



# Strategic Plan

## 2011-2013

New Hampshire Sea Grant





[www.seagrants.unh.edu](http://www.seagrants.unh.edu)



- 2 A Message from the Director
- 4 Safe and Sustainable Seafood Supply
- 6 Hazard Resilience in Coastal Communities
- 8 Healthy Coastal Ecosystems
- 10 Sustainable Coastal Development
- 11 Marine Literacy



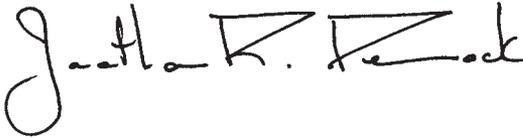
The New Hampshire Sea Grant College Program is one member in a national network of 30 Sea Grant programs, which together have a primary mission to promote the wise use, conservation and sustainable development of marine and coastal resources. Sea Grant approaches this mission with an integrated program of research, extension, education and communications that focuses the expertise and capacity of our university systems with stakeholder engagement to address the most pressing needs of our coastal communities and the public.

The 2011-2013 New Hampshire Sea Grant Strategic Plan, developed in concert with our New Hampshire Sea Grant Policy Advisory Committee and local stakeholders, is somewhat different from our most recent strategic plans in that it is intended to meet a programmatic need to synchronize with the new National Sea Grant College Program four-year funding cycle that will begin in 2013 and to provide a ‘bridging plan’ that incorporates and focuses N.H. Sea Grant’s activities on the highest priority issues facing the state of New Hampshire, the Gulf of Maine region and the nation. As such, this plan does not include the level of background information characteristic of our previous plans (please refer to the 2007-2011 New Hampshire Sea Grant Strategic Plan for more detailed background regarding the major areas of concern). While the previous background information is still relevant, it is important to note that we have made a deliberate decision, based on stakeholder input, to focus the goals, potential activities and desired outcomes outlined in this plan to a significantly greater degree than has been done in the past. This has been done to insure that our limited resources are applied to the most pressing state, regional and national needs.

The 10 goals outlined below fall into the four Focus Areas identified in the 2009-2013 National Sea Grant College Program Strategic Plan (Safe and Sustainable Seafood Supply, Hazard Resilience in Coastal Communities,

Healthy Coastal Ecosystems, and Sustainable Coastal Development) and a cross-cutting goal in Marine Literacy.

We look forward to addressing these priority areas through engagement with our academic, governmental, non-governmental and stakeholder partners and we encourage all interested partners to contact N.H. Sea Grant so that we can together work to develop sound science and assist our stakeholder, community and policy decision makers in the sustainable use and management of our vital coastal ecosystems and communities.

A handwritten signature in black ink, reading "Jonathan R. Pennock". The signature is written in a cursive style with a large initial 'J' and a stylized 'P'.

Jonathan Pennock  
Director, N.H. Sea Grant College Program



**GOAL: A healthy domestic seafood industry that harvests, produces, processes and markets seafood responsibly to meet public demand.**

*Activities:*

- Assess, develop and transfer strategies and technologies that reduce the impact of commercial fishing on marine habitats and fish populations and that improve the capacity for fishermen to access Annual Catch Limits.
- Enhance the capacity to manage marine and coastal fisheries using ecosystem-based management approaches.
- Develop and advance strategies that lead to improved energy and operational efficiencies and reduced environmental risk by commercial fishing operations.
- Develop and convey technologies that lead to sustainable production of marine aquatic species while minimizing environmental impacts.
- Assess, develop and communicate strategies that promote ecosystem services provided by cultured marine organisms.
- Develop and optimize restoration methods, and encourage community involvement that builds partnerships between scientists, environmentalists and coastal communities.
- Educate and inform consumers about the importance of ecosystem health and sustainable harvesting practices to the future of our domestic fisheries, the health benefits of seafood consumption, and the safety of the seafood products they buy.

*Outcomes:*

- Commercial fishermen choose conservation engineered fishing strategies and/or practices that result in decreased impact on marine habitat and fish populations.

- Fisheries managers, government agencies and marine policy makers make decisions regarding marine policy and fisheries regulations based on the best available science.
- State and local decision makers and the general public support marine aquaculture and sustainable fishing practices.
- Marine aquaculture production is increased.

**GOAL: A resilient fishing community with the capacity to adapt to a dynamic regulatory environment and changing marine ecosystems.**

*Activities:*

- Improve awareness and understanding about catch share and sector allocation programs among fishermen, regulators and the public.
- Measure and monitor baseline social, cultural, economic, policy and other human dimensions data on fisheries, coastal communities and the region.
- Develop marketing strategies and alternative enterprises that enhance the sustainability of fishing operations.

*Outcomes:*

- Resource managers are informed and consider socioeconomic impacts of changing regulations to coastal communities and businesses.
- A sustainable fisheries stakeholder community evolves and responds to changing regulations and ecosystems.



**GOAL:** Coastal communities in New Hampshire improve their resilience to severe weather, sea level rise, flooding and other climate effects that pose risks to life, health, property and infrastructure.

*Activities:*

- Assess current and projected regional climate impacts on ecosystems, coastal resource sectors, community infrastructure and socioeconomic well-being.
- Assess actual and perceived risks associated with current and projected climate effects such as sea level rise, storm surges, drought and changes in intensity, frequency and type of precipitation.
- Develop tools, technologies and techniques to improve understanding of climate impacts, community vulnerabilities and potential solutions for reducing risks from climate effects on municipalities, enterprises, ecosystems and individual health and property. Promote improved understanding of climate impacts with civic, business, agency, academic and organizational leaders.
- Assess feasibility, appropriateness and effectiveness of implementing climate adaptation techniques including hard and soft shoreline stabilization (protection), redesign (accommodation) and planned relocation (retreat) for different places, times and situations.
- Assess barriers to adoption of climate adaptation strategies.
- Promote the use of regional climate assessments, risk and vulnerability assessments, climate-related tools, adaptation strategies and social processes to increase the capacity of municipalities, coastal resource sectors, environmental organizations and others to adapt effectively to a changing climate.

*Outcomes:*

- Communities of decision makers, municipal staff members, planners, development professionals, businesses, environmental organizations and others learn about current and projected climate conditions and related tools and techniques, and use them to incorporate climate considerations into decision-making and actions.



**GOAL: Coastal communities effectively plan for the future and mitigate existing problems associated with coastal development and deleterious natural events.**

*Activities:*

- Develop early warning systems for the ecosystem impacts of climate change and sea level rise.
- Develop methods to distinguish between anthropogenic impacts to coastal ecosystems and variability caused by natural processes.
- Work with local and state agencies to provide clear information on the potential impacts of, appropriate planning for, and response to increased incidence and severity of storm water runoff and natural disasters.
- Determine the relative costs and benefits of all approaches for mitigating effects of land-use impacts and wastewater/storm water runoff treatment strategies on the health of coastal ecosystems.

*Outcomes:*

- Coastal communities and environmental agencies have the tools to diagnose, predict and manage the cumulative effects of climate change, population growth and land-use change on the health of the Gulf of Maine and coastal watersheds.

**GOAL: Critical coastal habitats and their ecosystem function are restored.**

*Activities:*

- Develop new techniques for restoring and monitoring the effectiveness of restoration in critical habitats.
- Develop models to predict trends in properties and critical processes within critical coastal habitats.

- In collaboration with local and state management agencies, develop outreach programs to transfer critical habitat knowledge and restoration technologies to public officials and citizenry.

*Outcomes:*

- Governmental agencies and coastal communities have the capacity and knowledge of technical approaches for effective restoration of critical habitats in the Gulf of Maine and regional estuaries.

**GOAL: Coastal waters are safe for recreation and locally harvested seafood is safe for consumers.**

*Activities:*

- Develop methods for identifying sources of fecal-borne microbial pathogens in beach and shellfish-growing waters.
- Identify sources, track the fate, and determine the impacts of toxic contaminants on aquatic coastal ecosystems.
- Determine the incidence and locally relevant causes of naturally occurring pathogens and toxin-producing algae.
- Support the development of new technologies for monitoring, assessing and predicting the effects of pollutants of concern in coastal ecosystems.
- Support new and cost-effective approaches to prevent and mitigate coastal pollution.

*Outcomes:*

- Anthropogenic pollutants, naturally occurring pathogens and toxin-producing algae in the region's estuaries are detected, their sources and causes identified, and their impacts timely and effectively mitigated.



**GOAL: Coastal communities in New Hampshire's coastal watersheds employ strategies that protect ocean and coastal resources from degradation associated with the built environment and growing demands on coastal resources.**

*Activities:*

- Identify and evaluate impacts of land cover, different land care practices, site design standards, and conventional and low-impact development options on coastal water quality and quantity.
- Evaluate economic and social impacts of various land uses and development practices in relation to water and other natural resources.
- Develop tools, technologies and techniques that can be used to reduce harmful effects of or improve decision making related to different land uses on water and other natural resources.
- Assess barriers to adoption of effective natural resource protection strategies.
- Promote proven strategies including land conservation, maintaining and enhancing riparian buffers, minimizing effective impervious cover, and incorporating low-impact development techniques with community-based audiences.

*Outcomes:*

- Communities of decision makers, municipal staff members, planners, development professionals, environmental organizations and others learn about best practices, tools and techniques for coastal resource protection and take action to incorporate them into land use planning, regulation, policies and activities.



# Marine Literacy

**GOAL: An environmentally literate and engaged public supported by formal and informal education and outreach opportunities in ocean, coastal and climate sciences.**

*Activities:*

- Assess the most effective approaches to convey marine science to educators and students.
- Continue to develop and offer UNH Marine Docent formal and informal ocean, coastal and climate education programs that utilize the latest scientific research and educational best practices.
- Strengthen collaborative relationships with UNH and other researchers to develop K-12 and teacher professional development programs.
- Strengthen collaborative relationships with regional informal marine education organizations and develop new delivery methods and expanded audiences.
- Develop correlative educational programs with N.H. Sea Grant and regional extension staff to enrich the educational impact of extension programming.

*Outcomes:*

- Participants in informal and formal programs increase their ocean, coastal and climate literacy and make informed decisions regarding society's impact on the ocean and the Earth's climate.

**GOAL: Formal and informal educators utilizing ocean, coastal and climate curriculum and programming grounded in nationally supported standards and principles.**

*Activities:*

- Collaborate with regional environmental education organizations to increase and strengthen interactions between researchers and in-service educators.
- Develop and implement Web- and distance learning-based professional development in ocean, coastal and climate principles and standards.
- Develop collaborative relationships with existing formal education professional organizations to encourage and implement professional development in ocean, coastal and climate principles and standards.

*Outcomes:*

- Increased number of formal and informal educators who sufficiently understand ocean, coastal and climate literacy principles and standards to utilize them in programming.

**GOAL: A workforce skilled in science technology, engineering and other disciplines critical to the resolution of ocean, coastal and climate issues.**

*Activities:*

- Develop and support graduate and undergraduate grants and fellowships in ocean, coastal and climate studies.
- Support the development and implementation of undergraduate courses in new and emerging fields.
- Encourage researchers to utilize undergraduate and graduate students in research and outreach.

*Outcomes:*

- Increased number of qualified applicants for ocean, coastal and climate related career opportunities.



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.

UNHMP-SP-SG-11-07

For additional copies, please contact:

N.H. Sea Grant Communications

UNH

Durham, N.H. 03824

603.862-6705



# Appendix

## N.H. Sea Grant Strategic Plan 2007-2011

### **Why does N.H. Sea Grant have two overlapping Strategic Plans?**

The 2011-2013 New Hampshire Sea Grant Strategic Plan was developed to meet a programmatic need to synchronize with the new National Sea Grant College Program four-year funding cycle that will begin in 2013, and to provide a “bridging plan” that incorporates and focuses N.H. Sea Grant’s activities on the highest priority issues facing the state of New Hampshire, the Gulf of Maine region and the nation. The plan was developed in concert with our New Hampshire Sea Grant Policy Advisory Committee and local stakeholders.

### **Why include the 2007-2011 plan for the PRP?**

The 2007-2011 New Hampshire Sea Grant Strategic Plan is included to provide reviewers with additional information about our program that is not included in the more concise “bridge plan.” It contains more detailed background information regarding the major areas of concern that may be helpful to the review panel. This is also the plan N.H. Sea Grant was operating under at the beginning of the 2010- 2013 period under review, however, because the PIER reporting system can have only one active Strategic Plan to report against, we had to report against the 2011-2013 plan for both the 2010 and 2011 reporting periods.

The 2011-2013 plan does not include the level of background information characteristic of our strategic plans. We made a deliberate decision, based on stakeholder input, to focus the goals, potential activities and desired outcomes outlined in the 2011-2013 plan to a significantly greater degree than has been done in the past. This was done to insure that our limited resources are applied to the most pressing state, regional and national needs.



# Strategic Plan

## 2007-2011

New Hampshire Sea Grant



The NH Sea Grant College Program provides support, leadership and expertise for university-based marine research, extension and education. Based at the University of New Hampshire, it is one of 30 members of NOAA's National Sea Grant College Program devoted to promoting the understanding, wise use and stewardship of our coastal resources.



[www.seagrants.unh.edu](http://www.seagrants.unh.edu)



## New Hampshire Sea Grant Strategic Plan 2007-2011

- 3 Overview, History & Strategic Goals
- 9 Conservation & Sustainable Utilization of Fisheries Resources
- 14 Sustainable Aquaculture
- 18 Coastal Ecosystem & Public Health
- 23 Coastal Communities & Economics
- 26 Marine & Aquatic Science Literacy
- 28 Fostering an Informed Citizenry
- 29 Developing a Technically Trained Workforce
- 31 NH Sea Grant Staff
- 32 NH Sea Grant Policy Advisory Committee





## Overview, History & Strategic Goals

The New Hampshire Sea Grant College Program is one member in a national network of 30 Sea Grant programs, which together have a primary mission to promote the wise use, conservation and development of marine and coastal resources. The *2007-2011 New Hampshire Sea Grant Strategic Plan*, developed in concert with our Policy Advisory Committee and stakeholders within the state, provides a broad vision for addressing the Sea Grant mission through the integrated marine research, formal education (undergraduate and graduate), extension and communications programs that are the hallmark of the Sea Grant model.

### History

A partnership with universities and research institutions, the National Sea Grant College program is a federal program of the National Oceanic and Atmospheric Administration (NOAA). Federal funding is provided by NOAA through a competitive grant process; federal funds must be matched 2:1 by non-federal funds.

The New Hampshire Sea Grant College Program, located at the University of New Hampshire (UNH), was established in 1968, just two years after Congress passed the National Sea Grant College Program Act. Eight years later, the universities of New Hampshire and Maine merged their independent Sea Grant programs to become the joint Maine/NH Sea Grant Institutional Program. At the time of the merger, the universities had complementary strengths in marine science and engineering fields, but were perceived to have insufficient research capacity on an individual basis to meet user needs. The joint program flourished, culminating in its designation as the Maine/NH Sea Grant College Program in 1980.

Over the next 20 years, Maine/NH Sea Grant accumulated a strong record of accomplishment and became one of the larger Sea Grant programs (in terms of federal funding). Research capacity, as measured by the number of marine faculty and their extramural funding, grew steadily at UNH through 1990. Since then, external research and extension support has increased dramatically with the addition of new academic

programs in the marine sciences and new marine facilities (i.e., vessels, research labs and demonstration projects). Matching funds have been provided by UNH and other institutions in New Hampshire receiving federal Sea Grant funds, private businesses and volunteers.

In light of the marked growth in the University's marine research and outreach community; private marine, biotech and engineering industries; and state and local programs with marine resource management and policy responsibilities, UNH joined the University of Maine in requesting the separation of the joint program in 2000. On Oct. 1, 2000, the NH Sea Grant Program became fully distinct in all administrative and budgetary functions.

Since that time, NH Sea Grant has taken a leadership role in encouraging, facilitating and promoting regional and national collaborations for NH marine researchers and NH Sea Grant staff. Our independent status has the advantage of allowing us to focus on the issues and needs associated with marine resource use within our state's borders and to capitalize upon the ever-expanding marine capabilities within New Hampshire.

As a result of these efforts, NH Sea Grant was awarded Sea Grant College status in August of 2003. This top tier status recognizes NH Sea Grant's dedication to maintaining a high quality and balanced program of marine research, education and outreach, and the Program's role in working with marine researchers at New Hampshire colleges and universities and the state's marine stakeholders to address current and future marine resource issues.



## Sea Grant at the University of New Hampshire

The University of New Hampshire is one of only nine institutions in the country that is recognized as a Land, Sea and Space Grant institution. Until the mid-1990s, NH Sea Grant was the principal source of support for marine-related research and extension activities in New Hampshire. Since that time, there has been considerable expansion in marine-related research, extension and education initiatives, activities and organizations. While some of these programs are focused at UNH, a large number are competitive programs open to researchers from any institution. NH Sea Grant serves as a facilitator between New Hampshire researchers and students and the following UNH-based programs:

⌘ The UNH/NOAA **Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET)** was established in 1998 to support the development of innovative technologies for understanding and ameliorating the impacts of coastal and estuarine contamination and degradation. Several CICEET outreach programs are currently delivered by NH Sea Grant Extension staff.

⌘ The UNH/NOAA **Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center (JHC)**, created in 1999, is a national center with expertise in ocean mapping and hydrographic sciences. NH Sea Grant has played a facilitative role in assisting the Seacoast Science Center, a public

science-education facility, to become the public outreach arm for CCOM.

⌘ The UNH/NOAA **Atlantic Marine Aquaculture Center**, formerly the **Cooperative Institute for New England Mariculture and Fisheries (CINEMar)**, established in 2000) houses the UNH **Open Ocean Aquaculture (OOA) Demonstration Project**. In addition to providing a facility for research, development and demonstration of open ocean finfish and shellfish aquaculture, the Center serves as a regional center where scientists, stakeholders and regulators can work together on issues in fisheries management and marine aquaculture. CINEMar evolved out of the successful three-year Maine/NH Sea Grant offshore finfish aquaculture enhancement project carried out from 1995-1998. Sea Grant provided leadership for the first two years of the OOA project; the project's outreach functions continue to be provided by Sea Grant Extension.

⌘ The **Northeast Consortium**, a regional initiative led by UNH, was created in 1999 to encourage and support effective, co-equal partnerships among commercial fishermen, researchers and other stakeholders to become active participants in cooperative research and the development of selective fishing gear technology. NH Sea Grant staff provide direct leadership and most outreach functions for this program.

⌘ Since 2002, three additional centers, the **Coastal Ocean Observing Center**, the **Center for Large Pelagics Research**, and the **Coastal Response Research**

**Center** have been established at UNH. NH Sea Grant extension educators have provided important leadership in many outreach, education and extension functions for these programs.

⌘ The **UNH Marine Program** provides the interdisciplinary umbrella for marine research, education and extension activities at the University and the facilities that support them. The growth of the **Jere Chase Ocean Engineering Laboratory**, the **Jackson Estuarine Laboratory**, the **Coastal Marine Laboratory**, and the **Shoals Marine Laboratory** (jointly run with Cornell University) provides significant resources for researchers studying living marine organisms, coastal ecosystems and the design performance of coastal engineering devices and structures. Sea Grant researchers have utilized these facilities to greatly enhance their efforts in finfish and sea urchin aquaculture, ocean engineering and coastal ecosystem health. UNH is

currently in the process of building a new pier and pier support facility in New Castle, NH, and a new Coastal Marine Laboratory adjacent to the Seacoast Science Center in Rye, NH, which will provide state-of-the-art marine culture and laboratory facilities for NH Sea Grant researchers and a showcase for Sea Grant Extension activities.

NH Sea Grant is fully integrated into the diverse array of marine institutes and initiatives at UNH.

The distinct NOAA/UNH partnerships are a direct result of perceived needs and opportunities for the university community and the state's citizens. In



some cases, such as the Atlantic Marine Aquaculture Center and the Northeast Consortium, NH Sea Grant has helped incubate the new organization by providing a research basis, vision and planning, and critical administrative and budgetary oversight. In other cases, such as CICEET, CCOM and the Coastal Ocean Observing Center, NH Sea Grant has successfully sought partnership opportunities to further our mission areas. Sea Grant remains unique in the broad definition of our mission and in the seamless integration of research, extension, education and communications elements.

## Sea Grant within the State and Region

Marine initiatives at the state and regional levels have also shown substantial growth in recent years, mirroring and enhancing the growth within UNH. Marine-related programs have created new opportunities for NH Sea Grant to build partnerships and capitalize on expanded research and outreach capabilities. Programs in this group include:

⌘ The formation and development of the **Regional Association for Research on the Gulf of Maine (RARGOM)** was undertaken to foster cooperative and coordinated research on this important marine ecosystem. NH Sea Grant has partnered with RARGOM to sponsor workshops on key issues affecting the Gulf of Maine.

⌘ The three-state, two-province **Gulf of Maine Council on**

**the Marine Environment** is developing and implementing long-term, regionally planned educational and monitoring activities designed to maintain the health of the Gulf of Maine ecosystem and its resources. NH Sea Grant is actively involved in the Council's leadership and volunteer water quality monitoring networks around the region and has provided training to many organizations within this network.

⌘ The construction of the **Seacoast Science Center (SSC)** at Odiorne Point State Park in Rye, NH, was made possible through a combination of state, private and corporate support. The SSC provides year-round marine science education programs for school children, teachers and adults. NH Sea Grant-trained Marine Docents frequently participate in and lead SSC marine education programs. In addition, NH Sea Grant is represented on the SSC Board of Directors, ensuring close collaboration on outreach efforts.



⌘ The creation of the **Great Bay National Estuarine Research Reserve (GBNERR)** has provided additional opportunities for research and outreach education. NH Sea Grant is represented on GBNERR's Policy Advisory Committee. In addition, several volunteer water quality monitoring and marine education programs are carried out jointly.

⌘ The **New Hampshire Estuaries Project (NHEP)**, housed at UNH, has developed a management plan for the Great Bay and Hampton Harbor estuaries, which serves to identify

opportunities and guide funding decisions for research and extension projects. NH Sea Grant is a member of the NHEP Management Committee and has received funding for an assortment of Sea Grant Extension water quality programs. NH Sea Grant is also represented on the Technical Advisory Committee of the NHEP.

In addition, NH Sea Grant interacts closely with numerous state agencies including the **NH Coastal Program**, the **NH Department of Environmental Services**, and the **NH Department of Fish and Game**. These agencies have management and regulatory responsibilities over estuarine and coastal waters within the state and are proactive advocates for these ecosystems.

While NH Sea Grant's mission has not changed over the years, the context within which we work most certainly has. Our continuing challenge is to clearly define Sea Grant's leadership role both within the university community and the state and to develop effective partnerships with other programs and initiatives with related missions.

A fundamental role of NH Sea Grant is to produce new information and understanding by funding excellent, needs-based research. NH Sea Grant's further role is to coordinate the dissemination of this information among academic institutions; federal, state or local agencies with stewardship responsibilities; private entrepreneurs and marine industries; and New Hampshire's citizens.

## Strategic Goals

The *NH Sea Grant Strategic Plan* builds upon and is consistent with the *National Sea Grant Strategic Plan* (2003-2008) in its overall focus on the economy, the environment and education. However, NH Sea Grant's specific goals and opportunities have been developed locally. Consistent with our dual role as an independent program and as a member of a national network of programs, NH Sea Grant identifies, encourages, facilitates and leads research, extension, education and communications efforts that address both local needs and national priorities.

The *NH Sea Grant Strategic Plan* focuses on five major theme areas: Conservation and Sustainable Utilization of Fisheries Resources, Sustainable Aquaculture, Coastal Ecosystem and Public

Health, Coastal Communities and Economics, and Marine and Aquatic Science Literacy. Within these theme areas, this plan presents a wide range of issues, needs and opportunities that together define our mission and direct our efforts, but it does not seek to direct individual researchers or extension personnel to particular topics or prioritize specific topics.

It is also important to note that while all of these themes have local priority to our state, our program also places particular value in regional-scale processes within the Gulf of Maine and on addressing topics of local, regional and national significance. Of particular interest is the relationship between the human dimension of our coastal communities and our estuarine and coastal ecosystems as defined through the concept of



ecosystem-based management.

This approach to strategic planning and priorities is selected with the clear guidance of our Policy Advisory Committee, which has consistently urged NH Sea Grant to focus on issues of high relevance to our state and region while refraining from specific targeting or prioritization of issues and topics that may result in the exclusion of innovative and high-risk projects.

Finally, the strategic goals presented here should be viewed in the context of a rapidly changing society. The marine enterprise in which NH Sea Grant is embedded includes academic, private and governmental organizations, institutes and programs. Sea Grant must serve a diverse constituency that itself changes with



state and national socioeconomic conditions. The breadth of Sea Grant's mission and the complexity of its relationships with its partners and clientele argue strongly for strategic and implementation plans that provide a general framework to define our mission, describe our vision for the future, and ensure flexibility for NH Sea Grant to respond, adapt and grow.

Ultimately, our success in implementing our strategic plan will be reflected in case studies of successful projects, compilation of data (including traditional measures of research productivity such as peer-reviewed publications, annual reports and other program documents), and the documented impacts of our efforts to the citizenry of New Hampshire.



## Conservation & Sustainable Utilization of Fisheries Resources

### National Perspective

Following the “Boom or Bust” fishing industry of the early 1990s, the majority of the fish stocks that the U.S. fleet depends on are over-utilized. Over the past decade, management, science and industry have worked to rebuild the stocks. Unfortunately, the urgency to begin protecting the resources has required stiff regulations in the form of quotas, trip limits, limited entry and allocated days at sea. Those regulations have contributed to an adversarial, distrustful climate among scientists, fishermen and managers.

In May 2004, the *NOAA Fisheries Report to Congress on the Status of U.S. Fisheries* announced that of the 894 federally managed fish stocks, 8.5 percent were classified as over-fished and 6.7 percent were experiencing over-fishing in 2003. This represents a decline in the number of over-fished stocks from 106 to 76 since 1997. The national landings for 2003 totaled 9.5 billion pounds valued at \$3.3 billion. Finfish accounted for 87 percent of the reported landings. This was an increase

of 108.3 million pounds and \$249.9 million compared with 2002.

In 2003, the Northeast had landings of 664 million pounds of fish, worth nearly \$691 million. The single most economically important species for the region continues to be the American lobster, with landings of 70.5 million pounds valued at \$278 million. Sea scallops, at \$116 million, ranked second in value, followed by mixed groundfish and flounder at \$97 million.

Detailed information on marine recreational fishing is required to support a variety of fishery management purposes and is mandated by the Sustainable Fisheries Act. In 2003, the Marine Recreational Fisheries Statistics Survey (MRFSS) reported 13 million anglers made 82 million marine recreational fishing trips to the Atlantic, Gulf and Pacific coasts. Landings were reported to approach 452 million fish. The Atlantic contributed over 6.4 million recreational fishing participants and more than 49 million trips with an estimated catch of 243 million fish.

The mainstays of the Northeast commercial fisheries (cod, haddock and yellowtail flounder) reached record low levels in spawning-stock biomass during the early 1990s. In 2005 stock biomasses were reported to have increased in only six of the 19 groundfish stocks since 2001: Georges Bank haddock, Gulf of Maine winter flounder, witch flounder, white hake, redfish and pollock. The average biomass increase of those six stocks was 50 percent. For the remaining stocks, which included Atlantic cod and yellowtail flounder, the average decrease was 19 percent. Under restricted fishing effort for these species, many inshore fishermen switched to dogfish, skates and monkfish. Consequently, these fish began to decline in number, leading to new regulations that restricted effort on these species as well.

By-catch and regulatory discards continue to be a significant challenge facing the commercial fishing industry. These issues can be addressed through regulations and conservation engineering. Commercial fishing in the U.S. continues to face the complicated challenge of mitigating interactions between gear and threatened/endangered species. Gillnetters in New England have reduced harbor porpoise mortalities by adopting acoustic pingers on their nets. However, the risk of right whale entanglement has forced modifications in the design of fixed gear, including lobster traps and gillnets, to make them more “whale friendly.”

Another issue challenging commercial fisheries is the impact of mobile and fixed gear on the benthic ecosystem. Over the coming years it will continue to be important for fisheries scientists and industry to work collaboratively to evaluate these impacts and

develop strategies that will promote a healthy and economically viable fishery.

Ecosystem considerations are increasingly being advocated for inclusion in traditional fisheries and alternative management. As national and regional management communities consider ecosystem management, it is critical that science and industry continue to gather information that defines local ecosystem boundaries, describes regional biological and economic environments, and unravels the complex dynamic of interactions between fish species.

## New Hampshire Sea Grant Perspective

The commercial fishing industry in New Hampshire is composed of nearly 150 commercial vessels, consisting of approximately 100 lobster and 50 groundfish boats. In 2003, the state had landings of 27.4 million pounds of fish, worth just over \$15 million. The single most economically important species for New Hampshire is the American lobster, with landings of two million pounds valued at \$9 million. Atlantic cod, at \$1.8 million, ranked second in value, followed by Atlantic herring, at \$1.2 million, and goosefish at just over \$1 million.

New Hampshire’s boats are divided almost equally between gillnetters and draggers, and each group landed approximately 3.5 million pounds in 2003. With the exception of one large company targeting offshore lobster, most of the state’s fishermen represent small, family-owned operations that fish inshore. NH commer-



cial fishermen are entrepreneurial, opportunistic and flexible, changing fisheries seasonally and as conditions dictate.

Both the state and our coastal towns have been supportive of the commercial fishing industry. Several communities have public facilities dedicated to the industry and two fishing cooperatives handle most of the groundfish landed in NH. Each of the state's three major harbors has several lobster buyers. The Yankee Fisherman's Cooperative in Seabrook has a sizeable tuna operation, conducting a daily auction during the tuna season.

New Hampshire fishermen have been significantly impacted by the further limitation of access to the resource through daily trip limits, closed areas, days-at-sea restrictions and seasonal quotas. Many of these regulations have impacted the smaller fishermen the hardest. A key element to an ecosystem management approach will be the understanding of the social impact that fishing regulations have had or could have on coastal communities under current and alternative management approaches.

Although accounting for less than one percent of the total U.S. recreational reported harvest, NH has a significant sport fishing industry. In 2003, NH reported 1.4 million pounds harvested and nearly one million fish released by recreational anglers. As fishery stakeholders continue to move towards ecosystem management, the impact of recreational fishing mortality on marine stocks will need to be more critically evaluated.



## Strategic Goals and Opportunities

NH Sea Grant remains dedicated to providing research-based information on science and technology to fishery stakeholders, so that informed decisions lead to improved conservation and sustainable utilization of our nation's resources. Sea Grant can most effectively work on these problems in collaboration with various groups and organizations. Chief among these are the National Marine Fisheries Service (NMFS), state and regional fisheries agencies, the commercial/recreational fishing sectors, the Northeast Consortium, and the New England Fisheries Management Council (NEFMC).

### **Goal 1: Develop new management strategies that utilize an ecosystem approach to stewardship of the fisheries resource.**

#### *Actions and Opportunities:*

- ⌘ Engage key fishery stakeholders to work together in ecosystem-based management.
- ⌘ Define the boundaries of local ecosystems.
- ⌘ Seek to characterize the structure and function of the ecosystems, including both the biological and economic environments.
- ⌘ Define indicators of ecosystem, fishery and coastal community health.

- ⌘ Seek to increase our understanding of system interactions between marine and coastal communities.
- ⌘ Determine the impacts that Gulf of Maine harmful algal blooms have on major fishery resources.

### **Goal 3: Develop strategies that will quantify and reduce sea-bed impacts by commercial and recreational fisheries.**

#### *Actions and Opportunities:*

- ⌘ Investigate and develop methods that can be used to evaluate the short- and long-term impacts of fishing operations on the seabed and benthic communities.

- ⌘ Examine the short- and long-term effects of fishing practices on various fisheries habitats.
- ⌘ Build techniques and technologies in cooperation with the commercial fishing industry that minimize the footprint of mobile and fixed gear on the seabed.
- ⌘ Construct outreach programs and provide educational opportunities for fishermen, fishery managers, scientists and other interested persons in so-called “soft” gear technologies.

### **Goal 4: Provide science-based information on essential fish habitat (EFH), marine protected areas (MPAs) and other closed areas that allows regulators to implement policies that balance the harvesting of living marine resources with environmental protection.**

#### *Actions and Opportunities:*

- ⌘ Identify and define, in collaboration with appropriate

### **Goal 2: Develop strategies and technologies that will lead to the reduction of bycatch, discard and unaccounted fishing mortalities.**

#### *Actions and Opportunities:*

- ⌘ Characterize fish behavioral interactions with gear to provide knowledge for species selective gear designs in both mobile and stationary gear.
- ⌘ Working with commercial and recreational fishing partners, develop techniques and technologies that separate species during fish capture processes.
- ⌘ Develop methods and research programs to evaluate mortalities of discards and escapees and to improve survivability of these animals.
- ⌘ Refine data collection methodologies pertaining to marine recreational fisheries.
- ⌘ Devise techniques that reduce the incidental take of marine mammals during fishing operations while minimizing economic impact on the fishing industry.
- ⌘ Expand and create outreach programs and provide educational opportunities for fishermen, fishery managers, scientists and other interested persons in conservation engineering, sustainable fisheries, fishery management and fishery sciences.



partners (NMFS and other Sea Grant programs), essential and critical fisheries habitats for economically important species.

- ⌘ Evaluate the effectiveness closed areas have had on benthic communities and fish stocks, and formulate recommendations for their continued use.
- ⌘ Develop and investigate strategies for identifying potential closure areas.
- ⌘ Determine the potential socio-economic and environmental costs/benefits of closed areas related to the commercial fishing industry.

**Goal 5: Provide fisheries managers with appropriate socioeconomic data and insight into social and management institutions necessary to effectively manage fisheries while minimizing the negative effects of their decisions on people and communities.**



### *Actions and Opportunities:*

- ⌘ Measure and monitor baseline social, cultural, economic, policy and other human dimensions data on fisheries, coastal communities and the region.
- ⌘ Assess the impacts of regulations, management regimes and other institutional changes on the fishing industry and coastal communities.
- ⌘ Study individual, community, institutional and other strategies for adapting to the social, cultural, economic and environmental transitions faced in fisheries and coastal communities.
- ⌘ Enhance coordination and networking among existing social science capacity in the region, NMFS, National Ocean Service and other local, state and federal agencies.
- ⌘ Develop outreach and education programs and tools to transfer knowledge gained from human dimension research to fisheries and coastal communities.



## Sustainable Aquaculture

### National Perspective

The United States aquaculture industry, at about \$1 billion, currently ranks eleventh globally and accounts for one percent of the world's annual production by weight. Farmed crops include mollusks, crustaceans, finfish and seaweeds. Much of the country's aquaculture production is for food, but there are also facilities producing bait, ornamentals and species for commercial and recreational stock enhancement.

While global aquaculture production has grown at nearly 10 percent each year over the past 15 years, growth within the U.S. industry has been less pronounced (about 45 percent over the 10-year period 1991-2000). There are approximately 4,000 aquaculture facilities in the U.S. spread across all 50 states, growing over 100 different species of aquatic plants and animals.

The bulk of U.S. production is in the South with freshwater catfish farms accounting for about 70 percent of farm-raised product by weight. While the U.S. has a fairly well-developed

freshwater industry, marine aquaculture lags far behind, accounting for only 15 percent of total domestic production. Annual U.S. seafood consumption continues to increase slowly, from 15.6 pounds per person in 2002 to 16.6 pounds per person in 2004. More than 60 percent of the fish and shellfish consumed in the U.S., however, is imported. This has led to a seafood trade deficit of more than \$7 billion annually.

With supplies of wild seafood limited by virtue of commercial harvests being at or near maximum sustainable yield, aquaculture will likely continue to expand in this country. Growth in the U.S. marine aquaculture industry is constrained, however, by a number of factors, including complex technology, environmental and ecological concerns, species diversity, multiple user conflicts especially in the nearshore areas, and a fragmented institutional and regulatory system.

While historically most U.S. marine aquaculture operations have been sited in coastal areas, potential for significant growth likely lies either in offshore regions or in closed-culture systems that are land-based. Recently, NOAA proposed the National

Offshore Aquaculture Act of 2005. This act would facilitate development of offshore aquaculture by consolidating permit requirements, providing environmental safeguards and establishing research and development industry partnerships.

## New Hampshire Sea Grant Perspective

There are currently about 10 aquaculture facilities in New Hampshire with a total annual farm gate value of \$1.5 million. Until this year (2006), all but one of these operations were freshwater-based. Major species include trout, baitfish, bullhead, summer flounder and cod. The two newest NH aquaculture operations, both blue-mussel long line culture, are sited in offshore waters and should begin harvesting this year.

Despite its being a relatively small industry, aquaculture has been a major focus of NH Sea Grant's research and outreach activities on a local and regional level since our Program's inception in 1968. Candidate species have included marine finfish (salmon, flounder, cod, haddock), shellfish (oysters, blue mussels), seaweeds (*Porphyra*) and sea urchins. Many of these projects were in partnership with commercial aquaculturists, local fishermen and fishermen's cooperatives. While a number of our earlier projects have assisted in the establishment and growth of marine aquaculture businesses in the region, particularly Maine shellfish companies, the growth of the industry as a whole has been much slower than expected.



Our situation is not unlike that on the national scale, where competing interests in the coastal zone make for very limited availability of suitable nearshore aquaculture sites. Consequently, NH Sea Grant is currently focusing attention on open-ocean (offshore) and closed-systems aquaculture. Where projects related to the offshore environment are envisioned, participants are highly encouraged to collaborate with the NOAA/UNH Atlantic Marine Aquaculture Center, which manages the UNH Open Ocean Aquaculture Demonstration Project. Specific niches for Sea Grant are identified in the Strategic Goals and Opportunities below.

While nationally Sea Grant has invested considerable resources in closed-system culture, the economic viability of these systems remains mostly unproven. Research on land-based closed systems that can either stand alone or support offshore aquaculture grow-out facilities is an area where NH Sea Grant can make an impact.

The prospects for growth of both the NH and U.S. marine aquaculture industries will be closely tied to their potential impacts on the environment. Many of the concerns focus on adverse impacts of disease, loss of genetic diversity, introductions of non-indigenous species, and potential for habitat degradation. Future research and development efforts must incorporate these concerns and build into them efforts to obtain environmental data, conduct basic biological and ecological research, determine environmental effects and offer environmentally compatible remedies.

## Strategic Goals and Opportunities

NH Sea Grant can play a major role in supporting the growth of NH and U.S. marine aquaculture through an integrated program of research, education and technology transfer that is focused on key scientific, engineering, environmental and socioeconomic issues that currently inhibit this emerging industry. In particular, we will continue to emphasize short-term, tractable needs facing coastal aquaculture enterprises, as well as long-term needs for developing re-circulating land-based systems and collaborating with the UNH Open Ocean Aquaculture Demonstration Project to address important issues for enhancing offshore aquaculture.

### Goal 1: Develop and improve culture system technology for cold-water marine species.

#### *Actions and Opportunities:*

- ⌘ Improve/develop systems engineering for land-based hatchery, nursery and grow-out facilities.
- ⌘ Integrate the use of alternative forms of energy (solar, wind, wave, etc.) with culture systems.
- ⌘ Develop cage designs that incorporate waste removal and disposal.
- ⌘ Design structures utilizing materials that discourage undesirable colonization by marine animals and encourage use by beneficial natural fauna.



- ⌘ Improve mooring and cage designs to reduce marine mammal interactions.

### Goal 2: Evaluate aquaculture feed components in relation to organism growth and final product quality.

#### *Actions and Opportunities:*

- ⌘ Identify the nutritional requirements of aquaculture candidates.
- ⌘ Develop cost-effective and environmentally friendly feeds for different life stages that reduce potential water quality problems.
- ⌘ Develop technologies for mass production of feeds.
- ⌘ Improve feed delivery, reduce waste and improve food utilization by combining technology with knowledge and fish biology/behavior.

### Goal 3: Develop improved diagnostic capabilities for aquatic pathogens and parasites leading to production of vaccines for cultured finfish and shellfish species.

#### *Actions and Opportunities:*

- ⌘ Investigate the defense mechanisms in marine systems for application in developing therapeutics.
- ⌘ Explore the role of viruses as disease agents in cultured species.
- ⌘ Develop new diagnostic and therapeutic techniques.

- ⌘ Improve fish health-management practices that reduce or eliminate the need for medicinal treatments.

#### **Goal 4: Ensure that commercial aquaculture and marine stock enhancement are economically and socially sustainable.**

##### *Actions and Opportunities:*

- ⌘ Evaluate market value and economic risk for farm-raised seafood.
- ⌘ Develop strategies to maximize the value of the farmed and capture fisheries sectors.
- ⌘ Enhance cooperation between aquaculturists and the capture-fishing sector to achieve mutually desirable goals.
- ⌘ Improve the design of aquaculture infrastructure to enhance its aesthetic appeal.
- ⌘ Develop business plans for different combinations of aquaculture species and systems.
- ⌘ Provide advice and assistance to those seeking aquaculture permits/leases.



#### **Goal 5: Ensure that commercial aquaculture and marine stock enhancement have minimal adverse impacts on the environment and wild stocks.**

##### *Actions and Opportunities:*

- ⌘ Develop easily measurable indicators of the environmental impacts of aquaculture on the marine environment.
- ⌘ Develop environmental models to determine the carrying capacities of marine systems.
- ⌘ Develop methods to reduce escapement of fish and shell fish from containment structures.
- ⌘ Develop science-based information for the public on the industry practices and environmental interactions.
- ⌘ Develop new methods for aquaculture site selection that accurately predict environmental impacts.



## Coastal Ecosystem & Public Health

### National Perspective

Coastal ecosystems are ecologically and economically valuable environments that are subject to multi-use demands, ranging from flood control and the purification of societal wastes to food production, transportation and recreation. These ecosystems support diverse and complex biological communities, providing essential habitat for the fish and shellfish that constitute 75 percent of commercial landings in the United States. Coastal environments also provide essential “ecosystem services” valued in the trillions of dollars annually on a global scale.

Nevertheless, the productivity, diversity and resiliency of these systems have become increasingly threatened by human-induced perturbations. These perturbations cause increased fish kills and the decline of species diversity in benthic communities. Nationally, harmful algal blooms have had an estimated economic impact of nearly \$50 million annually since 1987. Regionally, a massive *Alexandrium* red tide bloom caused commercial failure for the shellfish fishery across the Gulf of Maine

throughout the spring and summer of 2005 at a cost of about \$3 million per week, and some areas remained closed well into 2006. As the U.S. population continues to concentrate along the coast, human-induced impacts on our watersheds, estuaries and near-shore coastal waters increasingly threaten the health and sustainability of these valuable ecosystems.

In June 2003, the Pew Oceans Commission’s report, *America’s Living Oceans: Charting a Course for Sea Change*, listed point and non-point source pollution, invasive species, coastal development and habitat alteration as major threats to our oceans. The report specifically identified excess nutrient enrichment as the “greatest threat to coastal marine life today.”

Similarly, the recommendations of the U.S. Commission on Ocean Policy (2004) and the initial federal response to those recommendations outlined in the *U.S. Ocean Action Plan* highlight coastal ecosystem restoration, prevention of the spread of invasive species, enhancing use of ocean resources by addressing human health issues, pathogen detection, estuarine and coastal ocean observing, and the development of ecological

forecast models for harmful algal blooms and other emerging and nontraditional contaminants as priority areas for research and the application of new and innovative technologies and management tools. These issues are included in the *NOAA Sea Grant Strategic Plan (2004)* and the National Sea Grant Ecosystems and Habitats Theme Team report. The report highlights a specific role for Sea Grant in minimizing the negative impacts of human-induced changes to coastal ecosystems by addressing four areas: reducing stresses on coastal ecosystems, limiting invasive species, assessing and managing coastal watersheds, and conserving and restoring critical habitats.

To effectively address these critical issues and maintain and improve the health of our coastal marine ecosystems, strategies must be found to balance the multiple uses of these environments with the impact of continued growth. Rooted in the development of these new strategies is the need to be able to document and quantify the effects of human perturbations and management practices on these environments. These efforts require new basic research understanding of key organismal and ecological processes, novel technologies, integrated monitoring and modeling methods, development of effective indicators, an ecosystem-based management approach, and the development and implementation of advanced restoration techniques. It is also essential that these scientific efforts be integrated closely with education and outreach efforts to assist states and communities in educating the citizenry of these critical processes.



## New Hampshire Perspective

Although New Hampshire is not a particularly populous state (1.3 million residents) and has a relatively short coastline, in many ways it mirrors other coastal states in the pressures of continued population growth and the demographics of that growth. Nearly 75 percent of the state's residents live within 50 miles of the coast, and the rate of growth in the seacoast region has increased 10 percent over the past decade, a rate nearly double that of the rest of the state. Coastal communities, deeply rooted in the resources of their estuaries and coastlines, are struggling with how to manage growth and its associated waste streams. The Great Bay Estuary is displaying indications of nutrient over-enrichment, microbial contamination and habitat loss. Meanwhile coastal fishermen are dealing with harmful algal bloom-related fisheries closures and the cumulative effects of point and non-point source pollution.

The Gulf of Maine and its tributary watersheds and estuaries are critical focal points for our stakeholders. As a result, NH Sea Grant and the University of New Hampshire have played an increasingly central role in regional efforts to understand and effectively manage the Gulf of Maine ecosystem with regional Sea Grant partners, the National Oceanographic and Atmospheric Administration, and a number of federal, state and private partners. Thus, we have a strong desire to continue to support critical basic and applied research, education and outreach on coastal ecosystem health in our local coastal ecosystems. At the same

time, we believe that we have a unique opportunity to build on our regional partnerships to focus our efforts on developing and enhancing ecosystem-based management approaches within our region and in using our local coastal environments as models for other areas of the country.

## Strategic Goals and Opportunities

NH Sea Grant has unique capabilities to enhance our understanding of coastal ecosystems and public health. We recognize related ongoing efforts that address the need for improved environmental indicators and the development and application of new technologies, as well as other efforts being conducted by partners in the region. In particular, we foresee close cooperation with the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) and the UNH Coastal Observing Center. We also recognize the need to address issues related to ecosystem and human health, climate change implications for both, and new issues as they emerge.

### **Goal 1: Develop and apply biological and chemical indicators to monitor natural and anthropogenic stressors and assess the health of the Gulf of Maine and regional estuaries.**

#### *Actions and Opportunities:*

⌘ Support research initiatives to develop novel molecular,



biochemical, organismal and system-level indicators and indices of the health of the Gulf of Maine and regional estuaries.

- ⌘ Encourage efforts to develop novel approaches to mining existing datasets to assess the ecological health of the Gulf of Maine and regional estuaries.
- ⌘ Support research efforts to determine the effects of multiple stressors on marine biota and ecosystem processes.
- ⌘ Develop methods to distinguish between anthropogenic impacts to these ecosystems and variability caused by natural processes.
- ⌘ Improve methods for monitoring and managing the effects of harmful algal blooms.
- ⌘ Develop early warning systems for the ecosystem impacts of climate change and sea level rise.
- ⌘ Support the development of new technologies for monitoring, assessing and restoring estuarine and near-coastal environments.
- ⌘ Advance sensor hardware, data management and interpretive techniques and models to fully integrate the coastal ocean observing system initiative into regional monitoring and management programs and Sea Grant goals.

### **Goal 2: Identify and model the cumulative effects of population growth and land-use change within the land-sea continuum in regional watersheds on the health of the Gulf of Maine, near-shore areas and regional estuaries.**

### *Actions and Opportunities:*

- ⌘ Identify sources and track the fate of contaminants from specific land-use practices (e.g., nutrients, pathogens, metals and organics) in aquatic marine ecosystems.
- ⌘ Develop hydrodynamic and GIS-based models to support increased understanding of contaminant sources, fates and impacts.
- ⌘ Work with local and regional planners, managers and resource users to utilize these data to minimize and reverse the impact of human- and land-based activities on our coastal and estuarine ecosystems.



### **Goal 3: Characterize status and change within critical estuarine and coastal habitats and keystone organisms in the Gulf of Maine region through assessment of ecosystem processes and conditions.**

#### *Actions and Opportunities:*

- ⌘ Analyze existing long-term datasets to provide critical understanding of the historic and predicted future trends of the properties and processes within critical coastal habitats.
- ⌘ Develop cause-and-effect understanding of the physical and biological forces (sea level rise, etc.) affecting these trends.
- ⌘ Develop predictive models for the future health of critical habitats and keystone organisms.

### **Goal 4: Provide scientifically based information to support the development of regional ecosystem-based management frameworks and strategies for the Gulf of Maine and regional coastal ecosystems.**

#### *Actions and Opportunities:*

- ⌘ Support research and data management to provide a better understanding of physical, biological and chemical processes affecting the Gulf of Maine ecosystem.
- ⌘ Catalyze and promote the interaction between scientists, socio-economic experts and managers involved in the development of ecosystem-based management initiatives.
- ⌘ Identify, examine and fill information gaps critical to the development and implementation of ecosystem-based management models for our regional ecosystems.

### **Goal 5: Develop and advance approaches for restoration of critical habitats in the Gulf of Maine and regional estuaries.**

#### *Actions and Opportunities:*

- ⌘ In partnership with appropriate federal and state agencies, design novel habitat restoration technologies.
- ⌘ Develop adaptive monitoring strategies and protocols to assess the effectiveness of habitat restoration efforts.

- ⌘ Develop new techniques to target specific high priority locations for restoration efforts.
- ⌘ In collaboration with local and state management agencies, develop outreach programs to transfer critical habitat knowledge and restoration technologies to public officials and the citizenry.

**Goal 6: Develop and improve methods for the detection, source identification and management of microbial pathogens and harmful algal blooms.**

*Actions and Opportunities:*

- ⌘ Develop methods for identifying sources of fecal-borne microbial pathogens in beach and shellfish-growing waters.
- ⌘ Develop improved and more rapid methods for monitoring water quality.
- ⌘ Support research on the ecology and dynamics of harmful algal blooms and indigenous microbial pathogens.
- ⌘ Develop outreach programs to effectively communicate the impact of harmful algal blooms in the region.
- ⌘ Support the development of new technologies for monitoring, assessing and predicting the effects of pathogens on coastal ecosystems.



**Goal 7: Enhance preparedness and reduce loss of human life, property and environmental resources from coastal natural hazards affecting the Gulf of Maine and regional coastal environments.**

*Actions and Opportunities:*

- ⌘ Work with local and state agencies to provide clear information on the potential impacts of, appropriate planning for, and response to natural disasters, in particular potential hurricane and nor'easter effects.
- ⌘ Develop outreach programs to effectively communicate the impact of sea level rise in the region.
- ⌘ Support the development of new models and visualizations for storm-surge impacts.
- ⌘ Develop outreach programs to effectively communicate the potential impact of storm surge in the region.



## Coastal Communities & Economics

### National Perspective

Coastal communities in our country represent vital economic, social and cultural centers that provide jobs, homes, recreation and an attractive quality of life for the people who live there. Yet rapid population growth and urbanization have led to declining environmental conditions along the coasts of our nation. The impact of this development on the natural environment is the loss of the important services coastal ecosystems provide. Accommodating growth while preserving the natural environment is one of the most significant, if not the most challenging, issue facing our country in the years ahead. Cumulative impacts of human development on coastal ecosystems have created conditions that are fundamentally unsustainable.

Coastal counties in the United States cover less than 17 percent of the land area of the country, but they are home to 53 percent of the population. A study of coastal population trends predicts average increases of 3,600 people a day moving to coastal counties, reaching a total population of 165 million

by 2015. These figures do not include the 180 million people who visit the coast every year (U.S. Commission on Ocean Policy). In just 15 years, the population in coastal counties is projected to grow by 27 percent. Fourteen of our largest cities are located along the coast. The nation's top 20 oceanic and Great Lakes coastal metropolitan areas are on track to add 32 million people by 2025 – and expand their urban footprint by 46 percent.

As coastal populations have grown, so also has their vulnerability to coastal hazards – winds, waves and floods generated by hurricanes and other major storms, as well as physical impacts caused by tsunamis, land subsidence, coastal erosion and long-term shoreline changes. All of these risks are compounded by projected sea-level rise. The social and economic consequences of these events are dramatic. The environmental consequences of coastal development are, however, the most insidious.

## New Hampshire Sea Grant Perspective

New Hampshire's coastal watersheds comprise 43 small cities and towns. The relatively small coastline is commercially, historically, recreationally, scientifically and ecologically significant and represents one of the fastest-growing regions in the fastest-growing state in New England. The state's population is expected to grow more than 28 percent from 2000 to 2025, with 80 percent of that estimated growth occurring in the four southeastern counties, the area nearest the coast.

Development pressure is high in NH, with land prices rising 61 percent since 1998. New Hampshire is losing forestland (about 17,500 acres each year from 1997 to 2002) and farmland. The state's character is changing as a result of this loss and the increasing population density. It is becoming predominantly urban and suburban rather than rural. Currently, about 10.7 percent of the coastal watershed has some form of permanent protection (*NH Estuaries Project 2003 State of the Estuaries Report*).

The rate of land consumption per capita, an indicator of sprawl-type development, is increasing in NH's coastal watersheds as well. As of the year 2000, the state's coastal communities had 1.4 percent to 33.9 percent of their land area covered by impervious surfaces. The average acres of imperviousness per person increased from 0.15 acres/person in 1990 to 0.217 acres/person in 2005 (*NH Estuaries Project 2006 Environmental Indicator Report: Land Use and Development*)



## Strategic Goals and Opportunities

Due to the interdisciplinary nature of our research and extension efforts, NH Sea Grant is particularly well suited to provide solutions to the problems caused by the overdevelopment of our coasts. While most academicians and agency personnel focus in on a narrow range of problems within their area of expertise, Sea Grant brings together disparate experts from the University and the community to attack problems from a number of angles.

We will continue to play a role as an information broker in the coastal community. Never has there been a greater need for a neutral, credible broker than in the area of coastal growth and development. The number of institutional and private stakeholders in this arena far exceeds that of our traditional clientele. The growth and development issues faced by local coastal communities are aggregated upwards into larger problems that must be addressed on a national scale.

Sea Grant investigators are encouraged to collaborate with various partners when addressing some of the opportunities listed below. These partners include the UNH/NOAA Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), the UNH Storm Water Center, the Natural Resources Outreach Coalition (NROC), and various state/regional agencies.

**Goal 1: Build community capacity, thus allowing citizens to guide coastal development in a way in which the environment is protected and balanced with the economy.**

### *Actions and Opportunities:*

- ⌘ Conduct assessments of coastal community decision-makers' information needs regarding land use and watershed planning.
- ⌘ Explore the use of various geospatial techniques for allowing communities to visualize proposed or imagined land uses and their potential impacts.
- ⌘ Use locally and nationally derived science and examples to help coastal decision makers understand the consequences of various land use decisions on natural and human systems.
- ⌘ Conduct assessments of local policies to determine their consequences and of policy changes to predict environmental and economic impacts.

### **Goal 2: Identify and evaluate sustainable growth thresholds that coastal communities can use in achieving a balance between environmental and economic sustainability.**

#### *Actions and Opportunities:*

- ⌘ Conduct analyses of different land-use scenarios to estimate economic and environmental impacts.
- ⌘ Conduct assessments of the effectiveness of various storm water management techniques to improve water quality and quantity for sustainable development, natural resource protection and hazard planning.



- ⌘ Conduct analysis of changes over time in waterfront land-use composition.
- ⌘ Develop key indicators of social, economic and environmental well-being that will provide feedback to decision-makers on growth policies and actions.

### **Goal 3: Enhance preparedness and reduce loss of human life, property and environmental resources from coastal natural hazards.**

#### *Actions and Opportunities:*

- ⌘ Develop new technologies for disaster prevention and remediation.
- ⌘ Develop and transfer economic evaluation techniques to state and local officials seeking to develop more effective mitigation, evacuation and recovery plans.
- ⌘ Improve shoreline mapping and change analysis methodologies.
- ⌘ Improve understanding and assessments of the relationship between shoreline change and environmental effects.
- ⌘ Assist local governments and developers in incorporating water availability limitations, erosion rates and setbacks, and coastal building codes into development activities.
- ⌘ Increase public and decision-maker awareness of threats from natural disasters through innovative outreach programs done collaboratively with appropriate state agencies.



## Marine & Aquatic Science Literacy

### National Perspective

The reports of two national commissions on the status of the oceans emphasize the important role of education in the future of the oceans. Both commissions, the Pew Oceans Commission and the U.S. Commission on Ocean Policy, stress that successful management of our ocean resources is dependant upon the development of a citizenry literate in marine and aquatic science.

Strengthening the nation's awareness of the importance of the oceans requires a heightened focus on the marine environment, through both formal and informal education efforts. School curricula, starting in kindergarten, should expose students to ocean issues, preparing the next generation of ocean scientists, managers, educators, and leaders through diverse educational opportunities. In addition, because formal curricula only reach students for a limited time, informal education aimed at the entire population is needed to foster lifelong learning.

– *U.S. Ocean Commission Report*

The challenges to marine and aquatic science education in this country are profound. Fifty-two million pre-college students are being taught science by 1.9 million elementary and 186,000 middle- and high-school teachers. Of these educators, 37 percent in high school, 83 percent in middle school, and practically all teaching science at the elementary level lack science degrees. To compound this problem, too few of the teachers who do have science degrees have studied marine and aquatic science.

The heightened urgency to increase marine literacy identified by the commissions joins the ongoing efforts in public schools throughout the country to significantly improve student performance in mathematics and science. This effort can benefit greatly from the utilization of marine and aquatic science as an engaging context for the teaching of core mathematics and science content.

The education of future environmental professionals and leaders is critical to the responsible use and management of our nation's marine and aquatic resources. Science majors and

future marine scientists need opportunities to learn science in real-world settings and to apply their skills at work under the mentorship of actual scientists.

Sea Grant supports the professional development of undergraduate and graduate students interested in marine and aquatic science by providing hands-on research opportunities, by funding the development of innovative courses, and by offering internships and fellowship programs, including the nationally competed John A. Knauss Marine Policy Fellowships.

## New Hampshire Sea Grant Perspective

New Hampshire has over 470 public and private schools serving nearly 230,000 students with an average per-pupil expenditure of \$8,495. Despite the state's small size and relatively low per-pupil expenditure, NH students produce SAT scores and SAT participation rates well above the national average. Nevertheless, NH and the other 49 states face similar performance problems in complying with the No Child Left Behind Act.

To prepare for the upcoming national science assessment requirements, work continues on reviewing and revising the NH Science Frameworks, which identify the science content students and schools will be held accountable for under the act. So far, the frameworks have been reorganized into a more "user-friendly" language and format. Once these new frameworks are adopted and put into use in the classrooms, teachers will face numerous challenges implementing them.

NH Sea Grant is committed to providing the curriculum resources and teacher professional development necessary for educators to successfully deliver marine-science education programs. The results of new research projects can be incorporated into revised curriculum to keep it up-to-date.

Delivery of marine-science extension programs in the region will continue to rely heavily on the more than 150 Sea Grant-trained volunteers, the UNH Marine Docents. Due to the small size of the state, NH Sea Grant and the Docents can make a significant contribution to the challenges public schools face incorporating new science standards into their curricula and improving student performance.

NH Sea Grant will continue to support and develop undergraduate and graduate opportunities in marine science, like the UNH Ocean Projects course (Tech 797), that provide hands-on experiential learning that challenges and inspires. In addition, fellowship opportunities will be broadly marketed around the state encouraging interested graduate students to apply.

## Strategic Goals and Opportunities

The recommendations resulting from the findings of the Ocean Commission align perfectly with the historic mission of Sea Grant to promote wise use, conservation and development of our marine resources through research, education, extension and communication. Over 30 years of experience in formal and informal marine science education program development and



delivery have created a firm foundation for NH Sea Grant to accept the challenges of implementing the commission recommendations. We will maintain our state leadership role in providing marine science education opportunities to students, educators and the general public. Sea Grant investigators are encouraged to develop partnerships and collaborations with other groups and agencies to address selected opportunities identified in this area. Those of particular interest include the NH Estuaries Project, the NH Coastal Program, the Seacoast Science Center, the Great Bay and Wells Estuarine Research Reserves, and the Natural Resource Outreach Coalition (NROC).



## A. Fostering an Informed Citizenry

### Goal 1: Create and sustain effective marine and aquatic science-based educational programs for both formal K-12 audiences and informal family and adult audiences.

#### *Actions and Opportunities:*

- ⌘ Review and revise existing programs and curriculum materials to support teaching core science standards through a marine context.
- ⌘ Develop new marine education K-12 programs that reflect emerging national scientific issues and address prioritized education standards.
- ⌘ Expand programs and materials that target adult audiences and recruit and train a cadre of UNH Marine Docents

specifically for that role.

- ⌘ Develop a new watershed-based curriculum for adult audiences that facilitates informed decision making about aquatic and coastal resources.
- ⌘ Assist teachers in measuring the improvement in student performance as a result of participation in programs.
- ⌘ Develop programs focused on high-school level teachers and students that provide exposure to marine research and encour-

age students to pursue marine fields in college and beyond.

- ⌘ Develop partnerships with marine faculty in the development and implementation of K-12 programs and initiatives.
- ⌘ Increase efforts to provide Marine Docent and Great Bay Coast Watch opportunities to home-school and other under-represented populations.
- ⌘ Encourage Sea Grant-supported researchers to include a K-12 education component or an outreach component in their research project whenever appropriate.
- ⌘ Expand and strengthen the role of the Great Bay Coast Watch in long-term aquatic environmental data collection and educational outreach through a well-developed strategic plan and stabilized funding.

### Goal 2: Support the use of marine and aquatic sciences content and examples in the teaching of science, mathematics, social sciences and language arts.

### *Actions and Opportunities:*

- ⌘ Develop guides to existing curricular and program materials that identify how the marine context can be used to address core content standards.
- ⌘ Collaborate with regional and national education organizations to develop resources that support the use of the marine context in the teaching of core content.
- ⌘ Collaborate with local, regional and national experts to document the effectiveness of using the marine context to teach core content standards and improve student performance.

### **Goal 3: Expand professional development opportunities for all educators.**

#### *Actions and Opportunities:*

- ⌘ Develop convenient and effective teacher training in conjunction with all boat-based and field programs utilizing both face-to-face and remote methods.
- ⌘ In partnership with K-12 schools, develop new programs that engage in-service and pre-service teachers directly with marine researchers, faculty and graduate students.
- ⌘ Participate in the planning and delivery of regional and national educator training programs through the partnership with the Maine-based Centers for Ocean Sciences Education Excellence–Ocean Systems (COSEE-OS) and new collaborations.



- ⌘ In collaboration with the UNH Leitzel Center, Education Department and Marine Program faculty, develop both credit and non-credit marine science programs for middle- and high-school teachers.

### **Goal 4: Cultivate leadership in, and the growth of, marine and aquatic sciences education communities.**

#### *Actions and Opportunities:*

- ⌘ Take a leadership role in the revitalization of the Gulf of Maine Marine Education Association.
- ⌘ Work closely with other informal and formal marine education organizations in New Hampshire to maximize impact and effectiveness with K-12 and adult audiences.
- ⌘ Take a leadership role in the National Marine Education

Association in the pursuit of improved teaching and learning through the context of marine science.

- ⌘ Work within the Sea Grant Educator Network to increase the sharing of ideas, programs and information that supports the mutual goals of our individual programs and the network.

### **B. Developing a Technically Trained Workforce**

#### **Goal 1: Utilizing marine science courses and internships, produce highly trained graduates to fill important jobs in the science, engineering and education fields.**

### *Actions and Opportunities:*

- ⌘ Develop communications products that provide students (and other interested parties) with an overview of the state's marine community and the opportunities it provides for students.
- ⌘ Investigate the feasibility of creating undergraduate marine science research fellowships/internships open to all students pursuing an appropriate degree at a NH university or college.
- ⌘ Investigate the feasibility of creating undergraduate marine-science internships with agencies, decision makers, aquaria, marine industries, etc. open to all students pursuing an appropriate degree at a NH university or college.
- ⌘ Support the development of undergraduate courses in new and emerging fields.
- ⌘ Continue Sea Grant support for UNH Tech 797.



### **Goal 2: Encourage more involvement of graduate students in research and outreach efforts as well as fellowship opportunities.**

#### *Actions and Opportunities:*

- ⌘ Involve graduate students in outreach efforts.
- ⌘ Encourage Sea Grant PIs to include student (graduate and undergraduate) support in their research projects.
- ⌘ Determine the most effective means to promote all fellowship opportunities.
- ⌘ Feature the opportunities on the NH Sea Grant web site and in appropriate program publications.
- ⌘ Work with researchers to identify and recruit promising fellowship candidates.
- ⌘ Explain fellowship opportunities to interested faculty and students at institutions of higher learning throughout the state.

# New Hampshire 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 & Communications

Kingman Farm/UNH  
Durham, NH 03824  
603.749.1565, fax 603.743.3997

**Steve Adams**, Communications Coordinator,  
steve.adams@unh.edu

**Sue Chalifoux**, Communications Assistant,  
sue.chalifoux@unh.edu

**Karen Diamond**, Great Bay Coast Watch Assistant,  
karen.diamond@unh.edu

**Candace Dolan**, Phytoplankton Project Coordinator,  
candace.dolan@unh.edu

**Brian Doyle**, Associate Director and Program Leader,  
brian.doyle@unh.edu

**Lori Lavac**, Program Assistant, lori.lavac@unh.edu

**Julia Peterson**, Extension Specialist/Water Resources,  
julia.peterson@unh.edu

**Ann Reid**, Program Associate, ann.reid@unh.edu

**Dari Ward**, Education Assistant, dari.ward@unh.edu

**Kirsten Weir**, Science Writer, kirsten.weir@unh.edu

**Mark Wiley**, Extension Specialist/Marine Education,  
mark.wiley@unh.edu

## NH Sea Grant Staff at other locations

**Rollie Barnaby**, Extension Educator  
113 North Road  
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  
603.862.3124, fax 603.862.0243, pingguo.he@unh.edu

**Steve Jones**, Assistant Director for Research  
Jackson Estuarine Lab/UNH  
Durham, NH 03824  
603.862.5124, shj@cisunix.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 has input from 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 Associate 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 & 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 &  
Estuarine Environmental Technology

## **Chris Mantzaris**

Deputy Regional Administrator, National Marine Fisheries Service

## **Besty Nicholson**

NOAA Regional Coastal Program Specialist, UNH

## **Linda Schier**

President, Acton Wakefield Watersheds Alliance

## **Bonnie Spinazzola**

Executive Director, Atlantic Offshore Lobstermen's Association

## **Peter Whelan**

Recreational/Charter Fishing Industry Member, Portsmouth, NH

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 NH Sea Grant College Program.

UNHMP-SP-SG-06-27

For additional copies, please contact:

NH Sea Grant Communications  
Kingman Farm/UNH  
Durham, NH 03824  
603.749.1565



UNIVERSITY of NEW HAMPSHIRE