NH Sea Grant Program Guide

2006 – 2007

Seafaring – *page 8*

Sea Bass – *page 14*

Seaweeds – *page 20*

The NH 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:

2 Director's Message
4 2006-2007 Research Projects
7 Highlights from our Annual Progress Report
7 Meyer Awarded Knauss Fellowship
8 Teaching Commercial Fishing 101
10 Fighting Back Against Alien Invaders
12 Protecting NH's Coastal Communities
14 The Ever-Changing Black Sea Bass
17 Moving Ocean Science Education Inland
19 OOA 10 Years Later
20 Studying Seaweeds to Measure Changes
22 NH Sea Grant Staff
24 Policy Advisory Committee
26 NH Sea Grant Publications
28 NHSG Publishes Stock Assessment Guide

UNIVERSITY of NEW HAMPSHIRE

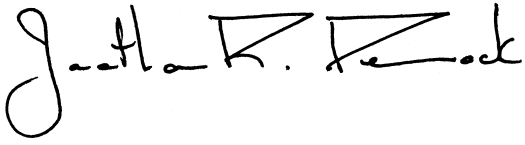
A Message from the Director

Since becoming director of the New Hampshire Sea Grant College Program, I have developed an ever deepening appreciation for the level of expertise, energy and commitment that our staff provides in support of the Sea Grant mission – to promote the understanding, wise use and stewardship of our coastal resources. Following this tradition, I am pleased to welcome Steve Jones to our staff as assistant director for research. Steve will further strengthen our commitment to Sea Grant's research mission and work directly with the New Hampshire marine research community, regional stakeholders and our own extension and education staff to enhance research that supports priorities of specific importance to our state and region.

I am also very pleased to report that NH Sea Grant has committed to support five multi-year research projects for the 2006-2007 biennial budget cycle. Overall, approximately $900,000 is being directed to support projects in the areas of finfish aquaculture, coastal and ocean regional governance, the ecology of invasive species, and finfish and lobster fisheries during this time. As importantly, through core support to the program, our extension staff members continue to serve as state and regional leaders in areas of coastal fisheries, communities, aquaculture and education. These staff members and our incredible Marine Docents also bring over $1 million in additional grant money each year to support NH Sea Grant priorities.

I invite you to become familiar with our ***2006-2011 NH Sea Grant Strategic Plan***, developed through the leadership of our Policy Advisory Committee (PAC). This plan sets clear priorities for our program in the areas of fisheries, ecosystems and habitats, aquaculture, coastal communities, and marine science literacy for the next five years. I 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 NH Sea Grant or assist you in addressing priority research, extension and education needs consistent with these strategic goals.

I and the rest of the NH Sea Grant staff look forward to working with you!



Jonathan Pennock
Director

2006-2007 Research Projects

Using New Approaches to Update and Collect Fisheries-Specific Data on Age Determinations of the Spiny Dogfish in the Gulf of Maine

Paul Tsang, Dept. of Animal and Nutritional Sciences, UNH, Durham, NH 03824, 603.862.3479, pct@cisunix.unh.edu
James Sulikowski, Florida Program for Shark Research, Univ. of Florida at Gainesville; **David Koester**, Anatomy Dept., Univ. of New England

Efforts to manage the spiny dogfish (*Squalus acanthias*) in the Gulf of Maine are being hampered by a lack of information on its life history. This research team is addressing one element of that by developing a new method for determining the age of spiny dogfish. The researchers are comparing the traditional dorsal fin spine method of aging to the vertebral centrum method to ascertain which structure produces the most accurate and reliable correlation between age and total length. In addition, they are examining age at sexual maturity in order to determine if this parameter has changed along with the documented reduction in size at maturity. The results will provide accurate and updated information on the biology of the spiny dogfish, which will benefit scientists, fisheries biologists and fishermen. Furthermore, the validated age measurements, growth rates and information on age at sexual maturity will add credence to future assessment of population dynamics and stock structure of the spiny dogfish.

The Relationship between Seasonal Migrations of Berried Female Lobster (*Homarus americanus*), Egg Development and Larval Survival

Winsor Watson, Dept. of Zoology, UNH, Durham, NH 03824, 603.862.1629, win@unh.edu

Using both laboratory and field studies, Watson is examining the fine-scale seasonal movements of berried female American lobsters (*Homarus americanus*); the relationship between these movements and specific habitats, depths and water temperatures; and ultimately the influence of these movements on the number of viable larvae that hatch from their eggs. These data will provide the first detailed, year-round view of the reproductive life history strategy of these lobsters. This project will provide vital information about the sources of new recruits to the fishery and the interactions between lobster stocks. It will be the first to

determine if the movements of females have an impact on their reproductive output and thus the preservation of the species. The data will also help identify: habitats where berried females aggregate so that lobstermen can avoid these locations and areas where berried females release their larvae, making it possible to model the fate of larvae, identify the source of recruits, and determine which populations or stocks overlap. These types of data are essential in order to sustain this valuable marine resource through establishment of sound fishing practices and development of proper management strategies.

How to Make Coastal and Ocean Regional Governance Work: A Study of Communication Networks

Troy Hartley, Dept. of Resource Economics and Development, UNH, Durham, NH 03824, 603.862.1729, troy.hartley@unh.edu

The US Commission on Ocean Policy concluded that "a lack of communication, coordination, and a strong sense of partnership continues to inhibit effective [management] action." They recommended that "a first step in enhancing the management of oceans and coasts is improving coordination among these many federal programs." Hartley is assessing the communication networks in projects undertaken within the Atlantic States Marine Fisheries Commission, the New England Fisheries Management Council, the Gulf of Maine Council and the NH Coastal Program. He is particularly interested in the level of inter-organizational communication, the roles being played by individuals and organizations in the regional structure, and the perceptions among people of the influence they have on each other and of the impediments to greater regional communication. The study will also test hypotheses derived from deliberative discourse theory, particularly examining whether iterative dialogue (i.e., frequent, two-way communication) contributes to greater mutual understanding and influence. The findings will identify strengths and weaknesses in existing regional governance networks and help coastal and ocean managers address their networks' limitations and the impediments to greater regional communication.

Improving Egg Quality of Cultured Finfish

David Berlinsky, Dept. of Zoology, UNH, Durham, NH 03824, 603.862.0007, david.berlinsky@unh.edu
Frederic Goetz, Great Lakes WATER Institute, Univ. of Wisconsin at Milwaukee

The production of inadequate numbers of larval fish due to broodstock repro-

ductive failure is a major impediment to the expansion of marine aquaculture. Inferior egg quality, in particular, is one of the most pervasive reproductive problems in finfish aquaculture throughout the world. Working in collaboration with their industry partner, GreatBay Aquaculture, the researchers are addressing the problem of poor egg quality in two cultured marine species, Atlantic cod and summer flounder. The focus of the research is to develop physiological predictors that can be used to spawn fish when egg quality is optimal. Specifically, they are working to identify biochemical, molecular and morphological characteristics of developing oocytes that can be used as markers of high quality eggs. They will also correlate the presence of these markers in oocytes obtained from ovarian biopsies with egg quality (fertilization and hatching success) in fish pharmacologically induced to ovulate. The results will lead to the development of simple assays that culturists can use to gauge the optimal time for ovulation induction in marine finfish species. Finally, they will develop methods to effectively spawn cod manually and determine their inter-ovulatory interval.

Ecological Effects and Coastal Zone Management Implications of Recently Discovered New England Populations of Two Fast-Growing Asian Seaweeds, *Porphyra yezoensis* Ueda and *Porphyra katadae* Miura

Arthur Mathieson, Dept. of Plant Biology, UNH, Durham, NH 03824, 603.862.5133, arthur@cisunix.unh.edu
Christopher Neefus, UNH Dept. of Plant Biology

Invasive non-indigenous seaweeds can significantly impact intertidal ecology by displacing native species, sequestering nutrients and utilizing common resources. Populations of two Asian species of the red seaweed *Porphyra* have recently been discovered in New England. One of the species (*P. katadae*) has been confirmed at five sites near Cape Cod. The second species (*P. yezoensis*) has been found at 26 sites ranging from mid-coastal Maine to Rye, NY. The researchers are assessing the extent, impact and potential ecological threat(s) of these two seaweeds in New England. They will determine how long the seaweeds have been present in New England; establish the seasonality, geographic extent and expansion rates of the current populations; and measure the ecological impact of current populations of *P. yezoensis* and *P. katadae*. Finally, they will provide information and recommendations to coastal zone managers and regulatory agencies regarding the status and potential environmental threat(s) posed by the spread and/or further introductions of Asian *Porphyra* species.

Highlights from the 2005 Annual Progress Report

Each year, NH Sea Grant prepares a report on its recent research and extension activities and submits the report to the National Sea Grant Office. The following excerpts are taken from our 2005 report and briefly describe progress we've made in several areas.

Seafood Production (Commercial Fisheries)

The **northeast skate complex** consists of seven species indigenous to the Gulf of Maine. In the past, skates taken during Gulf of Maine commercial groundfishing operations were generally discarded as by-catch because of their low commercial value. More recently, the rapidly expanding markets for human consumption of skate wing and for use as lobster bait have made three of these species commercially more valuable. Despite the increasing commercial importance of the thorny skate, little is known of its biology and harvesting of the species has been prohibited since 2003.

The primary objective of a project by Paul Tsang (UNH), James Sulikowski (Florida Program for Shark Research) and others is to determine why a disparity in age and size at sexual maturity exists in a localized population of thorny skates within the western

Meyer Awarded Knauss Fellowship

Recent UNH graduate John Meyer, who completed his M.S. in zoology last spring, has been awarded a Dean John A. Knauss Marine Policy Fellowship for 2006. Sponsored by the National Sea Grant College Program, the year-long paid fellowship program matches recent graduate students with hosts in the legislative and executive branches of government.

Beginning in February, Meyer will spend one year in Washington, DC, working with US Rep. Wayne Gilchrest (R, Maryland) on marine-related policies and regulations. "I've been into ecology for a long time, but I've always had policy in the back of my mind," Meyer says.

Meyer, originally from San Diego, first became interested in marine policy while earning a B.A. in environmental studies from the University of California, Santa Barbara. As a master's candidate at UNH, Meyer worked with assistant professor of zoology Jeb Byers to study ecology in the Gulf of Maine. Specifically, he investigated how the creation of the Western Gulf of Maine Closure Area, an area closed to ground fishing, has affected the local community of invertebrates.

Gulf of Maine. The researchers have obtained enriched microsatellite libraries for the small and large reproductive groups from the Gulf of Maine. In addition, sequencing of each library has begun in anticipation of identifying clones, and PCR primers have been designed in order to screen samples to determine which loci are polymorphic.

The **ocean sunfish**, *Mola mola*, is found worldwide yet its biology is poorly understood. Though common in the Atlantic, no data on temporal and spatial distribution are available. The primary objectives of a development project by Hunt Howell (UNH) and graduate student Inga Potter are to determine the general distribution of *Mola* off the northeast coast of the US and to look for migratory patterns and behaviors using pop-up archival transmitting tags. To date, five sunfish have been tagged and released. Two tags popped off prematurely, but were retrieved with data intact. A third tag, recovered in January, showed the individual had traveled to the Gulf of Mexico. The other tags are scheduled to be released in the coming months. Preliminary data from this project has allowed the researchers to write and submit a proposal to the Large Pelagics Research Center at UNH to expand this effort.

Teaching Commercial Fishing 101

Dressed in orange rubber pants and a late-summer tan, Joe Jurek hauled up his net and dumped a pile of shimmering silver herring onto the deck of his boat, *Mystique Lady*. "Look, we got some dogs!" he said and grinned as he pulled one of the foot-long sharks from among the mass of herring.

Jurek was demonstrating his profession as part of a workshop organized by NH Sea Grant Extension specialists Pingguo He and Ken LaValley and Hampton fisherman David Goethel. He and LaValley work to generate cooperation among commercial fishermen, fisheries scientists and fisheries managers. They spend much of their time working with fishermen to improve gear and promote smart, safe fishing practices. On the flip side, they also aim to inform the public about commercial fisheries. To that end, they devised a fishing gear workshop that was held in late August. They plan to make it an annual event.

Commercial fisherman Erik Anderson and Northeast Consortium Outreach Coordinator Troy Hartley talk about nets; Joe Jurek demonstrates the art of trawling aboard his *Mystique Lady.*

Populations of the **eastern oyster** (*Crassostrea virginica*) have been in long-term decline in many areas along the eastern US coast. A major hindrance to effective oyster management has been lack of a methodology for effectively and economically obtaining data on distribution and abundance. The overall goal of a project by Ray Grizzle (UNH) and others is the development of new and innovative remote sensing technologies culminating in a recommended general protocol for further testing in other areas. The researchers are assessing the effectiveness of new acoustic, visualization, videographic and GIS-based mapping technologies for characterizing subtidal oyster reef habitat.

This effort involves collaboration between UNH scientists and personnel from the NH Fish and Game Department. Thus far, data have been gathered on oyster size and density (quadrat sampling), videographic characterizations, and acoustic soundings. Progress was also made in the development of a dynamic digital elevation model for the processing of acoustic data.

As the number of fishing days that are available to New Hampshire commercial fishermen continue to diminish, **safety at sea** becomes a larger issue because fishermen are

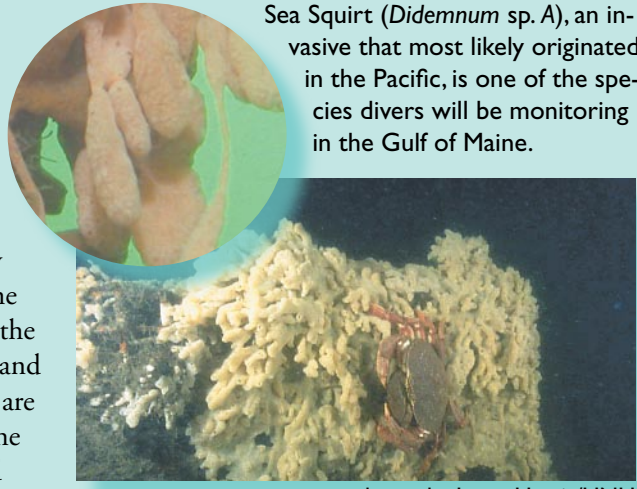
Fishing regulation is a complicated subject that today's commercial fishermen must understand inside and out. But regulators and conservationists don't always have an equivalent understanding of the challenges that fishermen face on the water. How does a gillnet differ from a trawl net? What effects do the different gear types have on the underwater environment? How do fishermen maintain their equipment to comply with regulations?

To help answer such questions, He and Goethel recruited three other local fishermen to explain their profession. The workshop drew a wide audience that included congressional staffers, members of conservation organizations and volunteer groups, and employees of the Coast Guard, NH Fish and Game, and NOAA's National Marine Fisheries Service.

The three-day event began on dry land, with an introduction that touched on fish behavior, fishing gear and gear improvements that aid conservation efforts. During the next two days, the participants went to sea to witness the gear in action. "This gave me a better understanding of the NH fishery," Clare McBane, a marine biologist for NH Fish and Game, said. "Having actual fishermen as the instructors was a great idea."

Fighting Back Against Alien Invaders

Some invasive species, like zebra mussels and snakehead fish, have earned a lot of attention in the media. But many introduced marine species – such as the Asian shore crab and the rapa whelk – are typically out of the public's sight and mind.



Sea Squirt (*Didemnum* sp. *A*), an invasive that most likely originated in the Pacific, is one of the species divers will be monitoring in the Gulf of Maine.

photos by Larry Harris/UNH

Sea Grant extension specialist Mark Wiley is helping to change that. He's participating in a Northeast regional Sea Grant project to reduce the spread of non-native marine invaders. The collaboration includes Sea Grant specialists from every state in the region, from New York to Maine.

Wiley's team has singled out three of the groups that spread aquatic nuisance species around the globe: commercial ships, the marine bait industry and the seafood industry. Ships may transport invaders in ballast water as they move from place to place, for example. Recreational fishermen may dump unused baitfish overboard, and seaside restaurants may accidentally discard live seafood, such as shellfish, into the water. Wiley and his partners aim to develop outreach materials specific to each of those groups to increase awareness of invasive species.

Wiley is also heading up another component of the project. He's helping to train recreational divers to monitor sites around the Gulf of Maine for aquatic nuisance species. The volunteer divers will track the spread of recent introductions and keep an eye out for new invaders.

going further offshore and staying out on longer trips. Forty-two industry members completed a Sea Grant-sponsored vessel safety training program. They learned emergency response protocols, ground safety equipment use and inspection, as well as fire, flood and abandoning ship procedures. The participants were also trained in at-sea survival techniques, signaling and flare use.

Interest in and support of **cooperative research** increased through Sea Grant Exten-

sion contacts with fishermen in Gloucester, MA, Portland, ME, Seabrook, NH, and Portsmouth, NH. Eight commercial fishermen partnered with three UNH scientists, which resulted in one project funded by the NMFS Cooperative Research Partnership Program, four project development proposals submitted to the Northeast Consortium (NEC), and one funded full proposal through the NEC.

In a development project, Win Watson (UNH) and others received funding to examine the local and seasonal migrations of **horseshoe crabs** in the Great Bay Estuary. The PIs are tracking and quantifying seasonal movements using both ultrasonic listening stations and a fixed array ultrasonic telemetry system. This past year, they successfully tracked nine horseshoe crabs and their preliminary data indicate that horseshoe crabs remain within Great Bay throughout the year. This preliminary research helped the investigators secure NSF funding to further this line of research. The PIs also developed a successful prototype horseshoe crab trap that they will use in the future to quantify the abundance of horseshoe crabs in the estuary.

Understanding **fishing gear selectivity** and designing gear that reduces bycatch and discards have remained primary focuses of Sea Grant Extension activities during the past year. A recent project tested two new low-vertical-profile gillnets designed to reduce cod catch. A low profile net with one third of the height of a standard cod net was found to have potential to reduce cod catch without a reduction in flounder catch.

A project that uses water-borne kites to expand meshes in a shrimp codend to provide easier escape for small fish and small shrimp was funded by the Northeast Consortium. Flume tank tests and sea trials have been carried out. Two new projects to modify shrimp trawl designs to further reduce the catch of fish and small shrimp have been funded by the Consortium and the NMFS Cooperative Research Partners Program.

With emerging challenges of continued low biomass of the Atlantic cod in the Gulf of Maine and Georges Bank, and a marked increase in haddock biomass, the design, testing and utilization of haddock trawls has become a priority in fisheries management in New England. Two projects testing new concepts of haddock trawls have started. Preliminary sea trials have had promising results. Further sea trials will be carried out during spring/summer of 2006.

Regulating codend mesh sizes in trawls is a key element in the multispecies fisheries management plans in the northeastern US. Effective mesh regulation requires good understanding of codend mesh size selectivity for different species. Two projects to study trawl codend selectivity have been completed. A project supported by the Northeast Consortium focused on the development of a new codend cover for use onboard small fishing vessels in the Gulf of Maine. The cover was used in a project to study codend selectivity funded by the NMFS.

Jeff Bolster (UNH) and colleagues are involved in a project that is analyzing **19th century fisheries records** to determine historical abundance and distribution of Gulf of Maine cod. Whenever possible, the researchers are adapting modern fisheries stock assessment models and non-linear statistical methods to data from log books from the inshore 1852-1866 codfishery. Data recovery is ongoing and analysis is beginning. The landings that have been reviewed so far are significant. For instance, vessels based in

Protecting NH's Coastal Communities

New Hampshire's population is the fastest-growing in New England, and much of that growth is happening in communities within the coastal region. As farms and forests are paved over for new homes and businesses, more polluted runoff spills into streams, rivers and bays, threatening the coastal ecosystem.

Julia Peterson, a NH Sea Grant extension specialist in water resources, is reaching out to help seacoast communities manage their growing pains. Peterson helps towns plan for growth through her work with the Natural Resources Outreach Coalition (NROC), part of the National Nonpoint Education for Municipal Officials Network (NEMO). A partnership of regional, state and federal organizations, NROC helps communities protect their wildlife habitats, agricultural lands and water resources – while still preserving each town's economic vitality and unique cultural character.

After a town has applied for and been selected for NROC assistance, Peterson or another NROC team member makes a customized presentation to community members using GIS maps to illustrate the current state of the town's natural resources. Over the following year, NROC partners work closely with board members and other community volunteers to develop strategies for protecting the community's natural resources as it grows. Thanks to NROC support, towns have applied for grants, formed action committees, developed open-space plans and secured funding for land conservation. As one participant from Dover said, "NROC helped us see beyond our own community's boundaries and begin to recognize the importance of looking at the bigger picture and working with our neighbors to protect our valuable natural resources."

photo by Bill McGrew/New Durham, NH

Frenchman's Bay that fished between Monhegan Island and Grand Manan landed more cod in 1861 than the entire Gulf of Maine fleet landed in 1998, 1999 and 2000 combined. Catch data alone show that this area supported a much more important fishery than has heretofore been acknowledged.

Investigation of the dynamics of the early life stages of **northern shrimp** in the western Gulf of Maine is needed in order to understand the dramatic fluctuations in abundance that have occurred in this region over the past 50 years. In a multi-stage project, Jeff Runge (UNH) and others are determining whether the first-order environmental factors controlling survival of these early life stages are one or a combination of temperature and food supply, which affect larval growth and cumulative mortality rates, and the fine-scale circulation pattern. Initial results from particle tracking runs using physical circulation models indicate dramatic changes in proportion of larvae retained in nearshore nursery areas depending on winds in winter and early spring.

One explanation for environmental control of recruitment variability in Gulf of Maine northern shrimp is that the timing of the winter-spring bloom and the appearance of planktonic stages of northern shrimp will lead to a match or a mismatch between the larvae and their food supply, resulting in variable growth and subsequent survival rates. The researchers have focused on the preparation of a temperature-controlled chamber equipped with basins and a sea water supply suitable for conducting the larval shrimp feeding experiments, which are scheduled to start in winter 2006.

Seafood Production (Aquaculture)

The initial objective of a project by Jessica Bolker (UNH) was to measure possible effects of larval diet on both visual behavior and albinism in hatchery-reared **summer flounder**, a species being developed for aquaculture. However, initial work revealed that testing visual performance at larval stages was not feasible due to the very small size of the larvae and the difficulty of eliciting normal behavior under appropriate experimental conditions. Moreover, by the time the project began, the industry partner (GreatBay Aquaculture of Newington, NH) had succeeded in eliminating albinism from their cultured fish by changing to a larval diet enriched in vitamin A.

Although it eliminated the problem of albinism, the change to a Vitamin A-enriched diet resulted in a dramatic increase in the frequency of abnormal blindside coloration. Since the change in malpigmentation coincided with the change in diet, it was assumed that the enriched diet had a relatively direct effect on coloration. One strong candidate for the active factor was retinoic acid (RA), a highly biologically active derivative of Vitamin A. Prompted by the apparent effects on pigmentation of vitamin A-enriched feed, Bolker and graduate student Michael Baron directly examined the effects of RA on summer flounder pigmentation. They found that RA exposure disrupted pigmentation development: Vitamin A-treated tanks had a smaller percentage of normally pigmented fish than did controls, with increased numbers of both hypo- and hyperpigmented individuals. Exposure also affected the development of several skeletal features. RA treatment correlated with a significant increase in the severity of defects in jaws, fins, hypurals and vertebrae compared to control groups. These findings underscore the need for the control of Vitamin A supplementation in larval diets, as well as the utility of identify-

ing specific morphological hallmarks of RA toxicity. It also points to the importance of understanding the etiology and functional significance of RA-induced developmental defects in cultured flatfishes.

Sea Grant Extension is a collaborator on the $3 million/year UNH **Open Ocean Aquaculture** Demonstration Project that has been developing the technology to grow finfish and shellfish in deep water environments. Recently, scientists working on this project have perfected the techniques to economically grow blue mussels on long-line rope culture. Extension staff provided guidance to two local fishing cooperatives on gaining commercial-scale permits for blue mussel culture. The first ever permits in NH state waters allow for the deployment of 10 submerged longlines. Currently, four are in the water and have mussels growing on them with harvest anticipated in the fall of 2006.

The overall goal of a recent project by Chris Neefus (UNH) and others was the development, optimization and continuous operation of a Modular Integrated Recirculation **finfish/seaweed Aquaculture** System

photo by Karen Ro

Uncovering Sex- of the Blac

In a former cow shed on the edge of the UNH campus, David Berlinsky, assistant professor of zoology, peers into a big blue plastic tub. Inside, black sea bass circle slowly in the dim light. The converted barn is now an aquaculture research facility for the College of Life Sciences and Agriculture, and home to Berlinsky's latest research.

Black sea bass feature prominently on many menus, but wild populations of the fish are in decline and their availability is limited. Because of the high demand, they're a good candidate for aquaculture on the east coast. Except, that is, for one problem: they have a tendency to change sex unpredictably in captivity.

"In the wild, black sea bass are born as females and turn into males at around two to five years old," Berlisky explained. "When you bring them into captivity, they change into males more quickly." Some captive-born fish emerge as males even before reaching adulthood, devoting energy toward reproductive development and away from growth. Such problems make breeding and growing the fish in captivity a tricky proposition.

"Black sea bass is a wonderful fish to culture and to eat," said George Nardi, vice president and director of GreatBay Aquaculture, a commercial fish farm in Newington, NH. But the sex change problem must be tackled if fish farmers are to bring a high-quality fish to market. "We invest in our brood stocks, the parents of the young fish, much as a thoroughbred horse farm

eder/NOAA National Marine Sanctuaries

-Change Secrets
k Sea Bass

invests in mares and stallions," he said. "It doesn't do us much good if we always have to go out and get new females."

With funding from NH Sea Grant, Berlinsky has teamed with Nardi and GreatBay Aquaculture to study what triggers sex reversal in black sea bass – and how to prevent it.

Berlinsky and his colleagues have discovered that fish are more likely to become males if raised at constant temperatures. But, he said, temperature is hardly the only factor involved. Sex ratios and density also come into play. Berlinsky's team found that females were more likely to change sex when no males were present in the tank. Additionally, the fish were more likely to turn into males when kept in crowded tanks.

Based on those findings, Berlinsky recommends that fish farmers interested in growing black sea bass keep the fish in small tanks with one male and fairly low numbers of females. "In that way you can prevent, or at least delay, sex reversal," he said.

Despite his successful findings so far, his work with sea bass is far from finished. He's continuing his experiments to clarify the role that water temperature plays and to further understand what factors determine the initial sex of captive-born fish.

Berlinsky is also collaborating with Canadian researchers to study the underlying biochemical mechanisms that cause the fish to change sex. In female fish, estrogen plays the major role, he said. In males, a steroid hormone called 11-ketotestosterone is involved. The scientists are studying those hormones and the enzymes that control them.

By turning off estrogen production, Berlinsky said, he can turn a female fish into a male within a week. Giving 11-ketotestosterone to a female converts it into a male. "We're studying the ways to control the enzymes that control sex reversal," he said. "We're coming at the problem both behaviorally and biochemically."

Though he still has details to sort out, Berlinsky said, he has already made important steps. "We have already made progress, determining optimal sex ratios and delaying sex reversal by controlling density," he said. "We've already made strides toward making black sea bass aquaculture possible."

Collaborating Institutions

Dartmouth College
Fisheries and Oceans, Canada
Maine Department of Marine Resources
Massachusetts Institute of Technology
Memorial University (Newfoundland)
NH Fish & Game
Plymouth State University
University of Connecticut
University of Florida
University of Maine
University of New Brunswick
University of Rhode Island
University of Southern Maine

(MIRAS). The system produces fish and seaweed, maintains healthy water quality, and substantially reduces nutrient loading in the system effluent. The researchers built a greenhouse and the MIRAS at Great Bay Aquaculture (GBA), a commercial fish farm in Newington, NH. This project demonstrated successful operation of the system and initiated a series of experiments aimed at optimizing the production of fish, nori (seaweed) and nori pigments; maintaining water quality; and removing nutrients from the system effluent. The results of juvenile black sea bass feeding trials were used in conjunction with nutrient uptake data to predict safe seaweed:biomass ratios for the integrated system. Black sea bass and Atlantic cod, in conjunction with three native species of *Porphyra*, grew at rates equal to or greater than those of the conventional system at GBA. The *Porphyra* grew up to 30% per day and water quality remained excellent. Using these results, the PIs were able to generate predictive models of nutrient levels that should be maintained in the system for different fish:seaweed biomass ratios for a limited set of conditions.

Coastal Ecosystem Health and Safety

Because of a typically large number of anthropogenic disturbances, efforts to identify the agents of **degradation of salt marshes** can be costly and difficult. These agents include chemical pollution, physical degradation and modification of biological structure and consequent trophic interactions. Jeb Byers (UNH) is developing an efficient, holistic method of assessing whether a marsh system is significantly degraded by analyzing the structure of digenetic trematode parasites within the marsh community.

A total of 15 marshes ranging from Boston to Portland, ME, were extensively surveyed over the past two summers. Marsh sites were carefully chosen for suitable snail habitat and general patterns in marsh vegetation and hydrographics, such that areas incorporated into the study will provide a meaningful basis of comparison. At each site more than 200 snails of *Ilyanassa obsoleta* were collected from two size classes in a stratified random design. Snails were dissected in the lab to analyze the prevalence and species richness of infecting trematodes.

Extensive field measurements were also made concurrently at each site. Sediment samples were collected and are currently being analyzed. Organic contaminants will also be analyzed in some of the sediment samples from each site. The organic compounds targeted for these analyses include 18 polyaromatic hydrocarbons, seven PCBs and 21

pesticides. Collectively these analyses will enable Byers to correlate trematode richness and prevalence with various measures of marsh health. Currently, he is using GIS databases and aerial photos to assess physical degradation of sampled marshes. This represents the final quantification step.

Human **exposure to metals** such as mercury is largely from consumption of fish, which bioaccumulate this neurotoxin. To date, research on the transfer of mercury in aquatic food webs to fish has focused on freshwater systems where metal concentrations in fish are related to a variety of biotic and abiotic factors. However, most fish consumed by humans come from marine systems. The objective of a development project by Celia Chen (Dartmouth) was to examine the bioaccumulation and trophic transfer of mercury in estuarine food webs, particularly in the resident and transient benthic, epibenthic and nektonic species inhabiting the intertidal and subtidal portions of estuaries.

Chen compared the food webs of three Gulf of Maine estuaries that differ in hydrology, physical transport and mixing, as well as in contaminant and nutrient inputs. Chen collected biotic samples of benthic and pelagic species including common mummichog, periwinkles, mussels, green crabs and polychaetes. Mercury concentrations in biota from each site reflected the differences in contaminant inputs to these estuaries. The Great Bay sites were the most contaminated and Wells, ME, was the most pristine. Although

Moving Ocean Science Education Inland

The Centers for Ocean Sciences Education Excellence (COSEE), a national network of regional partnerships, work to promote and improve marine science education. Now NH Sea Grant is participating in a new COSEE partnership, the first of the centers to be based around a theme rather than a geographical region. NH Sea Grant extension specialist Mark Wiley is involved in the new "COSEE Ocean Systems," along with educators from the Bigelow Laboratory for Ocean Sciences, the University of Maine and other partners from the University of New Hampshire.

There's a big push for K-12 teachers to focus on core standards, Wiley said, like math, language arts and general science. Many teachers, especially in inland schools, don't have the time or the resources to explore ocean sciences in the classroom. The idea behind COSEE Ocean Systems is to use marine science as a context for teaching core science, Wiley explained.

The new COSEE partners will collaborate over the next five years to develop tools to extend marine science inland. They'll work with educators and researchers to create new approaches and develop new classroom materials. In the later stages of the project, they'll hold professional development workshops to train teachers in the new curricula. "It's neat to be involved," Wiley said, "both because it will create new partnerships and because it will be cutting-edge from an educational point of view."

the industrial areas in Great Bay are concentrated around Portsmouth Naval Shipyard, the dynamic tidal flux in the bay apparently circulates water from the mouth up into the more forested regions in the upper portion of the bay. The data from this pilot study was used to support a successful $1.4 million grant application on this topic to the Department of Defense.

With support from development funds, Larry Harris (UNH) is investigating the usefulness of satellite temperature data in the nearshore Gulf of Maine environments in relation to the **ecology of marine invasives**. The most interesting finding to date is that the monthly average summer temperatures at the mouth of Portsmouth Harbor are two degrees C. warmer now than just 25 years ago. In addition, transitions from winter to summer and from summer to winter are much sharper and reduced in time. If these patterns hold true for other estuaries in the study, it may help explain why some invasive species are now showing much more aggressive population growth than when originally introduced and why some are becoming more common farther north in the Gulf of Maine.

Marine Education and Human Resources

As in prior years, the **Marine Docents** continue to be the major conduit through which Sea Grant Extension delivers its marine science education programs to a wide variety of stakeholders. The nearly 200 volunteers participated in 100 programs reaching about 8,000 people including 3,500 students in 35 schools.

Boat-based education programs continue to be very popular. The Great Bay Living Lab, intended for middle school students and teachers, the Floating Lab for junior and senior high school students, and the Discovery Cruises for adults made more than 50 trips with a total of 1,500 participants. Surveys of Discovery Cruise participants this year found that they consistently reported increased knowledge of estuaries and estuarine research. The Floating Lab provides students an opportunity to gain ship-board experience in water quality measurements, plankton collection and observation, current measurement, benthic sampling and navigation. Most of the participating schools have formally incorporated this program into their science curriculum.

Low power radio continues to be a useful tool for Sea Grant Extension to reach a large audience traveling through a particular geographic location. Great Bay Area Radio continues to broadcast messages about the Great Bay Estuary, research and related events. Topics this year included information about nonpoint source pollution, septic systems, wildlife, marine research projects and the recruitment of volunteers, as well as announcements about educational events and opportunities in seacoast New Hampshire. A portion of the listeners responded to an online survey and indicated an interest in learning more about estuaries in general, the Great Bay in particular, estuarine wildlife, research, events and educational opportunities. There is some evidence that radio listeners are attending events and facilities they hear about on the radio. Great Bay Area Radio continues to be viewed as an attractive resource for partner educational agencies and organizations in coastal New Hampshire who contact us requesting coverage.

OOA 10 Years Later

Ten years ago, offshore commercial fish-farming was just a dream. But around that time, a few experimental projects were launched in the United States, including the UNH Open Ocean Aquaculture Project.

In 1996, NH Sea Grant Extension Educator Rollie Barnaby organized an international symposium to get people talking about growing fish at offshore sites. Over 200 people from 13 countries attended.

In the decade since, offshore aquaculture has begun to transition from experiment to profitable industry. Researchers and fish farmers have answered many questions about which fish to raise, how best to raise and harvest them, and how to do so in an environmentally responsible way.

Launched as part of a Florida Sea Grant initiative, the Aquaculture Center of the Florida Keys supplies juvenile cobia and snapper to two open ocean aquaculture companies.

In addition to the UNH project, which has produced haddock, halibut, cod and blue mussels, three commercial farms operate in the US: two in Hawaii and one in Puerto Rico. Barnaby recently spent a six-month sabbatical visiting those and other sites around the globe to check up on the progress of the offshore aquaculture industry. He was encouraged by what he saw.

Although hurdles remain in establishing a permitting process, Barnaby says, he believes the industry has a bright future. Worldwide, many fish stocks have been hit hard by overharvesting. Yet demand for seafood continues to grow. With open ocean aquaculture, Barnaby says, "we have an incredible opportunity to provide our citizens with needed protein in a safe, sustainable and environmentally responsible way."

Sea Grant Extension successfully hosted the 2005 **Nor'easter Bowl**, the northern New England regional component of the National Ocean Science Bowl (NOSB). NOSB is an annual national academic competition in marine science for high school teams. Seven teams of students competed in the day-long event, which involved short answer and group essay questions. The winning team moved on to the national competition.

Sea Grant marine education staff are active in regional and national associations that promote the teaching of marine science concepts in the classroom. NHSG staff member Mark Wiley is president-elect of the **Gulf of Maine Marine Education Association**, which will host the National Marine Education Association's annual conference in 2007. Wiley also presented a very positively evaluated workshop at the recent NMEA conference on incorporating marine science into standards-based lesson planning.

Studying Seaweeds to Measure Ecosystem Changes

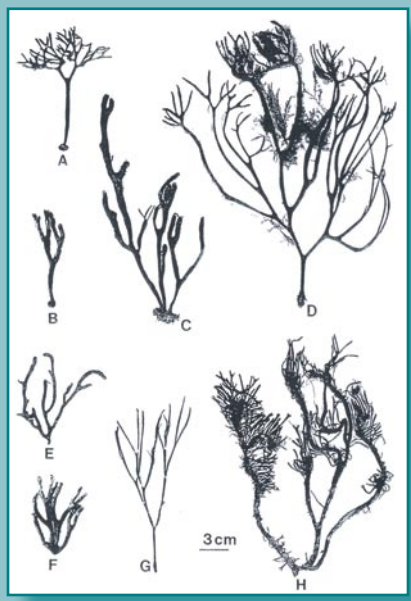
Arthur Mathieson's science is wholly modern, but his techniques evoke memories of another era. Mathieson is a marine phycologist, or seaweed specialist, with UNH's Department of Plant Biology and Jackson Estuarine Laboratory. Just as Victorian naturalists once did, Mathieson collects seaweed samples, carefully dries his specimens and adds them to an impressive collection of preserved samples (housed, in this case, in the Hodgdon Herbarium at UNH). It's fitting, then, that one of Mathieson's most important collaborators is Frank Shipley Collins – an amateur botanist who died before Mathieson was even born.

Collins collected seaweed from the Gulf of Maine during the late 19th and early 20th centuries. His preserved specimens survive to this day, housed in museums and universities across the country. Thanks to Collins and his detailed collections and diaries, Mathieson has been able to make direct comparisons between flora past and present, in order to assess what changes have occurred in Casco Bay over the last century.

With funding from NH Sea Grant, Mathieson and several colleagues have collected thousands of seaweed samples from 200 sites around Casco Bay. Comparing his findings to Collins' samples, they've discovered that the bay's seaweed community is quite similar to that of the late 1800s, overall. Mathieson collected 79 percent of the species that existed in the bay a century ago. In some

Formal Education

UNH's **Ocean Projects Course (Tech 797)**, which is partially supported by Sea Grant funds, provides opportunities for undergraduate students in engineering, physical, life and social sciences to work as members of interdisciplinary teams. Over the course of two semesters, each team addresses a contemporary problem in the ocean and coastal zone under real-world conditions. The goals of the 2005-2006 projects are to build an instrumented, acoustic buoy for monitoring noise potentially harmful to marine life, to design satellite tags for large fish and marine mammals with maximum pull-out resistance, and to develop systems to enable a hovercraft to operate over water.



Originally from Japan, *Codium fragile* ssp. *tomentosoides* (shown here in several of its developmental and seasonal forms) was introduced to Boothbay Harbor, Maine, from Long Island Sound in the 1960s during shellfish reseeding efforts. Since then the single-celled plant has spread south along the coast by a process of fragmentation.

specific sites within the bay, however, the similarity between historical and modern seaweed flora is less than 50 percent.

Some organisms have disappeared from the bay, Mathieson said, possibly as a result of pollution. Casco Bay is a major oil port and has suffered contamination by trace metals and organic pollutants. Meanwhile, new species have been introduced into the bay. Some are relatively benign. Others, such as the introduced Asian species *Codium fragile* ssp. *tomentosoides,* are not. This spongy green seaweed was introduced into Long Island Sound in the 1950s and is believed to have been carried to Maine along with transported oysters. A tenacious invader, it can drive out native seaweeds and smother shellfish beds.

Despite the introductions and localized changes in flora, Mathieson was encouraged that, overall, the seaweed community hadn't changed significantly in the last hundred years. "Man has impacted Casco Bay, especially near the [heavily polluted] Fore River," Mathieson says. "But overall the bay's flora is intact."

NH Sea Grant Staff

NH 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

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

Brian Doyle, Associate Director and Program Leader, 603.749.1565, brian.doyle@unh.edu
Lori Lavac, Program Assistant, 603.749.1565, lori.lavac@unh.edu
Mark Wiley, Extension Specialist/Marine Education, 603.749.1565, mark.wiley@unh.edu
Ann Reid, Program Assistant, 603.749.1565, ann.reid@unh.edu
Candace Dolan, Phytoplankton Project Coordinator, 603.749.1565, candace.dolan@unh.edu
Karen Diamond, Great Bay Coast Watch Assistant, 603.749.1565, karen.diamond@unh.edu
Julia Peterson, Extension Specialist/Water Resources, 603.749.1565, julia.peterson@unh.edu
Steve Adams, Communications Coordinator, 603.749.1565, steve.adams@unh.edu
Kirsten Weir, Science Writer, 603.749.1565, kirsten.weir@unh.edu
Sue Chalifoux, Communications Assistant, 603.749.1565, sue.chalifoux@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

Rollie Barnaby, Extension Educator
113 North Rd.
Brentwood, NH 03833
603.679.5616, fax: 603.679.8070
rollie.barnaby@unh.edu

Pingguo He, Extension Specialist/Commercial Fishing
137 Morse Hall, UNH
Durham, NH 03824
603.862.3154, fax: 603.862.0243
pingguo.he@unh.edu

Ken LaValley, 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

Policy Advisory Committee

The NH 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 NH 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.

Andy Armstrong
Codirector
NOAA/UNH Joint Hydrographic Center

David Bartlett
Associate Director
UNH Institute for the Study of Earth Oceans & Space

James Byers
Assistant Professor, Zoology
UNH

Bob Campbell
Manager, Yankee Fishermen's Cooperative
Seabrook, NH

Janet Campbell
Research Professor and Codirector
UNH Ocean Process Analysis Lab

Jack Chambers
UNH Marine Docent
Portsmouth, NH

Celia Chen
Research Assistant Professor, Biological Sciences
Dartmouth College

Richard Fralick
Professor, Natural Science
Plymouth State University

Ellen Goethel
Marine Biology Educator
Hampton, NH

Barbara Hopkins
Outreach Director
UNH Leitzel Center for Mathematics, Science and Engineering Education

Jennifer Hunter
Director
NH Estuaries Project

Peter Kinner
Vice President, Normandeau Associates
Bedford, NH

Richard Langan
Codirector
NOAA/UNH Cooperative Institute for Coastal and Estuarine
Environmental Technology

Chris Mantzaris
Deputy Regional Administrator
National Marine Fisheries Service

Betsy Nicholson
NOAA Regional Coastal Program Specialist
UNH

Bonnie Spinazzola
Executive Director
Atlantic Offshore Lobstermen's Association

NH Sea Grant Publications

This section contains information on some of the recent publications produced by researchers, students, extension staff and others associated with NH 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 27.

Research Publications

The Effects of Tagging and Transport on Stress in Juvenile Winter Flounder,* Pseudopleuronectes americanus: *Implications for Successful Stock Enhancement (UNHMP-JR-SG-05-10) J. Sulikowski, E. Fairchild, N. Rennels, H. Howell and P. Tsang. Reprinted from *J. World Aquaculture Society* 36(1):148-156. $3.

Estuary/Ocean Exchange and Tidal Mixing in a Gulf of Maine Estuary: A Lagrangian Modeling Study (UNHMP-JR-SG-04-26) A. Bilgili, J. Proehl, D. Lynch, K. Smith and R. Swift. Reprinted from *Estuarine, Coastal and Shelf Science* 65(4):607-624. $3.

***Factors Affecting the Post-release Survival of Cultured Juvenile* Pseudopleuronectes americanus** (UNHMP-JR-SG-01-29) E. Fairchild and H. Howell. Reprinted from *J. Fish Biol.* 65:69-87. $3.

The History of Ocean Resources: Modeling Cod Biomass using Historical Records (UNHMP-JR-SG-05-02) A. Rosenberg, J. Bolster, K. Alexander, W. Leavenworth, A. Cooper and M. McKenzie. Reprinted from *Front. Ecol. Environ. 2005*, 3(2):84-90. $1.

Mapping and Characterizing Oyster Reefs using Acoustic Techniques, Underwater Videography and Quadrat Counts (UNHMP-PR-SG-05-22) R. Grizzle, L. Ward, J. Adams, S. Dijkstra and B. Smith. In *Benthic Habitats and the Effects of Fishing* (American Fisheries Society Symposium 41, pp. 153-160). $2.

Molecular Ecological Studies of New England Species of* Porphyra *(Rhodophyta, Bangiales) (UNHMP-JR-SG-00-13) A. West, A. Mathieson, A. Klein, C. Neefus and T. Bray. Reprinted from *Nova Hedwigia* 80:1-24. $4.

Plan a "Visit" to the National Sea Grant Library

NH Sea Grant and the other 29 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://nsgd.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.

Nutritive Phagocyte Incubation Chambers Provide a Structural and Nutritive Microenvironment for Germ Cells of* Stronglyocentrotus droebachiensis, *the Green Sea Urchin (UNHMP-JR-SG-05-11) C. Walker, L. Harrington, M. Lesser and W. Fagerberg. Reprinted from *Biol. Bull.* 209:31-48. $3.

***Production and Storage of Sperm from the Black Sea Bass,* Centropristis striata** (UNHMP-JR-SG-04-28) J. DeGraaf, W. King, C. Benton and D. Berlinsky. Reprinted from *Aquaculture Research* 35:1457-1465. $2.

Salem as Athenaeum (UNHMP-CH-SG-04-19) M. McKenzie. Chapter in *Salem: Place, Myth and Memory*, Northeastern University Press, Boston. $3.

The Use of LHRH Analogue for Ovulation Induction in Black Sea Bass (*Centropristis striata*) (UNHMP-JR-SG-05-21) D. Berlinsky, V. King and T. Smith. Reprinted from *Aquaculture* 250:813-822. $2.

Extension Publications

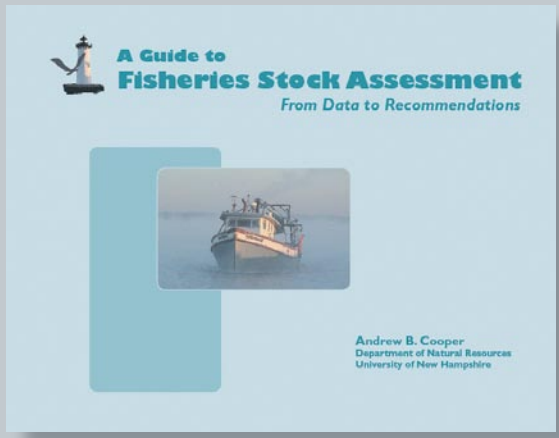
Great Bay Coast Watch 2005 Annual Report (UNHMP-AR-SG-06-19) $13.

Great Bay Coast Watch Volunteer Water Quality Monitoring Manual (UNHMP-M-SG-05-07) $16.

Refinements to Nordmore Grate May Increase Shrimp Selectivity (UNHMP-IS-SG-05-08) no charge.

A Report on the Seacoast Regional Wastewater Outfall Study Forum (UNHMP-R-SG-05-12) no charge.

Guide Explains the Fisheries Stock Assessment Process



NH Sea Grant and the Northeast Consortium have partnered to produce ***A Guide to Fisheries Stock Assessment: From Data to Recommendations***. The guide was written by Andrew B. Cooper, a research assistant professor of natural resources at UNH.

Stock assessments lay at the heart of virtually all fisheries regulations, providing decision makers with the information necessary to make sound management choices. For many people affected by those choices, though, the stock assessment process is largely a mystery. Available from NHSG (UNHMP-TR-SG-06-17, $5), the guide is designed to clarify the stock assessment process for fishermen, regulators, science journalists and others interested in the fishing industry.

Standard Operating Procedures: Phytoplankton Monitoring Program (UNHMP-M-SG-05-09) $8.

What's Going on with NH's Clam Harvesting Opportunities? (UNHMP-FS-SG-04-15) no charge.

2005 Tech 797 Ocean Project Reports

North Atlantic Right Whale: Designing a 1/8 Scale Model (UNHMP-TR-SG-05-13) H. McRae, D. Lewis and R. McMicken. $9.

***Investigation of Hydrodynamic Properties and Failure Modes of Pop-up Satellite Tags used on Atlantic Bluefin Tuna,* Thunnus thynnus** (UNHMP-TR-SG-05-14) A. Thomas, T. Pettengill and C. Christensen. $16.

Investigating the Effect of Loading on a North Atlantic Right Whale Mandible (UNHMP-TR-SG-05-15) A. Unrein, R. Marsella and M. Packard. $16.

This publication is made possible by the National Sea Grant College Program of the US Department of Commerce's National Oceanic and Atmospheric Administration grant NA16RG1035 to the NH Sea Grant College Program.

Additional copies are available from:

NH Sea Grant Communications
Kingman Farm/UNH
Durham, NH 03824

UNHMP-PG-SG-06-01

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

University of New Hampshire

NH Sea Grant
Kingman Farm/UNH
Durham, NH 03824

Sea Grant
New Hampshire

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE