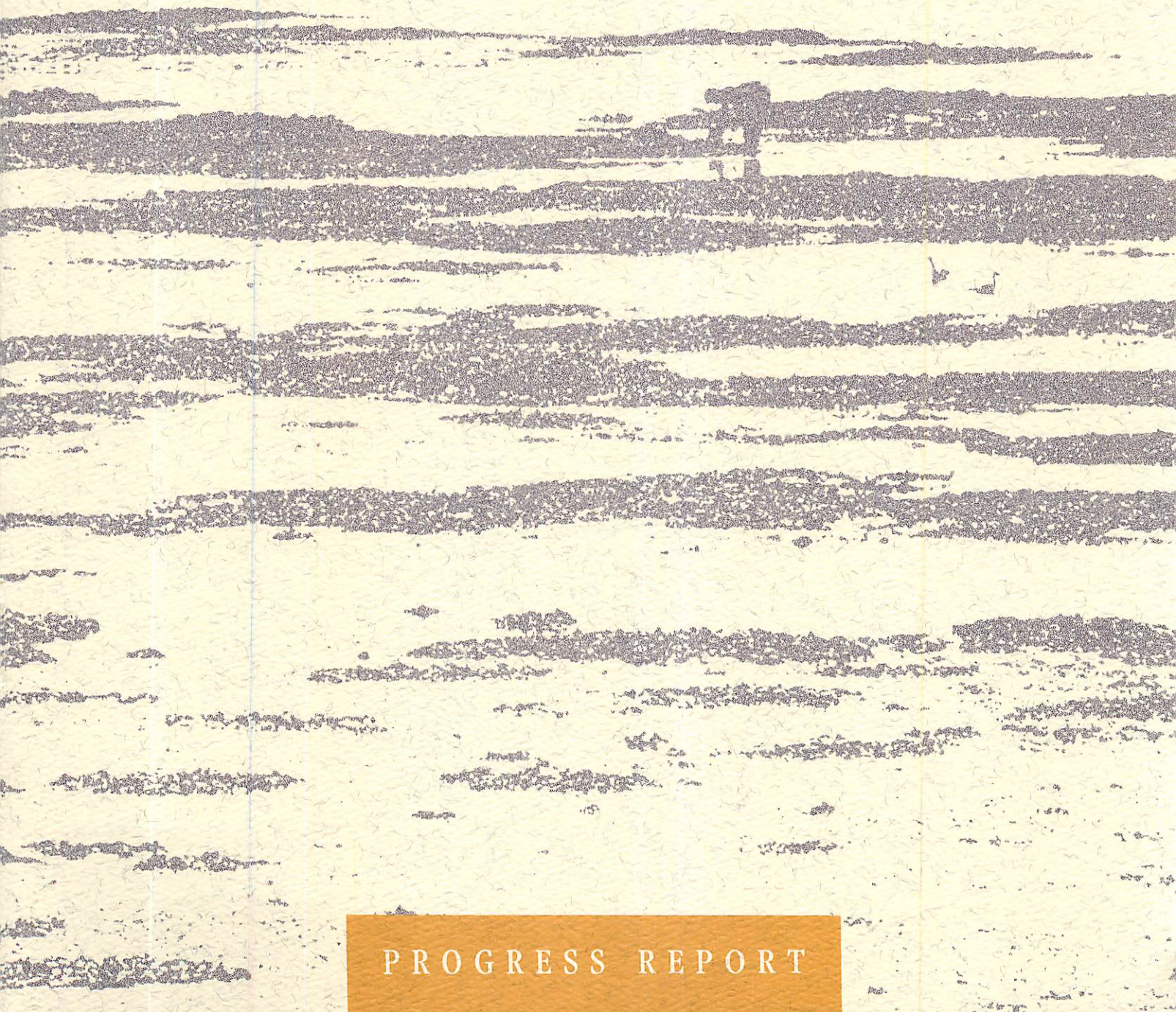


CONNECTICUT SEA GRANT

COLLEGE PROGRAM



PROGRESS REPORT

The Connecticut Sea Grant College Program is sponsored by the National Sea Grant College Program,
National Oceanic and Atmospheric Administration,
United States Department of Commerce,
under grant NA 90AA-D-SG443.

The Connecticut Sea Grant College Program at the University of Connecticut Marine Sciences Institute is part of a national network of university-based programs in coastal and Great Lakes states, established by Congress in 1966 and modeled after the Land Grant Colleges, and is supported by federal and state funds. Connecticut Sea Grant fosters the wise use of marine and coastal resources through research, outreach and education.

This report covers the funding period between July 1, 1990 and June 30, 1992.

Written and edited by Peg Van Patten and Ken Sherwood.
Designed and illustrated by Judy Ricketts-White.
Cover photo by Michael J. Vitti.

Additional single copies are available free of charge from:

Connecticut Sea Grant Publications
University of Connecticut
1084 Shennecossett Rd.
Groton, CT 06340-6097



The Connecticut Sea Grant College Program Report CT-SG-94-02

PROGRESS REPORT

TABLE OF CONTENTS

L	ETTER FROM THE DIRECTOR	
	Edward C. Monahan.....	2
MARINE BIOTECHNOLOGY		
	Crustacean Growth and Reproduction.....	4
	Applications of Biochemical Genetics to Kelp.....	6
LIVING BENTHIC MARINE RESOURCES		
	Neoplasia in Clams.....	8
	Salt Tolerance in Sponges.....	10
NUISANCE SPECIES		
	Zebra Mussels and Ballast Water.....	12
COASTAL PROCESSES		
	Sea Level Rise.....	14
CLIMATE CHANGE AND SEA LEVEL RISE		
	Economic Implications.....	16
PROGRAM DEVELOPMENT		
	Ghost-Busters at Sea!.....	18
EDUCATION		
	Marine Studies Sourcebook.....	20
LANDS ACROSS THE WATERS		
	Irish-American Aquaculture Program.....	22
	SEA GRANT MARINE ADVISORY PROGRAM.....	24
LONG ISLAND SOUND STUDY		
	Public Involvement Program.....	26
	COMMUNICATIONS/PUBLICATIONS.....	28
	FINANCIAL REPORT.....	30
	JOURNAL ARTICLES.....	32

LETTER FROM THE DIRECTOR

EDWARD C. MONAHAN

One is tempted to comment, when searching for a description of the biennium covered by this Progress Report, that it has been a period marked by “highs and lows” for our Connecticut Sea Grant College Program. But I would hasten to add that the “highs” have far outweighed the “lows” in the past biennium, and I am confident that this is an objective assessment, not simply a reflection of the optimistic outlook which forms a necessary part of the tool kit of all program stewards in the ‘90’s.

Indeed, the one “low” point for our program worthy of mention, was the early retirement of the Sea Grant Office’s long-serving Administrative Assistant, Ms. Eleanor Minik. Eleanor took with her much of this office’s memory of the early days of Sea Grant in Connecticut. While we were sad to see Eleanor depart, I know I speak for all of her former colleagues when I wish her well in retirement. We look forward to the day when the economic circumstances of the State of Connecticut will be such that we can fill the void created by Eleanor’s retirement.

We are fortunate in being able to report that federal support for the Connecticut Sea Grant College Program, both financial and programmatic, has been one of the “high” points over the past two years. While the “core” Sea Grant support for the recent biennium was essen-

tially level with the “core” support for the previous two-year period, significant additional support was garnered for several major program activities via “pass-through” funding originating in other Federal agencies. We were very pleased that our program was awarded more than \$100,000 via the Sea Grant Zebra Mussel Initiative to support the research on that nuisance species being carried out by Dr. Jim Carlton at Williams College-Mystic Seaport.

“Pass-through” funding from the U.S. Environmental Protection Agency again made possible our program’s outreach effort on behalf of the Long Island Sound Study’s public education and participation initiative, and “pass-through” monies from the U.S. Coast Guard are supporting additional work by Dr. Carlton on the importation in ballast waters of various alien species.

The evolution of the Irish American Aquaculture Initiative, an international technology transfer effort for which our office has undertaken the coordinating role on behalf of the Sea Grant College Programs in New England and New York, has certainly been another “high” point for us in the past two years. It has been a delight to sense the positive response of industrial development officials, in the Republic of Ireland and likewise in Northern Ireland, to the Sea Grant approach of bringing the insights and knowledge

of the university to bear on the practical issues of commercial development, especially as they relate to small marine enterprises.

We are particularly pleased that the omnibus proposal prepared during the 1990-1992 biennium, the first of our proposals evaluated under the new NOAA competitive procedures, has resulted in our program being given an 18.6% increase in its level of “core” Sea Grant support for the upcoming 1992-1994 biennial period. I want to acknowledge with thanks the efforts of all our project P.I.’s and of the hard-working staff in our Sea Grant Office, efforts that were responsible for this much-needed “shot-in-the-arm”.

We were delighted that our Communications Office was the beneficiary of a \$5,000 gift from McDonalds Foods, a gift used to support our 1991 Coastweeks activities, an effort carried out jointly with the Connecticut Department of Environmental Protection. Gifts and awards such as this, at times like these, make all the difference. We cherish each of them!

The detailed evaluation of our program that resulted from the recent proposal review and site visit confirmed our impression of the strengths of our Sea Grant Marine Advisory Program, and of our Communications effort. This same document urged us to expand the

research component of our program. This is a charge that we have already taken to heart.

Looking to our sister programs for guidance as to how to proceed, we have set about a quest for an Assistant Director for Research, or for a group of Subject Area Coordinators, to help our office in its role of encouraging and guiding faculty members, in particular new faculty members, in the preparation of Sea Grant Research Project proposals. In our search for such assistance we are fortunate to have within the universities and colleges of Connecticut such a depth of intellectual resources. We are confident that as we go about expanding the coordination of research efforts, and identifying new areas of research focus, we will also be strengthening the already strong bonds between the various campuses of the University of Connecticut, and between UConn and its sister universities and colleges in this state.



Edward C. Monahan, Ph.D., D.Sc.
Director, Connecticut Sea Grant
College Program



Signing the historic Irish-American agreement are, seated from left, Boston Mayor Raymond Flynn and Connecticut Sea Grant Director, Edward C. Monahan representing the Northeast Sea Grant programs. Looking on are, from left, Ralph O'Gorman, Udaras na Gaeltachta (an Irish economic development agency); Mary O'Rourke, Ireland Minister of Education and John P. Mercer, representing University College, Galway (Republic of Ireland).

MARINE BIOTECHNOLOGY

CRUSTACEAN GROWTH AND REPRODUCTION

Dr. Hans Laufer, professor of molecular and cell biology at the University of Connecticut, has been studying the hormones in crustaceans that are similar to the juvenile hormones already known to exist in insects. Since insects and crustaceans have many things in common (they are both arthropods with jointed legs), it is conceivable that their growth and reproduction are regulated by similar chemical compounds.

In 1987 Laufer and his associates identified a juvenile hormone-like compound, *methyl farnesoate* (MF), that appears to regulate metamorphosis in crustaceans in the same way a similar compound (JH III) does in insects. MF is an organic compound found in the blood of certain crabs, lobsters and shrimp, and it may have other important physiological functions in addition to regulating metamorphosis. Depending on the life cycle of the animal, it may affect either the animal's morphology or its gonadal maturation. In addition, MF may be involved in the vitellogenesis (yolk protein synthesis) of females, and in

enhancing the growth of the reproduction system of males.

Laufer also identified the site where MF is formed, the mandibular organ located on the tendon of the jaws, and he found that the formation and release of methyl farnesoate is regulated by a gland in the animal's eyestalks. Removing the eyestalks in some crabs induces the final molt, but prevents the metamorphosis into the adult form, producing abnormally large juveniles.

While Laufer's previous Sea Grant work focused on crabs and lobsters, his current project extends the application to shrimp and prawn, and his latest discovery has the potential to revolutionize commercial crustacean aquaculture, brightening the outlook for the world's food supply, especially that of shrimp cocktail lovers everywhere.

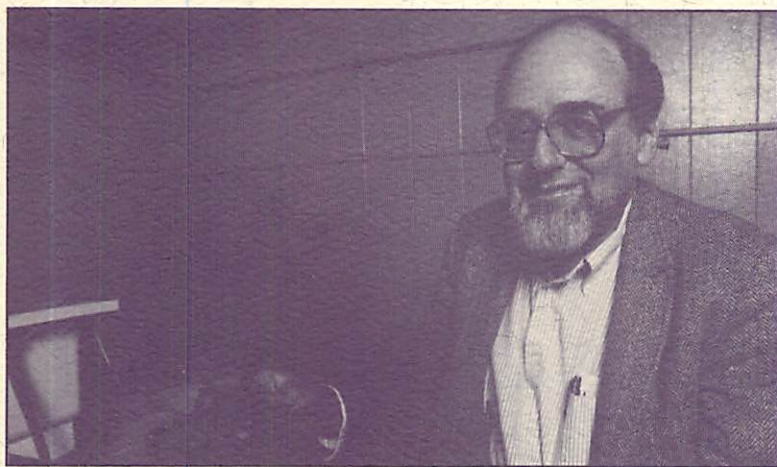
Laufer has devised a method for introducing a vital reproductive hormone into shrimp feed to grow them to maturity in commercial hatcheries. He made his discovery while working with the Pacific white shrimp, *Panaeus vannamei*, a large, tasty, fast-growing, disease-resistant species. A U.S. Patent

"BRIGHTENING
THE OUTLOOK FOR
THE WORLD'S
FOOD SUPPLY.
ESPECIALLY
THAT OF SHRIMP
COCKTAIL LOVERS
EVERYWHERE."





*Male morphotypes of the spider crab *Libinia emarginata*. Left, large claw unabraded; right, large claw abraded.*



Hans Laufer is shedding light on the process of crustacean reproduction by studying the spider crab's endocrine system.

has been issued to the University of Connecticut for the process, and while the initial research involved shrimp, the biotechnology can also be applied to other crustaceans.

Shrimp don't reproduce well in captivity, either in a laboratory or at shrimp farms, and crustaceans harvested from the sea are often infected with viruses harmful to shrimp (although not humans). Larvae produced and protected in captivity, on the other hand, do not readily mature, leaving a shortage of viable eggs. Laufer's method now offers the means to produce that necessary supply of eggs.

Improving our understanding of the way crustaceans grow and reproduce will benefit the seafood industry tremendously, producing greater numbers and improving stocks while decreasing expenses. Ultimately, it will augment the world's food supply.

MARINE BIOTECHNOLOGY

APPLICATIONS OF BIOCHEMICAL GENETICS TO KELP

Evolutionary relationships and taxonomy among macroalgae are poorly understood, because so much variation in form and structure can occur within a species, under different conditions. In a joint project of the Connecticut and New Hampshire Sea Grant programs, researchers have developed techniques to compare the genetic similarities and differences of brown seaweeds. Dr. Charles Yarish, Professor of Ecology and Evolutionary Biology at the University of Connecticut at Stamford, with Dr. Chris Neefus and colleagues at the University of New Hampshire, tested electrophoresis procedures and used them to track genetic markers in kelp. Although similar past attempts were inadequate, these investigators screened and modified many sample preparation techniques, using starch gels with various buffers and stains. Using these procedures, they performed isozyme electrophoresis on populations collected at different locations from eight species of kelp.

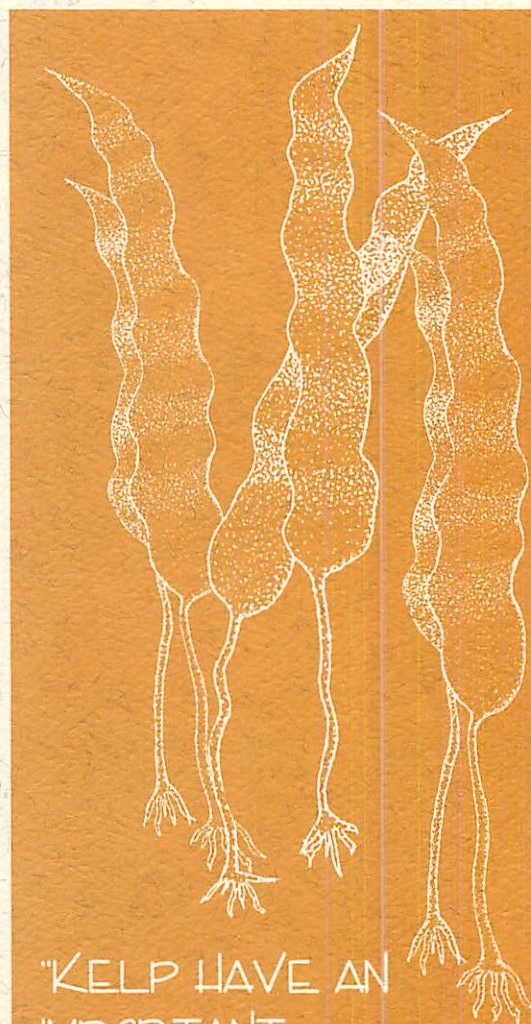
Pieces of kelp were ground with liquid nitrogen, using a mortar and pestle, then mixed with a buffer for protein extraction. Samples were then thawed and the extract absorbed onto

paper wicks and electrophoresed in starch gels. In electrophoresis, molecules with an electric charge migrate in a solution, under the influence of electric current.

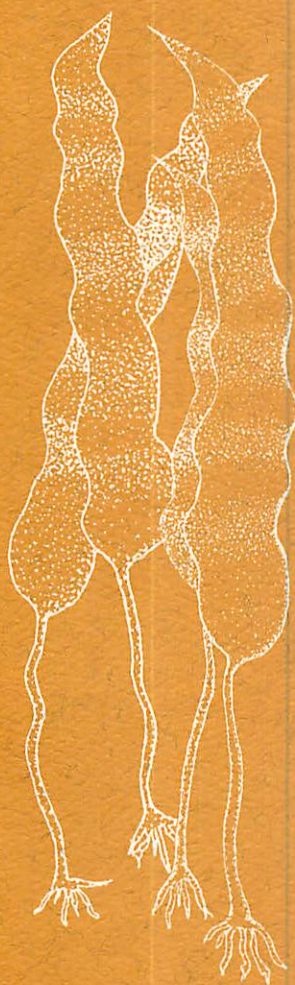
Because enzyme molecules travel varying distances along a path through a starch gel, stopping at different positions, the enzymes can be separated. The molecules, which have been stained, change color in the presence of ATP, forming distinct markings or bands in the gel. These bands can be compared and interpreted as differentiation in genetic structure.

Using these procedures, the research team was able to obtain distinct bands for 20 enzymes. Results showed that kelp populations have very similar enzymes, indicating only minor genetic differences. This may imply a recent evolution of the group as a whole, or may reflect minor variations that occurred in kelp that arose from restricted post-glacial populations in the western North Atlantic.

Kelp have an important ecological role in subtidal coastal ecosystems and are valuable commercially as food, fertilizer, and a source of algin, an emulsifier used in paper, fabric, cosmetic, and pharmaceutical products.




"KELP HAVE AN
IMPORTANT
ECOLOGICAL
ROLE IN SUBTIDAL
COASTAL
ECOSYSTEMS."



As a first step in the electrophoresis procedure, kelp samples from several locations were ground with liquid nitrogen using a mortar and pestle, then mixed with a buffer to prepare for protein extraction.

LIVING BENTHIC MARINE RESOURCES

NEOPLASIA IN CLAMS

ematopoietic neoplasia, a leukemia-like disease in soft-shell clams, has reached epidemic levels in some clam populations along the north Atlantic seaboard. Research by Diane Brousseau and her colleagues has shown that some populations in Long Island Sound are among those in which the disease is prevalent. More than 60% of the animals are infected in some areas of Massachusetts, Connecticut, and Rhode Island.

While the disease is not harmful to consumers or predators who eat the clams, it can be devastating indeed to the clam populations. As the disease progresses, abnormal hemocyte cells form, giving the blood a cloudy appearance. Tissue and organ damage can occur in severely diseased animals. No wonder that fisheries managers and shellfishing industries are anxious to get a handle on how the disease spreads and how serious its consequences are.

For three years, Brousseau, a Professor of Biology at Fairfield University, has conducted both field and laboratory tests to determine how widespread the disease is in Connecticut, and whether the disease results in high mortality. Brousseau and her colleagues "bleed" the clam and examine the blood samples microscopically to

determine the presence and extent of the disease. They then mark the clams by attaching numbers to their shells, and return them to the clam bed. When they dig the clams up again later on, they examine the same clams again to see if and how much the disease has progressed, and how many have died.

Results showed that, under normal conditions, neoplasia does result in high mortalities. Brousseau has found 51% mortality in severely diseased clams and 6 to 34% mortality in less severely infected clams, compared to only 3% mortality in clams without neoplasia. While the disease is very likely to progress over time, as most diseases do, complete remission can occur if the severity is low. About 16% of the clams in the field experiments underwent such remissions. In addition, Brousseau found that more deaths occur in the springtime, when temperatures are rising and metabolic activity is increasing.

Animals with advanced hemato-poietic neoplasia may be immunocompromised, Brousseau suggests, and thus more susceptible to bacterial infections. By examining the clams' blood chemistry, Brousseau hopes to find out if the disease cause the immune system to break down. She and William Robinson, a colleague at the University of

Massachusetts-Boston, are looking at enzyme concentrations in the blood that break down bacteria. Higher levels of the disease have been found in polluted areas, but no direct link between neoplasia and pollution has been found. Environmental stress

"DISCOVERIES ABOUT THE CAUSES AND TRANSMISSION OF THIS DISEASE IN CLAMS MAY HAVE APPLICATIONS TO RESEARCH ON HUMAN CANCERS."

may affect animals' susceptibility to disease, however, and accelerate its progression.

Discoveries that they make about the causes and transmission of this disease in clams may have applications to research on human cancers, since the disease resembles some human mammalian cancers.

Above: The round shape of these cells from a soft-shell clam is abnormal, and indicates neoplasia, a leukemia-like clam disease. Below: Diane Brousseau uses mark-and-recapture collections to look for neoplasia, a mollusk disease, in these soft-shell clams. After blood is extracted from these numbered clams for examination, they are replaced unharmed. Clams are recollected at a future date, to track the disease progression.

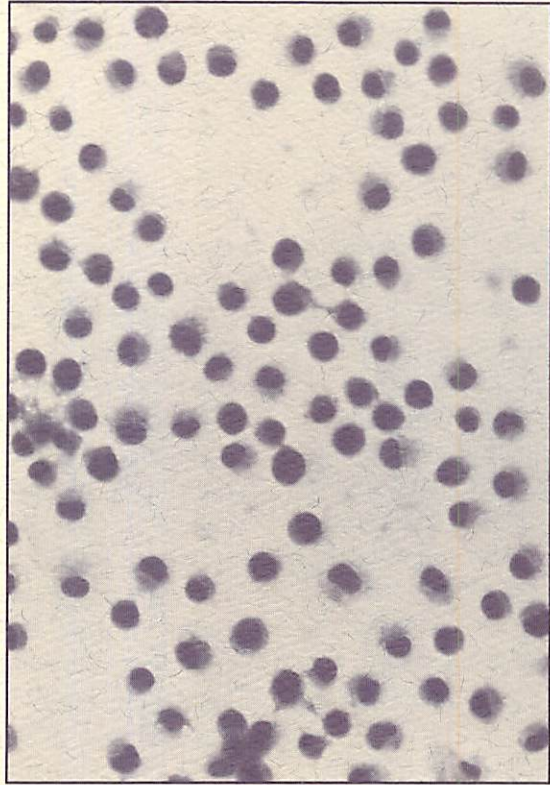


Photo by D. Brousseau



LIVING BENTHIC MARINE RESOURCES

SALT TOLERANCE IN SPONGES

Sponges are abundant in hard-bottom and some soft-bottom communities worldwide, yet little is known about their ecology and ecophysiology. Many are economically important because they are dried and sold as household items and because they destroy oysters and clams by smothering them, or by boring holes in their shells making them less marketable. Sponges also compete with other animals for food and space.

To learn more about sponges, Professors Stephen H. Loomis and Paul E. Fell of Connecticut College (New London) conducted experiments on the sponge *Microciona prolifera* to determine how it adjusts its body to varying salinity levels – <15‰ to >35‰ – in its estuarine environment. *Microciona* was selected because it is a good “laboratory animal” for short- and long-term physiological studies.

Specifically, Loomis and Fell investigated (1) the degree of tissue hydration that occurs when sponge tissue is exposed to different levels of salinity and (2) the mechanisms that regulate cell volume, a process known as osmoregulation. Since most previous work was done on freshwater sponges, little is

known about osmoregulation in estuarine or marine species.

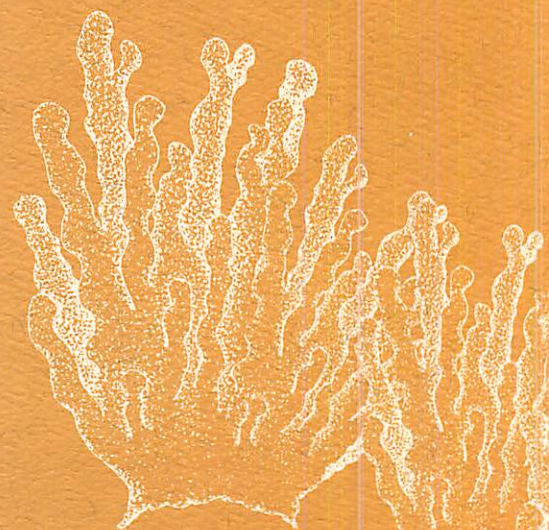
Sponge tissue was exposed to different salinities, and then, borrowing a technique used to count blood cells in medical labs (spinning a test tube sample in a centrifuge), Loomis and Fell were able to measure the percentage volume of solution comprised of cells for each sample. As expected, over the short-term the cells swelled to compensate for low salinity levels, but soon returned to normal. In addition, those sponges that underwent quick, severe changes in salinity become dormant for a few days, but, evidently, once the sponges made the necessary physiological adjustments to the change in salinity, they emerged from the dormant state able to resume normal activity.

The question then became: What mechanisms help them compensate?

It is thought that, since most marine invertebrates change their free pool of amino acids, *Microciona* may use its amino acids as an osmotic regulator by (1) burning the amino acids for energy, (2) leaking them to the outside, or (3) converting them to protein. Since the amino acid in highest concentration is glycine, it is thought it may be the main

mechanism used for osmotic regulation. It is also believed that changes in the concentrations of inorganic ions (sodium, potassium, magnesium and calcium) may also play a part in cellular volume regulation.

Understanding osmotic regu-



“SPONGES THAT UNDERWENT QUICK SEVERE CHANGES IN SALINITY BECOME DORMANT FOR A FEW DAYS.”

lation and the mechanisms that allow sponges to thrive in environments with changing salinity levels may help in the management of commercially important bivalves.

Some Sponges have a remarkable ability to change their bodies in response to variations in the water's salinity.



NUISANCE SPECIES

ZEBRA MUSSELS AND BALLAST WATER

It may not be as dramatic as a Hollywood-style alien, popping out of the stomach of its host. Nevertheless, the zebra mussel, *Dreissena polymorpha*, is an equally costly alien soon to be in a "body" of water near you. At least, that is what many believe.

So great is the concern over its potential to spread and over the threat of future invasions that research projects are being supported by special grants from NOAA and the U.S. Coast Guard. Two such grants, part of a "special focus program" of Connecticut Sea Grant, were given to Dr. James T. Carlton, Professor of Marine Sciences for Maritime Studies at the Williams College-Mystic Seaport Program in Mystic.

The mussel was first discovered in the U.S. in the Great Lakes Basin in Lake St. Clair in 1988, thought to have hitchhiked in the ballast water of ships from Europe. One year later it numbered in the hundreds of thousands and fouled intake screens, blocked water pipes and blanketed floats, pilings, boat bottoms and buoys, causing millions of dollars in damage. Now the critter has been found in New York state,

and is expected to reach Connecticut, if it hasn't already.

It can grow 7.5 cm long, and colonies of hundreds of thousands per square meter have been reported. It is a freshwater mollusk with the ability to tolerate brackish water, making this critter a potential nuisance of great proportions.

Dr. Carlton's efforts have been twofold: (1) to identify dispersal mechanisms of the zebra mussel, one of the most urgent priorities, and (2) to study the role shipping plays as a means of transport of nonindigenous (non-native) aquatic species into and throughout U.S. waters.

Although natural spreading mechanisms exist, Dr. Carlton has identified that 18 of 22 mechanisms are human related and, of those, boating and fishing activities will probably be the primary means of overland dispersal. As a result, interviews were conducted at several Michigan boat launches asking questions about past, current and future boat use, destinations, size of boat, etc. In addition, samples from boating and fishing equipment were taken to locate both larval and adult stages of the mussel. And although some were found, a

potentially more important mechanism of dispersal was identified: the transfer of adults growing on vegetation caught on boat trailers. Since many fisherman in the Great Lakes region "jump" to other inland waters weekly or even daily, it was concluded that large lakes



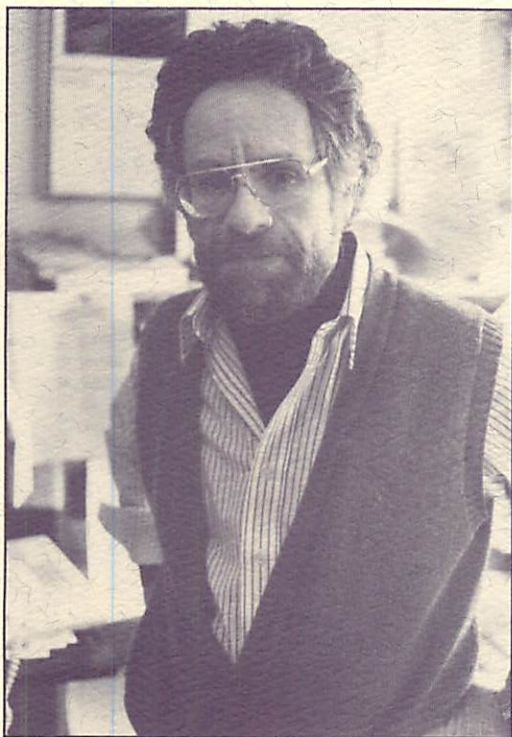
"IT MAY NOT
BE AS
DRAMATIC
AS A
HOLLYWOOD-
STYLE ALIEN
POPPING OUT
OF THE
STOMACH OF
ITS HOST."

will probably be the primary sites of the initial invasion, followed by a secondary invasion in smaller lakes.

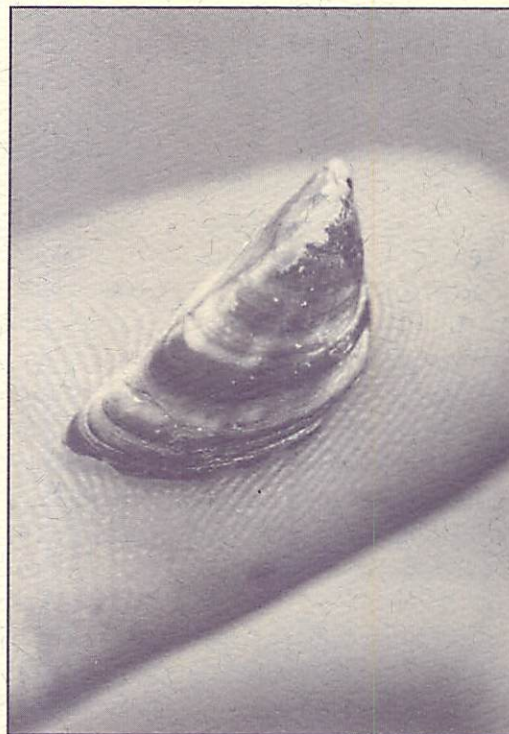
On a much larger scale, a second study designed to determine the role shipping plays in transporting nonindigenous aquatic species

into and throughout U.S. waters is also looking at possible alternatives for control and the feasibility of regional versus national measures. Researchers boarded vessels at 21 of 22 large ports, and conferred with over 500 people from local, state and national agencies,

universities, and industry. It's no surprise that ballast water was the focus with particular attention on where the water comes from and where it is discharged. Results were submitted in a report to the U.S. Coast Guard in December 1992.



James T. Carlton, Director of Maritime Studies at Williams College/Mystic Seaport, has found many mechanisms of dispersal used by zebra mussels and other exotic species, including boat hulls, ballast water, live wells and bait buckets.



Although they're small, zebra mussels like this cause tremendous damage to industries and utilities by clogging underwater pipes and intake valves.

COASTAL PROCESSES

SEA LEVEL RISE

Sea level has been rising since the last melting of glaciers began some 15,000 years ago, and the process is expected to continue into the foreseeable future. Combine that with global warming caused by the "greenhouse effect," and you have, for many, cause for concern. Some predict a continual rise in sea level over the next century due to melting ice caps and thermal expansion of our oceans.

If true, such predictions would have far-reaching implications for everyone, especially those living in the coastal zones of the world. One method used to make such predictions is to create computer models that predict rising temperatures resulting from the greenhouse effect, or that predict rising tides using tidal records and then extrapolating into the future. But such predictions are obviously highly theoretical.

Very little is known about actual variations in the rate of sea-level rise as a result of climate fluctuations in the very recent geological past. Tidal records are a good measuring tool, but such records go back only 100 years in the U.S. and a few centuries in Europe. Sediment samples taken from intertidal zones are used to look back thousands of years: age and depth profiles of peat samples taken

from a number of locations are graphed at intervals of several hundred years. But this method assumes that marshes grow as a result of smooth accumulation, and variations in the rate of rise, possibly caused by climatic events lasting a few centuries, cannot be determined.

To fill the gap from 200 to 2,000 years left by the above methods, Johan C. Varekamp and Ellen Thomas, both of Wesleyan University (Middletown) and supported by the Connecticut Sea Grant College Program, are researching sea-level rise records using sediment samples taken from a marsh in Clinton, Connecticut. But they've added to the traditional methods.

Working in the Hammock River marshes, Varekamp and Thomas took 2m core samples and then sliced them into 2cm pieces, a very labor-intensive method but one that yields numerous data points, instead of the traditional method of core-sample points taken here and there.

The age of several samples was then determined using radiocarbon. All plants die with trace amounts of radiocarbon left in them, and, although amounts vary over time and must be adjusted for, the radiocarbon can be used to measure the time that lapsed since

the plant died. The result of such a process is an accurate age of many levels in the marsh cores. (It should be noted that ^{210}Pb , a radioactive lead isotope found naturally on the earth's surface, is now the best age indicator for the last 100 years.)

But Varekamp and Thomas didn't stop there. They then added a paleo-environmental analysis: a look at the fossilized record hidden in each core sample. A marsh can be divided into differ-

"A CONTINUAL
RISE IN SEA
LEVEL OVER
THE NEXT
CENTURY
WOULD HAVE
FAR-REACHING
IMPLICATIONS
FOR
EVERYONE."

ent zones based on the abundance of life found on the surface of the marsh, in particular a small unicellular organisms called foraminifera. Such organisms congregate in various levels of the marsh – high marsh, low marsh, mud flats – depending on flooding/exposure and the tolerance of the particular species. They also looked at the physical/chemical characteristics of the marsh sediments. Using the information of the modern marsh, they were able to reconstruct changing marsh environments from the core samples.

Another source of information used was climate. Climate for the past two millennia has been recorded using historical records, tree rings and studies of lake beds, and such information is readily available.

The middle part of the first millennia was relatively cool, whereas the *Middle Ages* were very warm. This was followed by the *Little Ice Age*, a globally cool period that ended in the middle of the 18th century. The average temperature has risen since then, with an enhanced warming trend possibly starting at the beginning of this century.

Using all of the data this is what they found: Strong fluctuations in the rate of sea-level rise have occurred, and most of the rise over the past two millennia took place during two or three short periods of rapid rise (2-3 mm/yr), whereas the intervening periods saw only a very slow rise in sea level (<1 mm/yr).

The reason for these changes in the rate of sea-level rise are unclear, but there seems to be a strong correlation between the cold *Little Ice Age* and a **low rate** of sea-level rise and a sudden warming at the end of the *Little Ice Age* associated with a sudden **increase in the rate** of sea-level rise in the northern hemisphere. The last 150 years do not show an acceleration in the rate of sea-level rise, however, despite the increase in temperature over that period.

Varekamp and Thomas estimate that, on average, sea level has risen 1mm per year over the past 2-3,000 years, and their current research efforts are geared toward obtaining a very precise chronology of changes in the rate of sea-level rise at several localities.



Left: Ellen Thomas examines marsh sediments for fossils of foraminifera, tiny animals that have varying tolerance for submergence in salty water. Right: Johan Varekamp analyzes sediment cores from Connecticut salt marshes, using geochemical techniques to find clues about past sea level rise.

CLIMATE CHANGE AND SEA LEVEL RISE

ECONOMIC IMPLICATIONS

Rising sea level may impact coastal regions around the world over the next century. The impact, however, may vary, and therein lies the concern. Are certain areas of the country more vulnerable than others to rising sea level? What will the cost be if we do nothing, or if we try and stop it from happening?

Scientists predict that the greenhouse effect – a buildup of heat-absorbing gases, like carbon dioxide, methane, nitrous oxides, and chlorofluorocarbons – will continue to heat the atmosphere and, as a result, raise sea level due to melting ice caps and thermal expansion of our oceans. Current predictions put the potential rise in temperature from one to nine degrees over the next century, resulting in a rise in sea level from 1mm per year to as much as 2 meters. In 1980 the economic impact estimate of such an event was \$450 billion.

But many scientists now believe that even an estimate as low as \$100 billion is unwarranted based on recent projections that the seas will not rise as much as once feared. The new projections are a result of more detailed economic models developed by Dr. Gary Yohe,

professor of economics at Wesleyan University (Middletown, CT).

According to Dr. Yohe's work less than 3 percent of the country's current dry land will be flooded if sea level rises two feet over the next century and nothing is done about it. As expected, the low-lying southeast could suffer the greatest economic losses, but, because of the high cost of land, Connecticut and the northeast would be the next most vulnerable area.

Sea level has been rising since the melting of glaciers began some 15,000 years ago. But given the recent surge in coastal development, the economic, social and political ramifications of such a change in the high water mark could be devastating. Predicting the impact, however, is not easy because of the large range of estimates used and the number of human uncertainties involved. That is exactly what interests Dr. Yohe.

"We can estimate the cost of constructing devices, such as sea walls, to try and hold back the sea, but in order to make the best decisions, we need to predict the costs that will be incurred if we do nothing," says Yohe.

As a principal investigator for the Connecticut Sea Grant College

Program, Dr. Yohe assigned probabilities over time to a range of sea-level scenarios projected by the Environmental Protection Agency, the Inter-governmental Panel on Climate Change, and others. He then used computer-driven mapping capabilities to superimpose these scenarios over

"SEA LEVEL HAS BEEN RISING SINCE THE MELTING OF GLACIERS BEGAN SOME 15,000 YEARS AGO."



topographic maps of the coast, pinpointing vulnerable areas.

"Eventually, property will disappear and the market will take this into account. Reductions in cost on the order of 50 percent are possible with perfect foresight over a 60-year time horizon that might be associated with slow

sea-level rise."

Yohe plans to continue his studies by adding 30 additional sites. He will be trying to develop more accurate estimates of how market reaction to imprecise understanding of future sea-level rise might affect actual damage costs. Trying to estimate what

land might be worth is difficult at best in the present, but it is near to impossible when dealing with land that is vulnerable to flooding that might happen 20 to 60 years from now.

One thing's for certain — sea level's rising along the north-east coast. Gary Yohe's research provides statistical formulas to help us to anticipate the possible economic consequences.



PROGRAM DEVELOPMENT

GHOST-BUSTERS AT SEA!

Connecticut Sea Grant's development funds are used to fund small scale pilot or "seed" research projects, and new evolving program activities. Here is an example of just one such project:

Lost or discarded fish nets needlessly entrap and kill marine animals by the thousands as they drift along with the currents, "ghost-fishing". Kenneth Gonsalves at the University of Connecticut is developing new degradable materials that could be used in the construction of fishing nets, lobster trap closures, and other marine equipment. If lost at sea, the new materials would degrade in about a year. At present, nylon materials lost at sea may persist for 30 to 50 years.

A 1985 United Nations Food and Agricultural Organization (FAO) report estimated the worldwide loss of fishing gear to be 150,000 tons. "Ghost-fishing" by this lost gear may cause the deaths of more than 1 million seabirds and 100,000 marine mammals and sea turtles annually, according to estimates by the U.S. Secretary of the U.S. Department of Transportation. In addition, fish populations are reduced, lowering fish harvests.

While fishermen are after adults of one or more target species, ghost nets do not discriminate between juveniles and adults, or target species versus nontarget species. They just ensnare everything in their path.

Lost and abandoned pots used for lobster, finfish, and crab fishing also stay intact and continue to entrap animals for a very long time after the loss of human contact. Presently, more than 2 million inshore pots and 42,000 offshore pots are in use in the Northeast region alone.

Gonsalves has received a seed-grant from Connecticut Sea Grant to begin to develop low-cost degradable polymers for use in fishing gear products, including lobster pots and traps as well as nets. The polymers would differ in chemical structure as well as mechanical and thermal properties from the nylon and polyethylene materials now used. When left unattended in the marine environment for long periods of time, products made with the new polymers would begin to break down into harmless constituents such as starch. However, they must also perform well under everyday use at sea. If the new materials hold up well in testing and evaluation, and eventually are adopted for use in

fishing gear, endangered species facing the specter of extinction and dwindling fisheries stocks will all benefit.

While the research is primarily focused on the North Atlantic region, it could have worldwide applications. A delegation from the Japanese Textile and Structure Foundation has already visited

"GHOST-FISHING
BY THIS LOST
GEAR MAY
CAUSE THE
DEATHS OF MORE
THAN 1 MILLION
SEABIRDS AND
100,000 MARINE
MAMMALS AND
SEA TURTLES
ANNUALLY."

Gonsalves' laboratory at the UConn Institute of Materials Science to find out more about the new polymers. Scientists and engineers from Japan are especially interested in Gonsalves' research, since fishing is a vital industry there—Japan's annual fish catch may be about 4 times that of the United States.



Dr. Ken Gonsalves holds containers made of special plastic polymers that will break down harmlessly when lost at sea.

EDUCATION

MARITIME STUDIES SOURCEBOOK

Project Oceanology – a nonprofit consortium of schools and educational institutions – has long been a resource for educational materials on the marine environment.

Using their popular 3-volume sourcebook, *Investigating the Marine Environment* (Weiss and Dorsey 1979), as a foundation, the Project is expanding its secondary and college-level curriculum to include newly developed collecting and teaching methods. In addition, local study sites used in the original publication are being replaced with less site-specific habitats to expand its usefulness to a broader audience.

The purpose: provide teachers with the up-to-date resources necessary to use ocean environments to illustrate basic scientific principles to their students.

Similar in format to the original sourcebooks with volumes on field studies, laboratory and classroom studies, and a teacher's manual, the new edition will contain additional chapters on (1) field studies on marine

mammals, with specific attention on seal and whale-watching; (2) electronic navigational techniques, focusing on Loran and newer techniques of satellite navigation using GPS (Global Positioning System); (3) data analysis, using onboard computers to enter data and compute graphs; and (4) satellite imagery, to monitor such things as ocean currents and warm-core rings.

Teachers will even be able to buy computer disks designed to make data collecting and analysis in the field or school classroom easier.

Topics included in the original three books, such as chemical and physical oceanography, marine geology, marine biology and sampling techniques, will also be included in the revised edition.

All of the Project's resource materials are available by contacting them directly at: Project Oceanology, Avery Point, Groton, CT 06340, or by calling (203) 445-9007.

MARITIME
STUDIES
SOURCEBOOK
FOR
SECONDARY
AND
COLLEGE
LEVELS

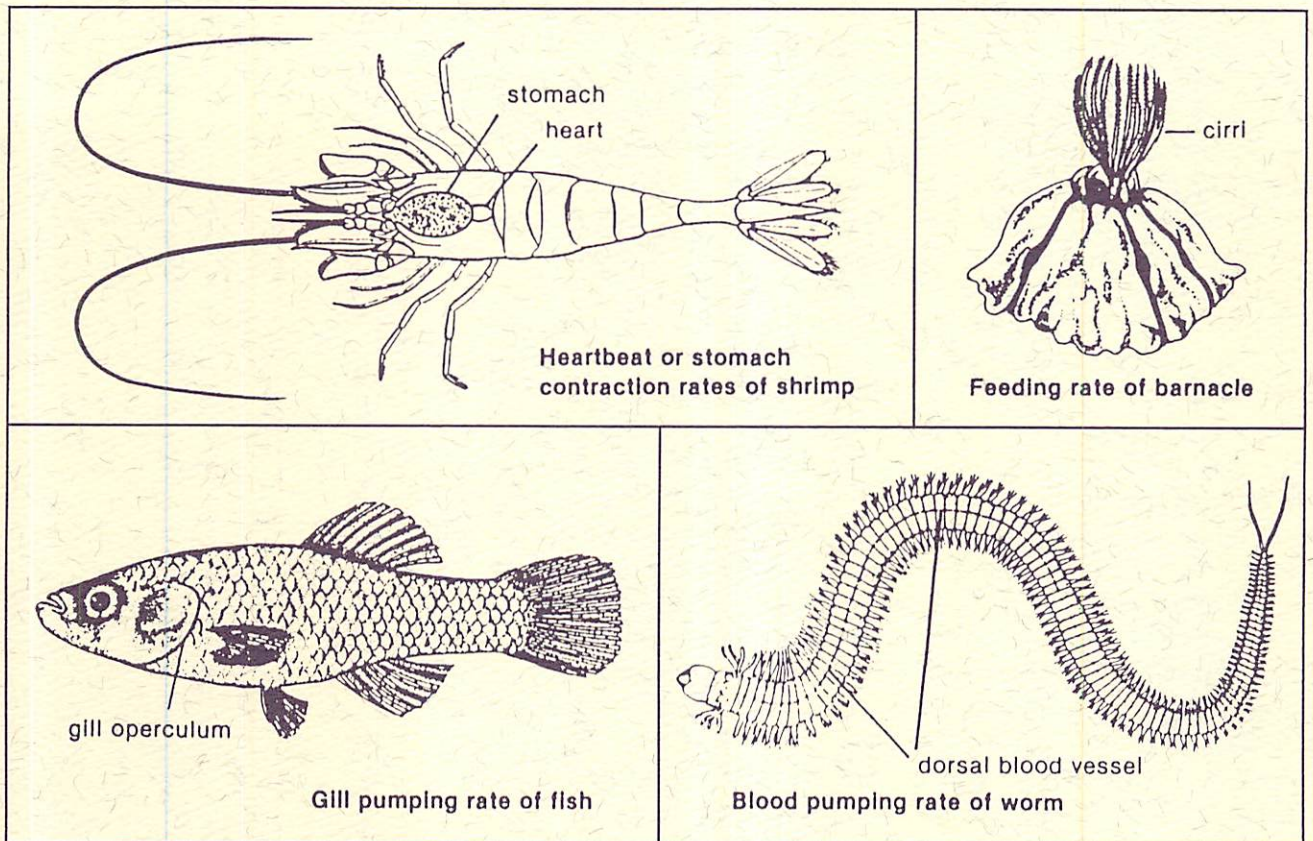


Illustration from the chapter, "The Effects of Temperature on the Metabolic Rhythms of Marine Animals".

HANDS ACROSS THE WATERS

IRISH-AMERICAN AQUACULTURE PROGRAM

Cooperative international programs can be a vital mechanism to link ideas and people in mutual understanding. Just as the oceans are connected, nations can network to share knowledge and expertise to their mutual benefit. This is the philosophy behind Ir-Am-Aqua, short for Irish/American Aquaculture, an international initiative between the Northeastern Sea Grant Colleges and universities in Northern Ireland and the Republic of Ireland. These trans-Atlantic neighbors share the same oceans, many of the same marine organisms, and thus many of the same concerns in aquaculture efforts. Over a span of several years, the universities plan to exchange research technology and practical experience in farming fish, shellfish, sea urchins, and seaweed.

Connecticut Sea Grant has taken a leadership role in organizing and implementing the project. Dr. Edward C. Monahan, Director of the Connecticut Sea Grant Program, serves as the American liaison in this international effort. The first milestone was an applied aquaculture workshop held in Furbo in 1989. Subsequently, a tripartite Memo of Understanding regarding cooperation in aquaculture was signed in the Boston office of Mayor Ray Flynn, in March, 1991. The document was ratified in Galway in April, with officials of the U.S. and

Irish governments and a representative of the British Consul attending.

In November 1992, Ir-Am Aqua held its second international workshop at the Martin Ryan Marine Sciences Institute at University College in Galway, Ireland. While the first workshop in 1989 focused finfish and shellfish, most of the presentations at the 1992 workshop emphasis shifted to the cultivation of abalone, sea urchins, lobster, and kelp, all commercially important species popular with Asian consumers. Following the research presentations, the group took field trips to a fish-packing plant and to the Shellfish Research Laboratory in Carna, Connemara. Participants examined plankton and animals in cultivation tanks, as well as a nearby seaweed factory.

The venture fosters close collaboration and cooperation across borders. Institutions involved in the international program include the Sea Grant colleges of the Northeast, University College Galway, and Queen's University, Belfast. Organizers of the event were Edward C. Monahan, Director of the Connecticut Sea Grant College Program, John P. Mercer, Director of the Shellfish Research Laboratory Carna, and Patrick J.S. Boaden, Director of the Portaferry Marine Station of Queen's University, Belfast.

Speakers from the western side of the Atlantic Ocean, representing the Sea Grant Programs, included Joseph Buttner, SUNY College at Brockport; John W. Crenshaw, University of Georgia Marine Extension Service; Miriam Polne-Fuller, University of California, and

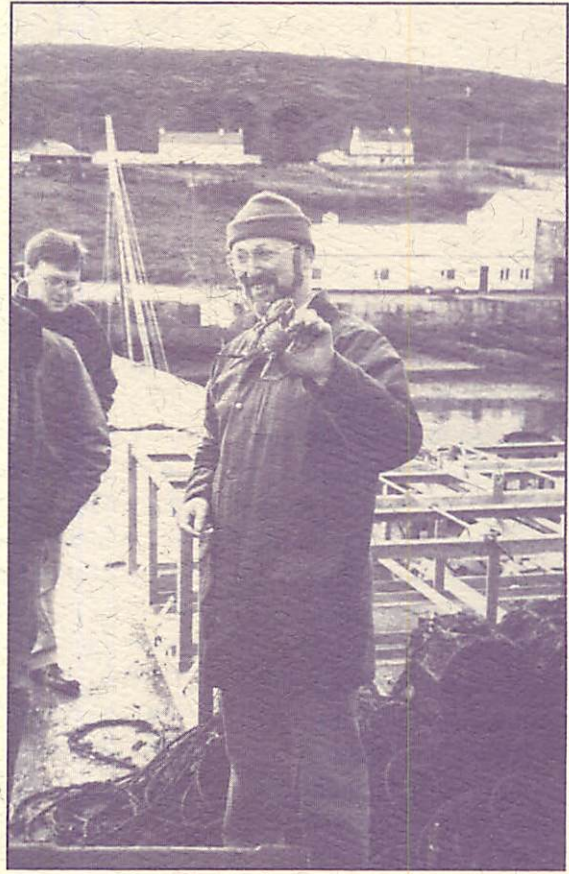
"SHAMROCKS
AND SHELLFISH.
LINKING IDEAS
AND PEOPLE
IN MUTUAL
UNDERSTANDING"

Jim Sullivan, Director of California Sea Grant; Hans Laufer and Peg Van Patten, both Connecticut Sea Grant; and Brian Beal, Robert C. Bayer, Michael B. Loughlin, Deanna L. Prince, all of Univ. of Maine.

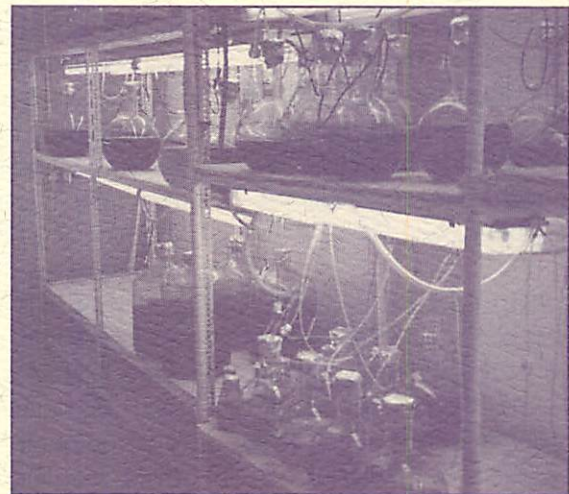
Proceedings of the workshop were published by the Connecticut Sea Grant College Program. The ongoing program's next event will be a conference to take place in the spring of 1994, in Galway, and future meetings are also planned in Belfast, Northern Ireland.



Above: Connecticut Sea Grant Communicator Peg Van Patten examines fresh salmon at a packing plant in Connemara, Ireland. Right: Vats of phytoplankton in several "flavors" — a staple diet of many animals cultivated for export at the Shellfish Research Laboratory in Carna.



Dan Minchin, scientist for the Irish Department of the Marine, shows American visitors aquaculture facilities in County Galway, Ireland.



SEA GRANT

MARINE ADVISORY PROGRAM

Information is the key to public awareness, and the **Connecticut Sea Grant Marine Advisory Program** is an important source of marine-related information. Working as a collaboration between the Connecticut Sea Grant College Program and the University of Connecticut's Cooperative Extension System, SGMAP is responsible for delivering timely information about the marine environment resulting from research conducted by the scientific community, in particular research supported by the Connecticut Sea Grant College Program. Information is transferred through a variety of outreach and informal, educational programs.

The SGMAP *Advisory Committee*, representing a broad spectrum of marine interests, including commercial and recreation fishermen, aquaculturists, environmentalists, marine trade managers, municipal planners, boat captains, and seafood processors, assists the program in planning and evaluation.

MAJOR PROGRAM INITIATIVES

Because of the multitude of user groups, a variety of issues relating to the use of Connecticut's coastal resources often arises. In response, SGMAP develops a number of programs that arm interested citizens, industrial leaders and

public officials with the necessary information to make informed decisions concerning (1) use and development of living and non-living coastal resources, (2) optimum management of resources and (3) pollution and quality control. Areas of program emphasis during 1990-92 included coastal planning, environmental quality, aquaculture, fisheries, marine recreation, marine business management, marine education and marine economics.

On-the-Water Boat Trips

Each year SGMAP offers a series of on-the-water programs with the specific goal of sharing information and raising awareness. This is the sixth and seventh years such workshops have been offered, and they remain very popular, even under rainy conditions, as interest in Long Island Sound and adjacent waters continues to grow.

Workshops focusing on the Connecticut, Thames and Pawcatuck River systems, in addition to Niantic Bay, New Haven and Branford Harbors, and Clinton/Madison shorelines, were conducted for public officials and community leaders. While underway, participants heard speakers, collected and analyzed sediment samples, or sorted through an abundance of living specimens collected in an otter trawl net pulled from the back of one of Project Oceanology's (a

nonprofit, educational organization) research vessels.

A 16-page guide, *Notes on Connecticut's Coastal and Marine Resources*, was compiled for participants to use during the workshops.

Similar workshops were conducted throughout the year for urban youth learning about coastal and marine resource issues.

Recreational Marine Fisheries Forum

Issues and developments in recreational fishing and the fishing industry, legislation, management, pollution, habitat loss and seafood contamination were some of the topics discussed at the first *Connecticut Recreational Marine Fisheries Forum*, held in January 1990 at the University of Bridgeport's Bernhard Arts and Humanities Center.

Coordinated by Timothy C. Visel, extension educator-in-residence, the forum was a cooperative venture between the University of Bridgeport, Fairfield County League of Sportsmen's Clubs and SGMAP.

Additional topics, such as water quality, fisheries restoration, identification and maintenance of public right-of-ways, liability associated with recreational access, reproduction successes, population trends in recreationally important fisheries, and artificial-

reef programs, were also discussed at this daylong event.

Zebra Mussel Workshop

Concern that the prolific zebra mussel, *Dreissena polymorpha*, will find its way into Connecticut waters was the motivation behind a 2-day workshop held at the University of Connecticut's Avery Point campus.

Cosponsored by SGMAP and the New York Sea Grant Extension Program (SGEP) and assisted by Sea Grant Programs of Rhode Island and MIT, Woods Hole Oceanographic Institution, South Central Water Authority, and Northeast Utilities, attention was focused on the non-native, freshwater bivalve that has caused costly fouling problems in the Great Lakes, and is expected to spread throughout much of the US in the near future.

James T. Carlton, director of the Maritime Studies Program of William's College in Mystic, CT,

whose research in this area is sponsored by the Connecticut Sea Grant Program, outlined the potential dispersion problems, and discussed the mussel's biology and physiology. Additional speakers discussed the mussel's ecological and economic impact on recreation/tourism and business/industry, as well as methods of treatment and control.

The New York Sea Grant Extension Program provided speakers as part of a grant from the US Fish and Wildlife Service and The National Sea Grant College Program.

Note: Sightings of zebra mussels should be reported immediately to your nearest Sea Grant College Program.

4-H Marine Sciences Day

The 10th-annual 4-H Marine Sciences Day organized by SGMAP and Cooperative Extension youth educators was held in the summer

of '92 at the University of Connecticut's Avery Point campus. More than 100 4-H youths/leaders and their families recruited from each county in the state experienced first hand what its like to be an oceanographer.

Often spirited on by their parents and grandparents, youths took to the sea on the *Enviro-Lab II*, one of Project Oceanology's research vessels, to sample the physical and chemical properties of water, learn navigational skills, and examine plant and animal life collected in an otter trawl net.

Back on land, participants explored tide pools, salt marshes and a sandy beach, and brought back treasures to be identified. At the end of the day, the now fully initiated oceanographers pressed seaweed, and were treated to agar-agar gelatin.

Sound Educators Conferences

In response to growing interest by educators in Long Island Sound – kindergarten through college – SGMAP, William's College-Mystic Seaport Maritime Studies Program and The Maritime Center of Norwalk hosted two conferences in October '91 to provide a forum for local educators to meet and share resources. One was conducted at the Avery Point campus of the University of Connecticut, the other at the Stamford branch.

Sessions covered such topics as "Long Island Sound in a Jar," sea music, plants and animals of the Sound, and techniques for studying habitats.

Both conferences were funded by a grant from the LIS Research Fund of the Connecticut Department of Environmental Protection, in keeping with their belief that educating people on the importance of this large estuary is the key to saving it.

"PARTICIPANTS
EXPLORED
TIDE POOLS,
SALT
MARSHES
AND A SANDY
BEACH."



Heather Crawford, Sea Grant Marine Advisory Program educator-in-residence, helps 4-H children learn about water quality using fun educational activities like "Long Island Sound in a Jar". Children pollute the water, then suggest and try ways to clean it up.

LONG ISLAND SOUND STUDY

PUBLIC INVOLVEMENT PROGRAM

Connecticut's interests, as well as those of Rhode Island and New York, in the health of Long Island Sound are many. After all, the Sound is a valuable natural resource used for beach-going, fishing, boating, transportation and shipping, waste disposal and power generation.

Five million people live along LIS's Connecticut and New York coasts, and development inherent in such a large population has stressed the estuary in recent years as people compete with one another – and the Sound's flora and fauna – for limited resources.

Activities related to the Sound add up to hundreds of millions of dollars annually. It might be said that the well-being of the Sound is a financial barometer for the well-being of the state.

In 1987, LIS was designated an "Estuary of National Significance" as part of the National Estuary Program, established through amendments to the federal Clean Water Act.

Since then, SGMAP and the New York Sea Grant Extension Program (SGEP) have been working cooperatively on a portion of the **Long Island Sound Study** (LISS) called the "Public Involvement Program," a public outreach initiative that

originated under the National Estuary Program. Together, they are responsible for encouraging public participation in the ongoing process to (1) identify the most pressing problems affecting water quality in the Sound and (2) formulate a comprehensive management plan that addresses them.

Status Report and Interim Actions for Hypoxia Management

In 1990, LISS issued the *Status Report and Interim Actions of Hypoxia Management*, a publication that identified *hypoxia* – a low, dissolved-oxygen condition – as the most pressing problem affecting water quality in the Sound, one that may even threaten large portions of the estuary. Other problems identified were (1) toxic contamination, (2) pathogens, (3) floatable debris and (4) the health of the flora and fauna as they relate to water quality.

To solicit public reaction to the document, SGMAP and SGEP held 14 public hearings in Connecticut and New York. Over 400 citizens attended or provided written comment. A summary of the hearings upon submission to the LISS management committee led to a response document, "Action

Now Agenda," the first formal policy generated by the Study. It outlined actions concerning water quality to be implemented immediately, rather than waiting for the Study to be completed.

To facilitate public understanding of the water quality problems causing hypoxia, the effects of hypoxia upon marine resources, and the steps that must be taken to reduce hypoxia, SGMAP produced a four-page fact sheet, *Long Island Sound Study Hypoxia Management Update*, based on the *Status Report*.

Citizens Advisory Committee

LISS's major challenge is to combine scientific research with meaningful public input to create a final report – a blueprint for action – called the *Comprehensive Conservation and Management Plan*.

To ensure that all interested parties are represented, the public participation coordinators in the two states reorganized the LISS *Citizen Advisory Committee* (CAC), which links citizens with the study's management committee. At present, CAC includes 36 organizations representing a wide spectrum of viewpoints from educational, environmental, industrial, and political. Members review research results and

comment on the direction of the Study.

A bonus of strong public involvement by a myriad of groups interested in the Sound and LISS was the creation of an umbrella organization called the *LIS Watershed Alliance*. The new organization resulted in a stronger, more common voice on issues related to the Sound.

Outreach

Accompanying the growing interest in Long Island Sound and the Study is the demand for information. SGMAP receives numerous requests for presentations. In excess of 70 (slide or informal discussions) were presented each of the two years to groups ranging from school children to fishermen to members of Congress. The bulk of the presentations were to civic groups, such as Rotary Clubs, League of Women Voters, and garden clubs.

Publications

LISS continues to create materials that educate the public on key issues.

Fact Sheets, begun in 1987, remain popular as people desire succinct and current information on a multitude of marine-related topics. As a result, seven new fact sheets (bringing the total to 14) were added: floatable debris, pathogen contamination, seafood safety, toxic contamination, nutrient removal, septic systems and water conservation. Over 125,000 copies of the sheets have been printed.

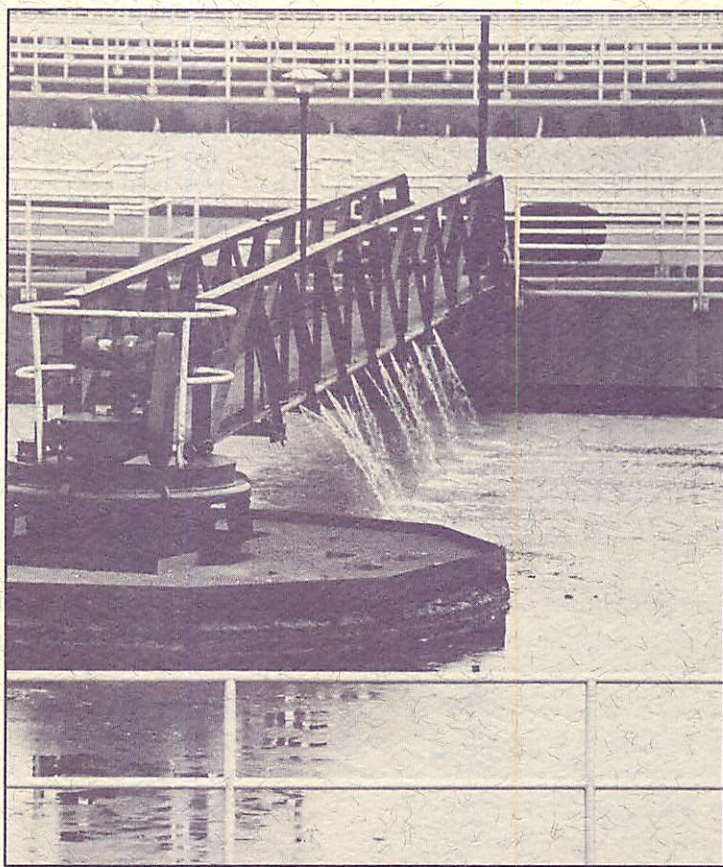
Another publication, *Plants and Animals of Long Island Sound* by Lisa Wahle, was completed. This popular 33-page guide includes detailed line

drawings that demonstrate the beauty and diversity of the Sound's creatures. To date, 15,000 copies have been printed. To supplement the booklet, LISS completed a slide program that depicts the flora and fauna in vivid color. The program is available free for short-term loan.

In the spring of 1992, LISS Public Involvement Program officially assumed sole responsibility for the publication of *LISS UPDATE*, the study's quarterly newsletter that reaches 7,000 citizens. Key topics relevant to the well-being of the Sound are covered in depth.

"IDENTIFY THE
MOST PRESSING
PROBLEMS
AFFECTING THE
WATER QUALITY
IN THE SOUND."

Photo by Michael J. Vitell



Education helps the public understand the value of Long Island Sound and why costly upgrading of sewage treatment facilities is needed.

COMMUNICATIONS

PUBLICATIONS

The Communications program is the voice of Connecticut Sea Grant, linking the various components of the overall program—administration, research, technology transfer, and education. Each component has its own particular needs, and the Communicator makes sure that the messages sent are in appropriate language and style for the intended audience. Using a variety of media, Communications reaches out to the public as well as the scientific and academic community, in order to effectively inform those who live, work, or play on the water.

The Communications effort is mounted by a one-person staff, Communicator Peg Van Patten, with occasional assistance from freelance and temporary help. Van Patten uses a Macintosh desktop publishing system to produce annual reports, proposals, a quarterly newsletter, magazine features, technical reports, and other publications.

The program's primary publications for a general audience are *Connecticut Currents*, the Sea Grant Marine Advisory Program's quarterly newsletter, and *Nor'easter*, a regional Sea Grant magazine for the Northeast programs. A *Coastal Resources Restoration Handbook* was also completed, and found to be very useful for coastal municipal

officials. A popular new product for educators is our travelling slide show, *Plants and Animals of Long Island Sound*. Profiles of researchers and staff members are also produced and used as background handouts at meetings or for newspaper features.

In addition to producing printed publications, the Communicator answers requests for information, distributes publications, keeps mailing list databases, and interfaces with the media. In an effort to expand existing audiences, first attempts were made at using radio and television, on a shoestring budget. Two series of radio public service announcements were produced jointly with the New York Sea Grant Program. The first set, *Sound Waves*, provided tips on water quality and conserving Long Island Sound, while the second, *Sound Gardening*, focused on environmentally-sound gardening practices. Both series aired on major radio stations throughout Connecticut and New York.

Van Patten co-hosted five episodes of a monthly talk show called "Listen to the Sound", filmed live on public access television, to become familiar with television scripting, filming, editing, and broadcasting. In addition to co-hosting, she identified program topics, wrote scripts, arranged guests, obtained accessory

footage, and dressed the set. The Connecticut Sea Grant Director was a guest on the first show, which introduced a local audience of 43,000 to Sea Grant. Other show topics included Long Island Sound, overfishing, exotic species, and marine debris, all featuring Sea Grant personalities. In addition, Connecticut Sea Grant experts made appearances on WTNH Action News.

Special events are another good way to enhance a program's visibility. Van Patten coordinates National Beach Cleanup Day and Coastweeks for the state. Beach cleanup day 1992, reported prominently in the *New York Times*, involved overseeing the efforts of more than 900 volunteers statewide. Other popular Connecticut Sea Grant Coastweeks events included Coastweeks Row on the Mystic River, a coastal photography contest, and the presentation of the annual Environmental Awareness Awards. The awards, a joint project between Connecticut Sea Grant and the Connecticut Department of Environmental Protection, are presented to educators and students who are outstanding at educating the public on coastal and marine issues.

Special events wouldn't be complete without colorful displays. Working with the Sea Grant staff, Van Patten prepares travelling displays that have appeared at

workshops, conferences, forums, family fun events, schools, libraries, garden shows, shopping malls, and Earth Day events. In 1991, a display called "Seaweeds are not Weeds" won a First Prize award from the National Council of Education, and in 1992 "Wetlands in Danger" won a Judges' Special Award at a Mystic Garden Club show.

Using this potpourri of methods, the Communications program has

forged ties with other organizations and agencies, contributed to regional and national efforts, and enhanced the visibility of the Connecticut Sea

Grant program by using the powerful magic of words and pictures to pass on good ideas to those who can use them.

"COMMUNICATION
PROGRAMS
USE THE
POWERFUL MAGIC
OF WORDS AND
PICTURES TO
PASS ON
GOOD IDEAS."

Above: Coastweeks Row on the Mystic River was a new event in 1992, demonstrating a benign use of coastal environments. The event is now Coastweeks Row and draws participants state-wide. Below: Peter Auster's color photo of a nudibranch and bryozoans, titled "Sea Strawberries" won first prize in the 1992 Coastweeks photo contest.



FINANCIAL REPORT

\$ \$ \$ \$ \$ \$ \$ \$

<u>Project</u>	<u>Section and Project Title</u>	<u>Investigator</u>
R/A-8	Marine Biotechnology Control of Crustacean Reproduction with Some Emphasis on Shrimp	H. Laufer
R/A-6-CT R/A-6-NH	Aquaculture Applications of Biochemical Genetics to the Economic Kelps, <i>Laminaria saccharina</i> and <i>L. longicuris</i>	C. Yarish C. Neefus
R/LR-8	Living Resources and Marine Animal Husbandry Field Mortality Rates of Neoplastic vs. Non-Neoplastic Soft-shell clams (<i>Mya arenaria</i>)	D. Brousseau J. Baglivo
R/LR-10	Osmotic Regulation by the Euryhaline Sponge, <i>Microciona prolifera</i>	S. Loomis P. Fell
R/OE-2	Coastal Processes and Engineering Late Holocene Sea-level Fluctuations: Implications for Future Environmental Changes Along the Connecticut coast	J. Varekamp E. Thomas O. van de Plassche
R/SL-5	Marine Economics Adaptive Response and the Value of Information in the Face of Greenhouse-induced Sea Level Rise Along the Northern Shore of Long Island Sound	G. Yohe
E/T-6	Marine Education On-the-Sound Workshops for Community Leaders	H. Weiss
A/E-1	Advisory Services Sea Grant Marine Advisory Program	N. Bender
M/PA-1	Program Management Program Administration	E. Monahan
M/PD-1	Program Development	E. Monahan
M/CP-1	Communications Program	P. Van Patten
	Pass-Through and Miscellaneous Funding Long Island Sound Study Public Education Program	C. Arnold
	Introduced Species	J. Carlton
	Other	

*U.S. Coast Guard

**Environmental Protection Agency

***McDonalds Foods

****Knauss Fellowship

TOTALS

NOAA	Other	NOAA	Other	Totals
'90-'91	'90-'91	'91-'92	'91-'92	'90-'92
\$ 56,762	\$ 38,240	\$ 62,438	\$ 41,848	\$ 199,288
\$ 45,281	\$ 33,691	—	—	\$ 78,972
\$ 28,450	\$ 26,117	—	—	\$ 54,567
\$ 7,610	\$ 7,610	\$ 7,610	\$ 7,610	\$ 30,440
\$ 10,713	\$ 17,430	\$ 6,687	\$ 14,583	\$ 49,413
\$ 25,218	\$ 21,694	\$ 26,969	\$ 22,993	\$ 96,874
\$ 16,992	\$ 30,519	\$ 22,764	\$ 66,119	\$ 136,394
\$ 129,658	\$ 216,861	\$ 140,281	\$ 226,331	\$ 713,131
\$ 69,077	\$ 132,299	\$ 74,573	\$ 138,915	\$ 414,864
\$ 21,424	—	\$ 31,542	—	\$ 52,966
\$ 58,815	—	\$ 77,136	—	\$ 135,951
—	\$ 120,003**	—	\$ 75,000**	\$ 195,003
—	—	\$ 56,487	\$ 198,950*	\$ 255,437
\$ 15,000****	\$ 5,000****	\$ 30,000****	—	\$ 50,000
\$ 485,000	\$ 649,464	\$ 536,487	\$ 792,349	\$ 2,463,300

JOURNAL ARTICLES

FROM CONNECTICUT SEA GRANT RESEARCH '90-'92

- Brousseau, D.J. and J.A. Baglivo. 1991a. Disease progression and mortality in neoplastic *Mya arenaria* in the field. *Mar. Biol.* 110:249-252.
- Brousseau, D.J. and J.A. Baglivo. 1991b. Field and Laboratory Comparisons of Mortality in Normal and Neoplastic *Mya arenaria*. *J. of Invert. Path.* 57:59-65.
- Egan, B. and C. Yarish. 1990. Productivity and life history of *Laminaria longicruris* at its southern limit in the Western Atlantic Ocean. *Mar. Ecol. Prog. Ser.* 67: 263-273.
- Egan, B. and C. Yarish. 1990. The distribution of the genus *Laminaria* (Phaeophyta) at its southern limit in the Western Atlantic Ocean. *Botanica Marina* 31:155-161.
- Egan, B., Z. Garcia-Esquivel, B.H. Brinkhuis and C. Yarish. 1990. Genetics of morphology and growth in *Laminaria* from the North Atlantic Ocean. *Botanica Marina* 31:155-161.
- Homola, E., A. Sagi and H. Laufer. 1991. Relationship of claw form and exoskeleton condition to reproductive system size and methyl farnesoate in the male spider crab, *Libinia emarginata*. *Invertebrate Reproduction and Development* 20(3): 219-225.
- Laufer, H. and K.H. Albrecht. 1990. Metabolism of methyl farnesoate *in vitro* by peripheral tissues of the spider crab, *Libinia emarginata* (Decapoda). pp. 217-222. In: *Advances in Invertebrate Reproduction* 5. M. Hoshi and O. Yamashita, eds. Elsevier Science Publishers.
- Laufer, H. and W. J. Bigger. 1992. Juvenile Hormone-like Compounds in Crustacea and their Implications for Receptor Evolution. In: *Recent Advances in Cellular and Molecular Biology*. R.J. Wegmann and M.A. Wegmann, eds. Peters Press, Leuven, Belgium. pp. 301-310.
- Laufer, H. and E. Homola. 1992. Hormonal Regulation of Reproduction in Female Crustacea. NOAA Technical Report NMFS 106.
- Laufer, H. and A. Sagi. 1991. Juvenile hormone-like compounds and reproduction in male and female spider crabs *Libinia emarginata*. Proceedings, International symposium on reproductive biology in aquaculture. *Academia Sinica*, Taipei, R.O.C., p. 30.
- Laufer, H. and A. Sagi. 1991. Juvenile Hormone-like Compounds and Reproduction in Male and Female Crustaceans: with Implications for Aquaculture. *Bull. Inst. Zool., Academia Sinica, Monograph* 16:541-551.
- Laufer, H., E. Homola and A. Sagi. 1990. Methyl farnesoate may be a morphogen determining morphotypes in the adult male spider crab, *Libinia emarginata*. Proc. 15th Conference of European Comparative Endocrinologists, p. 46.
- Laufer, H., A. Sagi, J.S.B. Ahl, and E. Homola. 1992. Methyl farnesoate appears to be a crustacean reproductive hormone. *Invertebrate Reproduction and Development* 22:17-20.
- Neefus, C.D., B. P. Allen, H.P. Baldwin, A.C. Mathieson, R.T. Eckert, C. Yarish, and M.A. Miller. 1993. An examination of the population genetics of *Laminaria* and other brown algae in the laminariales using starch gel electrophoresis. *Hydrobiologia* 260/261:67-69.
- Osman, R.W., R.B. Whitlatch, R. J. Malatesta and R.N. Zajac. 1990. Ontogenetic changes in trophic relationships and their effects on recruitment. In: *Trophic Relationships in the Marine Environment*, Proc. 24th Europ. Mar. Biol. Symp., M. Barnes and R.N. Gibson, eds., pp. 117-129.
- Sagi, A., E. Homola, and H. Laufer. 1990. Methyl farnesoate synthesis in the spider crab *Libinia emarginata* is related to male morphology and development of the reproductive system. *Am. Zool.* 30:12A.
- Shimshock, N. G. Sennefelder, M. Dueker, F. Thurberg, and C. Yarish. 1992. Patterns of Metal Accumulation in *Laminaria longicruris* from Long Island Sound. *Arch. Environ. Contam. Toxicol.* 22:305-312.
- Thomas, E. and J.C. Verekamp. 1991. Paleo-environmental analyses of marsh sequences (Clinton, Connecticut): evidence for punctuated rise in relative sealevel during the latest Holocene. *J. Coastal Res.* 8(11):125-158.
- Van Patten, M.S. and C. Yarish, in press. Allocation of blade surface to reproduction in *Laminaria longicruris* of Long Island Sound. *Hydrobiologia* 260/261:173-181.
- Verekamp, J.C. 1991. Trace Element Geochemistry and Pollution History of Mudflat and Marsh Sediments from the Connecticut Coastline. *J. Coastal Res.* 8(11):105-123.
- Verekamp, J.C., E. Thomas, O. Van de Plassche, 1992. Relative sea-level rise and climate change over the last 1500 years. *Terra Nova*, Global Change special issue, 4:293-304.
- Whitlatch, R.B., and R.W. Osman, in press. A Qualitative Approach to Managing Shellfish Populations: Assessing the Relative Importance of Trophic Relationships Between Species. *Journal of Shellfish Research* 13 (1) 223-236.
- Yarish, C., C. A. Penniman and P. Van Patten, eds., 1990. *Economically Important Marine Plants of the Atlantic*. Sea Grant Publication CT-SG-89-07, 158 pp.
- Yohe, G. W. 1991. Selecting 'interesting' scenarios with which to analyze policy response to potential climate change. *Climate Research* 1:169-177.
- Yohe, G. W. 1992. Imbedding Dynamic Responses with Imperfect Formation into Static Portraits of the Regional Impact of Climate Change. In: *Economic Issues in Global Climate Change*, J. M. Reilly and M. Anderson, eds. Westview Press, pp. 200-214.
- Yohe, G. W. 1992. Carbon emissions taxes: their comparative advantage under uncertainty. *Annu. Rev. Energy Envir.* 17:301-326.

Connecticut Sea Grant Office Staff

Dr. Edward C. Monahan, Director
Charlene Antonio, Secretary
Chester L. Arnold, SGMAP Educator-in-residence
Nancy Balcom, SGMAP Educator-in-residence
Norman K. Bender, SGMAP Program Leader
Dolores Chambers, SGMAP Secretary and Computer Coordinator
Heather M. Crawford, SGMAP Educator-in-residence
Eleanor Minik, Administrative Assistant
Captain Charles H. Nixon, Executive Officer
Peg Van Patten, Communications Coordinator
Timothy C. Visel, SGMAP Educator-in-residence

Marine Sciences Institute

Dr. Richard A. Cooper, Interim Director

Connecticut Sea Grant Advisory Board

Dr. Thomas J. Tighe Vice President and Provost University of Connecticut	Captain J.P. Marnane President The Maritime Center at Norwalk
Dr. Jarad L. Cohon Dean, School of Forestry and Environmental Studies Yale University	Dr. Thomas Porter Vice-President for Academic Affairs Connecticut State University
Dr. Robert Wall Vice-President for Academic Affairs Fairfield University	Dr. William A. Sanders Dean of Academics U.S. Coast Guard Academy
Dr. William A. Niering Professor of Botany Connecticut College	Dr. David Beveridge Faculty of Sciences Wesleyan University
	Mr. J. Revell Carr President Mystic Seaport Museum

Sea Grant Program Review Panel

Dr. Robert G. Bachand The Maritime Center at Norwalk	Dr. Harry Haakonsen Southern Connecticut State University
Mr. Norman K. Bender Sea Grant Marine Advisory Program	Dr. Edward C. Monahan, ex officio Connecticut Sea Grant College Program
Dr. Gaboury Benoit Yale University, School of Forestry and Environmental Studies	Mr. Ronald Rosza Conn. Dept. of Environmental Protection, Office of Long Island Sound Programs
Dr. Diane J. Brousseau Fairfield University	Mr. Eric M. Smith Conn. Dept. of Environmental Protection, Marine Fisheries Division
Dr. James T. Carlton Williams College - Mystic Seaport	Dr. Douglas Tolderland U.S. Coast Guard Academy
Dr. Paul E. Fell Connecticut College	Dr. John Varekamp Wesleyan University

