N.H. Sea Grant Program Guide

2010 — 2011

Brian Doyle Honored

(see page 9)

The N.H. Sea Grant College Program provides support, leadership and expertise for university-based marine research, extension and education. A component of NOAA's National Sea Grant College Program and based at the University of New Hampshire, it is one of 30 programs throughout the nation promoting the understanding, wise use and stewardship of our coastal resources.

Sea Grant
New Hampshire

Visit us online at:
www.seagrant.unh.edu

In this issue:

A Message from the Director

These are challenging times for coastal and estuarine environments worldwide. Increasingly, our coastal ecosystems are asked to fulfill numerous, and at times conflicting, expectations from our society. On one hand, our coasts are economic engines, supporting industry, international trade, living resources and jobs. On the other hand, these ecosystems provide essential habitat for fisheries and support the high property values and quality of life that are associated with clean and healthy coasts. In the coming decades, these long-term conflicts will be amplified as our coasts are further impacted by rising sea levels associated with climate change and by other pressures.

The New Hampshire Sea Grant College Program is charged with promoting the understanding, wise use and stewardship of our coastal resources. We work to address these goals through integrated programs in research, education, outreach/extension and communications. These activities are led by a talented staff, leading researchers and educators around the state, and a dedicated external Policy Advisory Committee (PAC) that assists us in identifying the most critical challenges facing our state, region and nation.

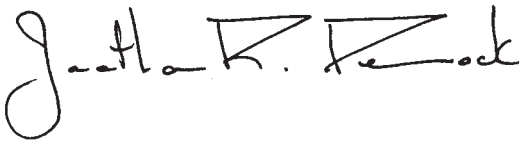
In this program guide you will be introduced to some of the diverse projects and activities that N.H. Sea Grant has undertaken over the past several years as well as those that we will be initiating in 2010-11. All of these activities are driven by the N.H. Sea Grant Strategic Plan and aligned with the National Sea Grant College Program Strategic Plan and include: (1) Conservation & Sustainable Utilization of Fisheries Resources; (2) Sustainable Aquaculture; (3) Coastal Ecosystem & Public Health; (4) Coastal Communities & Economics; and (5) Marine & Aquatic Science Literacy. In the coming year, we will continue to reassess and focus these overall goals to ensure that they are current and are closely reflective of state and national needs in areas such as climate change and marine spatial planning.

In this guide, we review some of the multi-year research projects and a number of development grants that were directed to support projects in areas such as

lobster reproduction, advanced fisheries stock assessment tools, pathogenic oyster diseases, hydrocarbon sources and fates in coastal watersheds, and mercury bioaccumulation in local riverine and estuarine sediments. This guide also summarizes new projects for the upcoming 2010-11 biennium, including studies of trace metal and nutrient cycling in the sediments of Great Bay, microbial contaminant removal from stormwater, seaweed aquaculture systems and lobster fishery management. All of these projects will add critical knowledge needed for the wise management of our local and regional coastal resources. In conjunction with this research, our extension and education specialists will be working directly with local communities, students, fishermen and research managers to ensure that new knowledge is brought to bear on the critical challenges that our coastal environments face today. From assisting in the development of natural resource plans, to developing the "New Hampshire Fresh and Local Seafood" brand, to delivering programs to thousands of children annually, N.H. Sea Grant is here to serve the needs of our coasts and those who live here.

I hope that you find this program guide useful and encourage you to contact me, members of our staff or members of the PAC if you have suggestions for ways in which we can improve N.H. Sea Grant or assist you in addressing priority research, extension and education needs consistent with our strategic goals.

I and the rest of the N.H. Sea Grant staff look forward to working with you!



Jonathan Pennock
Director

2010-2011 Research Projects

During the current funding cycle, N.H. Sea Grant is supporting five UNH-based research projects (pages 4-6). It is also partnering with the other Sea Grant programs in the northeast, from Maine to New York, to support two regional projects (page 7).

Microbial pathogen removal guidance for stormwater management

As coastal communities grow in size and population, it is increasingly important that stormwater treatment systems be designed to prevent negative impacts from occurring to local water quality. Previous studies have suggested that certain conventional stormwater treatment systems, such as ponds and swales, may discharge elevated levels of fecal-borne bacterial contaminants into nearby waterways during storm events. There is speculation that *E. coli*, enterococci and fecal coliform may persist and re-grow in stormwater treatment systems due to turbulence and resuspension of the bacteria and other particles. Roseen will evaluate the bacterial removal performance of the major classes of stormwater treatment systems, including: settling (stormwater ponds), enhanced settling (hydrodynamic systems) and filtration (vegetated, sand and manufactured treatment devices). Water and soil samples will be collected year-round from these systems at the UNH Stormwater Center after storm events and will be tested for bacterial indicators. Recommendations will be made regarding the implementation of stormwater treatment systems that best mitigate bacterial loads. This will result in improved aquatic habitat and enhanced control of bacterial issues. Roseen will collaborate with Miller at the Great Bay National Estuarine Research Reserve (GBNERR) Coastal Training Program to develop guidelines to assist resource managers in their decision-making process and hold workshops to assist communities with bacterial water quality issues.

Robert Roseen, UNH Stormwater Center, 603.862.4024, robert.roseen@unh.edu
Steve Miller, Great Bay NERR Coastal Training Program

Calibrating lobster ventless trap and standard trap surveys to optimize measurements of lobster abundance

The abundance of American lobsters (*Homarus americanus*) and the size composition of their population are typically calculated using data from lobsters captured in traps. However, lobster traps selectively sample the lobster population, which leads to biases in these estimates. Watson will deploy standard and ventless lobster traps equipped with video recording systems at two study sites near the N.H. Seacoast. One site has naturally occurring fluctuations in lobster density so that the relationship between catch and density can be examined. The other site will have replicate 30m x 30m underwater mesocosms he will stock with known densities of marked lobsters. SCUBA surveys will be used to accurately quantify the density of lobsters while videos will reveal the factors that influence the probability that a lobster will approach, enter or exit a trap. Data will be used to determine how fast traps saturate and whether or not the time to saturation is proportional to lobster density. Comparisons will also be made between lobster catch in standard versus ventless traps, because ventless traps are being used more widely to assess aspects of New England lobster populations. The data from this research will help managers calibrate their catch in standard and ventless traps so they can more accurately estimate the density of lobsters of various sizes in the Gulf of Maine.

Winsor Watson, UNH Department of Biological Sciences, 603.862.1629, win@unh.edu

Establishing historic baselines and time series for rebuilding anadromous fish populations and coastal marine ecosystems in the Gulf of Maine

Anadromous fish species help to link terrestrial and marine ecosystems, and play a valuable role in New England's history and ecology. Once numerous, species like salmon, alewives and shad have experienced population declines during the past few centuries. However, very little is known about their status prior to the declines, how human activities affected fish populations, and how declining populations affected the Gulf of Maine. Understanding long-term population changes is imperative because it directly impacts the anadromous fish restoration efforts currently taking place throughout the Gulf of Maine region. Bolster and Rosenberg will develop historical landings timelines, beginning in 1807, for anadromous fish species in rivers leading to the Gulf of Maine. This project will identify historical sources and assemble spatially explicit time series of historical landings based on fish inspector reports and fish commission reports. These time series will be correlated with U.S. census data on demographic and land-use changes and linked with modern data. Catch per unit effort and catch density will be calculated and the data plotted using GIS. The results will be directly relevant to fisheries scientists and managers, conservation organizations and various other stakeholders.

W. Jeffrey Bolster, UNH Department of History, 603.862.3016, jeff.bolster@unh.edu
Andrew Rosenberg, UNH Ocean Process Analysis Laboratory

Development of seaweed culture system technologies to support integrated multi-trophic aquaculture and sea vegetable aquaculture in New England coastal waters

On a global basis, seaweed aquaculture surpasses the production of finfish, shellfish and all other marine organisms, and yet seaweed aquaculture production in North America is extremely small. Seaweed is grown primarily for human food, but is a commercially important source of colloids and natural compounds found in cosmetics, pharmaceuticals and food. Seaweeds are also used as fertilizer and as food for finfish, abalone and sea urchins. A number of recent studies have demonstrated the use of seaweeds as an "extractive component" capable of removing excess nutrients in integrated multi-trophic aquaculture (IMTA) systems. A number of seaweed species (*Porphyra*, *Saccharina*, *Gracilaria* and *Chondrus*) have been shown to be effective extractors of nutrients produced by the "fed component" (e.g., finfish), thus reducing the nutrient "footprint" of the system. A significant obstacle to the incorporation of seaweed components in commercial integrated aquaculture systems is the absence of a source of young seaweed plants. This project will lay the groundwork for development of a commercial seaweed nursery to supply the aquaculture industry. Researchers will develop scalable technology for the mass culture of young seaweed plants for use in commercial IMTA and sea vegetable production. An operating manual and accompanying DVD will be developed to help teach details of the construction and operation of the culture system to various end users.

Christopher Neefus, UNH Department of Biological Sciences, 603.862.1990, chris.neefus@unh.edu
Charles Yarish, Department of Marine Sciences, University of Connecticut

Nutrient, trace metal and particle release from sediments in the Great Bay Estuary and Riverine System

Nutrients and metals that accumulate in aquatic sediments are not permanently trapped in the sediments but can be re-released into the water column and may adversely impact water quality. Most research underestimates the extent and magnitude of release from coastal sediments because sampling is usually conducted during calm conditions rather than during high water flows or other events that disturb the sediment and mix particles into the water column. In addition to increasing the turbidity in the water, this resuspension of sediment may also enhance the release of nutrients and metals. Kalnejais and Foster will study the release of nutrients and trace metals to determine if sediments and sediment resuspension are contributing a significant source of contaminants to the Great Bay Estuary. The researchers will employ a combination of sampling methods, including traditional sediment sampling, a laboratory-based erosion chamber, field measurements of velocity, sea floor profiles and suspended sediment concentration profiles at three sites in Great Bay to determine the processes that are driving the release of nutrients and trace metals from sediments. Results from this study will provide managers with current data on the benthic fluxes of nutrients and will determine if sediments are a significant source of contaminants to Great Bay.

Linda Kalnejais, UNH Department of Earth Sciences and Ocean Processes Analysis Laboratory, 603.862.1008, linda.kalnejais@unh.edu
Diane Foster, UNH Department of Mechanical Engineering

Mitigating risk to whales from lobster fishing

Endangered North Atlantic right whales are injured or killed by ship strikes and gear entanglement, including lobster gear. Shifting the ship traffic lanes in New England waters away from areas of high right whale densities has helped to significantly reduce the risk of ship strikes. A preliminary model developed by Kite-Powell suggests that risk of large whale entanglement from lobster gear along the Maine coast may be cut in half by shifting less than 10% of fishing efforts. The researchers will develop a more detailed model of entanglement risk to right whales from lobster fishing off the coast of Maine. Data on lobster fishing effort and right whale activity will be compared to determine the best efforts to reduce the risk of entanglement. Changes in fishing effort, fishing locations or gear configurations will be tested in the model to predict potential interference with right whale movements, while also determining cost-effective methods for lobster fishermen to make adjustments. The model will be available for use by various marine resource managers and lobster fishing organizations.

Hauke Kite-Powell, Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, 508.289.2938, hauke@whoi.edu
Chris Brehme, Institute for Broadening Participation, Damariscotta, ME
Scott Kraus and **Kerry Lagueux**, New England Aquarium, Boston, MA
Patrice McCarron, Maine Lobsterman's Association, Kennebunk, ME

Using technology to assess the impacts of the invasive sea squirt, Didemnum vexillum, *on fisheries and ecosystems*

The sea squirt *Didemnum vexillum* is a highly invasive colonial tunicate species found in the waters off the coast of New England and Canada. Although *Didemnum* is thought to impact fisheries, foul aquaculture facilities and alter native communities, the extent of its role as an ecological engineer remains largely unknown. More information regarding its spatial coverage is necessary in order to evaluate the ecological impacts and guide management decisions regarding this species. The researchers will develop and test an optical sensor for detection of *Didemnum* via an autonomous underwater vehicle (AUV). The sensors and digital cameras on the AUV will help researchers map the spatial coverage of the tunicate in selected areas of the Gulf of Maine and Georges Bank, as well as examine the benthic species diversity in the presence and absence of large mats of *Didemnum*. Results from this project will be used by MIT Sea Grant to develop web-based outreach materials to raise awareness of these tunicate infestations.

Franz Hover, MIT Department of Mechanical Engineering, Cambridge, MA 02139, 617.253.6762, hover@mit.edu
Robert Whitlatch, Department of Marine Sciences, University of Connecticut
Emmanuel Boss, School of Marine Sciences, University of Maine

Erika Washburn

awarded Knauss Fellowship

UNH alumna Erika Washburn (Ph.D. '09) has been awarded a John A. Knauss Marine Policy Fellowship for 2010. Sponsored by the National Sea Grant College Program, the year-long fellowship matches current and recent graduate students with hosts in the legislative and executive branches of government.

Beginning in February, Washburn will spend one year in Washington, D.C., working in the office of the deputy assistant secretary of Commerce for international affairs. Washburn will have opportunities to contribute to the development of NOAA international policy positions, participate in foreign policy discussions and negotiations, and analyze international NOAA program activities, as well as to draft policy briefings and NOAA negotiating positions.

"I am interested in the land/sea interface and the social landscape of how people make decisions about that type of ecosystem," Washburn said. "Specifically, what are the impediments and opportunities to move towards ecosystem-based planning? What framework is already in place that we can take advantage of?"

Washburn, who is originally from Kalamazoo, Mich., received her undergraduate degrees in biology and archaeology from Boston University and her master's degree in anthropology from Texas A&M University. She cites her Fulbright fellowship in the Netherlands during 1998-99 as the turning point in her professional career, one that sparked her interest in environmental policy and planning.

"The Dutch are decades ahead of the U.S. in terms of watershed perspectives, land use planning and the role of the public becoming involved in the planning boards," she said. "They think hundreds of years ahead to incorporate aspects of spatial planning, ocean sciences and climate change."

Washburn's research at UNH dealt with the 14 towns within the Lamprey River watershed and mapping the social landscape of land use decision making and examining the possibilities for ecosystem-based, watershed-scaled land use planning. This included discussions about upstream and downstream land use decisions, communication within the watershed and the challenges of spatial scaling.

Citing the challenges of applying ecosystem-based management, Washburn said "there is a great need to have one foot in natural science, the other foot in social science to make positive changes."

Undergraduate Fellowship Honors

Memory and Vision of Brian Doyle

The Brian E. Doyle Undergraduate Fellowship Program was established in honor of its namesake to contribute to the education and development of juniors and seniors attending college in New Hampshire who are interested in marine science. Four students pursuing careers in marine science, marine social science and policy, oceanography or ocean engineering will be chosen through a competitive process and awarded up to $2,000 per year in research stipend and tuition support.

"The Brian E. Doyle Undergraduate Fellowships in Marine Science are designed not only to support students interested in establishing careers in applied coastal ocean science, but also to provide an opportunity to work with the Sea Grant model of integrating science with extension actions to serve the nation's coasts," said Jon Pennock, director of N.H. Sea Grant.

Brian Doyle (October 1948-December 2008) was a long-time supporter of the marine sciences, Sea Grant and undergraduate education. He worked at UNH in various capacities beginning in 1980 and was well-respected among his colleagues and friends. He most recently served as the associate director of N.H. Sea Grant and program leader for UNH Cooperative Extension's Water Resources prior to his death in December 2008.

"Over the years, Brian always felt that N.H. Sea Grant and the broader national Sea Grant network did an excellent job of supporting researchers and their graduate students," Pennock said, "but he felt that we could do a better job of encouraging undergraduate students to pursue degree programs and ultimately careers in marine science-related fields."

Doyle left behind a legacy of working hard and thinking positively that carried over to his co-workers. "He expected great work from his team and would always acknowledge when it happened," said Julia Peterson, N.H. Sea Grant water resources specialist.

Steve Adams, communications coordinator for N.H. Sea Grant, added that Doyle was a supportive and enthusiastic colleague. "Brian had a way of bringing people together and moving things forward, and he could manage the big picture without losing sight of all the little pictures," Adams said.

Doyle's dedication to coastal issues and student development made the decision to start a fellowship program in his name an obvious one.

"We can think of no better way to honor his commitment to these issues and to serving the students of the state," Pennock added.

For more information about the fellowship, please visit **www.seagrant.unh.edu**.

Researchers using new Sonar Technology to

Study Cod Populations

Sonar has long been vital to our understanding of seafloor features and marine creatures. Now, researchers at UNH are employing new sonar technologies to study imperiled cod populations in New England waters.

"Cod is considered the iconic species of the New England fishery," said Hunt Howell, UNH professor of zoology. "There are concerns about their population status, so using acoustic technologies can help researchers learn more about their abundance and habitat preferences."

With funding provided by N.H. Sea Grant, Chris Gurshin, a Ph.D. candidate in zoology, is working with Howell to demonstrate the advantage of multi-beam sonar over more traditional methods of fisheries stock assessment.

Trawl surveys are typically used to determine fish abundance, but they can be time-consuming and expensive. The data are only representative of a discrete point of time and limited to the sampled portion of the ocean bottom, Howell said. Using new acoustic technology allows researchers to cover larger areas at a reduced cost because all the work is conducted remotely, he added. Acoustic surveys can also eliminate the unintended mortality of fish that occurs during trawling.

Many fish species have a slightly different acoustic "signature" that distinguishes them from other marine life and seafloor characteristics. Cod have been acoustically assessed by researchers in Norway and Canada using single beam sonar. Conversely, multi-beam sonar sends out a

fan of 160 overlapping acoustic beams as far as a few hundred meters and provides a more thorough view of the abundance and location of cod.

Currently, there are numerous technological and analytical challenges associated with multi-beam sonar studies because there are many variables that can affect the acoustic estimate of fish abundance.

"When you get a large number of fish in spawning aggregations, for example, they're all heading in different directions," Howell said. "There is a lot of overlap so that the acoustic signal returning from them is not going to give you an exact picture because it's reflecting off multiple fish that are hidden behind one another."

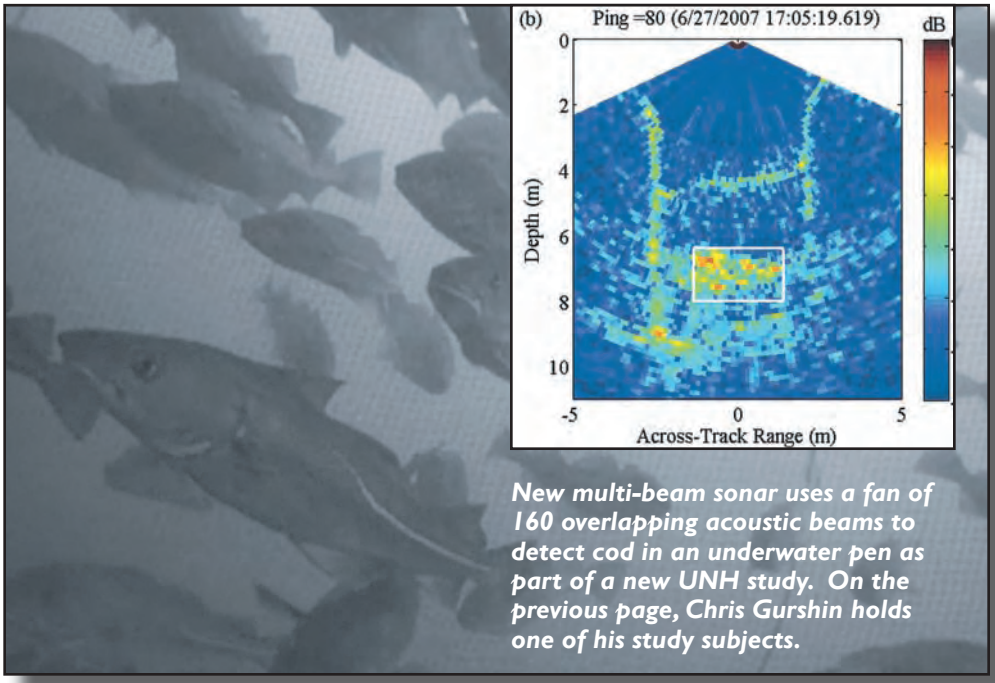
Gurshin used the multi-beam sonar to collect data on acoustic backscatter from cod in underwater pens and in open water. A known number and size of fish were placed in pens near the UNH open ocean aquaculture site and he used the sonar to examine their acoustic signature. Gurshin is using these data to develop a statistical relationship that links acoustic backscatter to cod populations.

Howell and Gurshin previously conducted acoustic studies on cod in Ipswich Bay (Mass.) using multi-beam sonar in tandem with a trawling vessel to compare results. Although Gurshin is still analyzing the results, he expects the surveys will match one another closely.

"I'm excited to finish analyzing that data because I think it will prove valuable in describing the spatial distribution of cod during a known spawning event," Gurshin said.

Howell is currently working with Norwegian scientists to use multi-beam sonar to determine the biomass of fish in their aquaculture pens. Closer to home, one of the newer NOAA research vessels, the *R/V Henry B. Bigelow*, is equipped with multi-beam sonar that was specifically designed for fisheries research.

"I think it's fair to say that using acoustical data is the future of stock assessments," Howell said.



New multi-beam sonar uses a fan of 160 overlapping acoustic beams to detect cod in an underwater pen as part of a new UNH study. On the previous page, Chris Gurshin holds one of his study subjects.

UNH researchers:

the Oyster Thief

is here to stay

No one is exactly sure how invasive green seaweeds found their way to the Seacoast or where they came from, but despite their population fluctuations, they are likely here to stay. UNH researchers are learning more about the species to determine its origins and economic and ecological impacts on the region's fish and shellfish populations.

More commonly known as the "oyster thief," the green seaweed *Codium fragile* has the ability to attach to hard substrates like rocks or shells. Its buoyancy carries the shells with the waves and often up onto land. In regions where *Codium* has attached to bottom substrates, it has displaced native kelp species that are important habitat for juvenile fish.

Codium is capable of surviving in a wide range of temperatures, and if pieces of the seaweed break off and drift, they can re-establish elsewhere to spread the population, explained Anita Klein, associate professor of biological sciences.

With funding from the National Sea Grant College Program and the N.H. Agricultural Experiment Station, Klein is working with UNH colleagues Art Mathieson, Kelly Cullen and Larry Harris to document *Codium's* current distribution, determine its origins and model the economic impacts the species might have on the region.

Codium has existed in the northwest Atlantic since the 1950s. Populations near the Seacoast were relatively small until the 1980s when they began to spread south from Boothbay Harbor, Maine, and north from the Cape Cod Canal. Locally, the Isles of Shoals and Cape Neddick are two regions that have been hit hard by the *Codium* invasion, according to Mathieson, professor of plant biology. Areas that were once large beds of native kelp species are now home to the giant green seaweed.

Although it is suspected that *Codium* came from the Sea of Japan, genetic tests were necessary to confirm its origin. Klein conducted genetic analyses based on DNA extracted from the seaweed chloroplasts. The results confirmed that all green seaweed species collected in the Gulf of Maine were the same invasive species, but the tests were not refined enough to determine the species' origin.

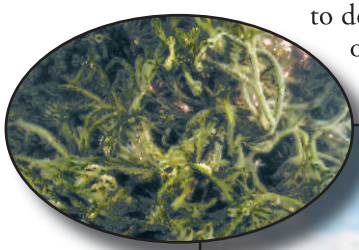
Klein said using genes from the seaweed's nucleus might be the key to help detect fine-scale genetic differences to answer that question and to determine if the species is being continuously introduced.

"Tracking where an invasive species comes from allows us to potentially stop other new introductions," Klein explained.

According to projected economic impacts calculated by associate professor of natural resources Kelly Cullen, a continued expansion of *Codium* could have a multi-million dollar impact on the regional shellfish economy.

However, recent field studies, including rapid assessment surveys, of some northwest Atlantic sites indicate that *Codium's* populations are decreasing in some areas, while expanding in others.

Regions that were entirely covered by *Codium*, like the Isles of Shoals, are now interspersed with other plant species. Areas near Prince Edward Island that hosted an abundance of *Codium* a decade ago now must be visually scoured to detect any sign of the invasive seaweed.



***Codium fragile*, or the "oyster thief," is an invasive green seaweed that has established in the subtidal zone throughout the Gulf of Maine. UNH graduate student Lucy Pleticha holds a specimen collected at a site in Stonybrook, Conn. The map of the Gulf of Maine indicates areas where surveys were conducted to determine Codium's distribution and populations.**

This change, Klein said, has been very unexpected.

Larry Harris, professor of biological sciences, explained that *Codium*, like many other invasive species, became a dominant species for a number of years and soon assimilated into the ecology where other species learn to adapt to compete and interact with the new invasive species. The change in *Codium* abundance is likely due in part to this. But, he cautioned, this species is not going to disappear altogether, but rather it will probably persist indefinitely.

"The whole ecosystem isn't the same anymore after they are introduced," Harris said. "The notion of restoring a system to its natural state is a pipe dream. You cannot restore a system that is full of introduced species."

For more information on *Codium fragile*, please visit **www.codium.unh.edu**.

Community Supported Fishery Initiative

Finding Fans in Coastal New Hampshire

New Hampshire Fresh and Local Seafood is a new brand initiative that connects N.H.-caught seafood with consumers, restaurants and retail outlets near the seacoast. Fishermen and foodies benefit from this endeavor, as it provides locally harvested products while supporting the state's commercial fishing industry.

The N.H. fishing industry has been impacted by recent federal regulations that further limit the days-at-sea allocation for multi-species permit holders. The state's fleet has been reduced in recent years and now only 140 commercial vessels remain active. The rising cost of fees and fuel, coupled with a tenuous economy, caused fishermen to weigh their options and find a positive solution.

"The N.H. fishing industry wanted a way to sell fish locally in order to reduce the cost of transportation and handling by out-of-state distribution agents as well as provide additional economic opportunities," said Erik Anderson, president of the N.H. Commercial Fishermen's Association (NHCFA). The NHCFA collaborated with UNH Cooperative Extension, N.H. Sea Grant and Yankee Fishermen's Cooperative, along with local seafood groups, restaurants and fish markets, to develop the brand.

Seafood products that carry the new red "N.H. Fresh & Local Seafood" label directly support the local economy and fishing industry. Brand products include locally harvested shrimp, lobster and fish.

The term 'local' covers species landed by boats based in N.H. ports, others that unload their catch in the state, or those within a 15-mile radius that are affiliated with the N.H. fishing community. Vendors sign an agreement that products marketed under the brand have been delivered efficiently and directly to consumers, that the species marketed are those managed sustainably, and that there is confidence regarding their point of origin.

Young and old were fascinated by NHSG staffer Mark Wiley's presentation on lobsters and lobstering at the 2009 N.H. Fishtival.

Right to left, fisherman Tom Sutton, NHSG staffer Ken La Valley, and Yankee Fishermen's Co-op manager Bob Campbell discuss seafood with a local resident at a farmers' market.

"My hope is that this initiative will encourage people to see that we have many choices for local, sustainable seafood," said Sarah Zoë Patterson, founder of Seacoast Eat Local, which advocates eating locally grown and harvested food for ecological, social, cultural and environmental reasons. "If consumers changed their habits from buying imported shrimp to instead buying sustainable and clean native shrimp, that would be very gratifying and make a positive impact on the environment and on the livelihoods of New England fishermen."

Seacoast residents can also support local fishermen and buy fresh, sustainable seafood through a new community supported fishery (CSF) initiative. Modeled after community supported agriculture, a CSF is a shore-side community of people collaborating with local fishermen to buy fish directly for a predetermined length of time. CSF shareholders give the fishermen financial support and then receive a weekly share of seafood caught during the season, said Ken La Valley, commercial fishing specialist for N.H. Sea Grant and UNH Cooperative Extension. Developing CSFs using N.H. Fresh and Local seafood is a natural choice to fulfill consumer interest, he added.

"A member of a CSF has the benefit of knowing exactly where their food came from and who their fisherman is," La Valley said. "By investing in fishermen, a shareholder helps to strengthen the local community."

Along with these initiatives, N.H. Sea Grant teamed up with Prescott Park Arts Festival, the City of Portsmouth Fishing Industry Committee, Seacoast Local, Seacoast Eat Local and Slow Food Seacoast to sponsor the first-ever N.H. Fish and Lobster Festival in Portsmouth. The event educated the public about the economic, environmental and health benefits of eating fresh and local seafood.

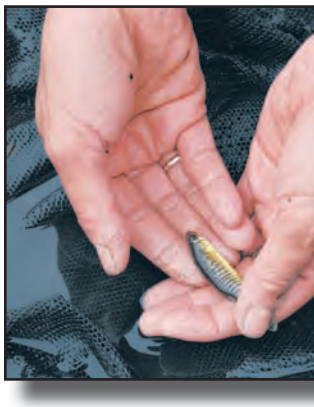
Thousands of individuals and families attended the "Fishtival" and enjoyed live music, tasty seafood prepared by local chefs, educational presentations about lobsters and fish, and tours aboard commercial fishing vessels. Festival attendees were treated to savory bites made with locally caught hake, lobster, blue mussels and various other seafood species.

"In the last few years, eating locally has gone from being a fringe idea to an idea that is very central to people who care about food," Patterson said. "The choices we make when we buy food can have enormous impacts on the fishermen's livelihoods, in our environment and our community."

New Study Focuses on

Mercury Cycling

in the Great Bay Ecosystem



Biologist Celia Chen and her technician Deenie Bugge were up to their knees and elbows in thick grey marsh mud, searching for small polychaete worms buried in the Squamscott River sediment. They rinsed off by pulling a seine through the water channel at low tide, looking for mummichogs — a small estuarine fish — and green crabs.

These organisms, along with water and sediment samples, help reveal how the heavy metal mercury moves through the intricate estuarine food web and how it could impact humans near the seacoast. Exposure to high levels of this neurotoxin can impair motor coordination and sensory ability, and estuaries such as Great Bay are ideal locations for the accumulation of contaminants like mercury that settle out from surrounding rivers and industrial land use.

Chen, a research associate professor of biological sciences at Dartmouth College, is collaborating with Aria Amirbahman from the University of Maine and Mary Voytek from the U.S. Geological Survey to conduct molecular analyses and DNA fingerprinting on the samples. While previous research has focused on mercury concentrations in either sediments or living organisms, the results from this N.H. Sea Grant-funded project will connect organisms with their environment to determine the method and level of mercury cycling in nearby waterways.

"We're trying to tease apart all the components of this issue," Chen said. "We want to determine how much mercury is in the water and bound to sediments, how much is available to species that live in the mud, and how much is eaten by organisms higher in the food chain," she said.

The main sources of mercury in the New England environment are coal-fired power plants, incinerators and other point sources that discharge waste directly into waterways or the atmosphere. Some mercury arrives on air currents from regions further west, including the Ohio River Valley and as far away as Asia, Chen said.

Mercury deposits on the land and eventually enters the waterways and settles into the sediments on the bottom. Tiny organisms called sulfate-reducing bacteria transform mercury into methylmercury, which can then be absorbed or consumed by other organisms that live near the sediments. Polychaete worms and other bottom-dwellers mix the top sediment layers and thus potentially enhance methylmercury cycling and eventual uptake, Amirbahman said.

Preliminary results indicate that methylmercury concentrations in polychaete worms, mummichogs and green crabs were higher for those collected in the Squamscott River channel at Great Bay in Stratham than at the Piscataqua River

Deenie Bugge, a technician who works with Celia Chen at Dartmouth College, digs for small polychaete worms in the Squamscott River mud. A new study is examining how these worms and other organisms affect mercury cycling in Great Bay. On the left, a mummichog.

near Seavey Island in Kittery, Chen said. However, mercury levels were higher in both channels than in nearby salt pannes — the small pools in a salt marsh that retain water during low tide.

"The mercury levels in Great Bay in general are not alarmingly high, but they are about half as high as a very contaminated site located in New Jersey," Chen said. "By comparison, our sampling site with the lowest mercury levels is in Wells Estuary in Maine."

"The Great Bay sediments are not any more contaminated than the Penobscot River sediments, which have been subject to point-source contamination," Amirbahman added.

Tidal cycles, water circulation, surrounding land use and the presence of carbon and iron at the sites could contribute to the differences in mercury and methylmercury levels, she explained. Researchers will conduct more sampling to determine why the site differences are occurring. Results from this study will be used to help inform environmental policy recommendations made by local and regional agencies.

Tom Niejadlik, administrator for the N.H. Department of Environmental Services (DES) Environmental Health Division, said that mercury and methylmercury levels in Great Bay are similar to levels in the entire northeast U.S. "This isn't just a local problem," he said, "Although some places have 'hot spots' where mercury and methylmercury levels are slightly higher, in general the levels are about the same throughout the northeast."

UNH Marine Docents

Stay Up To Date

with Changing Scientific Knowledge

Marine educators near the Seacoast know that their teaching curricula, like their saltwater subjects, must adapt to changing times.

The University of New Hampshire Marine Docent program, now in its 32nd year, is a group of more than 170 volunteers who educate the community about coastal resources, teaching up-to-the-minute marine science at sea aboard the University's research vessel and in classrooms and other meeting spaces around the region, and while volunteering at the Seacoast Science Center and the Great Bay Discovery Center.

The docents' challenge is being able to translate scientific information to the public to match the needs of the current times, explained Mark Wiley, N.H. Sea Grant marine educator. The docents' SeaTrek educational programs, for instance, offered to schools and the public, are continuously reviewed and tweaked to reflect the most up-to-date information available.

"Our SeaTrek program about global climate change has traditionally been focused on the science aspects of the phenomenon,"

Wiley said. "The changing thoughts and increasing importance of this topic has caused us to shift the program's emphasis to what communities and individuals can do about it. Now we provide practical information on the next steps to take regarding climate change."

This proactive approach to marine literacy is not limited to one program — Wiley is working closely with docents and other educators to develop new curricula about healthy seafood consumption and the current population status of New England fish species.

In addition, the docents offer programs to encourage hands-on learning about lobsters, rocky shores, sandy beaches, aquaculture and marine mammals.

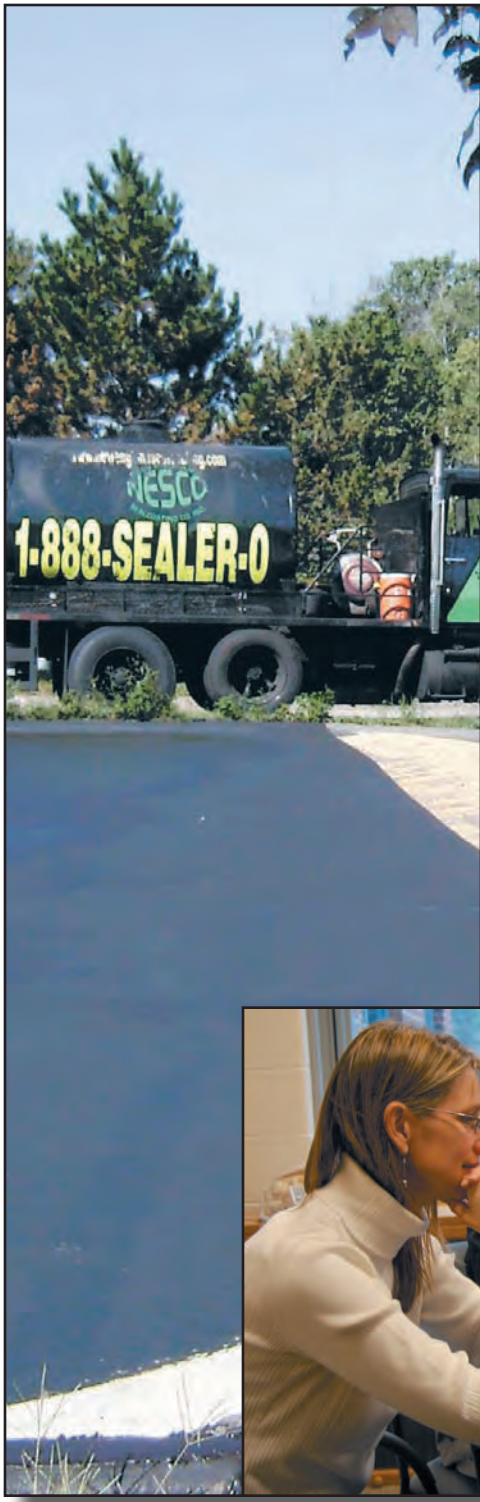
"The strength of the Docent Program is that we train people to help make marine science topics accessible to the public," Wiley said.

To prepare for their roles as educators, marine docents get hands-on training in local history and science by UNH faculty, extension educators and other experts in the marine field. Training takes place both inside the classroom and out, with a variety of field trips to sites around the Seacoast. The five-month training program begins in September, with courses held Tuesday and Thursday mornings.

No prior experience is required to become a marine docent. Ideal candidates possess a love of learning, a keen interest in the marine environment, a sense of stewardship for the marine world, and a desire to share their knowledge with children and adults in the community.

The Marine Docent Program is sponsored by N.H. Sea Grant, UNH Cooperative Extension and the UNH Marine Program.

Left, marine docent John Lamson talks about lobsters and lobstering with a group of elementary school students during a Day of the Coast celebration. These day-long events involve dozens of docents as well as other community members with marine information to share. Above, other docents discuss a range of marine critters with students.



Study finds Sealcoat a "Preventable" Source of PAHs in Stormwater Runoff

Driveways and parking lots may look better with a layer of sealcoat applied to the pavement, but the water running off the surface into nearby streams will be carrying more than just oxygen and hydrogen. New research conducted at the UNH Stormwater Center (UNHSC) indicates that sealcoat may contribute to increasingly significant amounts of PAHs entering waterways from stormwater runoff.

Polyaromatic hydrocarbons, more commonly known as PAHs, are found in diesel and crude oil and are considered to be carcinogenic. Although small amounts of PAHs are typically found in the waters around the N.H. seacoast, the sudden spike in the hydrocarbon concentrations in water draining from a university

Researchers Alison Watts and Tom Ballestero have teamed to study several stormwater-related problems.

parking lot caused Tom Ballestero, UNH associate professor of civil engineering, to be concerned about unknown impacts.

"Our society has been sealcoating pavement for decades and there are things we've never asked about," he added. "Now we're starting to probe and ask these questions."

Although it is intended to remain on the pavement surface, much of the sealcoat eventually washes or scrapes off and ends up in nearby streams and rivers, said Alison Watts, affiliate faculty member at the UNHSC. The PAHs from the sealcoat attach to organic matter, such as leaves or sediment, where they may be ingested by organisms or buried in other sediments.

As part of this N.H. Sea Grant funded research, 1/4 acre of a parking lot located near the UNHSC was covered with coal tar-based sealcoat and 1/3 acre was covered with asphalt-based sealcoat. The remainder of the nine-acre lot was left unsealed. On-site stormwater drains off the parking lot and into a nearby swale. The PAH concentration was measured in the water and sediments coming from the sealcoated and unsealed parking lot sections.

Both types of sealcoat led to a surprisingly rapid increase in PAH concentrations in the initial runoff — up to 5,000 parts per billion (ppb), significantly higher than the 10 ppb levels released from the unsealed lot, although concentrations decreased after several rainstorms. The PAH concentrations in the sediments mirrored these trends; the concentrations immediately downstream of the coal tar-sealed lot increased by nearly two orders of magnitude within the first year.

Unlike other compounds, PAHs do not break down easily and thus persist in the environment for decades. Even a small amount of PAHs coming off sealcoated parking lots may overwhelm an aquatic ecological system already stressed by other contaminants.

Increased PAH concentrations in waterways could be a human health issue if people are exposed to it regularly. Initial sampling of the soil around the parking lots indicates very high concentrations of PAHs in the dirt nearby. Concentrations of benzo(a)pyrene, a particularly harmful PAH, were detected at 19 mg/kg, nearly 100 times the recommended level to protect human health. These concentrations are high enough to potentially be troublesome for children who play on the sealed surface, Watts explained.

"You don't see people falling over from PAHs in sealcoat, it's not that big of a health issue," Ballestero said. "But it could be a cumulative exposure problem that gets uglier over time."

Ballestero said he has sensed an interest by the sealcoat industry to offer more environmentally friendly, less toxic alternatives in the future. There should be options that allow workers in the industry to continue to make a living, but without causing additional harm to the local ecosystems and human health, he noted.

"There are much bigger environmental problems out there than PAHs from sealcoats, but the bottom line is that it is easily preventable," Watts added. "All you have to do is not apply it to pavement."

Marine Debris to Energy Program

Goes to the Classroom

Area students will soon be studying trash — specifically, marine debris — to learn more about science and statistics.

School teachers in N.H. and Maine are working closely with UNH and the Blue Ocean Society to incorporate information about marine debris into their lesson plans. Marine debris can include derelict commercial fishing gear such as nets, trawl material or buoys, and it may end up floating offshore on the ocean surface, littering the bottom or washing up on beaches. Debris also includes trash, that washes out to sea.

"Using marine debris to help teach basic scientific principles is an effective and engaging way to interest students and help them perform at the level set by the state's educational standards," said Mark Wiley, marine educator for N.H. Sea Grant and UNH Cooperative Extension.

At a workshop, teachers worked in teams to formulate suggestions for science curricula revolving around marine debris. They worked with the web site **www.nhmarinedebris.org** that offers tools such as GIS maps and data that allow the user to search by beach or debris type to learn about the type and quantity of pollution near the Seacoast. The web site also features video clips of marine debris taken from recent sonar tows.

"We want to increase the awareness of resources for marine debris lesson planning," Wiley said. "This subject will lend itself to class lessons quite well."

For example, teachers could use this program to help students improve their math and statistics skills. One suggestion was for students to do a beach cleanup and note the amount of each trash type collected, according to Ken La Valley, commercial fisheries specialist for N.H. Sea Grant and UNH Cooperative Extension. Students can then upload the data onto the web site's database and use tools on the site to create maps, charts, and graphs to determine the rate of trash decomposition or percentage of debris that may represent a risk to human or animal well-being.

"It's exciting to see what creative curriculum ideas the teachers came up with," Wiley said. The finalized lesson plans will be available on the web site in the upcoming months.

The program seeks a holistic approach to cleaning up the Gulf of Maine, La Valley explained. It incorporates recycling and waste-to-energy as part of the cleanup effort and has resulted in the collection of over seven tons of debris thus far.

N.H. Sea Grant Staff

N.H. Sea Grant Director's Office
Chase Ocean Engineering Lab, UNH
24 Colovos Road, Durham, NH 03824
603.862.7007, fax: 603.862.0241

Jonathan Pennock, Director, 603.862.2921, jonathan.pennock@unh.edu
Linda Wade, Program Assistant, 603.862.2987, linda.wade@unh.edu

N.H. Sea Grant Extension and Communications
Kingman Farm/UNH
Durham, NH 03824
603.749.1565, fax: 603.743.3997

Steve Adams, Communications Coordinator/Assistant Director for Communications, 603.749.1565, steve.adams@unh.edu
Sue Chalifoux, Communications Assistant, 603.749.1565, sue.chalifoux@unh.edu
Lori Lavac, Program Assistant, 603.749.1565, lori.lavac@unh.edu
Julia Peterson, Extension Specialist/ Water Resources, 603.749.1565, julia.peterson@unh.edu
Dari Ward, Great Bay Coast Watch Coordinator/Education Assistant, 603.749.1565, dari.ward@unh.edu
Mark Wiley, Assistant Director for Education/Extension Specialist Marine Education, 603.749.1565, mark.wiley@unh.edu
Rebecca Zeiber, Science Writer, 603.749.1565, rebecca.zeiber@unh.edu

NHSG Staff at other locations

Steve Jones, Assistant Director for Research, Jackson Estuarine Lab/UNH
Durham, NH 03824
603.862.5124, fax: 603.862.1101
shj@cisunix.unh.edu

Ken La Valley, Assistant Director for Extension/Commercial Fishing Technology Specialist
219 Nesmith Hall, UNH
Durham, NH 03824
603.862.4343, fax: 603.862.0107
ken.lavalley@unh.edu

Lisa Scigliano, Fiscal Administrator Sponsored Research, Service Building
UNH, Durham, NH 03824
603.862.0529, fax: 603.862.3564
lisa.scigliano@unh.edu

N.H. Sea Grant Policy Advisory Committee

The N.H. Sea Grant Policy Advisory Committee (PAC) provides advice and oversight for all aspects pertaining to the management and operation of the program. Appointed by the UNH president, PAC members play a critical role in strategic planning, including determining program priorities in research, extension, education and communications. The members are selected to ensure that N.H. Sea Grant is listening to people with diverse interests and expertise, including university administrators, academic researchers, entrepreneurs, clientele and concerned citizens, as well as federal, state and local agency staff.

John Annala
Chief Scientific Officer
Gulf of Maine Research Institute
Portland, ME

Andrew Armstrong
Codirector
NOAA/UNH Joint Hydrographic Center
Durham, NH

David Bartlett
Associate Director
Institute for the Study of Earth, Oceans & Space
Director
N.H. Space Grant Consortium
UNH, Durham, NH

Robert Campbell
Manager
Yankee Fishermen's Cooperative
Seabrook, NH

Brian Fitzgerald
UNH Marine Docent
Rye, NH

Richard Fralick
Professor Emeritus, Natural Science
Plymouth State University
Durham, NH

Ellen Goethel
Marine Educator
Hampton, NH

Jennifer Hunter
Director
Piscataqua Region Estuaries Partnership
UNH, Durham, NH

Peter Kinner
Vice President
Normandeau Associates
Bedford, NH

Richard Langan
Codirector
Cooperative Institute for Coastal and Estuarine Environmental Technology
Director
Atlantic Marine Aquaculture Center
UNH, Durham, NH

Steve Loos
Great Bay Coast Watch
Dover, NH

Allison McLean
Municipal Relations & External Affairs Specialist
Public Service of New Hampshire
Manchester, NH

Katherine Mills
Research Coordinator
Great Bay National Estuarine Research Reserve
Durham, NH

Betsy Nicholson
NOAA Regional Coastal Program Specialist
UNH, Durham, NH

Mark Okrant
Professor of Tourism Management and Policy
Director
Institute for New Hampshire Studies
Plymouth State University
Plymouth, NH

Bonnie Spinazzola
Executive Director
Atlantic Offshore Lobstermen's Association
Bedford, NH

Nancy Thompson
Science & Research Director
Northeast Fisheries Science Center
Woods Hole, MA

Theresa Walker
Rockingham Planning Commission
Exeter, NH

Peter Whelan
Recreational/Charter Fishing Industry
Portsmouth, NH

N.H. Sea Grant Publications

These pages contain information on some of the recent publications produced by researchers, students, extension staff and others associated with N.H. Sea Grant. All of these publications are available for purchase from NHSG or from the National Sea Grant Library on loan or as PDF downloads. For more on the library, see the box on page 28.

Research Publications

Bottom habitat mapping using towed underwater videography: subtidal oyster reefs as an example application (UNHMP-JR-SG-08-05) R. Grizzle, M. Brodeur, H. Abeels and J. Greene. Reprinted from *Journal of Coastal Research* 24(1):103-109, January 2008. $2.

Cases of collaboration in New England coastal communities: an approach to manage change (UNHMP-JR-SG-08-22) T. Hartley, M. Gagne and R. Robertson. Reprinted from *Human Ecology Review* 15(2):213-226, 2008. $3.

Controls of spatial variation in the prevalence of trematode parasites infecting a marine snail (UNHMP-JR-SG-08-04) J. Byers, A. Blakeslee, E. Linder, A. Cooper and T. Maguire. Reprinted from *Ecology* 89(2):439-451, 2008. $3.

The distribution, morphology and ecology of three introduced Asiatic species of *Porphyra* (Bangiales, Rhodophyta) in the Northwest Atlantic (UNHMP-JR-SG-08-29) C. Neefus, A. Mathieson, T. Bray and C. Yarish. Reprinted from *Journal of Phycology* 44(6):1399-1414, December 2008. $3.

An historical comparison of seaweed populations from Casco Bay, Maine (UNHMP-JR-SG-03-07) A. Mathieson, E. Hehre, C. Dawes and C. Neefus. Reprinted from *Rhodora* 110(941):1-102, Winter 2008. $12.

Measurements of acoustic backscatter and density of captive Atlantic cod with synchronized 300-kHz multibeam and 120-kHz split-beam echosounders (UNHMP-JR-SG-09-11) C. Gurshin, J. Jech, W. Howell, T. Weber and L. Mayer. Reprinted from *ICES Journal of Marine Science* 66(6):1303-1309, July 2009. $3.

Multiple assessments of introduced seaweeds in the Northwest Atlantic (UNHMP-JR-SG-08-28) A. Mathieson, J. Pederson, C. Neefus, C. Dawes and T. Bray. Reprinted from *ICES Journal of Marine Science* 65(5):730-741, July 2008. $4.

Putting the ocean in Atlantic history: maritime communities and marine ecology in the Northwest Atlantic, 1500-1800 (UNHMP-JR-SG-08-07) W. Bolster. Reprinted from *American Historical Review* 113(2):19-47, February 2008. $4.

Rapid assessment surveys of fouling and introduced seaweeds in the Northwest Atlantic (UNHMP-JR-SG-08-27) A. Mathieson, J. Pederson and C. Dawes. Reprinted from *Rhodora* 110(944):406-478, December 2008. $8.

Solving cryptogenic histories using host and parasite molecular genetics: the resolution of *Littorina littorea's* North American origin (UNHMP-JR-SG-08-35) A. Blakeslee, J. Byers and M. Lesser. Reprinted from *Molecular Ecology* 17(16):3684-3696, 2008. $3.

Using parasites to inform ecological history: comparisons among three congeneric marine snails (UNHMP-JR-SG-08-08) A. Blakeslee and J. Byers. Reprinted from *Ecology* 89(4):1068-1078, 2008. $2.

Using underwater videography to monitor oyster farms (UNHMP-AR-SG-08-10) R.

Grizzle and M. Pietrak. Reprinted from *The Dredge* 2(2), Spring 2008, Connecticut Sea Grant. $2.

What appeared limitless plenty: the rise and fall of the nineteenth-century Atlantic halibut fishery (UNHMP-JR-SG-06-06) G. Grasso. Reprinted from *Environmental History* 13(1):66-91, January 2008. $5.

Extension Publications

Bacterial community profiling of the American oyster (*Crassostrea virginica*): comparison of culture-dependent and culture-independent outcomes (UNHMP-JR-SG-09-19) K. La Valley, S. Jones, J. DeAlteris, M. Rice and M. Gomez-Chiarri. Reprinted from *Journal of Shellfish Research* 28(4):827-835, December 2009. $3.

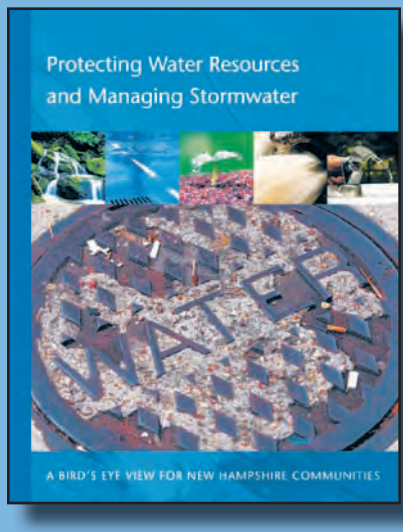
A Decade of Discovery: Collaborative Research in the Gulf of Maine (UNHMP-R-SG-08-34) no charge.

Great Bay Coast Watch Standard Operating Procedures – Phytoplankton Monitoring Program (UNHMP-M-SG-08-06) $5.

Great Bay Coast Watch – Water Quality and Phytoplankton Final Report (UNHMP-AR-SG-08-02) $5.

North Atlantic *Vibrio vulnificus* surveillance from post-harvest oysters at a U.S. shellfish processing facility (UNHMP-JR-SG-08-21)

New Stormwater Management Guide helps Communities understand their Options



Designed to help communities understand the strategies available to help protect their water resources, ***Protecting Water Resources and Managing Stormwater*** is a collaboration among Julia Peterson (NHSG and UNHCE), Amanda Stone (UNHCE) and James Houle (UNH Stormwater Center). It encourages community boards and municipal departments to consider a variety of options and use an integrated approach to water resource protection. It is intended to help communities recognize and discuss the state of their current water resource management, determine where gaps exist and consider next steps.

Development of the guide was supported by a grant from the Environmental Protection Agency. It can be downloaded from **www.seagrant.unh.edu/stormwater.pdf** or **www.issuu.com/nemohub/docs/pwrmsunh**.

Plan a "visit" to the National Sea Grant Library

N.H. Sea Grant and the other programs in the national Sea Grant network submit copies of all of their publications and other communications products to the National Sea Grant Library, which makes all of those items available as PDFs and/or on loan. The library is available online at:
http://nsgl.gso.uri.edu/

If you're interested in NHSG publications in particular, go to:
http://www.seagrant.unh.edu/publications.html
From there, you can initiate a search of the library's holdings of NHSG publications or of all Sea Grant publications.

K. La Valley, J. DeAlteris, M. Rice and M. Gomez-Chiarri. Reprinted from *Journal of Foodservice* 19:234-237, 2008. $3.

A Report on the Conference: Seafood – Balancing Benefits and Risks (UNHMP-R-SG-08-03) $15.

Tagging 2008: A Report on the Northeast Regional Tagging Symposium (UNHMP-R-SG-09-02) no charge.

Training in reversal: a fishing gear workshop by fishermen for non-fishermen (UNHMP-JR-SG-08-33) K. La Valley and P. He. Reprinted from *Journal of Extension* 46(3), June 2008. Article #3IAW5. $2.

UNH Marine Docents – Come Join Us! (UNHMP-B-SG-09-01) no charge.

UNH Marine Docents – Program Offerings (UNHMP-B-SG-09-17) no charge.

Tech 797 Ocean Project Reports

Development of a Polyculture System (UNHMP-TR-SG-08-16) G. Leuchtner, B. Cilley and A. Bottom. $5.

Fog Horn (UNHMP-TR-SG-09-14) M. Feraud, D. Fournier, W. O'Day and M. Ouellette. $5.

Rigid-Hull Inflatable Boat (RHIB) Based Pinger Deployment System (UNHMP-TR-SG-08-18) M. Martinelli, F. Vazquez, E. Williams and L. Woodbury. $8.

Tidal Power Generation: Infrastructure (UNHMP-TR-SG-09-13) J. Browne, K. Buruchian, D. Dreyer, T. Ducharme, K. Dutile and M. Pelletier. $5.

Tidal Power Generation in the Piscataqua River (UNHMP-TR-SG-08-15) Z. Annino, B. Campelia, L. Coppa, S. Gagliardi, S. Lincoln, R. O'Meara Jr., I. El Ayadi and G. Partridge. $14.

Tidal Turbine Performance Analysis (UNHMP-TR-SG-09-15) J. Finch, K. Pflanz and C. Thompsen. $7.

Wave Energy (UNHMP-TR-SG-08-17) M. Allard, C. Fischer, T. Grindrod, J. Murray and K. Russ. $8.

Wave Energy Converter Research (UNHMP-TR-SG-09-16) T. Miller, E. Gray, M. Giovinazzo, N. Timoshchuk, S. Badger and M. Dignan. $8.

This publication is made possible by the National Sea Grant College Program of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration grant NA060AR4170109 to the N.H. Sea Grant College Program.

Additional copies are available from:

N.H. Sea Grant Communications
Kingman Farm/UNH
Durham, NH 03824

UNHMP-PG-SG-10-01

Printed with soy inks on 100% post-consumer recycled paper, manufactured chlorine-free.

Sea Grant
New Hampshire

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce