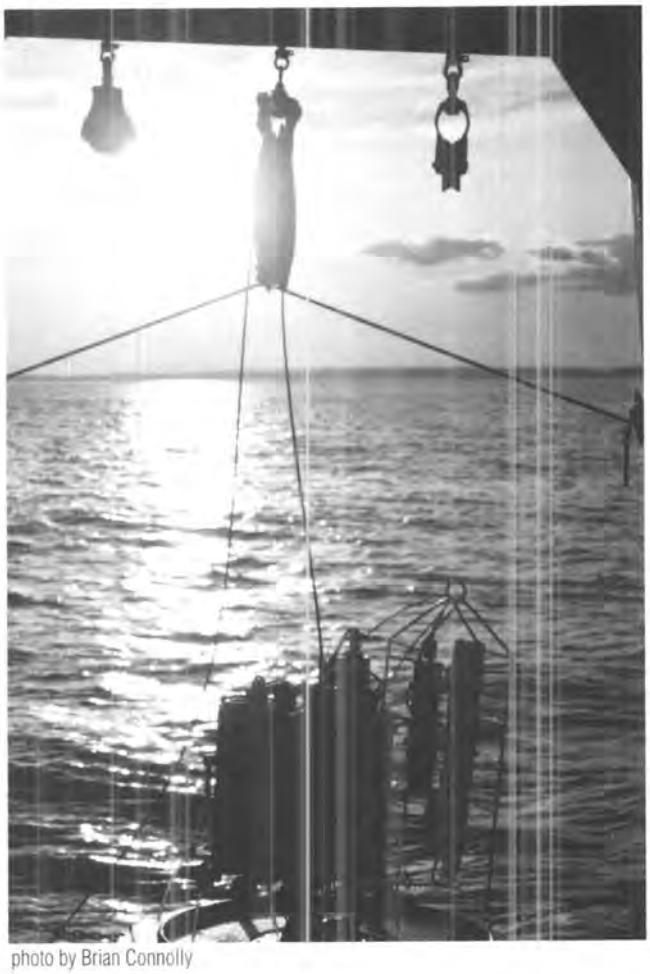


photo by Brian Connolly

▲ *Preparing the rosette sampler for a cast in the New York Bight Apex, June 1994.*

problem must build on a sound knowledge of the vertical mixing process.

The technology to measure microstructures (on the scale of a few centimeters) was originally developed for the Navy's need, but in the last decade this technology has found remarkable application in the study of deep-ocean mixing. MSRC scientists are adapting this state-of-the-art technology to study vertical mixing in estuaries.

It is worthy to note that a wealth of information already has been gathered on how vertical mixing alters the salinity and currents in estuaries. There is also considerable model expertise on how to **parameterize** the effect of vertical mixing in shallow tidal environments. For comparison, the relation between internal mixing and large-scale oceanic motion still remains little understood. Thus, the physical oceanographers are well-positioned to utilize the new information on vertical mixing to provide a complete description of the dynamic system that governs motions in estuaries.

Small-scale fronts

When estuarine waters empty onto the shelf, they form distinct narrow bands. Small-scale fronts — regions of intensified gradients of temperature, salinity and nutrients — are ubiquitous coastal features. These regions are strong convergence zones, and concentrate floating pollutants and planktonic organisms. Because coastal fronts are narrow and unstable regions, it is difficult to measure them quantitatively. Also, the mathematics that describes frontal motion is highly nonlinear, making it equally difficult to simulate them in a model. Thus, despite con-siderable past efforts in identifying gross frontal features, the nature of coastal fronts remains largely elusive.

Satellite, radar, sonar, Acoustic Doppler Current Profiler (ACDP) and towed undulating vehicle are a suite of high-technologies that have started to bring in new observations. These new instruments have drastically improved sampling resolution by orders of magnitude. Meanwhile, the next generation, massively parallel supercomputers, have drastically multiplied the present computing power also by orders of magnitude. With the new observational and computational technologies, unlimited new possibilities exist to probe the mystery of coastal fronts. MSRC physical oceanographers are applying these new technologies to study the interaction between estuaries and the inner shelf. They are also actively collaborating with the Center's biologists to study how coastal fronts control fish recruitment — an essential issue in marine resource management.

MSRC physical oceanographers have in the past made important contributions to understanding the physics of estuaries and coastal waters, always using the innovative, emerging technologies to unveil important physical processes. In future years, they will focus more on studies of vertical mixing in estuaries and the genesis of coastal fronts. They will also play an increasing role in using science to solve the ever recurrent problems facing coastal environments. The numerical ocean model, among others, is likely to play an even larger role in future resource and environmental impact management.

parameterize -
to represent processes that cannot be resolved in the model

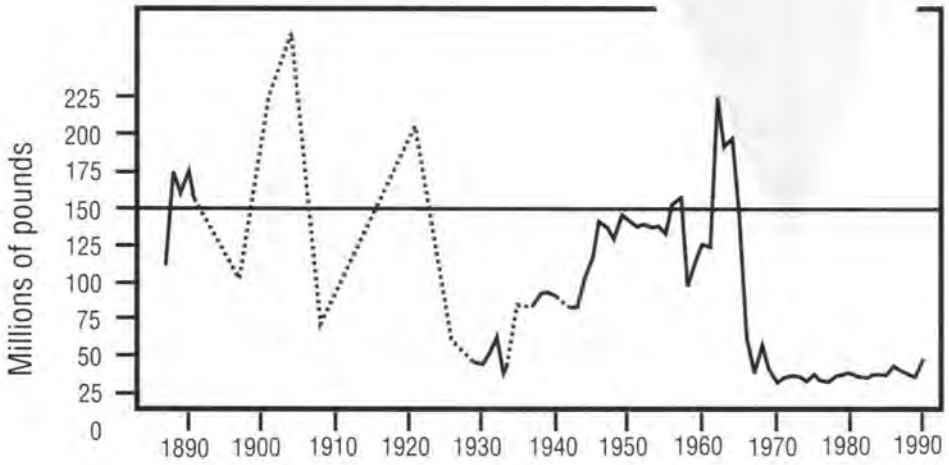
Tide Hole

West of Crane Neck
where boulders
from the bluff
fall into the sea,
waves at high tide
recede from the shore,
roil the surface
and twist the kelp
in the seawind.
Beach pebbles
catch the glow
of the winter sun,
their quartz and amethyst
holding cold fire
here where gulls
soar over their shadows
on the sand.

—Les Paldy
Distinguished
Service Professor
University at Stony Brook
from
For an okay free woman
© 1992, published by
Night Heron Press

The Institutes

Living Marine Resources Institute



Total New York landings of fish and shellfish by weight.

The decade of the 70s was a pivotal one for fishermen in New York and throughout the mid-Atlantic region. In 1976, the United States extended its jurisdiction over marine fisheries resources to 200 miles from the shore, prompting a precipitous decline in foreign fishing in these waters and a corresponding expansion of domestic offshore fisheries in the last several years of the decade.

Through the mid-1970s, New York State regularly led the nation in the production of hard clams. As a result of the banner year class of 1970 (fish born in that year), coastal stocks of striped bass were at record levels of abundance through the early and middle part of the decade. Technological advances in navigation; larger, refrigerated catch holding capacity; and fish location equipment enabled commercial fisheries and the fast-developing recreational fisheries to find and catch fish more efficiently.

Expanding fishing in a shrinking fishery

By the mid-1980s, this expansive scenario had changed greatly. The explosive growth of domestic trawl fisheries following the extension of U.S. fisheries jurisdiction to 200 miles from the coast had created an over-sized, more efficient fleet that was harvesting traditional resource species. The enlarged fleet exceeded the sustainable harvest, severely depleting stocks of many species.

In a different fishery, but one reaching a similar endpoint, other factors were at play. Hard clamming in the bays was relatively easy to do, relying on inexpensive equipment and close access to land. Today, the hard clam fishery of Long Island has become a shadow of its former self, the victim of overharvesting and poor reproductive success in such important clamming areas as Great South Bay.

Striped bass

Coastal species are easily exploited because of their proximity to land, but they are also, because of this proximity, easily affected adversely by human influences that cause changes in the coastal environment. The coastal migratory stock of striped bass had fallen to very low levels of abundance because of poor reproductive success in Chesapeake Bay, the species' main spawning area. Perhaps this was a result of coastal changes, but perhaps also made worse by overharvesting throughout its range.

The "brown tide"

In 1985 bays on eastern Long Island were first afflicted with a mysterious, devastating alga bloom, the "brown tide," which nearly wiped out the important bay scallop resource in these waters. In many areas of the coast, water quality and habitat degradation posed grave threats to the vitality of fishery resources. For fishermen, resource managers, and fishery scientists alike, the bountiful days of fisheries of the mid-1970's had become a bittersweet and fast receding memory. A sense of crisis and urgency pervaded fisheries resource management.

Some management successes

In the decade of LIMRI's existence, fisheries have experienced some reversal in fortune. While the causes of the "brown tide" remain unknown, the bay scallop has made a limited comeback in Long Island's eastern bays, a reflection of the subsidence of the "brown tide" and the combined effects of juvenile scallop transplant programs and reproduction of rem-nant wild populations east of Shelter Island.

Stringent limits on the harvest of striped bass, first imposed in 1986, have begun to restore this species to its former abundance. Under the joint auspices of the Mid-Atlantic Fishery Management Council and the Atlantic States Marine Fisheries Commission, management of these multi-jurisdictional fishery resource species important to New York has become regionalized and better founded in scientific information. Coastal water quality in many parts of the region also has

RESTORATION OF BAY SCALLOP AND STRIPED BASS

improved since the mid-1980s, particularly in those areas that have historically been most degraded.

Remaining problems

The above notwithstanding, serious and ominous problems remain. Offshore trawl and other commercial fisheries remain capable of harvesting well beyond what the target species can sustain. Fishermen are facing severe economic hardships as management plans aimed at rebuilding depleted stocks force boats to remain at the dock. Marine recreational fisheries, too, are increasingly under catch restrictions, producing economic hardship in the many service and support industries associated with angling.

The hard clam fishery, once Long Island's premier commercial fishery, collapsed in the late 1970s and has not rebounded appreciably since that time, despite the best efforts of managers and scientists. The fishery presently supports less than 20 percent of the number of commercial clammers in the 1970s.

Aquaculture, hailed a decade ago as a "growth industry," has not grown in New York, and in that time, the number of firms growing marine species has actually declined. We still have only the most rudimentary understanding of the dependency of fishery resources on specific coastal and estuarine habitats and how changes in those habitats affect their functionality.

Research to protect the resource

Concerned with the future of New York's fishery resources, in 1985 the State Legislature established LIMRI, the Living Marine Resources Institute, within MSRC to enhance the Center's expertise and capabilities in fisheries and aquaculture and to apply these capabilities more directly to priority fishery issues.

From its inception, LIMRI has developed a balanced program of fundamental and applied research. This research has focused on several key areas: interaction of the biology of finfish during early life history stages (larval and post-larval) with physical transport (currents and eddies) in the nearshore waters of the mid-Atlantic coast; causes, nature, and effects of noxious marine algal blooms (especially the "brown tide"); the population biology of commercial shellfish species (*Mercenaria mercenaria, Spisula solidissima, Mya arenaria*); environmental factors affecting shellfish resource productivity; determinants of larval recruitment success in commercial finfish and crustaceans (lobsters and crabs); catastrophic mortalities of young cultured oysters; and effects of coastal development on nearshore fishery habitat. More detailed accounts of these research programs can be found on pages 25-27.

Participants in better management

The region's fisheries are complex and multifaceted; so too are the issues that confront and confound them. Improved scientific and technical understanding are clearly required to resolve many of these problems satisfactorily, yet more and better information alone is often not sufficient. The overriding challenge is to identify those issues and problems where LIMRI can make a difference and to target the limited resources available to these priority tasks.

LIMRI scientists and staff are active participants in the interactive management process that governs the region's fisheries, sitting on a wide variety of boards, councils, committees, and commissions that deal with the condition of fishery resources and the habitats they occupy and rely upon. Through the office of the LIMRI Director, the Institute works directly with regional and state fishery managers, and the State Legislature, to forge strategies and policies that

Recreational fishermen at Shinnecock Inlet. ▼

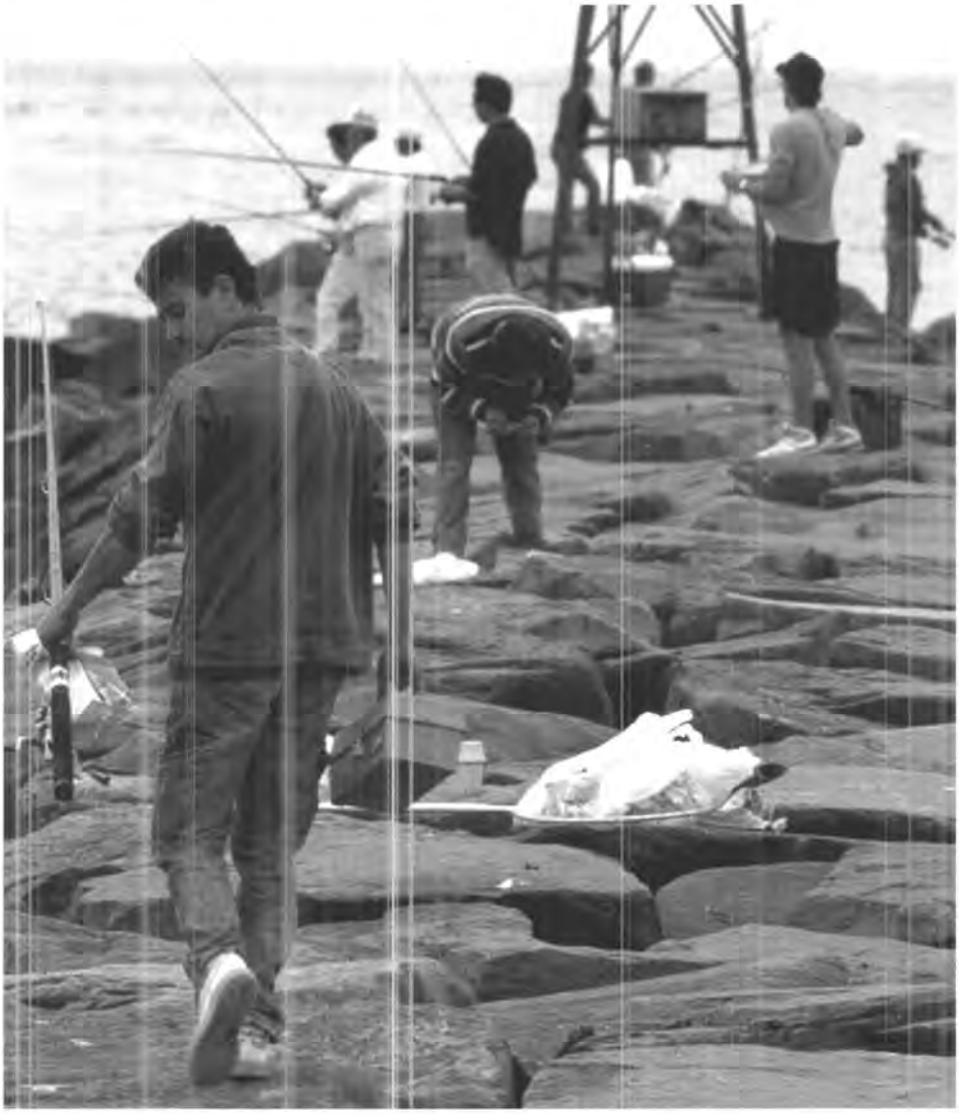


photo by Ian Stupakoff

benefit from the best available resource-based scientific information and that respond as well to socio-economic considerations, part and parcel of present-day fishery and environmental management.

Supporting research facilities

Along with its research and policy activities, LIMRI's mission includes the development of MSRC's scientific infrastructure, particularly that fraction dedicated or applicable to studies in fisheries and aquaculture. LIMRI has purchased diverse scientific equipment for use in various investigator's labs and research, including a sophisticated computer-based image analysis system, state-of-the-art fisheries research trawl and other nets, and components for the precise sectioning and microscopic examination of mollusk shells to aid in shellfish growth studies.

A key resource for MSRC's fisheries and aquaculture studies is the Flax Pond Marine Laboratory, which has undergone a number of LIMRI-sponsored improvements to its scientific facilities and equipment in the past decade. Through LIMRI, the Center has recently received a large facilities improvement grant for the laboratory from the National Science Foundation. These funds are being used to renovate and improve the lab's seawater supply system.

A decade of progress

Over the past decade, LIMRI has emerged as a leader in the involvement of the MSRC with key environmental issues affecting Long Island and the region. The Institute's research on the brown tide, its continuing interaction with organizations attempting to revive a depressed inshore shellfishery, the close working relationship that has been established with fishery managers and the fishery management process—these are the hallmarks of a program that effectively bridges the gap between the University and the community of which it is a part. Across this bridge, information and ideas have flowed — and will continue to flow — that help sustain the region's fishery resources and the economically important activities these resources support.

They Corresponded

So Beulah of Brooklyn sent a gram
To this dry land
Surrounded by waters
Where hoarse black crows
Still try to sing

Tell me
She asked
Whats with the land the waters the pizza
Whats the Pizzazz
Answer Stella of StonyBrook

Stella read and cried:
Dear Beulah old friend
The land is arid after hot summer
Scraggly trees still called Pine in their barrens
Dip and fall in sunless grottos
Vultures with hand tools scream:
"Down with the trees
Up with the malls"
Oh the malls
No Parthenons
Worse at completion
Than Acropolis after
Millennia of wind and rain
Oh their malls
Profane towers of too much
Organized boxes shelves and hangers
In crypts secure
Rags and leathers
To clothe overfed forms
Who run impatient to fast food feasts
Swallow in haste
Pizza brocolleria mozzarellia
Discs of joy
Its lunch
Its supper

Let me tell you Beulah of Brooklyn
Fish left in our waters
Swim insulted
At whats left to drink
Fishermen used to muse angle and pull
Sang with the pleasures of challenging waters
Returned home with uncomplaining captives
Cooked and fried
Our big daddies the heroes
Fish gone from shores of sludge
Pleasure boat oils
From unloved waters
Resigned to the triumphs of pizza
Oh Beulah the island has changed

My tears fill
Its creased sorry face

The indoor cynic
The south fork artist
Pompously explains:
Nothing is its own beauty
Then goes on to splatter paint
On new pseudo terrain his fat canvas
Mans imagination
Labeled and priced
Transformed
From dunes given free
That still faintly survive
In sun drenched fancy

Oh Beulah
That is life
Its not all bad and tears
Each September
When the sun
Has baked its fill of our helpless shore
Our Museum in red barn architecture
Near lawns of chemo nourishment
Now allowed to rest
We gather fiddlers
Rejects of Carnegie
Mostly with roots in Killarney or Burgundy
We jump in reveries of other worlds
Sip wines of other places
Greet autumn
Bid the fish
Have faith
Return

Beulah our mosques of
Too much merchandise
Will fall
There's a new generation here
Content to wear jeans in patches
Pizza will turn to manna
Commandments will sing
From the dunes of Wildwood

Thanks for your gram old pal
Stella of StonyBrook

—Marsha Furman Siegel
2nd Place Winner
MSRC-Taproot
Poetry Contest, 1993

Waste Management Institute

The Waste Management Institute (WMI) was created by the New York State Legislature in 1985 to confront the increasingly complex waste issues arising on Long Island, where per capita waste generation exceeds that in the rest of the U.S. Long Island is also a place where future landfills have been prohibited to protect the Island's drinking water, which is soley derived from an aquifer.

WMI's goal is to reduce the impact of waste generation on society through a program of research, assessment, education, and policy analysis. To realize this goal, efforts have been aimed at reducing the amount of waste generated through the promotion of waste prevention strategies, educational programs, and the development of creative uses for waste materials.

RESEARCH, ASSESSMENT, POLICY ANALYSIS

Continuing research programs

The Institute has grown considerably since its inception. A director was appointed in 1987, and WMI has since expanded to encompass a faculty of 11, plus an adjunct faculty of 10 and support staff.

WMI faculty currently maintain five research laboratories at MSRC. An Advisory Board, comprised of experts from government, environmental organizations, and private industry, was formed in 1992 so that the Institute might benefit from the expertise of others in the fields of waste management and public policy.

Research activities have spanned a wide range of waste issues. Examples include an assessment of the flow of municipal solid waste on Long Island; an investigation of rates of decomposition of degradable plastics in a variety of environments; an assessment of the use of municipal solid waste (MSW) compost as a soil amendment in the commercial production of sod; examinations of toxic substances in the marine food web; evaluations of transport mechanisms and economic consequences of marine debris in New York State coastal waters; a study of the possible relationship between ocean dumping of sewage sludge and shell disease in deep-sea red crabs; and the development of secondary materials, such as recycled plastic lumber and construction material made from MSW combustor ash and concrete.

Some of these secondary materials have already been successfully tested in a variety of experimental applications. For example, ash left after burning municipal solid waste has been tested as a substitute for aggregate. The ash is stabilized by mixing it with cement, and the mix is used in the fabrication of construction-grade blocks and other concrete forms.

The ash-cement blocks were used to build a boathouse in 1990 on the University campus, the first such project in the United States. WMI, with the State Department of Health, has recently finished internal air quality and surrounding soil chemistry tests, and the building blocks have been given a clean bill of health. Other demonstration projects were completed to assess the utilization of MSW combustor ash in highway paving and shoreline revetment applications.

Education and public outreach

WMI has been continually committed to developing educational programs. In collaboration with the School of Continuing Education, WMI developed the Waste Management Graduate Certificate Program, an 18-credit graduate level course of study designed to prepare students for careers in waste management. Beginning with the first class of graduates in 1991, 37 students have completed the certificate program. In 1993, 10 students completed the program, 31 new students were enrolled, and the program was expanded to offer students the option to earn a Master of Professional Studies degree with a concentration in Waste Management.

Public outreach has been an integral component of WMI's mission throughout its history. In cooperation with the State University of New York College of Environmental Science and Forestry and the New York Center for Hazardous Waste Management at the University at Buffalo, WMI has recently celebrated the fifth year of publication of the *Waste Management Research Report*, an informative journal published three times yearly which focuses on a specific environmental or waste management problem with each new issue.

Waste Management Institute faculty and staff are continually called upon to make presentations to various community groups, classrooms, and clubs on myriad environmental issues. WMI's special public outreach endeavors have been a feature of community Earth Day activities throughout the years.

Currently, WMI is broadening its public education efforts in an attack on

the persistent problem of beach debris. The Institute produced a video designed for grade school children to teach them how floatable debris gets on beaches and what can be done to prevent it. And a poster was developed for display on public beaches to help educate the general public on this topic.

Waste management on the policy front

WMI has organized and hosted a variety of conferences designed to bring together professionals to discuss and solve difficult waste management problems. Some topics addressed at these conferences included floatable debris in the ocean, ocean dumping, and medical wastes. In 1994, WMI hosted a symposium to draw together State and local leaders from across Long Island to aid in the development of an integrated waste management plan for the entire Island. This effort follows the completion of a comprehensive analysis of the environmental and societal impacts associated with the Suffolk County Plastics Law, which bans the use of certain plastic polymers in retail food applications.

photo by Leslie Adler

◀ *High volume air sampler set up to measure compounds such as PCBs, PAHs, and chlorinated pesticides.*

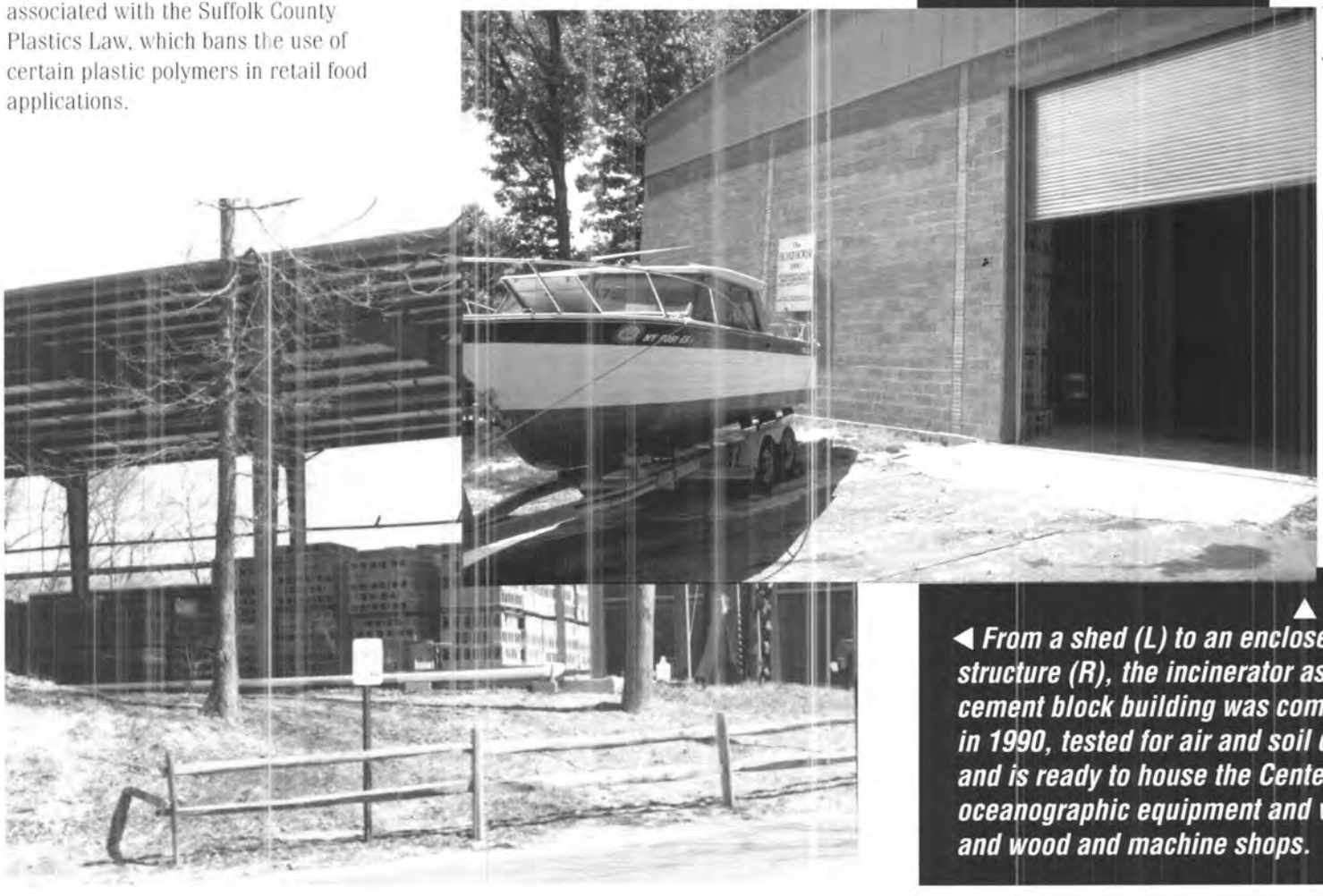


photo by Lori Palmer

◀ *From a shed (L) to an enclosed structure (R), the incinerator ash-cement block building was complet in 1990, tested for air and soil qual and is ready to house the Center's oceanographic equipment and vess and wood and machine shops.*

MSRC HIGHLIGHTS

Expanding roles for the future

Additions of two new faculty in the past year have expanded WMI's base of expertise, enhancing the Institute's capabilities in marine pollution and secondary materials development research. WMI has also embarked on a program to extend activities beyond the shores of Long Island to address waste management and pollution issues around the world.

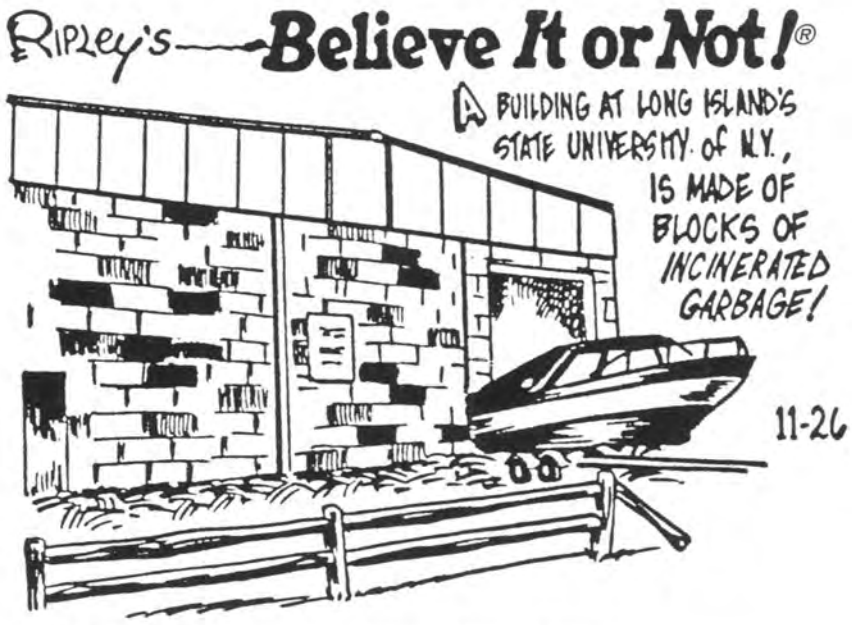
WMI has recently initiated research projects in sediment contamination in Lake Ontario, bioaccumulation of metals in bivalves from San Francisco Bay, and studies on the effects of radioactive wastes in the Arctic waters of Russia. Institute personnel have also begun a collaboration with researchers of Politecnico di Bari in Apulia, Italy to foster an international exchange of ideas and expertise on waste management and pollution issues. Two post-doctoral fellows from Italy are currently here as a part of this program.

From Incinerator Ash to Building Blocks

Secondary products are the progeny of recycling. They are the useful items that are fabricated from treated and reformed waste—park benches from plastic soda bottles, street pavement from old tires, and paper trays from newspapers.

In the ultimate reconstruction, sturdy building blocks virtually have arisen from the ashes—the ashes from burning municipal solid waste. While loose ash, when tested, can show levels of metals, such as cadmium and lead, that warrant careful and often expensive disposal, ash that is stabilized by combining it with cement can be used to fabricate safe, durable concrete building blocks and in poured structural forms.

The Waste Management Institute has been researching the structural and chemical integrity of stabilized ash-cement blocks in a building constructed on the south campus in 1990. Air quality and soil tests were completed in December 1993, and the building blocks have been judged environmentally safe and sound.

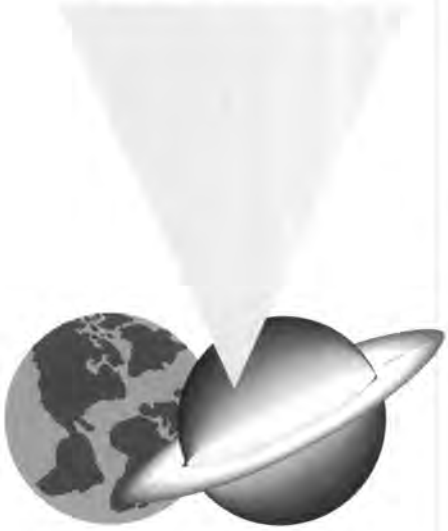


◀ "Ripley's Believe It or Not" cartoon syndicated in newspapers nationwide in 1991.

Institute for Terrestrial and Planetary Atmospheres

Human activities are altering the chemical composition of the Earth's atmosphere, most critically resulting in increased carbon dioxide and chlorfluorocarbons (CFCs). These modifications can rapidly (on time scales of decades) cause environmental changes that normally would only occur over several thousands of years. Activities such as fossil fuel burning and deforestation are largely responsible for increased atmospheric carbon dioxide (CO_2), causing global warming. Industrial activities are largely responsible for emissions of CFCs, which lead to ozone depletion and, consequently, greater solar ultraviolet radiation reaching the biosphere.

The speed and scope of these changes makes it imperative to obtain a better understanding of their effects so that those making policy decisions can make the most informed decisions. Research into such global atmospheric problems is the principal emphasis in the Institute for Terrestrial and Planetary Atmospheres (ITPA). But ITPA faculty also carry out much basic chemical and physical research on the Earth's atmosphere, as well as the atmospheres of the other planets of our solar system.



History of atmospheric sciences at Stony Brook

In 1975 the Laboratory for Planetary Atmospheres was established within the College of Engineering and Applied Sciences at Stony Brook. Its creation reflected the fact that several College faculty members had developed active research programs in this area. In 1988 the Institute for Terrestrial and Planetary Atmospheres was established within the University, reflecting the fact that faculty in several departments in different colleges had active research and graduate education programs in the atmospheric sciences. The Institute's creation facilitated interactions in this area, led to the addition of atmospheric science faculty at Stony Brook, and increased the external visibility of the University's efforts in the atmospheric sciences.

In 1992 the Institute relocated to MSRC, and the faculty had their appointments shifted to MSRC. This move reflected the University's realization that many aspects of the Earth's atmosphere and oceans must be considered in an integrated manner and that the ITPA's emphasis upon global atmospheric issues is an excellent complement to MSRC's emphasis on coastal issues.

Current research emphasis

Clouds and climate

There is no question that the addition of carbon dioxide to the Earth's atmosphere will increase the radiative forcing of the lower atmosphere. What the effect of this additional radiation on the climate will be, however, depends on how the Earth's land-ocean-atmosphere

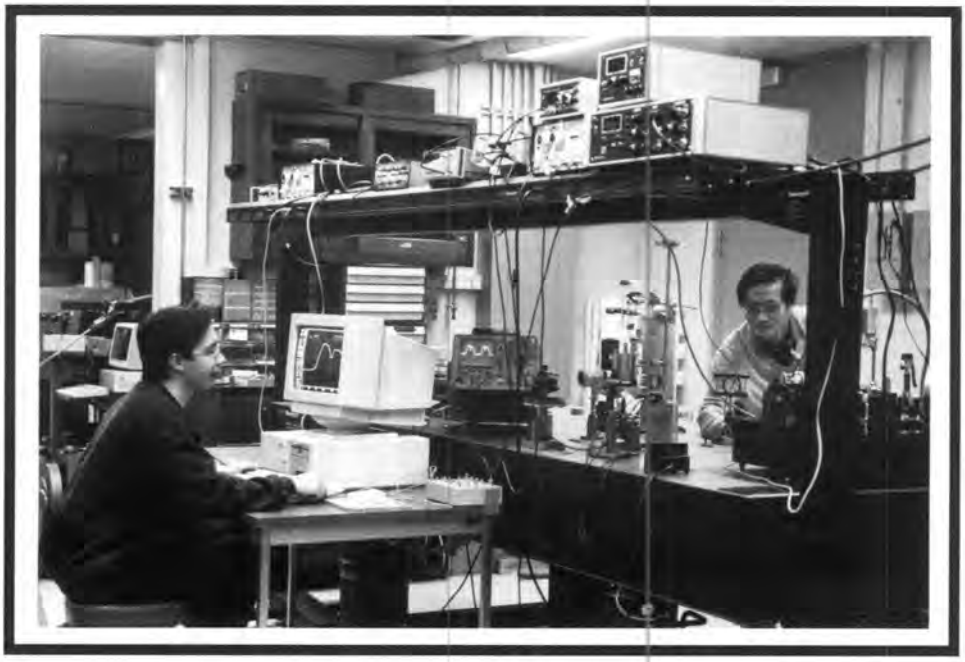


photo by Lori Palmer

One of the world's leading infrared spectroscopy laboratories, sited at MSRC, is used to analyze planetary atmospheric gases. ▶

system responds. Will changes in the system occur to counterbalance these radiation effects? How will the polar ice caps change? Will there be changes in the vegetative cover on land and in the cloud cover that lead to altered planetary reflectivity? Will the ocean's currents vary?

One of the factors that has emerged as a leading source of uncertainty in predicting future climate is the effect of clouds. Research conducted at the ITPA in this area is some of the most significant in the world. ITPA faculty have led international comparisons of climate models, and have demonstrated that the greatest difference among the various models is in their treatment of cloud-radiation processes. These researchers are examining Earth radiation satellite data to better understand the radiative effects of clouds and are using numerical general circulation models to understand the modeling of these effects.

Infrared spectroscopy

The ITPA has one of the world's leading infrared spectroscopy laboratories. In this laboratory, measurements are taken to experimentally determine the spectroscopic parameters of gases that are found in the atmospheres of Earth and other planets. This information is needed to calculate the radiative heating and cooling rates in planetary atmospheres, for example, the climate calculations referred to above, and to properly interpret satellite measurements of the atmospheres of Earth and the other planets.

Climate Variability

The Earth's climate shows a great deal of natural variability as a consequence of such factors as sporadic volcanic eruptions, atmosphere-ocean variability such as El Niño, and the chaotic variability of the atmosphere. ITPA scientists are engaged in studying atmospheric data, as well as numerical general circulation models, to characterize and understand the nature of this variability.

Understanding natural climate variability is important for several reasons. For one, it can cause great economic losses as well as loss of human life, such as has been the case in recent hurricanes and flooding events. Accurate prediction of these events would help in mitigating losses. Second, we will be able to identify anthropogenic effects on climate more readily if we understand natural variations in the climate record.

Stratospheric ozone

In recent years, there has been a great deal of research on the effects of increased emissions of industrial chlorofluorocarbons (CFCs) on stratospheric ozone. An ITPA faculty member was the first to observe and identify increased stratospheric concentrations of chlorine monoxide (resulting from the CFCs) as the cause of the Antarctic ozone hole. Another ITPA faculty member is using current satellite observations together with numerical models to better understand the processes that control ozone variations in the stratosphere.

Planetary atmospheres

The other planetary atmospheres in our solar system are very different physically and chemically than Earth's atmosphere. For instance, the atmosphere of Mars is much thinner than Earth's, while the atmosphere of Venus is much thicker than that of the Earth's. The giant planets, Jupiter, Saturn, and Neptune, exist under conditions with much less sunlight than does Earth because of their farther distance from the Sun. ITPA scientists study these planetary atmospheres, using spectroscopic parameters for the gases, and they study conditions that exist in planetary upper atmospheres by analyzing satellite data and constructing theoretical models.

The future

Society will be making very important environmental decisions in these next few decades. A chlorofluorocarbon or carbon dioxide molecule released into the atmosphere has the same environmental effect regardless of its country of origin. Therefore, many of these decisions will not be for individual states or even countries to make but will have to be made by the international community.

Making these environmental decisions will not be easy. Often, certain economic dislocations will need to be weighed against uncertain environmental benefits. ITPA scientists and others are conducting research that is aimed at establishing the uncertainties in predictions of future atmospheric effects and aimed at diminishing the uncertainties of these predictions.

radiative forcing - net radiation of heat into the lower atmosphere

These problems will not be disappearing soon. The concern about greenhouse

warming, for example, is likely to be around for a very long time. Although international action has led to world-wide agreement to phase out the CFCs that attack stratospheric ozone, it remains to be seen if the ozone responds in the manner predicted. And there is a new concern about the atmospheric effects of present and future commercial aircraft operations. The ITPA faculty plans to carry out research on these topics and to continue basic research on the atmospheres of the Earth and the other planets in an effort to better understand atmospheric processes.

Pt. Adolphis, *(Alaska)*
Leslie Adler
Winner — Best in Category
MSRC's Juried
Photography Exhibit,
"Environmental Exposures"
▼

The COAST Institute

The Coastal Ocean Action Strategies (COAST) Institute was created in 1989 to assist in coastal zone management and coastal marine policy analysis. It does this by working with policy makers and environmental managers in identifying and analyzing strategies that will conserve and, when necessary, rehabilitate the coastal ocean; by ensuring that not only is the best technical information included in developing the strategies, but economic and other critical information as well; and by forming effective linkages among environmental groups, the scientific community, lawmakers, regulators, and managers to tackle coastal environmental issues.

COAST has been called upon to assist in resolving coastal problems at home on Long Island, throughout the U.S. and in many parts of the world. For example, it was asked to facilitate the search for solutions to environmental threats or degradation in the San Francisco Bay delta estuary; the Florida Keys National Marine Sanctuary; Mamala Bay, Hawaii; New York-New Jersey Harbor; and in strategic planning for Ben-Gurion University of the Negev.

COAST also provides a real-world, action learning laboratory for graduate students at MSRC. Each year students who are interested in coastal management and policy take part in gathering and analyzing data, in transforming data into information, and in synthesizing information—all targeted at identifying and evaluating management alternatives to attack the problems that COAST is helping to solve.

Scenario planning for Long Island's coast

During the summer of 1993, COAST co-sponsored a large gathering of environmentalists, scientists, engineers, agency heads, and citizens of Long Island to explore future scenarios for Long Island's coastline and coastal environments. The meeting was organized in response to several large storms of the previous winter that caused severe flooding and erosion, including a breach in the barrier island system along Long Island's south shore.

The Coastal Conference was designed to explore what kinds of coastline and coastal environments Long Islanders want for Long Island in the future, and to evaluate a variety of different management strategies to see which are compatible with that vision. The vehicle used for these explorations was scenario planning. Unlike forecasts, scenarios describe different worlds, not just different outcomes in the same world. Four scenario themes were presented to the participants, who were divided, by lottery, into four theme groups. The themes were: "Mother Nature Knows Best;" "People and Nature: A Partnership in Sustainable Development;" "We Have Not Yet Begun to Fight;" and "Between a Rock and a Hard Place." Each group's task was to develop a rich description of Long Island's coastline and coastal environments that might be realized in 2020 if the story line was constrained by the strictest application of strategies consistent with that group's assigned theme.

At the end of many discussions and much debate, a concensus emerged that the vision most Long Islanders have for their coastline and their coastal environments in 2020 is consistent only with a strategy that includes working with Mother Nature, but not letting her have her own way in all instances. For example, participants concluded that maintaining the integrity of the barrier island system was consistent with their vision for Long Island's coastline in 2020. This meant that closing breaches immediately after they were cut, not only saved money but the environment of the bay behind the barrier beach, as well as protecting homes and businesses along the south shore of the mainland of Long Island from flooding.

MOTHER NATURE KNOWS BEST

PEOPLE AND NATURE IN PARTNERSHIP

WE HAVE NOT YET BEGUN TO FIGHT

BETWEEN A ROCK AND A HARD PLACE

photo by Lori Palmer

Coastal Summit

Leaders in the fields of coastal marine science and management, and global change came together in December 1993 in a "Coastal Summit." The Summit, held in celebration of MSRC's 25th Anniversary, focused attention on identifying major existing and potential threats to the coastal ocean, and on developing strategies to eliminate those threats. The topic was chosen because of MSRC's leadership in using science to develop strategies to allow humans to live in greater harmony with their environment. It was also chosen because of the growing threats to critical coastal ecosystems — more people than ever living near the coast, more reports of coastal degradation, and more developing countries unable to cope with these growing environmental stresses.

The scientists identified the major threats, both existing and looming in the future, to be nutrient pollution, chemical contamination, fresh water diversion, habitat destruction, overfishing, and microbial contamination. A number of promising management strategies were identified and explored. These included tackling the most serious and irreversible threats first; organizing research efforts and management decisions on an integrated coastal management basis; taking full advantage of existing scientific knowledge and technology; using new monitoring technologies that can be employed in many places and under adverse conditions; and encouraging linkages among university scientists, engineers, government scientists and administrators, environmental managers and non-governmental organizations.

IDEAL

Interactive Decision and Environmental Analysis Laboratory

During the Coastal Summit, conflicting positions and priorities were explored, sorted and ranked using MSRC's Interactive Decision and Environmental Analysis Laboratory (IDEAL) for the first time. IDEAL, also known as the "environmental war room" was inspired by military situation rooms and a few similar facilities scattered around the United States. IDEAL is the first computer-assisted group problem-solving facility that focuses on the coastal ocean.

IDEAL consists of a bank of computers with software adapted for coastal applications. The system allows the

simultaneous and anonymous input by up to 11 participants. All the computers are networked so that individual input can be aggregated, sorted, graphed, and displayed in an organized manner. Use of this technology has greatly facilitated group performance and improved the quality of analysis of environment problems.

Adapted to fit the role of COAST, IDEAL is being used by a host of management and policy decision makers for an array of contentious topics. Before IDEAL was inaugurated, many of these meetings were less than successful, due in part to the difficulty of resolving complex environmental problems for which decisions rest with groups of diverse stakeholders with well known and opposing positions — positions from which public retreat is difficult without losing face. MSRC now has a new portable version of IDEAL that utilizes laptop computers.

◀ (L) at MSRC's Coastal Summit in December 1993, summiteers broke into different teams. Here, one team works out a strategy for a coastal problem.

Interactive Decision-Making Laboratory Inaugurated

In December 1993 MSRC inaugurated the first computer-assisted marine environmental problem-solving facility in the United Sates — IDEAL (Interactive Decision and Environmental Analysis Laboratory).

IDEAL consists of a bank of networked computers with group problem-solving software adapted for coastal marine science applications and linked through a server that can aggregate, sort, graph, and display information and data in a number of ways. Users are able to input information simultaneously and anonymously.

With IDEAL, all participants compete on an equal basis. Titles, posturing, and personality traits are irrelevant. Ideas stand and fall on their merits as perceived by the participants. MSRC has recently developed a portable version of IDEAL—15 laptop computers and a portable server—and in May 1994, gave it a first test run at a workshop on contaminated sediments in New York-New Jersey Harbor.

photo by Leslie Adler

Institute for Urban Ports & Harbors

The creation of the Institute for Urban Ports and Harbors in 1988 signaled MSRC's continuing commitment to new approaches to balance conflicting demands in New York Harbor. For more than two decades, MSRC has served a significant role helping to develop strategies to confront a variety of environmental issues in this harbor, as well as other urban ports and harbors around the world.

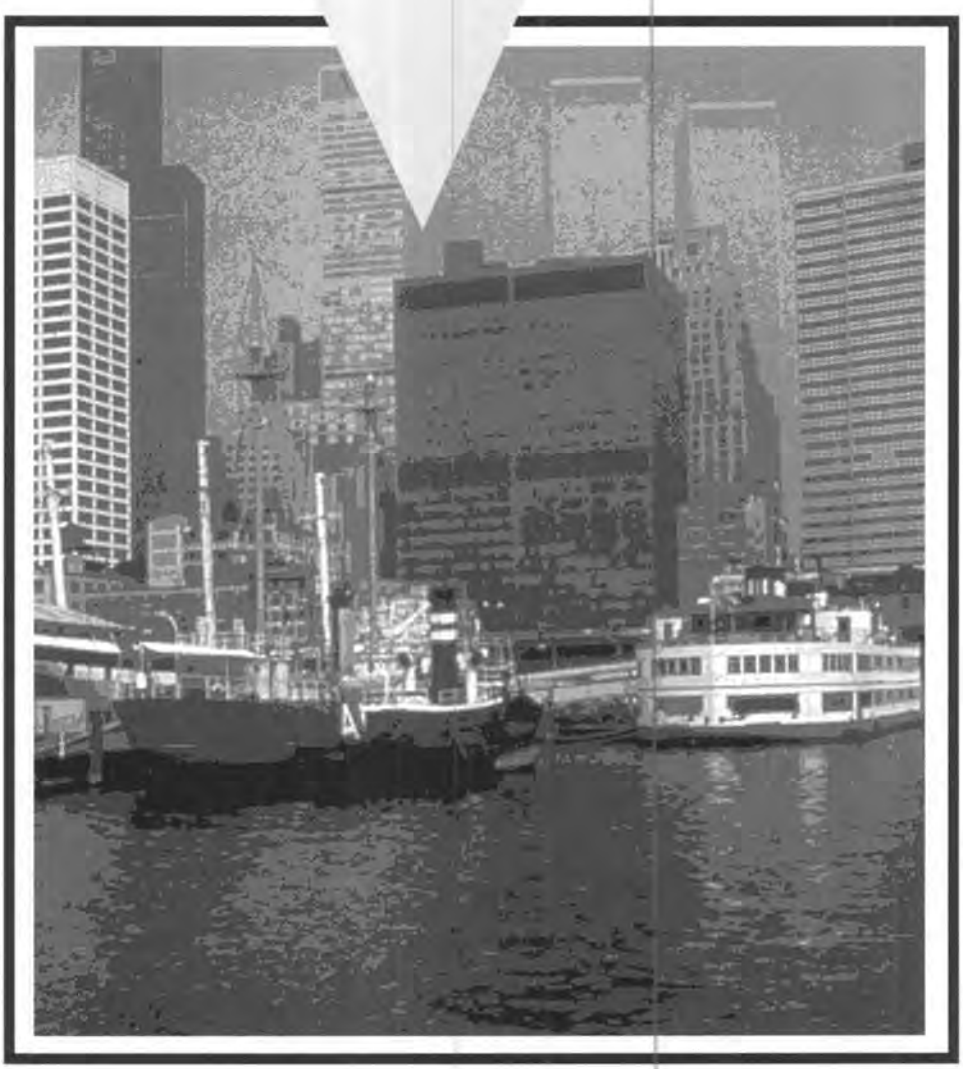
Over the years, MSRC scientists have conducted many research and advisory projects surrounding the New York-New Jersey Harbor from developing a dredging and dredged materials management plan, to assessing the environmental effects of different strategies of sand mining in the lower bay of the harbor, advising about the environmental effects of creating artificial islands in different areas of the harbor, deepening the principal navigation channels, and developing certain areas of the waterfront.

One of the most comprehensive studies ever done of harbor fish populations was completed by MSRC researchers. Summarizing the nutrient distribution in the lower Hudson estuary and in the harbor, researchers estimated the nutrient flux through the mouth of the harbor using a variety of methods.

In other projects, MSRC scientists have studied the potential effects of sea level rise on the infrastructure of New York City and collaborated to investigate the transport and fate of fish and shellfish larvae in the lower bay. MSRC's physical oceanographers have investigated the two-layered flow in the East River to estimate the net flow through the East River. They also have studied the circulation in the harbor using the latest advances in current measuring devices—the acoustic doppler current profiler —to help explain the shoaling of navigation channels and trapping particle-bound contaminants in the harbor.

Under current investigation is a new approach to an old problem — poor flushing of western Long Island Sound, which contributes to **eutrophication** and summer hypoxia. This approach makes use of tide gates across the East River, so that incoming tides cannot move nutrient-rich East River water up into the western Sound, but on outgoing tides, water is allowed to pass freely out of the Sound, through the river and harbor, and out to sea.

Other MSRC scientists assisted in the development of special monitoring plans for water quality in the harbor to understand the causes and effects of the low dissolved oxygen problem in western Long Island Sound.



Harbor video premiere

The Institute created an educational video on the harbor for the U.S. Environmental Protection Agency's (EPA) New York-New Jersey Harbor Estuary Program. The video, "Alive in an Urban Harbor," had its premiere on public television in 1992.

APPROACHES TO BALANCING NFLICTING VALUES AND USES

eutrophication-
over-enrichment of nutrients, resulting in a boost in algal growth

Facilities / Human Resources

Instrumentation

The constraints of the marine environment and the logistical difficulties involved in maintaining a human presence at sea have always forced oceanographers to turn to specialized instrumentation to collect data. In the 25 years since the founding of MSRC, the microelectronics revolution has had an impact on field oceanography that can hardly be overstated. In response, MSRC's Ocean Instrument Laboratory has been at the leading edge of instrumentation design, to provide new and better tools for researchers at MSRC and elsewhere.

Much of the equipment used in oceanography must be autonomous — able to record data without human intervention for long periods. Twenty-five years ago this meant that data were recorded on paper strip charts, punched paper tapes, photographic film, and the occasional magnetic tape drive. These recorders were slow, expensive, and often unreliable. Retrieving the data and entering it into computers required expensive, dedicated reading machines and human intervention.

Today, mechanical data recorders have been replaced by low power microprocessors. Inexpensive dedicated computer boards no larger than index cards can perform not just recording but sophisticated control and processing functions. Using this technology, the Ocean Instrument Laboratory has developed dozens of models of specialized scientific apparatus, including a deep ocean sediment-water interface sampler, deployed at 5000 meters depth by the manned submersible *Alvin*; a dissolved oxygen monitoring system that uses patented new technology to give reliable long term readings in exceptionally harsh environments; and a device for helping test the potential toxicity of incinerator ash by precisely controlling the acidity of water leaching through an ash sample.

Current instrument development projects at the Ocean Instrument Laboratory include an advanced salinity-temperature-depth (STD) profiler, and a low cost remotely operated vehicle (ROV). The STD will yield improved data quality compared to current technology through real time correction of data artifacts caused by differences in response time between temperature and conductivity sensors. The ROV is an engineering test bed for the concept of a low cost "data ROV," a vehicle designed from the ground up as a mobile data acquisition system, as opposed to a simpler "swimming eyeball."

LEADING EDGE OF INSTRUMENTATION DESIGN

Twenty-five years ago, computers were large and land-bound. Recording data on a ship meant writing them into a notebook (or perhaps taking a portable card punch along as an alternative to transcribing notebook data onto computer cards later). The advent of microcomputers in the early 1980s changed all that. In 1983, the Ocean Instrument Laboratory built one of the first portable data logging microcomputer systems used in oceanography. Specialized hardware interfaces and custom software developed at MSRC allowed this computer to control shipboard instruments and record their data automatically. Processed data could be displayed in real time. After a cruise, the same machine could transfer data directly to larger land-based computers.

Refinements of the past decade

Through the 1980s and into the 1990s, the Ocean Instrument Laboratory has advanced the concept of shipboard microcomputers through several generations of development. Personal computers are now used as the basis of an integrated shipboard data acquisition system customized for every different researcher. Typically, several PCs are used, each assigned to a group of instruments (for example, current profiling, salinity-temperature-depth recorder, or navigation). Data are exchanged between the PCs as needed, graphed and mapped on high resolution color displays, and sent to "offline" computers for further analysis. With this equipment, scientists can collect hundreds of times the volume of data than was possible just a few years ago and analyze it with shipboard microcomputers far more powerful than yesterday's land-bound mainframes. Researchers can easily do "quick look" preliminary analyses during a cruise. Armed with this information, sampling strategies can be adapted to refocus sampling efforts on phenomena of greatest interest.

Facilities & Equipment

Shipboard data acquisition

Technology developed at the Ocean Instrument Laboratory for shipboard data acquisition systems has recently come back to shore to fill a need for sophisticated real time data acquisition and control systems in laboratory settings. ISORES (Intermittent Sediment/Oxygen Resuspension System) is a device developed to aid in research on bacterial breakdown of hydrocarbons, such as spilled oil, in marine and freshwater sediments. ISORES can conduct experiments simultaneously on up to fifteen sealed sediment/water microcosms, controlling oxygen levels and resuspension activity, measuring oxygen demand, and physically sampling the overlying water. The Flax Pond Laboratory seawater control system (SCS) delivers controlled temperature seawater throughout the MSRC facility as well as monitoring critical building functions 24 hours per day. In the event of a mechanical or power failure at the laboratory, the SCS will actually telephone or page the technician on call and deliver a message describing the exact problem and its severity.

ACDP technology

Although moored current meters are still a mainstay of field oceanography, the acoustic Doppler current profiler (ADCP) is a most exciting development in the measurement of water currents.

OUR STORY 25 YEARS

Three Generations of Research Vessels

The earliest mention of a research vessel at MSRC is of the R/V *FRUMP* in a 1968 untitled progress report. That year, the Center acquired its second research vessel, the R/V *MICMAC*, a 40' Nova Scotia lobster boat with a wooden hull and a gasoline engine. By late 1973, planning was well underway to develop a successor to *MICMAC*.

Built and equipped exclusively for coastal oceanographic research, the all-steel, 55-foot vessel was put into service in April 1975, and christened R/V *ONRUST* which is Dutch for "restless."

In 1987 hydraulics were added to the stern gantry to easily and safely deploy and retrieve large pieces of sampling equipment, and in 1990 the boat was lengthened by five feet to add additional working area to the aft work deck.

During the vessel's nearly 20 years of service, most cruises were generally 1 to 2 days long. However, to prepare for cruises of the future involving longer time at sea, multiple pieces of major sampling equipment, and increased use of on-board electronic data acquisition and analysis instrumentation, plans are underway to replace *ONRUST* with a 21st Century coastal oceanographic research vessel, anticipated to be ready by Spring 1996.

Mounted in a boat or moored at the surface or bottom, the ADCP uses reflected sound to measure water speed and direction in a continuous profile from surface to bottom. The Ocean Instrument Laboratory has been in the vanguard in adapting this leading edge technology for use on coastal research vessels, including a semi-permanent mounting developed for the R/V *ONRUST* and a catamaran mounting that allows easy air transport and use of the ADCP from vessels of opportunity anywhere in the world. (See Physical Oceanography section, page 37, for more discussion on research using the ADCP).

The future of instrumentation

This is only a sampling of the instrumentation developments in oceanography over the past 25 years. Emerging technologies such as low-cost remotely operated vehicles (ROVs), real time telemetry of data from unattended sites, the extension of computer networks, and even the Internet to vessels at sea, Ocean surface current radar (OSCR), drifting data buoys, low cost satellite receiving stations, and instruments yet to be invented promise to make the next 25 years exciting ones for engineers and scientists alike.

Research vessel operations at MSRC

A sophisticated research vessel is, to many, the emblem of modern oceanography. No aspect of the enterprise is more visible, more immediately recognizable, more in tune with its quest. The oceans of the world remain a fertile ground for exploration and discovery. To embark on a voyage of discovery requires a ship. This is the story of research vessels at MSRC.

From the most humble beginnings, great things can arise. The earliest mention of a research vessel at MSRC is

Flax Pond and the Flax Pond Marine Laboratory

Flax Pond is a protected salt marsh located on Long Island Sound five miles north of the Stony Brook campus. The 146-acre marsh and adjoining uplands were jointly purchased in 1966 by the State University of New York and the State Department of Environmental Conservation (DEC).

During the 1960s and 1970s, Flax Pond was the object of seminal research on the structure and functioning of tidal salt marsh ecosystems. It continues to be an important locus of field research in salt marsh dynamics, ecology of estuarine organisms, and aquaculture conducted by scientists of MSRC and other Stony Brook departments.

In 1969, the DEC built a marine laboratory on the southern shore of Flax Pond, equipped with a seawater system that draws water from the pond, circulates it to experimental tables and chambers in separate finfish and shellfish wet labs, and eventually returns it to the pond. Since 1980, the MSRC has made significant improvements to the general service utilities and research support capabilities of the laboratory, including the addition of a large greenhouse to the south face for use in research on marine macroalgae (seaweeds). In 1993 the MSRC received a facilities improvement grant from the National Science Foundation to markedly upgrade the seawater supply and distribution system.

Presently, plans have been developed for the addition of a classroom/teaching laboratory that is plumbed with seawater. MSRC, DEC, and several University departments are cooperating to create a self-guided educational trail through the adjoining marsh, whose pristine condition makes it an ideal resource for formal and informal educational programs from pre-school to graduate levels.

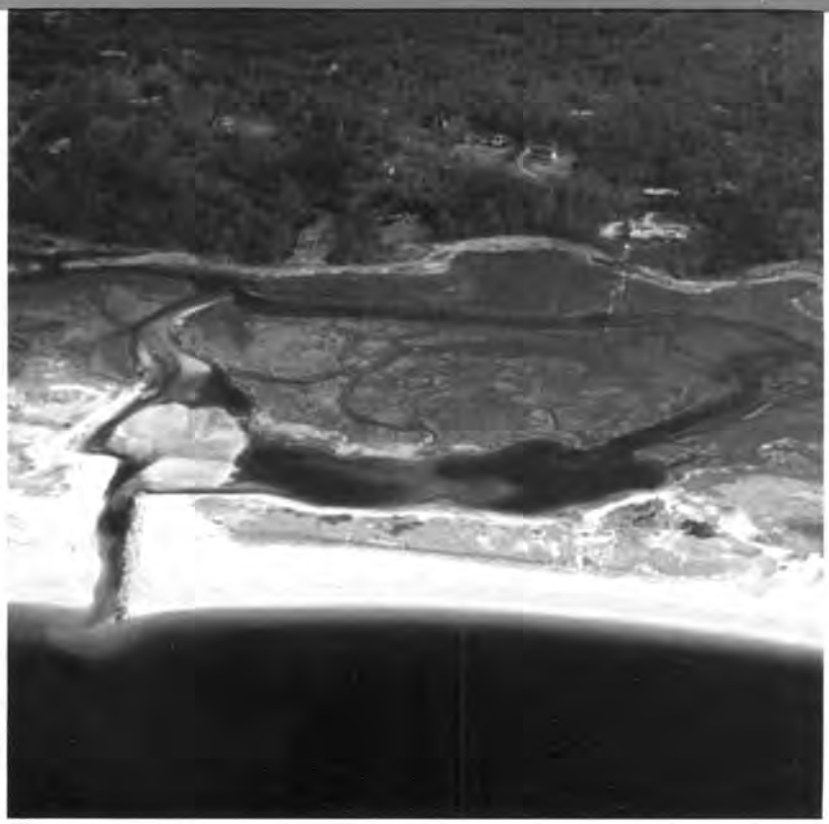


photo by R.G. Rowland

of the R/V *FRUMP* in an untitled progress report on the fledgling Marine Sciences Research Center, a report that can be dated to Spring 1968. The boat was apparently used during 1967 for plankton and sediment research in Long Island Sound and to tow an experimental hydrofoil catamaran designed by a faculty member in the College of Engineering.

In 1968 the Center acquired its second research vessel, the R/V *MICMAC*, named for the tribe of Native Americans that inhabited the Atlantic coast of what is now Canada. The purchase price was $5,074. Built in 1961, *MICMAC* was a 40' Nova Scotia lobster boat with a wooden hull and a gasoline engine.

Over the next several years, as activity increased at MSRC and monies became available, the boat was outfitted with navigational and communication

equipment, a winch, and other accoutrements of a bona fide research vessel. The daily charter fee in 1970 was $75. The current daily charter fee of R/V *ONRUST* is $1,000.

MSRC developed rapidly in the early 1970's. The Center's need for a seagoing vessel to support its growing research and educational programs was outstripping *MICMAC*'s capabilities. Small size and lack of interior space confined her use to collecting samples during day cruises. Her wooden construction and gasoline engine placed a heavy demand on the captain and mate for maintenance and repair. The vessel's deck equipment was not adequate to handle the demands of over-the-side sampling, increasingly required by the Center's research programs. More fundamentally, at the time of her purchase, *MICMAC* was in rather poor overall condition. In a word, she was a headache! By late 1973, planning was well underway to develop a successor to *MICMAC*.

MICMAC's replacement would be a new vessel, built and equipped exclusively for coastal oceanographic research. The all-steel vessel was ordered from Rhode Island Marine Services of Snug Harbor in February 1974 and delivered in October of that year. She was built on a stock hull of an offshore lobster boat—a tried and true design of proven seaworthiness. In April 1975 the 55-foot R/V *ONRUST* was formally christened at a ceremony at Stony Brook Yacht Club. The boat's name, which is Dutch for "restless," memorializes an earlier *ONRUST*—built in 1614 by the Dutch explorer Adriaen Block and his colleagues on the southern tip of Manhattan Island. It replaced their boat, *TYGER*, which caught fire and burned, leaving them temporarily stranded in an alien, new world. Block returned home shortly thereafter, but left the *ONRUST* under the command of one of his lieutenants to continue the exploration of the mid-Atlantic coast of North America from Cape Cod to Delaware Bay.

ONRUST proved to be an exceptionally durable and serviceable platform for the Center's field-based research and instructional programs. Over the years, major modifications and improvements to the boat were undertaken. In 1987 hydraulics were added to the stern gantry to make the deployment and retrieval of large pieces of sampling equipment easier and safer. In 1990, the boat was lengthened by five feet to add additional working area to the aft work deck. More recently, a thru-hull well was constructed in the aft work deck to mount an acoustic Doppler current profiler (ADCP).

R/V Onust working in New York Harbor.
▼

photo by R.G. Rowland

ONRUST has effectively met the Center's research vessel needs for nearly 20 years. During this period, most cruises were of short duration, generally one to two days. However, the nature of seagoing coastal oceanographic research is changing. Cruises of the future will be longer, involve multiple pieces of major sampling equipment, and make increasing use of on-board electronic data acquisition and analysis instrumentation. To assure that the Center is capable of supporting this research, plans are underway to replace *ONRUST* with a 21st Century coastal oceanographic research vessel. The Center's Ships Committee is working with the Webb Institute of Naval Architecture to develop preliminary design drawings and capability parameters of the new vessel. We anticipate having the vessel ready by Spring 1996.

Not all of the Center's field research requires a vessel of the size and capability of *ONRUST*. To support research in the inshore embayments around Long Island, the Center has maintained a fleet of smaller craft that are generally kept on trailers.

Computer facilities

The Center maintains a variety of computing equipment set up in several laboratories providing support for instructional, research, and administrative computing needs. The heart of our computing center consists of three DEC minicomputers: VAX 8530, VAX 6310 and VAX 6510. They form the hub for our centerwide Ethernet network, MSRCnet. There are four computational laboratories connected via the network to the hub machines consisting of 10 DEC workstations and 10 X-window terminals. Assorted peripheral equipment can also be found in these labs such as laser and color printers, digitizing tables, and pen plotters.

In addition to the above facilities, there are two instructional computing facilities available for student use. The first contains four Gateway 486/50 microcomputers and an HP LaserJet IVM+ laser printer. The second contains four Apple Macintosh IIcx and two Macintosh II microcomputers and an Apple LaserWriter IINT laser printer. A variety of software is available including word processing, spreadsheet, graphics, and statistics.

Graphic arts facilities

The Graphic Arts Department is a full service photography, drafting, and desktop publishing facility available to both faculty and students on a year-round basis. It is also home of the University's most comprehensive slide collection documenting Long Island's diverse coastal environment.

The department has existed since 1975 and has moved into the computer age along with the rest of the graphic arts world. Recent advancements include digital photography, video-frame capture, multimedia, and animation capabilities.

MASIC

Information center

The Marine and Atmospheric Sciences Information Center (MASIC) is a modern, technologically advanced prototype of the knowledge center of the future. The holdings include important marine and atmospheric science core journals, beginning and advanced monographs and texts, key reprints, MSRC masters' theses and doctoral dissertations, MSRC Special Reports and Technical Reports, nautical charts and maps, and a general science reference collection.

Current computer capabilities include access to STARS (the on-line NOTIS catalog for all west campus libraries); Dissertation Abstracts and Periodical Abstracts; the Aquatic Sciences and Fisheries Abstract database (ASFA), the Georef (geological) database, and the Regional Serials (LILRC) database on CD-ROM; and access to over 400 national and international databases through Dialog Information Services.

Planned expansion of these facilities includes direct access to other SUNY Center library catalogs and databases; high-speed document transmission from other branches and SUNY Centers; the expansion of on-line databases, including Water Resources Abstracts on CD-ROM and Current Contents on disk; and expanded access to other collections and information sources using Gopher, and MOSAIC via the Internet.

OUR STORY 25 YEARS

Marine and Atmospheric Sciences Information Center

In 1990, before the Institute for Terrestrial and Planetary Atmospheres joined MSRC, the Center had little more than a reference room with assorted books, donated journals, and nautical charts. All reference collections were held in the Biology or Earth and Space Sciences libraries.

In 1990 MSRC formed a reference room committee of faculty and students and hired a half-time librarian, Larry Herschenfeld. With a limited annual budget of $10,000, Larry began to transform the reference room into the modern center we have today, organizing the collections and adding several hundred books, numerous subscriptions to oceanographic journals, and the Center's first electronically accessed on-line database systems.

From these beginnings emerged today's Marine and Atmospheric Sciences Information Center (MASIC). MASIC is a modern, technologically advanced prototype of the knowledge center of the future. Besides the many important marine and atmospheric science core journals, monographs, texts, key reprints, and a general science reference collection, the information center has the most advanced computerized facilities on campus.

photo by Leslie Adler

Human Resources

Faculty

Josephine Y. Aller
Associate Research Professor;
Ph.D., 1975, University of Southern California. Marine benthic ecology, invertebrate zoology, marine microbiology, biogeochemistry.

Robert C. Aller
Professor;
Ph.D., 1977, Yale University. Marine geochemistry, marine animal-sediment relations.

Henry J. Bokuniewicz
Professor;
Ph.D., 1976, Yale University. Nearshore transport processes, coastal sedimentation, marine geophysics.

Malcolm J. Bowman
Professor;
Ph.D., 1970, University of Saskatchewan. Coastal ocean and estuarine dynamics.

Vincent Breslin
Assistant Professor;
Ph.D., 1986, Florida Institute of Technology. Chemical behavior of combustion wastes in seawater; rate and extent of degradation of biodegradable plastics.

V. Monica Bricelj
Associate Professor;
Ph.D., 1984, State University of New York at Stony Brook. Molluscan physiological ecology, benthic ecology.

Bruce Brownawell
Assistant Professor;
Ph.D., 1986, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution. Biogeochemistry of organic pollutants in seawater and groundwater.

Edward J. Carpenter,
Professor;
Ph.D., 1969, North Carolina State Universtiy. Nitrogen cycling among plankton and ambient seawater, phytoplankton and zooplankton ecology.

Robert M. Cerrato
Associate Professor;
Ph.D., 1980, Yale University. Benthic ecology, population and community dynamics.

Robert Cess
Distinguished Professor;
Ph.D., 1959, University of Pittsburgh. Atmospheric sciences and climate.

Jeng Chang
Research Assistant Professor;
Ph.D., 1989, State University of New York at Stony Brook. Phytoplankton physiology and ecology, species-specific growth rates, cell cycle analysis.

J. Kirk Cochran
Professor;
Ph.D., 1979, Yale University. Marine geochemistry, use of radionuclides as geochemical tracers; diagenesis of marine sediments.

Daniel Conley
Assistant Proefssor;
Ph.D. 1993,
University of California at San Diego/ Scripps Institution of Oceanography. Sediment transport, wave boundary layers, nearshore processes.

David O. Conover
Professor;
Ph.D., 1982, University of Massachusetts. Ecology of fish, fisheries biology.

Alessandra Conversi
Research Assistant Professor;
Ph.D., 1992, University of California at San Diego/Scripps Institution of Oceanography. Anthropogenic impacts on marine systems; long time series.

Elizabeth M. Cosper
Associate Research Professor;
Ph.D., 1981, City University of New York, City College. Phytoplankton physiology and ecology, resistance of microalgae to pollutants.

Robert K. Cowen
Associate Professor;
Ph.D., 1985, University of California at San Diego/Scripps Institution of Oceanography. Fishery oceanography, nearshore fish populations, fish ecology.

Robert G. Currie
Research Associate Professor;
Ph.D., 1966, University of California at Los Angeles. Signal processing of climatic data.

Nicholas S. Fisher
Professor;
Ph.D., 1974, State University of New York at Stony Brook. Marine phytoplankton physiology and ecology, biogeochemistry of metals, marine pollution.

Roger D. Flood
Associate Professor;
Ph.D., 1978, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution. Marine geology, sediment dynamics, continental margin sedimentation.

Jane L. Fox
Professor;
Ph.D., 1978, Harvard University. Structure and evolution of thermospheres-ionospheres of planets.

Marvin A. Geller
Professor;
Ph.D., 1969, Massachusetts Institute of Technology. Atmosphere dynamics; stratosphere/mesophere; climate.

Valrie A. Gerard
Associate Professor;
Ph.D., 1976, University of California, Santa Cruz. Marine machrophyte ecology and physiology.

Sultan Hameed
Professor;
Ph.D., 1968, University of Manchester. Climate change: analysis, impacts, and predictability.

Cindy Lee
Professor;
Ph.D., 1975, University of California at San Diego/Scripps Institution of Oceanography. Marine geochemistry of organic compounds, organic and inorganic nitrogen-cycle biochemistry.

Darcy Lonsdale
Associate Professor;
Ph.D., 1979, University of Maryland, College Park. Zooplankton ecology, with special interest in physiology, life history studies.

Glenn R. Lopez
Professor;
Ph.D., 1976, State University of New York at Stony Brook. Marine benthic ecology, animal-sediment interactions.

Kamazima Lwiza
Assistant Professor;
Ph.D., 1990, University of Wales. Structure and dynamics of shelf-seas and remote sensing oceanography.

James E. Mackin
Associate Professor;
Ph.D., 1983, University of Chicago. Geochemistry of suspended sediment-solution interactions.

Steven Morgan
Assistant Professor;
Ph.D., 1986, Univrsity of Maryland at College Park. Early life history dynamics of marine invertebrates and fishes.

Charles Nittrouer
Professor;
Ph.D., 1978, University of Washington, Seattle. Geological oceanography, continental margin sedimentation.

Akira Okubo
Professor;
Ph.D., 1963, The Johns Hopkins University. Oceanic diffusion, animal dispersal, mathematical ecology.

Hartmut Peters
Assistant Professor;
Ph.D., 1981, University of Kiel, Germany. Small-scale processes such as turbulent mixing, interaction of small- and larger-scale mixing.

Frank J. Roethel
Lecturer;
Ph.D., 1982, State University of New York at Stony Brook. Environmental chemistry, behavior of coal waste in the environment, solution chemistry.

Sergio Sañudo-Wilhelmy
Assistant Professor;
Ph.D., 1993, University of California, Santa Cruz. Geochemical cycles of trace elements, marine pollution.

J. R. Schubel
Dean and Director;
Ph.D. 1968, The Johns Hopkins University. Coastal sedimentation, suspended sediment transport, coastal zone management.

OUR STORY

25 YEARS

The New York Sea Grant Institute

The New York Sea Grant Institute (initially, the New York Sea Grant Program), founded as a cooperative activity of State University of New York and Cornell University, began operation in October 1971. The program was located at MSRC until early 1972, when the administrative offices were moved to Albany to emphasize Sea Grant's multiple-campus, two coast (marine and Great Lakes) character in New York.

By decision of the Institute's Board of Governors, in January 1987 the program relocated again to the Stony Brook campus. Conducting a search for a new director, the Board viewed a location on the campus of a major research university as both essential to attracting and retaining a top quality academician for this post and of general benefit to the successful functioning of Sea Grant in New York.

Mary I. Scranton
Professor;
Ph.D., 1977, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution. Marine geochemistry, biological-chemical interactions in seawater.

R. Lawrence Swanson
Director, Waste Management Institute;
Ph.D., 1971, Oregon State University. Recycling and reuse of waste materials, waste management.

Gordon Taylor
Assistant Professor;
Ph.D., 1983, University of Southern California. Marine microbiology; interests in microbial ecology, plankton trophodynamics, and marine biofouling.

Prasad Varanasi
Professor;
Ph.D., 1967, University of California, San Diego. Atmospheric spectroscopy; remote sensing; global warming.

Duane E. Waliser
Assistant Professor;
Ph.D., 1992, University of California, San Diego/Scripps Institution of Oceanography. Ocean-atmosphere interactions, tropical climate dynamics.

Dong-Ping Wang
Professor;
Ph.D., 1975, University of Miami. Coastal ocean dynamics.

Robert E. Wilson
Associate Professor;
Ph.D., 1974, The Johns Hopkins University. Estuarine and coastal ocean dynamics.

Peter M.J. Woodhead
Research Professor;
B.Sc.Hon. 1 Cl., 1953, Durham University, England. Behavior and physiology of fish, coral reef ecology, ocean energy conversion systems.

Jeannette Yen
Associate Professor;
Ph.D., 1982, University of Washington, Seattle. Marine zooplankton ecology, predator-prey interactions, sensory perception and lipid metabolism of copepods.

Minghua Zhang
Assistant Professor;
Ph.D., 1987, Institute of Atmospheric Physics, Academia Sinica. Climate modelling, atmospheric dynamics.

photo by Leslie Adler

A winter scene at Stony Brook Harbor. ▲

Joint faculty

Edward Beltrami
Department of Applied Mathematics and Statistics, Professor. Mathematical modeling of dynamical systems, operations research, optimization methods.

Robert L. de Zafra
Department of Physics, Professor. Experimental remote sensing of trace gases involved in stratosphere chemistry and climatology.

Theodore D. Goldfarb
Department of Chemistry, Professor. Chemically induced environmental effects, interactions between science and public policy.

William H. Greene
Division of Infectious Control, Health Sciences Center. Clinical Associate Professor of Medicine. Hospital-acquired infections, including infection prevention methods for health-care workers.

Herbert Herman
Department of Materials Science and Engineering, Professor. Ocean engineering, undersea vehicles, marine materials.

L. E. Koppelman
Center for Regional Policy Studies, Professor. Coastal zone management, planning, policy studies.

Jeffrey S. Levinton
Department of Ecology and Evolution, Professor. Benthic ecology, evolutionary biology.

W. J. Meyers
Department of Earth and Space Sciences, Associate Professor. Carbonates, sedimentology.

Sheldon Reaven
Department of Technology and Society, Associate Professor. Energy and environmental problems and issues, especially waste management.

Lawrence B. Slobodkin
Department of Ecology and Evolution, Professor. Theoretical ecology, marine ecology.

Adjunct faculty

Randall Alberte
University of California at Los Angeles, Department of Biology. Primary production, environmental regulation of plant and algal adaptation.

Harold Berger
Professor, part time, Region I Director (Retired), New York Department of Environmental Conservation. Solid waste disposal, groundwater quantity and quality, air emissions, wetland formation and protection

William Crawford
Institute of Ocean Sciences, Canada. Continental shelf and slope dynamics microstructure, tidal dynamics.

William Eichbaum
The Conservation Foundation/World Wildlife Fund. Coastal zone policy and management; environmental conservation.

Paul Falkowski
Brookhaven National Laboratory. Marine phytoplankton ecology, phytoplankton physiology.

Gene Feldman
National Aeronautics and Space Administration, Goddard Space Flight Center. Remote sensing of phytoplankton, satellite oceanography.

Charles Flagg
Brookhaven National Laboratory. Continental shelf dynamics, acoustical oceanography.

Martin Garrell
Department of Physics, Adelphi University. Physical processes and properties relative to marine environmental problems.

Douglas Hill
Engineeer, Sc.D., P.E.. Systems engineering, energy and environmental policy analysis.

Sarah Horrigan
Office of Management and Budget. Marine policy, plankton ecology.

Garry Mayer
National Oceanic and Atmospheric Administration. Estuarine processes marine environmental restoration.

Peter Minnett
Brookhaven National Laboratory. Physics of satellite remote sensing and applications to oceanography and climate studies, polar oceanography

Lawrence Noonan
Office of the Provost, University at Stony Brook. Management policy, budgeting and fiscal analyses.

Joel O'Connor
U. S. Environmental Protection Agency. Environmental assessment, policy, and quality indicators; marine ecology.

Claudio Pescatore
Brookhaven National Laboratory. Hydrogeology and groundwater transport of contaminants, mathematical modeling, radiochemistry.

Stephen E. Schwartz
Brookhaven National Laboratory. Atmospheric chemistry; cloud and aerosol chemistry and microphysics, chemical modeling, atmospheric radiation.

Scott Siddall
Kenyon College, Ohio. Benthic ecology aquaculture, animal-flow interactions, computer applications to ecological problems.

Dennis Suszkowski
Hudson River Foundation. Estuarine sedimentology, ocean and estuarine policy and management.

Richard Thomson
Institute of Ocean Sciences, Canada. Coastal oceanography, continental shelf waves, slope currents.

James Vaughn
Brookhaven National Laboratory. Transport fate and effects of viruses in the aquatic environment.

Mario Vieira
U.S. Naval Academy Oceanography Department, Annapolis. Circulation and the dynamics of coastal and estuarine waters.

Douglas Wallace
Brookhaven National Laboratory. Chemical oceanography, use of freons as oceanic tracers.

Professors emeritus

E. R. Baylor
H. H. Carter
J. L. McHugh
Donald W. Pritchard
Peter K. Weyl
Charles Wurster

Postdoctoral fellows

Marie deAngelis
Magali Gerino
Aidan Hampson
Christina Barnes Heilbrun
Per Hall
Patrick Hassett
David Hutchins
Byeong Gweon Lee

John M. Olin Postdoctoral Fellow

Doreen Monteleone

William E. and Maude Pritchard Coastal Marine Scholars

Eric Schultz
Uhyon Shin
Geoffrey Trager

Staff

Diane Arwood
Analytical Laboratory Technician
Diane Achman
Research Support Specialist
Janice Barone, Secretary
Trudy Bell, Editorial Associate
James Brister
Flax Pond Laboratory Manager (effective 5/93)
Christine Campbell
Staff Assistant
George Carroll
Manager, Computing Facilities
Carol Case, Administrative Assistant
Roy Cash
Research Vessel Mate (effective 2/94)
Aravind Cherukuri
Engineering Design Assistant
Joanne Cosgrove, Secretary
Amir Ehtisham
Research Support Specialist
Maureen Flynn, Secretary
Gina Gartin, Secretary
Eileen Goldsmith, Project Staff Assistant
Henry Harrison, Electronics Technician
Charles James
Flax Pond Laboratory Manager
Clifford Jones, Facilities Manager
Roger Kelly, Assistant Librarian

Jodi Kopp, Secretary
David Hirschberg
Senior Research Scientist
David Lucyk
Ocean Instrument Technician
Michele McTernan, Project Staff Associate
Lori Palmer, Director of Graphics Arts
Andrew Parrella
Research Support Specialist
Laura Richardson
Graduate Program Coordinator
Susan Rudnick, Project Staff Associate
Jeri Schoof
Executive Assistant to the
Dean and Director
Aileen Schwartz, Secretary
Christopher Stein
Research Support Specialist
Bonnie Stephens
Administrative Assistant
Helmut Stuebe
Research Vessel Captain (retired)
Ian Stupakoff
Research Support Specialist
Hiram Szeto
Research Support Specalist
Helen Ulreich, Secretary
Barbara Vallely, Staff Assistant
Maryanne Wente
Research Support Specialist
Anne West-Valle
Editoral Associate,
Waste Management Institute
Mark Wiggins, Field Specialist
Thomas Wilson
Oceanographic Instrumentation
Engineer
William Wise
Associate Director;
Director,Living Marine
Resources Institute
Bernice Wornow, Staff Assistant
Randy Young, Senior Staff Assistant
Bret Zielenski
Research Vessel Captain
Qing Xia, Research Support Specialist

Administration

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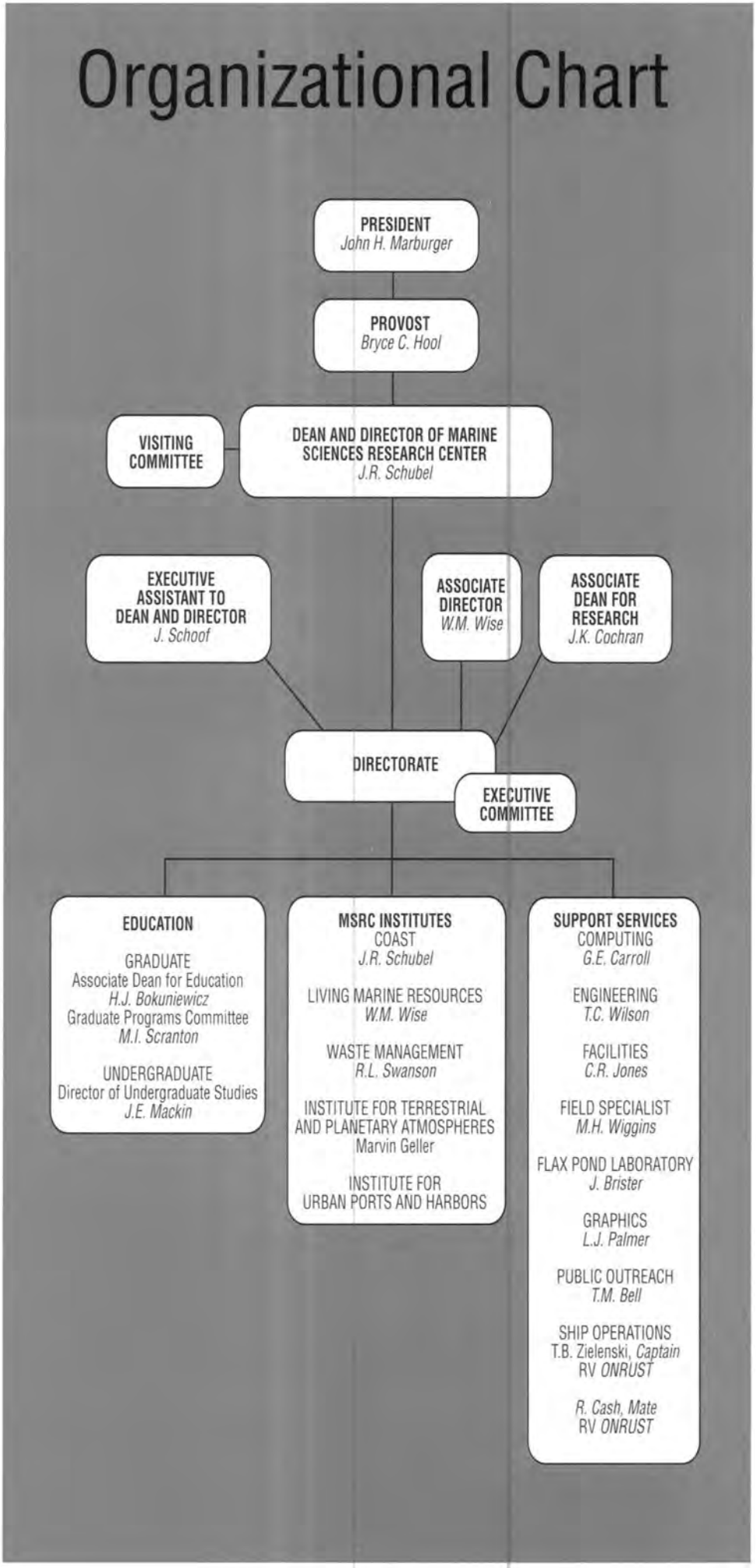
Dean and Director
H.J. Bokuniewicz
Associate Dean for Education
J. Kirk Cochran
Associate Dean of Research
M.A. Geller
Director of Institute for Terrestrial
and Planetary Atmospheres
J. Schoof
Executive Assistant to the Dean
R.L. Swanson
Director of Waste Management Institute
W. Wise
Associate Director

Organizational Chart



MSRC HIGHLIGHTS

MSRC Visiting Committee

The Visiting Committee is the Center's primary advisory body. Members provide general advice, guidance, and support for strengthening MSRC's existing plans and programs, as well as for undertaking new initiatives.

James A. Simons, Chairman
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Evelyn Berezin
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Abraham Krasnoff
James Larocca
Homer A. Neal
Ronald J. Oehl
Gordon Ray
Jeffrey A. Sachs
Rosemary Scanlon
Paul Windels, Jr.

Visitors

DISTINGUISHED VISITING SCHOLARS, 1992-1993

Robert Beardsley,
Woods Hole Oceanographic Institution

Bo Barker Jorgensen, University of Denmark at Aarhus

John Milliman, Woods Hole Oceanographic Institution

David Schindler, University of Alberta, Canada

Mary Silver, University of California, Santa Cruz

Victor Smetacek, Alfred-Wegener-Institut, Germany

INVITED SPEAKERS, 1992-1993

Jelle Atema, Marine Biological Lab, Woods Hole Oceanographic Institute

Carol Arnosti,
Woods Hole Oceanographic Institution

Carmen Benkovitz,
Brookhaven National Lab

William Boicourt,
University of Maryland, Horn Point

Denise Breitburg,
Benedict Estuarine Lab

Michael Danilin,
Moscow State University, Russia

Mark Cane, Lamont-Doherty Geological Observatory

David Caron, Woods Hole Oceanographic Institution

Steven Chiswell,
University of Hawaii/NZOI

Percy Donaghay,
University of Rhode Island

Steven Englebright,
Museum of LI Natural Sciences

John Farrington, Woods Hole Oceanographic Institution

William Fitzgerald,
University of Connecticut

Charles Flagg, Brookhaven National Lab

David C. Fritts,
University of Colorado

Scott Gallager, Woods Hole Oceanographic Institution

Chris Garrett, University of Victoria

Rocky Geyer, Woods Hole Oceanographic Institution

Robert Guillard, Bigelow Lab,Maine

William Hargis, Virginia Institute of Marine Sciences

Daniel Hartmann,
Ben-Gurion University

Paul Hays, University of Michigan

James Holton,
University of Washington, Seattle

Pablo Huq, University of Delaware

L. Craig Johnstone,
Cabot Plastics,Belgium

Mike Kingsford, University of Sydney

John Klinck, Old Dominion University

Charles Lin, McGill University

Rob Mason, Massachusetts Institute of Technology, Parsons Lab

Yacko Masuchi, Center for Marine Biotechnology, University of Maryland

Peter Minnett,
Brookhaven National Lab

Paul Moore, Monell Chemical Senses Center, Philadelphia

Lawrence Mysak, McGill University

Roger Newell, University of Maryland, Horn Point

Scott Nixon,
University of Rhode Island

Marjorie Oldfield, Seatuck Foundation

Michael Pace, Institute for Ecosystem Studies, Carey Arboretum

Eric Postmentier,
Long Island University

Thomas Powell,
University of California,Davis

V. Ramanathan,
Scripps Institution of Oceanography

Laurie Sanderson,
Virginia Institute of Marine Sciences

Paul Smith,
Southwest Fishery Center, La Jolla, CA

Malcolm Spaulding,
University of Rhode Island

John St. John,
Hydroqual Inc., New Jersey

Mark Tedesco, U.S. EPA, Long Island Sound Study Office

Keith Thompson,
Dalhousie University

Creighton Wirick,
Brookhaven National Lab

L. Donaldson Wright,
Virginia Institute of Marine Sciences

Publications, Awards, and Degree Recipients

Faculty Publications

Green, M.A.; **Aller, R.C.**; **Aller J.Y.** Carbonate dissolution and temporal abundances of foraminifera in Long Island Sound sediments. Limnology and Oceanography 38(2) 331-345; 1993.

Aller, R.C.; **Aller J.Y.** Meiofauna and solute transport in marine muds. Limnology and Oceanography 37(5)1018-1033; 1992.

Green, M.A.; **Aller, R.C.**; **Aller, J.Y.** Experimental evaluation of the influences of biogenic reworking on carbonate preservation. Marine Geology; 107:175-181; 1992.

Rude, P.D.; **Aller, R.C.** The influence of Mg^{2+} on the adsorption of fluoride by hydrous oxides in seawater. American Journal of Science 93:1-24; 1993.

Sun, M.-Y.; **Lee, C.**; **Aller, R.C.** Anoxic and oxic degradation of ^{14}C-chloropigments and a ^{14}C-labelled diatom in Long Island Sound sediments. Limnology and Oceanography 38:1438-1451; 1993.

Sun, M.-Y.; **Lee, C.**; **Aller, R.C.** Laboratory studies of oxic and anoxic degradation of chlorophyll-a in Long Island Sound sediments. Geochimica et Cosmochimica Acta 57:147-157; 1993.

Hall, P.O.J.; **Aller, R.C.** Rapid, small-volume, flow injection analysis for $\sum CO_2$ and NH_4^+ in marine and freshwaters. Limnology and Oceanography 37:1113-1119; 1992.

Bokuniewicz, H.J. Analytical description of subaqueous groundwater seepage. Estuaries 15:458-464; 1992.

Gayes, P.T.; **Bokuniewicz, H.J.** Estuarine paleoshorelines in Long Island Sound, NY. Journal of Coastal Research 11:39-54; 1992.

Bowman, M.J.; Visser, A.W.; Crawford, W.R. The Rose Spit Eddy; evidence for its existence and underlying dynamics. Atmosphere-Ocean 30:70-93; 1992.

Breslin, V.T.; Li, B. Weathering of starch-polyethylene composite films in the marine environment. Journal of Applied Polymer Science 48:2063-2079; 1993.

Breslin, V.T. Degradation of starch-plastic composites in a municipal solid waste landfill. Journal of Environmental Polymer Degradation 1(2):127-141; 1993.

Breslin, V.T.; **Swanson, R.L.** Deterioration of starch-plastic composites in the environment. Air and Waste 43(3): 325-335; 1993.

Woodbury, P.B.; **Breslin, V.T.** Assuring compost quality: suggestions for facility managers, regulators, and researchers. Biomass and Bioenergy 3(3-4): 213-225; 1992.

Bricelj, V.M.; Greene, M.; Cembella, A.D. Growth of mussels, *Mytilus edulis*, on toxic *Alexandrium fundyense*, and fate of dinoflagellate cells following gut passage. In: Smayda, T.J.; Shimizu, Y., eds. Phytoplankton Blooms in the Sea; New York: Elsevier; pp. 371-376; 1993.

Garcia-Esquivel, Z.; **Bricelj, V.M.** Ontogenetic changes in microhabitat distribution of juvenile bay scallops, *Argopecten irradians irradians* (L.), in eelgrass beds, and their potential significance to early recruitment. Biological Bulletin 185:42-55; 1993.

Bricelj, V.M.; Ford, S.E.; Borrero, F.J.; Perkins, F.O.; Rivara, G.; Hillman, R.E.; Elston, R.A.; Chang, J. Unexplained mortalities of hatchery-reared juvenile oysters,*Crassostrea virginica* (Gmelin). Journal of Shellfish Research 11(2):331-347; 1992.

Bricelj, V.M.; Krause, M.K. Resource allocation and population genetics of the bay scallop, Argopecten irradians irradians: effects of age and allozyme heterozygosity on reproductive output. Marine Biology 113:253-261; 1992.

Jayasinghe, D.S.; **Brownawell, B.J.**; Chen, H.; Westall, J.C. Determination of Henry's constants of organic compounds of low volatility: methyl-anilines in methanol-water. Environmental Science and Technology 26:2275-2281; 1992.

Ben-Porath, J.; **Carpenter, E.J.**; Zehr, J. Genotypic relationships in the genus *Trichodesmium* based in nifH sequence comparisons. Applied Environmental Microbiology 29:806-810; 1993.

Bergman, B.; Siddiqui, P.J.A.; **Carpenter, E.J.**; Peschek, G. Cytochrome oxidase: subcellular distribution and relation to nitrogenase derepression in the marine cyanobacterium *Trichodesmium thiebautii*. Applied Environmental Microbiology 59:3239-3244; 1993.

Carpenter, E.J.; Siddiqui, P.J.A.; Bergman, B.; O'Neil, J.; Capone, D.G. The tropical diazotrophic phytoplankter *Trichodesmium*: biological characteristics of two species. Marine Ecology Progress Series 95:295-304; 1993;

Ben-Porath, J.; **Carpenter, E.J.**; Zehr, J. Genotypic relationships in the genus *Trichodesmium* based on nifH sequence comparisons. Journal of Phycology 29:806-810; 1993.

Roenneberg, T.; **Carpenter, E.J.** Daily rhythm of O_2 evolution in the cyanobacterium *Trichodesmium thiebautii* under natural and constant conditions. Marine Biology 117:693-697; 1993.

Borstad, G.A.; Gower, J.F.R.; **Carpenter, E.J.** Development of algorithms for remote sensing of marine *Trichodesmium*. In: Carpenter, E.J.; Capone, D.G.; Rueter, J., eds. Marine Pelagic Cyanobacteria:*Trichodesmium* and Other Diazotrophs. Dordrecht: Kluwer Academic Publishers pp. 193-210; 1992.

Carpenter, E.J. Nitrogen fixation in the epiphyllae and root nodules of trees in the lowland tropical rainforest of Costa Rica. Acta (Ecologica 13(2): 153-160; 1992.

Carpenter, E.J.; Capone D.G. Significance of *Trichodesmium* blooms in the marine nitrogen cycle. In: Carpenter, E.J.; Capone, D.G.; Rueter, J., eds. Marine Pelagic Cyanobacteria: *Trichodesmium* and other Diazotrophs. Dordrecht: Kluwer Academic Publishers; pp. 211-217; 1992.

Carpenter, E.J., Bergman, B.; Dawson, R.; Siddiqui, P.J.A.; Söderbäck, E.; Capone, D.G. Glutamine synthetase and nitrogen cycling in colonies of the marine diazotrophic cyanobacteria *Trichodesmium* spp.Applied and Environmental Microbiology, September; 3122-3129; 1992.

Siddiqui, P.J.A.; Bergman, B.; **Carpenter, E.J.** Immunolocalization of phycobiliproteins and ribulose 1,5 bisphosphate carboxylase/oxygenase in the marine cyanobacterium *Trichodesmium thiebautii*. Journal of Phycology 28;320-317; 1992.

Siddiqui, P. Bergman, B.; Bjorkman, P-O.; **Carpenter, E.J.** Ultrastructural and chemical assessment of poly-B-hydroxybutyric acid in the marine cyanobacterium *Trichodesmium thiebautii*. FEMS Microbiological Letters 94:143-148; 1992.

Siddiqui, P.J.A.; **Carpenter, E.J.**; Bergman, B.*Trichodesmium:* ultrastructure and protein localization In: Carpenter, E.J.; Capone, D.G.; Rueter, J., eds. Marine Pelagic Cyanobacteria: *Trichodesmium* and Other Diazotrophs. Dordrecht: Kluwer Academic Publishers pp: 9-28; 1992.

Cerrato, R.M. Shellfish and benthic invertebrates. In: Bokuniewicz, H.; McElroy, A.; Schlenk, C.; Tarski, J. Estuarine Resources of the Fire Island National Seashore and Vicinity. Stony Brook: New York Sea Grant Institute; 133 pp.; 1993.

Cleveland, C.; **Cerrato, R.M.** The benthic and epibenthic fauna in the nearshore Atlantic Ocean waters off northern New Jersey: Sea Bright to Ocean Township Biological Monitoring Program. June and August 1991 sampling. Marine Sciences Research Center Special Data Report No. 14; State University of New York, Stony Brook; 86 pp.; 1993..

Lightfoot, K.G.; **Cerrato, R.M.**; Wallace, H.V.E. Prehistoric shellfish-harvesting strategies: implications from the growth patterns of soft-shell clams (*Mya arenaria*). Antiquity 67:358-369; 1993

Cerrato, R.M.; Keith, D.L. Age structure, growth and morphometric variations in the Atlantic surf clam, *Spisula solidissima*, from estuarine and inshore waters. Marine Biology 114:581-593; 1992.

Monteleone, D.M.; **Cerrato, R.M.**; **Lonsdale, D.J.**; Peterson, W.T. Abundance and seasonality of key forage species in Long Island Sound. Marine Sciences Research Center Special Report No. 100; State University of New York, Stony Brook; 111 pp.; 1992.

Cess, R.D.; **Zhang, M.-H.**; Potter, G.L.; Barker, H.W.; Colman, R.A.; Dazlich, D.A.; Del Genio, A. D.; Esch, M.; Fraser, J. R.; Galin, V.; Gated, W.L.; Hack, J.J.; Kiehl, J. T.; Lacis, A. A.;Liang, X.-Z.; Mahfouf, J.-F.; McAvaney, B. J. Meleshko, V. P.; Morcrette, J.-J.; Randall, D. A.; Roeckner, E.; Royer, J.-F.; Sheinin, D. A.; Sokolov, A. P.; Taylor, K. E.; Wang, W.-C.; Wetherald, R.T. Intercomparison of CO_2 radiative forcing in atmospheric general circulation models, Science 262: 1252-1255; 1993.

Kim, Y.; **Cess, R.D.** Effect of anthropogenic sulfate aerosols on low-level cloud albedo over oceans. Journal of Geophysical Research 98, pp. 14,88314,885; 1993.

Li, Z.; Leighton, H.G.; **Cess, R.D.** Surface net solar radiation estimated from satellite measurements: comparisons with tower observations. Journal of Climate 6, pp. 1764-1772; 1993.

Dlhoposky, R.; **Cess, R.D.** Improved angular directional models for clear sky ocean derived from Earth Radiation Budget Experiment data. Journal of Geophysical Research 98, pp. 16,713-16,721,1993.

Cess, R.D.; Nemesure, S.; Dutton, E.G.; DeLuisi, J.J.; Potter, G.L.; Morcrette, J.-J. The Impact of clouds on the shortwave radiation budget of the surface-atmosphere system: interfacing measurements and models. Journal of Climate 6:308-316; 1993.

Cess, R.D.; Potter, G.L.; Gates, W.L.; Morcrette, J.-J.; Corsetti, L. Comparison of general circulation models to Earth Radiation Budget Experiment data: computation of clear-sky fluxes, Journal of Geophysical Research 97: 20,421-20,426; 1992.

Falkowski, P.G.; Kim, Y.K.; Kolber, Z.; Wilson, C.; Wirick, C.; **Cess, R.** Natural versus anthropogenic factors affecting low-level cloud albedo over the North Atlantic, Science 256: 1311-1313;1992.

Cess, R.D.; Harrison, E.F.; Minnis, P.; Barkstrom, B.R.; Ramanathan, V.; Kwon, T.Y. Interpretation of seasonal cloud-climate interactions using earth radiation budget experiment data. Journal of Geophysical Research 97:7613-7617; 1992.

Charlson, R.J.; Schwartz, S.E.; Hales, J.M.; **Cess, R.D.**; Coakley, J.A., Jr.; Hansen, E.; Hofmann, D.J. Climate forcing by anthropogenic aerosols. Science 255:423-430; 1992.

Barnes, C.; **Cochran, J.K.** Uranium geochemistry in estuarine sediments: controls on removal and release process. Geochimica et Cosmochimica Acta 57: 555-569; 1993.

Cochran, J.K.; Buesseler, K.O.; Bacon, M.P.; Livingston, H.D. Thorium isotopes as indictors of particle dynamics in the upper ocean: results form the JGOFS North Atlantic Bloom Experiment. Deep-Sea Research 40:1569-1595; 1993.

Copenhaver, S.; Krishnaswami, S.; Turekian, K.K.; Epler, N.; **Cochran, J.K.** Retardation of U-238 and Th-232 decay chain radionuclides in Long Island and Connecticut aquifers. Geochimica et Cosmochimica Acta 57:597-603; 1993.

Barnes, C.E.; **Cochran, J.K.** Geochemistry of uranium in Black Sea sediments. Deep-Sea Research 38:S1237-S1254; 1992.

Buesseler, K.O.; Bacon, M.P.; **Cochran, J.K.**; Livingston, H.D. Carbon and nitrogen export during the JGOFS North Atlantic Bloom Experiment estimated from Th-234/U-238 disequilibria. Deep-Sea Research 39:1115-1137; 1992.

Buesseler, K.O.; **Cochran, J.K.**; Bacon, M.P.; Livingston, H.D.; Casso, S.A.; Hirschberg, D.; Hartman, M.C.; Fleer, A.P. Determination of thorium isotopes in seawater by non-destructive and radiochemical procedures. Deep-Sea Research 39:1103-1114; 1992.

Cochran, J. K. The Oceanic chemistry of the U-and Th-series nuclides. In: Ivanovich, M.; Harmon, R., eds. Uranium Series Disequilibrium-Application to Environmental Problems:Applications to Earth, Marine, and Environmental Sciences, 2nd Edition; Oxford University Press; pp. 334-395; 1992.

Cochran, J.K.; Landman, N.H. The use of radioisotopes to determine growth rates of marine organisms. Journal of Chemical Education 70:749-754; 1992.

Conley, D.C. Ventilated oscillatory boundary layers. Ph.D. dissertation. Scripps Institution of Oceanography, University of California, San Diego; 1993.

Conley, D.C.; Inman, D.L. Field observations of the fluid-granular boundary layer under nearbreaking waves. Journal of Geophysical Research 97(C6):9631-9643; 1992.

Juanes, F.; Marks, R.E.; McKown, K.A.; **Conover, D.O.** Predation by age-0 bluefish on age-0 anadromous fishes in the Hudson River estuary. Transactions of American Fisheries Society 122:348-356; 1993.

Lagomarsino, I.; **Conover, D.O.** Variation in environmental and genetic sex determining mechanisms across a latitudinal gradient in the fish, *Menidia menidia*. Evolution 47:487-494; 1993.

Marks, R.; **Conover, D.** Ontogenetic shift in the diet of young-of-the-year bluefish *(Pomatomus saltatrix)* during the oceanic phase of the early life history. Fishery Bulletin 91:97-106; 1993.

McBride, R.S.; Ross, J.L.; **Conover, D.O.** Recruitment of bluefish (Pomatomus saltatrix) to estuaries of the South Atlantic Bight, U.S.A. Fishery Bulletin 91:389-395; 1993.

Conover, D.O. Seasonality and the scheduling of life history at different latitudes. Journal of Fish Biology 41(b):161-178; 1992.

Conover, D.O.; Van Voorhees, D.A.; Ehtisham, A. Sex ratio selection and changes in environmental sex determination in laboratory populations of *Menidia menidia*. Evolution 46:1722-1730; 1992.

Present, T.M.C.; **Conover, D.O.** Physiological basis of latitudinal growth differences in *Menidia menidia*: variation in consumption or efficiency? Functional Ecology 6:23-32; 1992.

Conversi, A. Time series studies, and the distinction of anthropogenic from natural variability. *In:* Proceedings of the U.S. - C.I.S. Arabian Sea Workshop. Sevastopol, Crimea, Ukraine, 20-25 September 1993 (in press).

Conversi, A. Lessons from long time series in the Southern California Bight. *Abstract in:* Long Time Series Measurements in the Coastal Ocean: A Workshop. By C.L. Vincent, T.C. Royer and K.H. Brink. Coastal Ocean Processes (CoOP) Report Number 3, pp. 57-59; 1993.

Conversi, A. Variability of water quality data collected near three major Southern California sewage outfalls. Ph.D. Dissertation. Scripps Institution of Oceanography, University of California, San Diego; 1992.

Conversi, A.; McGowan, J.A. Variability of water column transparency, volume flow and suspended solids near San Diego sewage outfall (California): 15 years of data. Chemistry and Ecology 6:133-147; 1992.

Cowen, R.K.; Hare, J.A.; Fahay, M.P. Beyond hydrography: can physical processes explain larval fish assemblages within the middle Atlantic bight? Bulletin of Marine Science 53(2):567-587; 1993.

Hare, J.A.; **Cowen, R.K.** Ecological and evolutionary implications of the larval transport and reproductive strategy of bluefish (*Pomatomus saltatrix*). Marine Ecology Progress Series 98:1-16; 1993.

Currie, R.G. Luni-solar 18.6- and 10-11 year solar cycle signals in USA air temperature records. International Journal of Climatology 13:31-50; 1993.

Currie, R.G.; Wyatt, T.; O'Brien, D.P. Deterministic signals in European fish catches, wine harvests, sea level, and further experiments. International Journal of Climatology 13:665-688; 1993.

Currie, R.G. Deterministic signals in tree-rings from Argentina and Chile. Pure and Applied Geophysics 137:281-300; 1992.

Currie, R.G.; O'Brien, D.P. Deterministic signals in USA precipitation records: Part II. International Journal of Climatology 12:281-304; 1992.

Lee, B.-G; **Fisher, N.S.** Microbially mediated cobalt oxidation in seawater revealed by radiotracer experiments. Limnology and Oceanography 38: 1593-1602; 1993.

Lee, B.-G.; **Fisher, N.S.** Release rates of trace elements and protein from decomposing debris. 1 . Phytoplankton debris. Journal of Marine Research 5 1: 391-421; 1993.

Reinfelder, J.R.; **Fisher, N.S.**; Fowler, S.W.; Teyssie, J.-L..Release rates of trace elements and protein from decomposing debris. 2. Copepod carcasses and sediment trap particulate matter. Journal of Marine Research 51: 423-442; 1993.

Fisher, N. S.; Wente, M. The release of trace elements by dying marine phytoplankton. Deep-Sea Research 40: 671-694; 1993.

Wang, X.L.; **Fisher, N.S.** Determining the surface area of phytoplankton cells in seawater by acid-base titrations. Proceedings of the Pacific Congress on Marine Science and Technology; 1993.

Fisher, N.S. The release of carbon and metals from decomposing phytoplankton. Rapp. Comm. Int. Mer. Medit. 33; addendum; 1992.

Lee, B.-G.; **Fisher, N.S.** 1992. Decomposition and release of elements from zooplankton debris. Marine Ecology Progress Series 88: 117-128.

Lee, B.-G.; **Fisher, N.S.** Degradation and elemental release rates from phytoplankton debris and their geochemical implications. Limnology and Oceanography 37: 13451360; 1992.

Luoma, S.N.; Johns, C; **Fisher, N.S.**; Steinberg, N.A.; Oremland, R.S.; Reinfelder, J.R. Absorption of organo-

selenium and elemental selenium via ingestion in the bivalve *Macoma balthica*. Environmental Science and Technology 26: 485-491; 1992.

Schoonen, M.A.A.; **Fisher, N.S.**; Wente; M. Gold sorption onto pyrite and goethite: a radiotracer study. Geochimica et Cosmochimica Acta 56: 1801-1814; 1992.

Flood, R.D.; Shor, A.N.; Manley, P.L. Morphology of abyssal mud waves at Project MUDWAVES site in the Argentine Basin. Deep-Sea Research II, 40:859-888; 1993.

Mello, G.A.; **Flood, R.D.**; Orsi, T.H.; Lowrie, A. Sedimentary processes and features in the southern Brazil Basin: implications for continental rise evolution. In: Poag, C.W., ed. Geological Evolution of Atlantic Continental Rise. New York: Von Nostrand-Reinhold; pp. 189-213; 1992.

Manley, P.L.; **Flood, R.D.** Paleoflow history determined from mudwave migration: Argentine Basin. Deep-Sea Research II, 40:1033-1055 1993.

Viekman, B.; **Flood, R.D.**; Wimbush, M.; Faghri, M.; Asaho, Y.; Van Leer, J. Sedimentary furrows and organized flow structure: the Lake Superior study. Limnology and Oceanography 37:497-812; 1992.

Fox, J.L.; Production and escape of nitrogen atoms from Mars. Journal of Geophysical Research 98:3197; 1993.

Fox, J. L., J. F. Brannon, and H. S. Porter, Upper limits to the nightside ionosphere of Mars, Geophysical Research Letters, 20:1339, 1993.

J. F. Brannon; **Fox, J. L.** Evidence for day-to-night transport at low solar activity in the Venus pre-dawn ionosphere. Geophysical Research Letters, 20: 2739; 1993.

Fox, J. L., On the escape of oxygen and hydrogen from Mars. Geophysical Research Letters, 20:1747; 1993.

Fox, J. L., Dissociative recombination in planetary ionospheres, In:Rowe, B.R.; Mitchell, J.B.A.; Canosa, A., eds. Dissociative Recombination: Theory, Experiment and Applications. New York: Plenum; pp. 219-242; 1993.

Fox, J. L. Airglow and aurora in the atmospheres of Venus and Mars. In: Luhmann, J.G.; Tatrallyay, M.; Pepin, R., eds. Venus and Mars: Atmospheres, Ionospheres and Solar Wind Interaction; Geophysical Monograph 66; AGU Press; pp. 191-222; 1992.

Fox, J. L., The chemistry of the Venus nightside ionosphere, Planet. Space Sci. 40:1663; 1992.

Kim, Y. H.; **Fox, J. L.**; Porter, H.A. H_3^+ in the Jovian ionosphere: densities and vibrational distribution. Journal Geophysical Research 97:6093; 1992.

Douglass, A.; Rood, R.; Waters, J.; Froidevaux, L.; Read, W.; Elson, L.; **Geller, M.A.**; Chi, Y.; Cerniglia, M.; Steenrod, S. A 3D simulation of the early winter distribution of reactive chlorine in the North Polar vortex. Geophysical Research Letters 20:1271-1274; 1993.

Geller, M.A. Tropospheric forcing of the middle atmosphere. In: Chanin, M.L., Ed., Impact of the Stratosphere on Climate and the Biosphere; Kluwer Press; pp: 29-45; 1993.

Geller, M.A. Planetary wave coupling observations and theory. In: Thrane, E.V., ed. Coupling Processes in the Lower and Middle Atmosphere; Kluwer Press; pp:95-123; 1993.

Geller, M.A.; Chi, Y.; Rood, R.B.; Douglass, A.R.; Allen, D.J.; Cerniglia, M.; Waters, J.W. 3-D transport-chemistry studies of the stratosphere using satellite data together with data assimilation. In: Chanin, M.L., ed. Impact of the Stratosphere on Climate and the Biosphere. Kluwer Press; pp. 179-198; 1993.

Douglass, A.; Rood, R.; Waters, J.; Froidevaux, L.; Read, W.; Elson, L. **Geller, M.A.**; Chi, Y.; Cerniglia, M.; Steenrod, S. A 3-D simulation of the early winter distribution of reactive chlorine in the north polar vortex. Geophysical Research Letters 20:1271-1274; 1993.

Geller, M.A.; Nash, E.R.; Wu, M.F.; Rosenfield, J.E. Residual circulations calculated from satellite data: their relations to observed temperature and ozone distributions. Journal of Atmospheric Sciences 49:1127-1137; 1992.

Geller, M.A.; Chi, Y. Rood, R.B.; Douglass, A.R.; Kaye, J.A.; Allen, D.J.; Satellite observation and mapping of wintertime ozone variability in the lower stratosphere. Journal of Atmospheric and Terrestrial Physics. 55:1081-1088; 1992.

Gerard, V.A. Book review: Saltmarsh Ecology. Quarterly Review of Biology 67:70-71; 1992.

Dignon, J.; **Hameed, S.** Emissions of nitrogen oxides and sulfur oxides from the former Soviet Union. Ambio 21:481-82; 1992.

Hameed, S.; Pittalwala, I. I. The North Pacific oscillation: observations compared with simulations in a general circulation model. Climate Dynamics 6:113-122; 1992.

Sperber,K. R.; **Hameed, S.** Resonant modulation of Nordeste precipitation by tropical Atlantic and Pacific sea-surface temperatures. Proceedings of the 16th Annual Climate Diagnostics Workshop. University of California, Los Angeles; pp. 35-40, 1992.

Sperber, K. R.; **Hameed, S.**; Gates, W. L. Surface currents and equatorial thermocline in a coupled upper ocean-atmosphere GCM. Climate Dynamics;7:21-131; 1992.

Gong, G.; **Hameed, S.**.Temperature variation during historical times in China. In: Yi , Z. et al, eds. Climatic Variation and Its Impact; Beijing: Meteorology Press:1993.

Gong, G.; **Hameed, S.** Relationship between temperature and moisture in China for the last two thousand years. In: Yi , Z. et al, eds. Climatic Variation and Its Impact; Beijing: Meteorology Press;1993.

Gong, G.; **Hameed, S.** Identification of climatically sensitive agricultural areas of China.In: Yi , Z. et al, eds. Climatic Variation and Its Impact; Beijing: Meteorology Press;1993.

Hameed, S.; Sperber, K. R.; Meinster, A. Teleconnections of the southern oscillation in the tropical Atlantic sector in the OSU coupled upper ocean-atmosphere GCM. Journal of Climate 6:487-498; 1993.

Potter, G. L.; Boyle, J. S.; Sperber, K. R.; **Hameed, S.** Effect of spatial resolution on the simulation of regional precipitation in China in a global climate model. Proceedings of the AMS Fourth Symposium on Global Change Studies, UCRL-JC-111835; Anaheim, CA, January 17-22; pp. 34-37; 1993.

Sperber, K. R.; **Hameed, S.** Phase locking of Nordeste precipitation with sea surface temperatures. Geophysical Research Letters 20:113-116; 1993.

Zhenyao, L.; **Hameed, S.**; Zhou, L. Some characteristics of floods and droughts on the Tibetan Plateau during 1883-1984; Journal of Chinese Geography 3:48-57; 1993.

Hedges, J.I.; **Lee, C.**; Wakeham, S.G.; Hernes, P.J.; Peterson, M.L.. Effect of poisons and preservatives on the fluxes and elemental composition of sediment trap materials. Journal of Marine Research 51:651-668; 1993.

Jørgensen, N.O.G.; Kroer, N.; Coffin, R.B.; Yang, X.-H.; **Lee, C.** Dissolved free amino acids, combined amino acids, and DNA as sources of carbon and nitrogen to marine bacteria. Marine Ecology Progress Series 98:135-148; 1993.

Lee, C. Book review: Schidlowski, M. et al., eds. Early Organic Evolution: Implications for Mineral and Energy Resources. Geochimica et Cosmichimica Acta 57:2665-2666; 1993.

Lee, C.; Henrichs, S.M. How the nature of dissolved organic matter might affect the analysis of dissolved organic carbon. Marine Chemistry 41:105-120; 1993.

Peterson, M.L.; Hernes, P.J.; Thoreson, D.S.; Hedges, J.I.; **Lee, C.**; Wakeham, S.G. Field evaluation of a valved sediment trap designed to minimize collection of swimmin animals. Limnology and Oceanography 38:1741-1761; 1993.

Pantoja, S.; **Lee, C.**; Marecek, J.F.; Palenik, B.P. Synthesis and use of fluorescent molecular probes for measuring cell-surface enzymatic oxidation of amino acids and amines in seawater. Analytical Biochemistry 211:210-218; 1993.

Sun, M.; **Lee, C.**; **Aller, R.C.** Anoxic and oxic degradation of ^{14}C-labeled chloropigments and a ^{14}C-labeled diatom in Long Island Sound sediments. Limnology and Oceanography 38:1438-1451; 1993.

Sun, M.; **Lee, C.**; **Aller, R.C.** Laboratory studies of oxic and anoxic degradation of chlorophyll-a in Long Island Sound sediments. Geochimica et Cosmochimica Acta 57:147-157; 1993.

Wakeham, S.G.; **Lee, C.** Production, transport, and alteration of particulate organic matter in the marine water column. In: Engel, M.H.; Macko, S.A., eds. Organic Geochemistry. Plenum Press; pp. 145-169; 1993.

Wakeham, S.G.; Hedges, J.I.; **Lee, C.**; Pease, T. Effect of poisons and preservatives on the composition of organic matter in a sediment trap experiment. Journal of Marine Research 51:669-696; 1993.

Wang, X.-C.; **Lee, C.** Adsorption and desorption of aliphatic amines, amino acids and acetate by clay minerals and marine sediments. Marine Chemistry 44: 1-23; 1993.

Yang, X.-H.; **Lee, C.**; **Scranton, M.I.** Determination of nanomolar amounts of individual dissolved low molecular weight amines and organic acids in seawater. Analytical Chemistry 64:572-576; 1993.

Lee, C. Controls on organic carbon preservation: the use of stratified water bodies to compare intrinsic rates of decomposition in oxic and anoxic systems. Geochimica et Cosmochimica Acta 56:3323-3335; 1992.

Lee, C.; Hedges, J.I.; Wakeham, S.G.; Zhu, N. Effectiveness of poisons and preservatives in retarding bacterial activity in sediment trap material; Limnology and Oceanography 37:117-130; 1992.

Lee, C.; Wakeham, S.G. Organic matter in the water column: future research challenges. Marine Chemistry 39:95-118; 1992.

Weissman, P.; **Lonsdale, D.J.**; **Yen, J.** The effect of peritrich ciliates on the production of *Acartia hudsonica* (Pinhey) (Copepoda: Calanoida) in Long Island Sound. Limnology and Oceanography 38:613-622; 1993.

Lonsdale, D.J.; Weissman, P.; Dobbs, F.C. A reproductive-resting stage in an harpacticoid copepod, and the significance of genetically based differences among populations. Bulletin of Marine Science 53:180-193; 1993.

Lopez, G.R. Absorption of microbes by benthic macrofauna by the C-14:Cr-51 dual labelling method. In: Kemp, P.; et al., eds. Current Methods in Aquatic Microbial Ecology; Boca Raton, Fl: Lewis Publishers; pp.: 739-744; 1993.

Ahn, I.-Y.; **Lopez, G.R.**; Malouf, R. The effects of the gem clam, *Gemma gemma*, on early post-settlement emigration, growth and survival of the hard clam, *Mercenaria mercenaria*. Marine Ecology Progress Series 99:61-70; 1993.

Ahn, I.-Y.; Malouf, R.; **Lopez, G.R.** Enhanced larval settlement of the hard clam, Mercenaria mercenaria, by the gem clam, Gemma gemma. Marine Ecology Pregress Series 99:51-59; 1993.

Clough, L.M.; **Lopez, G.R.** Potential carbon sources for the head-down deposit feeding polychaete *Heteromastus filiformis*. Journal of Marine Research 31:1-22; 1993.

Decho, A.W.; **Lopez, G.R.** Exopolymer microenvironments of microbial flora: multiple and interactive effects on trophic relationships. Limnology and Oceanography 38:1633-1645; 1993.

Hill, A.E.; James, I.D.; Linden, P.F.; Matthews, J.P.; Prandle, D.; Simpson, J.H.; Gmitrowicz, E.M.; Smeed, D.A.; **Lwiza, K.M.M.**; Durazo-Arivizu, R.; Fox, A.D.; Bowers, D.G. Dynamics of tidal mixing fronts in the North Sea. Philosophical Transactions of the Royal Society of London; A; 1993.

McHugh, J.L. The Magnuson Act and the Middle Atlantic Fisheries Underwater Naturalist. Bulletin of the American Littoral Scoiety 22(1):3-11; 1993.

McHugh, J.L. The Magnuson Act and its effect on the fisheries of New York. Bulletin of the Marine Sciences Research Center; 2(1):1-6; 1992.

Morgan, S.G. Predation by planktonic and benthic invertebrates on larvae of estuarine crabs. Journal of Experimental Marine Biology and Ecology 163:91-110; 1992.

De Master, D.J., Dunbar, R.B.; Gordon, L.I.; Leventer, A.R.; Morrison, J.M.; Nelson, D.M.; **Nittrouer, C.A.**; Smith, W.O., Jr. Cycling and accumulations of biogenic silica and organic matter in high-latitude environments: The Ross Sea. Oceanography 5:146-153; 1992.

Harden, S.L.; DeMaster, D.J.; **Nittrouer, C.A.** Developing geochronologies for high-latitude continental shelf deposit: a radiochemical approach. Marine Geology 103:69-98; 1992.

Nittrouer, C.A. Controlling the ingredients that flow to the sea: oceanic processes near river mouths. Oceans 36:12-18; 1993.

Allison, M.A.; **Nittrouer, C.A.**; Kineke, G.C.; Sternberg, R.W. Use of an instrumented tripod system to examine sediment dynamics and fine scale strata formation in muddy surf-zone and nearshore deposits. Journal of Coastal Research (in press, 1993).

Nittrouer, C.A.; Pierson, G.H.; Morrison, J.M.; DeMaster, D.J. The movement of suspended materials in the Ross Sea. Antarctic Journal 27:77-78; 1993.

Nittrouer, C.A.; Wright, L.D. Unique opportunities of oil platforms for the study of sediment transport and accumulation. Marine Technology Society Journal 27:83-86; 1993.

Ackerman, J.D.; **Okubo, A.** Reduced mixing in a marine macrophyte canopy. Functional Ecology 7:305-309; 1993.

Andow, D.A.; Kareiva, P.M.; Levin, S.A.; **Okubo, A.** Spread of invading organisms: patterns of spread. In: Kim, K. C.; McPheron, B.A., eds. Evolution of Insect Pests and Patterns of Variation. J. Wiley & Sons; pp. 219-242; 1993.

Ebbesmeyer, C.C.; Ingraham, W.J.; McKinnon, R.; **Okubo, A.**; Strickland, R.; **Wang, D.-P.**; Willing, P. Bottles appear drifts across the Pacific. EOS 74(16); April 20, American Geophysical Union, Washington, D.C.; 1993.

Okubo, A. The role of diffusion and reltaed physical processes in dispersal and recruitment of marine populations. In: Sammarco, P.W.; Heron, M., eds. Marine Larval Dispersal and Recruitment: An Interdisciplinary Approach; American Geophysical Union; pp. 5-32;1993.

Proctor, L.M.; **Okubo, A.**; Fuhrman, J.A. Calibrating estimates of phage-induced mortality in marine bacteria: ultrastructural studies of marine bacteriophage development from one-step growth experiments. Microbial Ecology 25:161-182; 1993.

Okubo, A. Diffusion and dispersion in coastal waters (discussion). Journal of Hydraulic Engineering 118:655-656; 1992.

Timm, U.; **Okubo, A.** Diffusion-driven instability in a predator-prey system with time varying diffusivities. Journal of Mathematical Biology 30:307-320; 1992.

Yan, X.-H.; **Okubo, A.** Three-dimensional analytical model for the mixed layer depth. Journal of Geophysical Research 97:20,201-20,226;1 1992.

McPhaden, M.J.; **Peters, H.** On the diurnal cycle of internal wave variability in the equatorial Pacific Ocean: results from moored observations. Journal of Physical Oceanography 22: 1317-1329; 1992.

Roethel, F. J.; Chesner, W. H.; Aldous, K.. Laboratory ash-handling evaluation results of fugitive dust and volatilizations studies. In: Proceedings of the Fifth International Conference on MSW Combustor Ash Utilization. pp. 79-97; 1993.

Wente, M.; **Roethel, F. J.** Mobility of dioxins and furans from stabilized incineration residue in seawater. In: Waste Management Research Report, Volume 5, No. 1 State University of New York Press; 1993.

Roethel, F. J.; Breslin, V. T.; Stein, C. Leaching of municipal waste combustion residues. In: Proceeding of the Canadian Forum on Scientific and Regulatory Aspects of Leaching Tests. February 10-11, 1992. Burlington, Ontario.

Roethel, F. J.; Breslin, V. T. Recycling incineration ash residues to create solid masonry cinder blocks. New York Construction News. Section II, June 1992

Schubel, J.R. Dredging and disposal of contaminated sediments: Will we ever dig our way out of the controversy? VIA International, Port of New York-New Jersey, Vol. 45, No. 6;1993

Schubel, J.R. Understanding the environmental impacts of secondary growth. Proceedings of the North Carolina Ocean Outfall Forum, pp. 103-107, April 19-20, 1993.

Schubel, J.R. *Quoted in*: Long Island's Coasts: Meeting the Challenge. Long Island, the Official Magazine of the Long Island Association, Vol. 7, No. 6, pp. 16-18, June 1993.

Schubel, J.R.; Larocca, J. Scenario planning and the future of Long Island's coastline and near-coastal environment. Special Report No. 105, Ref. 93-3, Marine Sciences Research Center, SUNY Stony Brook, NY; 1993.

Schubel, J.R., and L.E. Noonan. Ben-Gurion University of the Negev. Report of a workshop with members of the Board of Governors, 12-13 May 1993. Working Paper No. 64, Ref 93-6, Marine Sciences Research Center, SUNY Stony Brook.

Schubel, J.R.; Schubel, S.E. Environment under stress. The Earth Times, September 7, 1993.

Bowman, M.; Fisher; N.; Schubel, J.R.; Swanson; R.L. Scientific and educational partnerships to alleviate aquatic environmental problems in Eastern Europe. Special Report No. 98, Ref. 92-3 of the Marine Sciences Research Center, SUNY Stony Brook.

Schubel, J.R. The need for new research modalities in waste management. Waste Management Research Report 4(3); 1992.

Schubel, J.R. On refinement of the use of salinity as the basis for a standard to use in conjunction with flow to protect important living resources of the San Francisco estuary. Working Paper No. 96., Ref. 92-1 of the Marine Sciences Research Center, SUNY at Stony Brook, NY; 1992.

Schubel, J.R. Turning Long Island's sensitive environment and its environmental problems into opportunities for entrepreneurs. Special Report No. 101, Ref. No. 92-9, Marine Sciences Research Center, SUNY, Stony Brook, 1992.

Schubel, J.R. Managing freshwater discharge to the San Francisco Bay Delta-Estuary: the scientific basis for an estuarine standard. Special Report No. 102, Ref. 92-10, Marine Sciences Reseearch Center, SUNY, Stony Brook; 1992.

Schubel, J.R.; Gulnick, G. **Conversi, A.** Integrated coastal management (ICM) — an idea whose time has come. Submitted to: Proceedings of the Third International Symposium on Coastal Ocean Space Utilization (COSU III), Santa Margherita Ligure, Italy, March 30-Apr. 2, 1992.

Schubel, J.R.; Neal, H.A., Garbage and Trash: Can We Turn Mountains into Molehills. A monograph in the National Liberal Arts series; 88 pp.; 1992.

Schubel, J.R.; Noonan, L.E. Ben-Gurion University of the Negev. Working Paper No. 61, Ref. 92-11, Marine Sciences Research Center, SUNY Stony Brook; 1992.

Schultz, E.T. Sexual size dimorphism at birth in *Micrometrus minimus* (Embiotocidae): a prenatal cost of reproduction. Copeia 1993: 456-563; 1993.

Schultz, E.T. The effect of birth date on fitness of female dwarf perch, *Micrometrus minimus* (Perciformes: Embiotocidae). Evolution 47:520-539; 1993.

Warner, R.R.; **Schultz, E.T.** Sexual selection and male characteristics in the bluehead wrasse, *Thalassoma bifasciatum*: mating site acquisition, mating site defense, and female choice. Evolution 46:1421-1442; 1992.

deAngelis, M.A.; **Scranton, M.I.**, Fate of methane in the Hudson River and Estuary. Global Biogeochemical Cycles 7:509-523; 1993.

Scranton, M.I.; Crill, P.; deAngeles, M.A.; Donaghay, P.L.; Sieburth, J. McN. The importance of episodic events in controlling the flux of methane from an anoxic basin Global Biogeochemical Cycles 7:491-507; 1993.

Yang, X.; Lee, C; **Scranton, M.I.** Determination of nanomolar amounts of individual dissolved low molecular weight amines and organic acids in seawater. Analyatical Chemistry 65:572-576; 1993.

Monetti, M.; **Scranton, M.I.**.Fatty acid oxidation in anoxic marine sediments: the importance of hydrogen sensitive reactions. Biogeochemistry 17:23-47; 1992.

Swanson, R.L. The incongruity of policies regulating New York City's sewage sludge: lessons for coastal management. Coastal Management 21:299-312; 1993.

Breslin, V.T.; **Swanson, R.L.** Deterioration of starch-plastic composites in the environment. Air and Waste 43:325-335; 1993.

Tonjes, D.; **Swanson, R.L.** What hath Albany wrought? Long Island and the New York State Solid Waste Management Plan. Waste Management Research Report 5(2):2-9; 1993.

Swanson, R.L. et al. 1993. An assessment of impacts associated with implementation of the Suffolk County plastics law, Local Law 10-1988. Waste Management Institute, Marine Sciences Research Center, Special Report No. 106; SUNY; 255 pp. 1993.

Swanson, R.L.; Bortman, M.; Schubel, J.R., eds. Secondary materials: engineering properties, environmental consequences and social and economic impacts. New York State Energy Research Development Authority; No. 93-116; Albany; unnumbered pp.; 1993.

Swanson, R.L. et al. Recreation vs. waste disposal: the use and management of Jamaica Bay. The Long Island Historical Journal 5(1):21-41; 1992.

Swanson, R.L.; West-Valle, A.S.; Decker, C.J. Recreation vs. waste disposal: the use and management of Jamaica Bay. The Long Island Historical Journal 5(1): 21-41; 1992.

Tonjes, D.J. and **Swanson, R.L.** Where does it all go? The size and methods of disposal of Long Island's solid waste, 1986 and 1991. Special Report 103, Marine Sciences Research Center, SUNY Stony Brook, 1992.

Taylor, G.T.; Troy, P.J.; Nullet, M.; Sharma, S.K.; Leibert, B.E.; Mower, H.F. Spectroscopic examination of protein adsorption onto titanium from seawater. Applied Spectroscopy 47:1140-1151; 1993.

Anderson, T.H.; **Taylor, G.T.** Pelagic microbial processes influencing hypoxia in western Long Island Sound. LIS Research Conference, Southern Connecticut State University; October 23-24; Connecticut Sea Grant Publication #CT-SG-93-03; pp. 163-167; 1992.

Xi, K.; Sharma, S.K.; **Taylor, G.T.**; Muenow, D.W. Determination of low concentrations of the azo-dye complex of nitrite in fresh water and seawater using surface-enhanced resonance Raman spectroscopy (SERRS) Applied Spectroscopy 46:819-826; 1992.

Kratz, D.P.; **Varanasi, P.** A reexamination of the greenhouse effect due to CFC-11 and CFC-12. Journal of Quantitative Spectroscopy and Radiative Transfer 48:245-254; 1992.

Varanasi, P. Absorption coefficients of CFC-11 and CFC-12 needed for atmospheric remote sensing and global warming studies. Journal of Quantitative Spectroscopy and Ratiative Transfer 48:205-219; 1992.

Varanasi, P. Absorption spectra of HCFC-22 around 829 cm^{-1} at atmospheric conditions. Journal of Quantitative Spectroscopy and Ratiative Transfer 47:252-255; 1992.

Varanasi, P.; Gopalan, A.; Brannon, J.F. Jr. Infrared absorptio-coefficient data on SF6 applicable to atmospheric remote sensing. Journal of Quantitative Spectroscopy and Radiative Transfer 48:141-145; 1992.

Waliser, D.E.; Gautier, C. A global climatology of the ITCZ. Journal of Climate 6: 2162-2174; 1993.

Waliser, D.E.; Graham, N.E. Convective cloud systems and warm-pool SSTs: coupled interactions and self-regulation. Journal of Geophysical Research 98(D7):12881-12893; 1993.

Waliser, D.E.; Graham, N.E.; Gautier, C. Comparison of the highly reflective cloud and outgoing longwave data sets for use in estimating tropical deep convection. Journal of Climate 6:331-353; 1993.

Jury, M.R.; Pathack, B.; **Waliser, D.E.** Satellite OLR and microwave data as a proxy for rainfall in the Southern Africa Madagascar region. International Journal of Climatology 13:257269; 1993.

VanWoert, M.L.; Whritner, R.H.; **Waliser, D.E.** Bromwich, D.H.; Comiso, J.C. The Antarctic Research Center: a source of multi-sensor satellite data for polar science. Transactions of the American Geophysical Union 73(6): 65; 1992.

Wang, D.-P. The Strait of Gibraltar model: internal tode, diurnal inequality, and fortnightly modulation. Deep Sea Research 40:1187-1203; 1993.

Wang, D.-P.; Wang, C.-W. Sensitivity of acoustic propagation in coastal water. In: Lau, R; Lee, D.; Robinson, A.R., eds. Computational Acoustics, Scattering, Supercomputing and Propagation; North-Holland, pp. 451-456; 1993.

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Flax Pond, Long Island ▲

Salat, J.; Tintore, J.; Font, J.; **Wang, D.-P.**; Vieira, M. Near-inertial motion on the shelf-slope front off northeast Spain. Journal of Geophysical Research 97:7277-7282; 1992.

Weissman, P.; **Lonsdale, D.J.**; **Yen, J.** The effect of peritrich ciliates on the production of *Acartia hudsonica* (Pinhey) (Copepoda: Calanoida) in Long Island Sound. Limnology and Oceanography 38:613-622; 1993.

Schultze, P.C.; Strickler, J.R; Bergstron, B.I.; Berman, M.S.; Donaghay, P.; Gallager, S.; Haney, J.F.; Hargreave, B.R.; Kils, U.; Paffenhofer, G.-A.; Richman, S.; Vanderploeg, H.A.; Welsch, W.; Wethey, D.; **Yen, J.** Video-based instruments for *in situ* studies of zooplankton abundance, distribution, and behavior. Arch. Hydro. Beih. 36:1-21; 1992.

Yen, J. ; Fields, D.M. Escape responses of *Acartia hudsonica* nauplii from the flow field of *Temora longicornis*. Arch. Hydro. Beih. 36:123-134; 1992.

Yen, J. ; Lenz, P.H.; Gassie, D.V.; Hartline, D.K. Mechanoreception in marine copepods: Electrophysiological studies on the first antennae. Journal of Plankton Research 14(4):495-512;1992.

Cess, R. D.; **Zhang, M. H.**; Potter, G. L.; et al. Uncertainties in carbon dioxide radiative forcing in atmospheric general circulation models. Science 262: 1252-1255; 1993.

Randall, D.; **Cess, R.D.**; et al.; and **Zhang, M. H.** Intercomparison and interpretation of surface energy fluxes in atmospheric general circulation models. Journal of Geophysical Research 97, D4; 3711-3724; 1992.

Working Papers & Special Reports

MSRC Working Papers 1992-93

H.J. Bokuniewicz. Environmental conditions along the proposed offshore path of the Transco Pipeline in the Lower Bay of New York Harbor. Ref. 92-05.

H.J. Bokuniewicz. A suggestion for anticipating the effect of local slopes in the DIFID model. Ref. 92-06.

J.R. Schubel, L.E. Noonan. Ben-Gurion University of the Negev. Ref. 92-11.

H.J. Bokuniewicz. Shoreline variations and long-term trends. Ref. 93-04.

A. Harsch, H.J. Bokuniewicz. Character of shelf sand reserves off the south shore of Long Island. Ref. 93-05.

J.R. Schubel, L.E. Noonan. Ben-Gurion University of the Negev. Report of a Workshp with Members of the Board of Governors. Ref. 93-06.

H.J. Bokuniewicz. Stability of the East Rockaway Inlet and the adjacent shoreface. Ref. 94-01.

MSRC Special Reports 1992-93

J.R. Schubel. On the refinement of the use of salinity as the basis for a standard to use in conjunction with flow to protect important living resources of the San Francisco Estuary. Ref. 92-1.

V.J. Breslin. Degradation of starch-based plastics in the environment. Ref. 92-2.

M.J. Bowman, N.S. Fisher, J.R. Schubel, R.L. Swanson. Scientific and educational partnerships to alleviate aquatic environmental problems in Eastern Europe. Ref. 92-03.

A. West-Valle, R.L. Swanson, C. Decker. Use impairments of Jamaica Bay. Ref. 92-04.

D.M. Monteleone, R. Cerrato, D.J. Lonsdale, W.T. Peterson. Abundance and seasonality of key forage species in Long Island Sound. Ref. 92-08.

Co-Sponsors - Long Island Environmental-Economic Roundtable, Long Island Research Institute, Marine Sciences Research Center, The University at Stony Brook's Regional Development Task Force. Ref. 92-09.

J.R. Schubel. Managing freshwater discharge to the San Francisco Bay Delta-Estuary: The scientific basis for an estuarine standard. Ref. 92-10.

Tonjes, D.J. and Swanson, R.L. Where does it all go? The size and methods of disposal of Long Island's solid waste, 1986 and 1991; Ref. 92-12.

Waste Management Institute. Floatable wastes in the ocean. Social, economic, and public health implications. Ref. 93-01.

Long Island Coastal Conference 16-17 June 1993. Sponsored by the Long Island Association, Marine Sciences Research Center, New York State Office of Parks, Recreation and Historic Preservation Nassau County, Suffolk County, NY Sea Grant. Ref. 93-03.

R.L. Swanson, V. Breslin, S. Reaven, S. Ross, R. Young, R. Becker. An assessment of impacts associated with implementation of the Suffolk County Plastics Law. Local Law 10-1988. Ref. 93-04.

Swanson, R.L. et al. An assessment of impacts associated with implementation of the Suffolk County plastics law, Local Law 10-1988. Waste Management Institute, Marine Sciences Research Center. Ref. 93-04.

P.K. Weyl. Envisioning the world ocean partial preliminary version. Ref. 93-07.

Awards

MSRC honored by the "Village Times"

The Village Times, a Three Village weekly newspaper, has an annual tradition honoring men and women of the community for their significant contribuitons. MSRC received this award in 1993 for its contributions in environmental activities.

In the Times' issue honoring their award recipients, news writer Caryn Moller noted that for the past 25 years, the Center "has been striving to raise environmental consciousness... long before environmental conservation became 'politically correct'."

In closing, Moller wrote, "Over the past 25 years, the Marine Science Center has managed to become an integral part of Long Island history and will continue to remain instrumental in shaping Long Island's environmental and consequently its economic future."

RAISING ENVIRONMENTAL CONSCIOUSNESS

Donald Pritchard elected to National Academy of Engineering

Donald W. Pritchard, physical oceanographer and Professor Emeritus of MSRC was elected to the National Academy of Engineering in February 1993. This honor is among the highest professional distinctions conferred to engineers, and a distinction only rarely given to scientists for their contributions to engineering. Pritchard is the second Stony Brook professor to be elected to the National Academy of Engineering, and is one of only 73 people nationwide elected in 1993.

In making the announcement, Dr. Robert M. White, President of the National Academy of Engineering, stated that Pritchard is being honored, "For contributions to understanding the hydrodynamics of estuaries and coastal waters and innovative applications of benefit to the environment and society."

An example of his innovativeness is his work on the problem of salt water intrusion into the Mississippi River—the drinking water source for 1.2 million people—during one of the worst droughts on record in the U.S. He helped design and evaluate the effectiveness of a temporarily constructed submerged weir, or artificial sill, in the lower Mississippi in 1988. This sill was installed to protect the fresh water supplies of the City of New Orleans and adjacent communities from salt water intrusion.

Pritchard, who retired in 1988, joined the MSRC in 1978 as Professor and Associate Director for Research and served as its Acting Dean and Director from 1986 to 1988. "Although Professor Pritchard is officially retired, he continues to play important roles in the education, research, and public service programs of the Marine Sciences Research Center," said MSRC Dean and Director Jerry Schubel.

MSRC's Robert Cess honored as Distinguished Professor

Distinguished professorships are difficult to attain at the State University of New York. Of the University at Stony Brook's more than 1,500 faculty, only 16 have been singled out for this prestigious award, which honors outstanding teachers and researchers. One of these is Professor Robert Cess of MSRC's Institute for Terrestrial and Planetary Atmospheres.

At a ceremony to honor the accomplishments that earned Cess this award, MSRC Dean and Director J. R. Schubel recounted some of his many achievements, awards, honors, titles, and his unusual hobby, collecting and restoring old Alfa Romeo sports cars. "A key to understanding Bob is his desire to understand how things work," said Schubel. "Through most of his life, it seems, he has taken this trait and applied it to many different disciplines from truck mechanic to climate modeler."

His first professional career was as mechanical engineer, joining Stony Brook in 1961 as Associate Professor of Engineering, becoming a full Professor of Engineering in 1965, and winning numerous awards for his heat transfer work. But he began shifting his attention and expertise to heat transfer in planetary atmospheres, and also shifted his appointment in 1975 to Professor of Atmospheric Sciences.

While working on heat transfer in the atmospheres of planets, he decided the Earth's climate was an important problem and began focusing on this planet. For his work in this new career, he received two NASA Langley Group Achievement Awards, as part of the Earth Radiation Budget Experiment — one in 1985 for the the Algorithm Development Team, and one in 1988 for the Data Validation and Archival Team. In 1989 he received the NASA Exceptional Scientific Achievement Medal.

Among his many achievements, Cess has served on a number of national and international committees and panels on world climate problems such as radiation, the effects of trace gases, and greenhouse warming. He is presently a member of the DOE Space Initiative Technical Oversight Group and a member of the Climate Research Committee of the National Academy of Sciences.

Cess received the E.B. Lemon Distinguished Alumni Award from Oregon State University in 1991. At Stony Brook, he was named Leading Professor of Atmospheric Sciences in 1981, Distinguished Service Professor in 1991, and in 1992, Distinguished Professor.

Ben-Gurion University Medal of Service awarded to J. R. Schubel

MSRC's Dean and Director, J. R. Schubel was awarded the Ben-Gurion University Medal of Distinguished Service for his significant contributions in strategic planning for the university's future development as a focal point for progress in light of the peace process and the major role of the Negev Desert in the country's future. These efforts have acted as a critical catalyst in mobilizing the university's various constituencies, faculties, and community agencies to work together in devloping a vision for Ben-Gurion in response to the Israeli government's mandate to double enrollments and extend its educational mission over the next five years.

Degree Recepients 1971-1993

1971-1975

Andrea, Joseph, M.S. '72
Bagg, James E., M.S. '75
Beller, Morris, M.S. '72
Bernero, Mary A., M.S. '72
Brim, Michael S., M.S. '72
Conway, Thomas, M.S. '73
Crosland, Patrick, M.S. '74
Davies, DeWitt, M.S. '72
Dorne, Stephen R., M.S. '72
Ginter, Jay J., M.S. '74
Hinz, Randolph H., M.S. '74
Hoffman, Richard, M.S. '72
Hulse, Glen, M.S. '74
Jay, David A., M.S. '74
Kao, Alan Z., M.S. '75
Kempner, Ann, M.S. '73
Knapp, William, M.S. '74
Koopman, Richard, M.S. '73
Lagna, Lorraine, M.S. '74
Liang, Yu-Jean, M.S. '71
Lin, Paul, M.S. '71
Low, Seth T., M.S. '73
Medeiros, William H., M.S. '74
Milhous, Madison, M.S. '75
Moskowitz, Paul, M.S. '73
Pastalove, Barbara, M.S. '73
Remmer, George, M.S. '73
Retzsch, Walter, M.S. '75
Robbins, Sy F., M.S. '75
Schneider, William J., M.S. '74
Schreiber, Robert, M.S. '73
Silbajoris, Robert A., M.S. '75
Stanton, Donald, M.S. '75
Suda, Joanne J., M.S. '74
Suszkowski, Dennis, M.S. '73
Teng, Tzu-Lin, M.S. '72
Tsao, Allen, M.S. '72
Williams, Anne, M.S. '75
Wise, William M., M.S. '75

1976-1980

Adler, Robert E., M.S. '78
Becker, D. Scott, M.S. '78
Behrens, William, M.S. '78
Bricelj, V. Monica, M.S. '79
Capriulo, Gerard, M.S. '77
Chytalo, Karen N., M.S. '79
Crocker, Douglas, M., M.S. '77
Doyle, Brian, M.S. '76
Erlebacher, Gale R., M.S. '78
Gaertner, Michael, M.S. '76
Green, Gregory T., M.S. '78
Greenhouse, Nathaniel A., M.S. '77
Greges, Monte P., M.S. '79
Grunseich, Gary S., M.S. '77
Haje, Roy, M.S. '76
Hamilton, Andrew D., M.S. '79
Harris, Richard B., M.S. '78
Heaton, Monteith G., M.S. '78
Hirschberg, David J., M.S. '79
Itzkowitz, Norman, M.S. '79
Kaneta, Pamela, M.S. '79
Kaufman, Barbarajean, M.S. '76
Klein, Michael, M.S. '76
Komitor, Robert Ian, M.S., '80
Lekan, John, M.S. '76
Leslie, Jeffrey, M.S. '76
Lynch, Gerald, M.S. '76
McDonough, Kathleen, M.S. '76
Mohr, Peter, M.S. '76
Mirchel, Andrew C., M.S. '80
Nau-Ritter, Glynnis, M.S. '80
Ninivaggi, Dominick, M.S., '79
Olson, Robert, M.S. '76
Parker, Jeffrey, M.S. '76
Penello, Wayne F., M.S. '79
Riper, David M., M.S. '78
Ringler, Warren E., M.S. '79
Robbins, Susan, M.S. '76
Salvo, Joseph, M.S. '76
Schnitzer, Michelle, M.S. '79
Seligman, James D., M.S. '77
Smith, Christopher F., M.S. '79
Steen, Alexis E., M.S. '79
Swartz, Scott M., M.S. '78
Tokos, Joseph J., M.S. '78
Tuthill, Carolyn D., M.S. '77
Underwood, Peter, M.S. '76
Wilke, Richard J., M.S. '78
Wong, Kuo-Chuin, M.S. '78
Wunderlich, Lewis, M.S. '76
Wyman, Kevin D., M.S. '80
Zeitlin, Michael, M.S. '80
Zeppie, Christopher R., M.S. '77

1981-1985

Adamson, Betty Ann, M.S. '82
Alexander, Mark S., M.S. '81
Ambrosio, Edward, M.S. '83
Andrade, Sergio, M.S. '84
Araujo, Rochelle, M.S. '83
Arnold, Chester Lee, M.S. '82
Arcos, Dagoberto R., M.S. '81
Ausubel, Seth, M.S. '83
Barton, Howard III, M.S. '83
Bass, Elizabeth, M.S. '83
Bauer, James, M.S. '84
Boampong, Eric, M.S. '84
Beckman, Brian R., M.S. '85
Breslin, Vincent, M.S. '82
Bricelj, Vera M., Ph.D. '84
Brown, Wendy, M.S. '85
Budin, John, M., M.S. '81
Buckner, Stuart, Ph.D. '84
Campbell, Lisa, M.S. '83
Campbell, Lisa, Ph.D. '85
Capriulo, Gerard, Ph.D. '82
Chang, Jeng, M.S. '84
Chemerys, Ruth, M.S. '83
Cheng, I-Jiunn, M.S. '83
Chiswell, Stephen M., Ph.D. '83
Chu, Gordon, M.S. '81
Chung, Ik-Kyo, M.S. '84
Collins, Stephen A., M.S. '81
Constantine, Laura, M.S. '85
Covell, Stephen A., M.S. '81
Cowan, David, M.S. '85
Cross, Timothy, M.S. '82
Dam-Guerrero, Hans, M.S. '85

Demond, Suzanne, M.S. '84
Dietz, Cynthia, M.S. '82
Douillet, Philippe, M.S. '84
Dube, Paul, M.S. '85
Duncan, Brian, M.S. '83
Edwards, Thomas, M.S. '83
Ellsworth, John, M.S. '82
Evjen, Arthur, M.S. '85
Feldman, Gene, C., M.S. '84
Feldman, Gene C., Ph.D. '85
Filadelfo, Ronald, Ph.D. '84
Firstenberg, Clifford, M.S. '82
Fitzpatrick, Walter III, M.S. '83
Flagg, Paul.J., M.S. '81
Fleischer, Mark, M.S. '83
Fogel, Richard, M.S. '82
Forbes, Thomas, M.S. '84
Forbes, Valery, M.S. '84
Gandarillas, Fernando E., M.S. '81
Gibbons, Mary C., Ph.D. '84
Gilmore, James, M.S. '85
Gold-Kaufman, Zena, M.S. '81
Goodrich, David, M.S. '81
Goodrich, David, Ph.D. '85
Gulbransen, Thomas, M.S. '84
Hasbrouck, Emerson, M.S. '81
Heins, Stephen, M.S. '84
Helm, Nancy, M.S. '83
Horvath, Rose F., M.S. '85
Hudak, John, M.S. '85
Hwang, Lucinda, M.S. '84
Kassner, Jeffrey, M.S. '82
Keith, Debra L., M.S. '85
Kelpin, Geraldine, M.S. '81
Kerner, Joseph P., M.S. '85
Kiene, Ronald, M.S. '84
Knutson, Amy Beth, M.S. '84
Korol, Benjie, M.S. '85
Koutitonsky, Vladimir, Ph.D. '85
Kramer, Jonathan, M.S. '82
Kurkowski, Kenneth, M.S. '81
Lechich, Alex, M.S. '84
Lee, Jin-Ae, M.S. '84
Legier-Visser, Marianne, M.S. '85
Liu, James, M.S. '82
Lively, John, M.S. '81
Lounsbury, Margaret E., M.S. '81
Lundy, Paul, M.S. '82
McCafferty, Shaun, M.S. '82
McDaniel, Julie, M.S. '85
McKown, Kim, M.S. '84
McManus, George, M.S. '81
Michener, Robert, M.S. '85
Monteleone, Doreen, M.S. '84
Murtagh, Richard, M.S. '83
Nardi, George, M.S. '82
Nicolson, John, M.S. '83
Overton, Jeffrey, M.S. '83
Paige, Carrie, M.S. '84
Park, Moon-Jin, M.S. '85
Park, Yong C., Ph.D. '85
Reese, Dwight, M.S. '82
Revelas, Eugene, M.S. '84
Richmond, Robert, M.S. '82
Rivara, Gregg, M.S. '85
Ro, Young-Jae, Ph.D. '85
Roethel, Frank J., Ph.D. '81
Rose, Hal, M.S., '81
Ruben, Howard J., M.S. '85
Sanderson, Brian, Ph.D. '82
Sarokin, David J., M.S. '81
Schaeffer, Jeffrey, M.S. '82
Schlenk, Cornelia, M.S. '83
Schneier, Shaun, M.S. '83
Schrey, Suzanne, M.S. '83
Shieh, Chih-Shin, M.S. '84
Simon, Harvey, M.S. '83
Slauson, Timothy, M.S. '82
Snow, Jeffrey, M.S. '82
Snyder, Barry, M.S. '85
Tanski, Joseph J., M.S. '81
Tewksbury, Hamilton T., M.S. '85
Turner, Elizabeth, M.S. '83
Ullman, David, M.S. '84
Valente, Raymond M., M.S. '85
Wong, Kuo-Chuin, Ph.D. '81
Wilson, Thomas, M.S. '83
Yamamoto, Nobuyuki, M.S. '83
Yarish, Seth, M.S. '85
Zimmerman, John, M.S. '83
Zimmerman, Mindy, M.S. '83
Zertuche, Jose G., M.S. '81
Zion, Philip, M.S. '82

1986-1990

Ahn, In-Young, Ph.D. '90
Anders, Merri, M.S. '86
Antia, Avan, M.S. '87
Appelmans, Nicholas, M.S. '89
Arcos, Dagoberto, Ph.D. '87
Arenwald, Joanne, M.S. '87
Arnold, Lynn, M.S. '86
Bellantoni, Diane, M.S. '87
Beristain, Melissa, M.S. '87
Cahalan, Jennifer, M.S. '88
Castro, Leonardo, M.S. '90
Chang, Jeng, Ph.D. '89
Chiaraviglio, Andrew, M.S. '89
Chiarella, Louis, M.S. '88
Chen, Dake, Ph.D. '90
Cheng, I-Jiunn, Ph.D. '88
Chung, Ik-Kyo, Ph.D. '87
Cohen, Melissa, M.S. '90
Costa, Frances, M.S. '89
Cottrell, Matthew, M.S. '88
Dam-Guerrero, Hans, Ph.D. '89
Davies, DeWitt, Ph.D. '90
Day, Elizabeth, M.S. '87
DiLorenzo, Joseph, Ph.D. '86
Dornblaser, Mark, M.S. '86
Drew, Catherine, M.S. '86
Dzurica, Susan, M.S. '88
DuBois, Kevin, M.S. '86
Epp, Jennifer, M.S. '89
Forbes, Thomas, Ph.D. '89
Forbes, Valery, Ph.D. '88
Fouke, Susan, M.S. '88
Garcia-Esquivel, Zaul, M.S. '90
Gayes, Paul, Ph.D. '87
Gomez-Reyes, Eugenio, M.S. '86
Gomez-Reyes, Eugenio, Ph.D. '89
Greene, Richard M., Ph.D. '90
Hennessy, John, M.S. '86
Henry, Diane, M.S. '90
Hutahaen, Walman, M.S. '90
Jacobson, Myrna, Ph.D. '90
Johnson, Thomas D., Ph.D. '87
Kerr, Robert P., M.S. '86
Kiene, Ronald, Ph.D. '86
Kim, Byung-Hwan, M.S. '89
Kuenstner, Susan, M.S. '88
Lagomarsino, Irma M.S., '90
Lee, Byeong-Gweon, M.S. '90
Lee, Jin-Ae, Ph.D. '87
Lee, Jonghyeon, M.S. '88
Lee, Sanghoon, M.S. '86
Lee, Sanghoon, Ph.D. '90
Liu, James, Ph.D. '87
Madden, Barbara, M.S. '86
Malione, Bernice, M.S. '87
Marshall, Greg J., M.S. '88
Matteoda, Anna, M.S. '86
McBride, Richard, M.S. '89
McKibbin, Thomas, M.S. '89
McManus, George, Ph.D. '86
McTiernan, Lawrence, M.S. '89
Meade, Melanie, M.S. '88
Michelson, Amy, M.S. '86
Mitchell, James, Ph.D. '88
Monaco, Cindy, M.S. '90
Monteleone, Doreen, Ph.D. '88
Nelson, Christopher L., M.S. '88
Novelli, Paul, Ph.D. '87
Nyman, Robert, M.S. '87
O'Hare, Mary Ann, M.S. '87
Ohla, Joseph, M.S. '90
Olaizola, Miguel, M.S. '86
O'Neill, Judith, M.S. '87
Pabst, Douglas, M.S. '87
Park, Jang-Geun, M.S. '89
Park, Kyeong, M.S. '87

Park, Moon-Jin, Ph.D. '90
Pavlik, Barbara, M.S. '88
Pohle, David, M.S. '90
Qadri, Anwar, M.S. '89
Quaglietta, Clare Ellen, M.S. '87
Salamanca, Marco, M.S. '88
Shima, Michiyo, M.S. '89
Slater, Jennifer, Ph.D. '86
Smith, George L., M.S. '86
Sneed, Sharon, M.S. '86
Subramaniam, Ajit, M.S. '89
Swider, Kenneth, M.S. '88
Tangren, Sara A., M.S. '88
Tantichodok, Pitiwong, Ph.D. '90
Tedesco, Mark, M.S. '86
Tsien, Hsiao-shu, M.S. '86
Valle-LeVinson, Arnoldo, M.S. '88
Visser, Andre, Ph.D. '89
Wang, Xu-Chen, M.S. '89
West, Anne, M.S. '89
Wiggins, Mark, M.S. '86
Wong, Shou-lien, M.S. '89
Yan, Xiao-hai, Ph.D. '89
Yedwabnick-Barnes, D., M.S. '86
Young, Randall, M.S. '90
Zertuche, Jose A., Ph.D. '88
Zhu, Ningli, M.S. '90

1991-1995

Agostini, Vera, M.S. '93
Allison, Mead, Ph.D. '93
Barnes, Christina, Ph.D. '91
Barr-Kumarakulasinghe, S., M.S. '92
Bauman, Jill, M.S. '93
Ben-Porath, Judith, M.S. '93
Boekhoudt, Byron, M.S. '92
Cenni, Serena, M.S. '91
Chant, Robert, M.S. '91
Chen, Minghang, Ph.D. '93
Clough, Lisa, Ph.D. '93
Decker, Cynthia, Ph.D. '92
Dooley, Patrick, M.S. '93
Epler, Nathan, Ph.D. '91
Eshet, Yuval, M.S. '91
Fields, David, M.S. '91
Galindo, Karen, M.S. '93
Gomez-Valdes, Jose, Ph.D. '93
Green, Mark, M.S. '91
Gupta, Sanjay, M.S. '92
Hamukuaya, Hashali, M.S. '91
Hince, Eric, M.S. '91
Jonasdottir, Sigrun, Ph.D. '92
Juanes, Francis, Ph.D. '92
Kazumi, Junko, Ph.D. '92
Kim, Woong-Seo, Ph.D. '93
Lee, Byeong-Gweon, Ph.D. '93
Lee, Jihyun, M.S. '93
Li, Boen, M.S. '92
Marks, Richard, M.S. '91
Mau, Jenq-Chi, M.S. '92
McShane, Kathleen, M.S. '91
Merkle, Peter, M.S. '91
Milligan, Allen, M.S. '92
Monetti, Matthew, M.S. '91
Morgan, Matthew, M.S. '93
Niño-Lopez, Rafael, M.S. '93
Olaizola, Miguel, Ph.D. '93
Pantoja, Silvio, M.S. '92
Parrella, Andrew, M.S. '92
Pierson, Geoffrey, M.S. '93
Proctor, Lita, Ph.D. '91
Ranheim, Robert, M.S. '91
Reinfelder, John, Ph.D. '93
Rotunno, Theresa, M.S. '92
Rude, Peter, Ph.D. '91
Salamanca, Marco, Ph.D. '93
Schubert, Christopher, M.S. '91
Seplow, Stacey, M.S. '91
Shen, Jiong, M.S. '93
Shi, Yan, M.S. '92
Siddiqui, Pirzada, Ph.D. '92
Sobel, Jack, M.S. '92
Sommerfield, Christopher, M.S. '93
Sosebee, Katherine, M.S. '91
Streib, Max, M.S. '92
Stupakoff, Ian, M.S. '93
Sun, Jianguo, M.S. '93
Sun, Ming-yi, Ph.D. '92
Tegge, Ralph, M.S. '92
Tisdell, Shawn, M.S. '93
Valle-LeVinson, Arnoldo, Ph.D. '92
Vigil, Heidi, M.S. '91
Wallace, Heather, M.S. '91
Wallace, William, M.S. '92
Wang, Chung-Wu, Ph.D. '93
Wang, Jing, M.S. '93
Wang, Xu-Chen, Ph.D. '93
Ward, Todd, M.S. '93
Weissman, Penny, M.S. '91
Wente, Maryann, M.S. '91
Wu, Hanguo, M.S. '93
Xia, Qing, M.S. '91
Yang, Xiaohua, M.S. '91
Zahn, Stephen, M.S. '93
Zhang, Chongle, M.S. '92
Zhang, Yingyi, M.S. '92
Zhou, Meng, Ph.D. '92
Zimmer, Robert, M.S. '91

MSRC HIGHLIGHTS

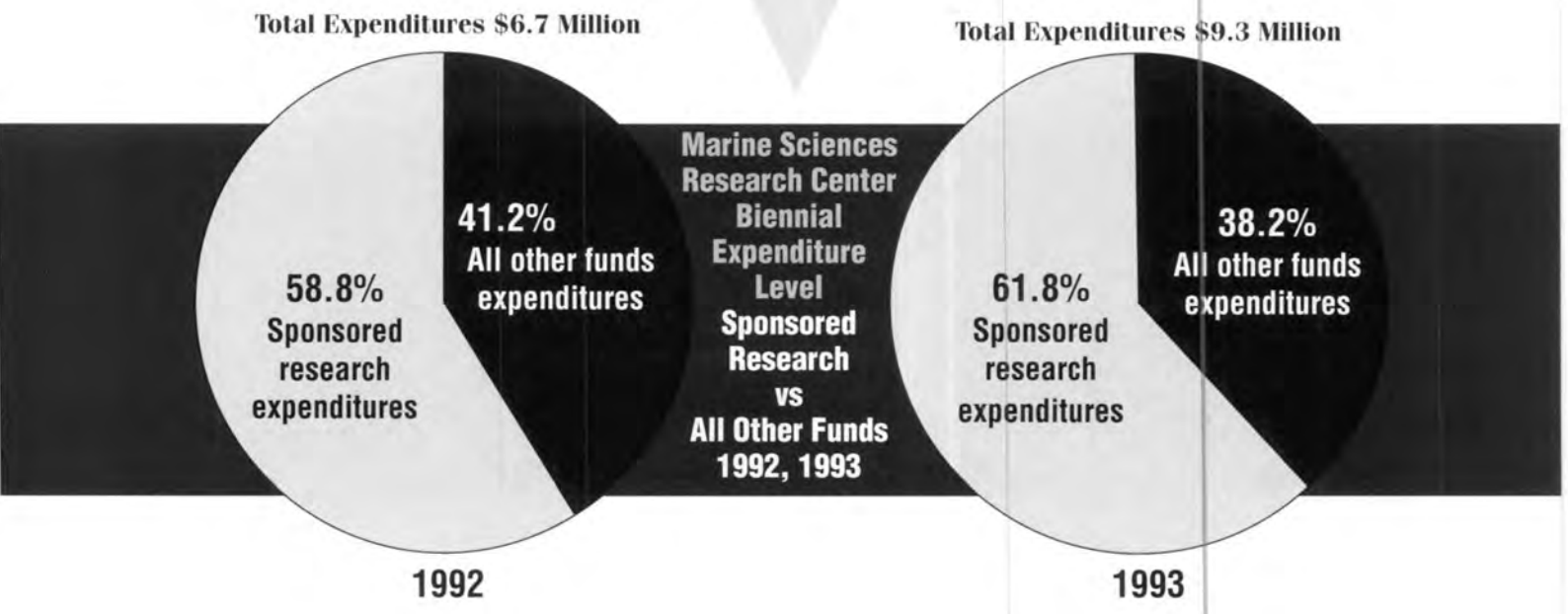
International Dinner

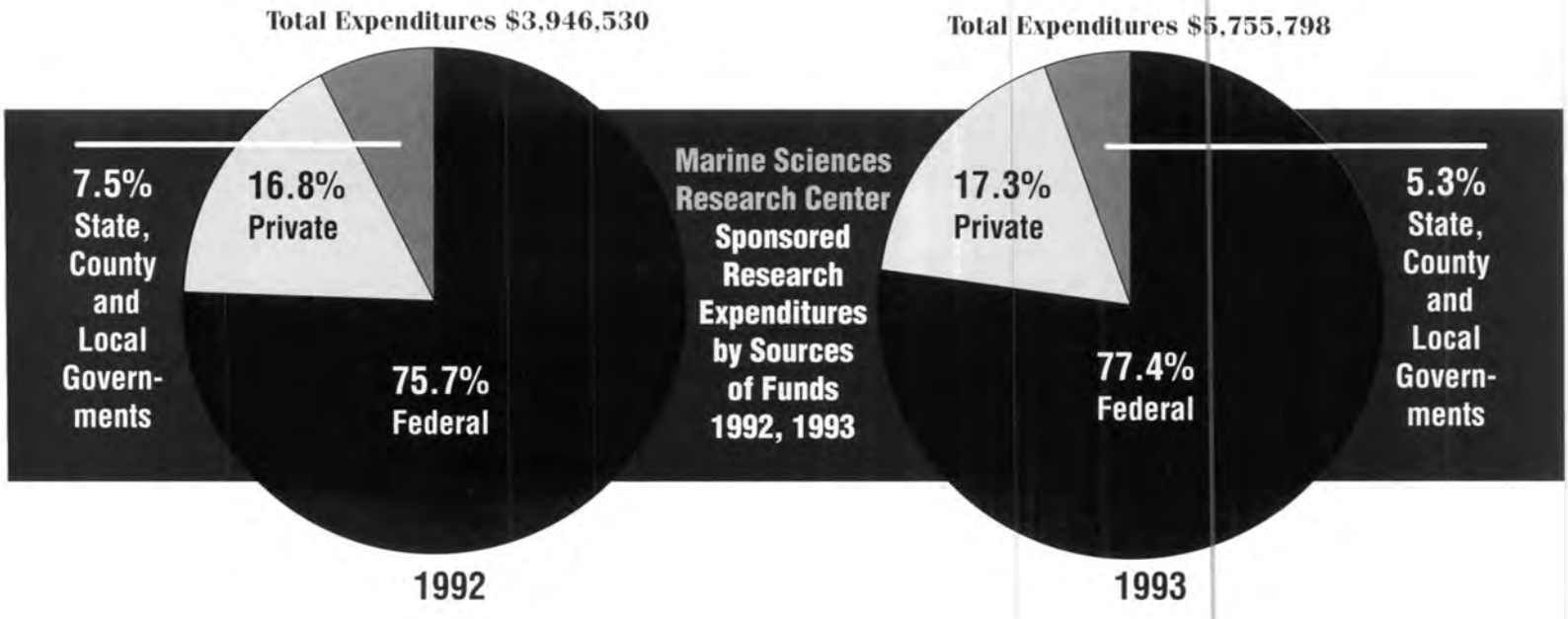
A number of events draw MSRC students, faculty, and staff together socially. One event is the annual Flax (Pond) to VAX (MSRC computer facilities) foot race and pot luck picnic afterwards. Another is the annual international dinner, when faculty, students, and staff prepare and share dishes from all nations.

In the past, the menu has featured dishes from Sri Lanka, India, Mexico, Columbia, Chile, Tanzania, China, Japan, Italy, France, Brazil, and the U.S. Following the dinner, talent of all types takes center stage — musicians and quipsters entertain with parodies, skits, songs, and dances that last into the evening.

photo by Ian Stupakoff

Finances


Total Expenditures $6.7 Million
41.2%
All other funds
expenditures
58.8%
Sponsored
research
expenditures
1992
Marine Sciences
Research Center
Biennial
Expenditure
Level
Sponsored
Research
vs
All Other Funds
1992, 1993
Total Expenditures $9.3 Million
38.2%
All other funds
expenditures
61.8%
Sponsored
research
expenditures
1993


Total Expenditures $3,946,530
7.5%
State,
County
and
Local
Govern-
ments
16.8%
Private
75.7%
Federal
1992
Marine Sciences
Research Center
Sponsored
Research
Expenditures
by Sources
of Funds
1992, 1993
Total Expenditures $5,755,798
17.3%
Private
77.4%
Federal
5.3%
State,
County
and
Local
Govern-
ments
1993

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Discrimination is unlawful. If you are a student or an employee of SUNY Stony Brook and you consider yourself to be a victim of illegal discrimination, you may file a grievance in writing with the Affirmative Action Office within forty-five (45) calendar days of the alleged discriminatory act. If you choose to file a complaint within the University, you do not lose your right to file with an outside enforcement agency such as the State Division of Human Rights or Equal Employment Opportunity Commission.


STONY
BROOK