



New Hampshire Sea Grant

Strategic Plan 2014-2017



The New Hampshire 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 33 members of the National Oceanic and Atmospheric Administration's National Sea Grant College Program, which is devoted to promoting the understanding, wise use and stewardship of our coastal resources.



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Contents:

2	A Message from the Director
4	Environmental Literacy and Workforce Development
10	Healthy Coastal Ecosystems
17	Resilient Communities and Economies
23	Sustainable Fisheries and Aquaculture

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A Message from the Director

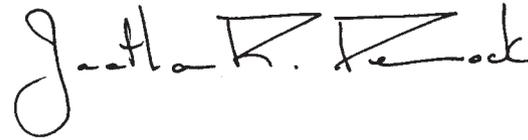
The guiding philosophy for New Hampshire Sea Grant (NHSG) is to serve our constituency by supporting innovative and cutting-edge research integrated with expert extension outreach and education to support dialog and science-based decision-making in areas of particular importance to our region. In so doing, we seek to promote the wise use, development and conservation of northern New England's coastal and marine resources. Since 1970, NHSG has established itself as a leader in developing solutions to critical issues, while establishing itself as an unbiased source of information and expertise rather than as an advocate for any one particular solution. NHSG is one element of a complex array of marine and NOAA entities associated with the University of New Hampshire (UNH), including the UNH Marine Program and numerous NOAA/UNH cooperative and joint institutes. The effectiveness, visibility and public value of our programs at UNH, across the state, and in the region is enhanced by leveraging, building and strengthening strategic partnerships with university resources as well as external partners to provide high quality and impactful programs.

Although New Hampshire has just over 18 miles of Atlantic coastline, the state's two major estuaries, Great Bay Estuary and Hampton-Seabrook Harbor, have nearly 220 miles of estuarine shoreline. These two estuaries differ in geology, hydrology and history, but both are valued for their beauty and rich array of natural resources that, along with Rye Harbor and Little Harbor, provide numerous commercial and recreational uses. Thirty-two percent of the state's 1.35 million people live within the two coastal counties and nearly 75% of the state's population lives within 50 miles of the coast. This represents a 15% increase over the past 10 years. As in N.H., the region's economy, culture and the lifestyle of its citizens are closely tied to the nearly 4500 miles of coastline and the wealth of marine resources found within the Gulf of Maine. Although there are myriad coastal issues and marine resource problems appropriate for NHSG's attention in N.H. and surrounding areas, we have attempted to use our limited resources efficiently by targeting only those that most closely match the capabilities and strengths of our academic institutions, staff and cooperators.

N.H. and the northeast region have been faced with both environmental and social challenges that are impacting land-use, water quality and natural resource management decisions, which in turn have affected coastal economies. To address these challenges, NHSG will focus research and extension efforts on improving the sustainability of the fishing and aquaculture industries while reducing their impact on fish stocks and marine habitats, enhancing the management of marine resources

through NHSG-supported research, and building science and decision-maker understanding of nutrient flux in coastal watersheds and storm water run-off while preparing to adapt to a changing climate. In addition, efforts in our environmental literacy and work force development focus area will provide youth and young adults with an appreciation and understanding of our marine ecosystem with the goal of building marine literacy, strengthening marine stewardship and encouraging future marine professionals.

The **2014-2017 New Hampshire Sea Grant Strategic Plan**, developed in concert with our New Hampshire Sea Grant Policy Advisory Committee and local stakeholders, represents a road-map that demonstrates how NHSG will meet the mission of the Sea Grant College Program through a comprehensive system approach to building a sustainable environmental and community interface for N.H.

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

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



Environmental Literacy and Workforce Development

Literacy is the foundation upon which people make informed decisions. A public with little understanding of ocean and coastal science results in a generally uninformed and apathetic public regarding the vulnerability and value of our nation's coastal resources. This leads to a lack of understanding of coastal conservation and management decision-making for people who are, and will be, our country's voters, workforce, and political and community leaders. National reports have reiterated the need for an informed public and well-trained workforce in ocean, coastal and Great Lakes issues (Pew Oceans Commission [2003]; U.S. Commission on Ocean Policy [2004]). Specifically, the U.S. Commission on Ocean Policy highlights the significance and excellence of the Sea Grant education program (e.g., Chapter 8).

In 2011 the National Research Council published *Conceptual Framework for New Science Education Standards*, the foundation for the development of new national K–12 science standards. These standards are very likely to be adopted by a majority of states and will constitute the science content and performance

expectations that U.S. students and educators will be held to for some time to come. The inclusion of more ocean science in national standards will put added pressure on marine educators to provide professional development support in ocean science to existing and future formal educators. Programs like Sea Grant are well positioned to help provide the curriculum resources and teacher professional development necessary to succeed.

N.H. has over 470 schools serving nearly a quarter million students with an average per pupil expenditure of \$13,725. Despite N.H.'s small size and modest per pupil expenditure, its students have SAT scores and participation well above the national average. Nevertheless, the state faces similar performance problems to others around the country in the face of "No Child Left Behind." NHSG can make a significant contribution to the challenges public schools face incorporating new science standards into their curricula and improving student performance.

The inclusion of more ocean science in national standards will put added pressure on marine educators to provide professional development support in ocean science to existing and future formal educators.

Overall Goal: New Hampshire citizens increase their environmental literacy and stewardship activity and utilize that increased knowledge in natural resource decision-making.

Research and Education

ELWD Goal 1: Environmentally literate and engaged pre-K–12 students and adults supported by formal and informal education, communication tools and outreach opportunities in environmental sciences.

How N.H. Sea Grant will address ELWD Goal 1: In collaboration with faculty, formal education institutions and regional organizational partners, NHSG will develop and provide environmental literacy material and programs to audiences in N.H. and New England through a variety of on-line and other communication media and face-to-face educational methodologies.

ELWD Research – Goal 1:

- Assess the literacy of N.H. pre-K–12 students and adults relative to NOAA-supported environmental literacy standards to determine baseline and post-participation literacy.

- Identify or develop evaluation methodologies that provide meaningful impact data of environmental literacy efforts on citizen literacy, student performance and stewardship activity.



- Identify or develop evaluation methodologies that provide meaningful impact data on stewardship activity as a result of increased literacy.

ELWD Education – Goal 1:

Learning Outcome:

1.1 New Hampshire residents increase their environmental literacy through N.H. Sea Grant informal ocean, coastal and climate education programs that utilize the latest scientific research and educational best practices.

Action Outcomes:

1.2 Participants in informal programs make informed decisions regarding society's impact on the ocean and our climate.

1.3 New Hampshire residents increase their environmental stewardship activities as a result of N.H. Sea Grant informal ocean, coastal and climate education programs that utilize the latest scientific research and educational best practices.

1.4 Environmental stewardship activities are enhanced by the participation of environmentally literate citizens.

Consequence Outcome:

1.5 Decisions regarding society's impact on the ocean and Earth's climate are developed and supported by engaged citizens who are literate in environmental science utilizing the latest scientific research.

Performance Measures:

- Number of participants in N.H. Sea Grant formal and informal education programs per year who demonstrate measureable perceived increases in environmental literacy.
- Number of education program participants per year who participate in environmental stewardship activities.
- Number of environmental stewardship programs per year that utilize education program participants.

ELWD Goal 2: Formal and informal educators utilizing environmental science curricula and programming grounded in the Climate and Ocean Literacy Principles and pertinent Next Generation Science Standards.

How N.H. Sea Grant will address ELWD Goal 2: In collaboration with other governmental and non-governmental organizations and environmental educators, N.H. Sea Grant will develop professional development programs and pedagogical support materials to facilitate the inclusion of environmental science standards in formal, informal and free-choice learning settings.

ELWD Research – Goal 2:

- Determine a baseline to assess the inclusion of environmental science curricula in pre-K–12 settings.
- Assess pre-and post-participation change in environmental science instruction strategies and content.
- Design and investigate optimal informal and/or formal learning methods for environmental science in pre-K–12 students.



**ELWD Education – Goal 2:
Learning Outcome:**

2.1 Formal and informal educators gain increased understanding of the Climate and Ocean Literacy Principles and pertinent Next Generation Science Standards.

Action Outcome:

2.2 Formal and informal educators incorporate the Climate and Ocean Literacy Principles and pertinent Next Generation Science Standards into their teaching.

Consequence Outcomes:

2.3 Pre-K–12 students and adults participating in informal environmental education programs measurably increase their environmental literacy.

2.4 Educators incorporate environmental science curricula to meet the Next Generation Science Standards.

Performance Measures:

- Number of educators per year assessed to determine pre- and post-training perception of literacy and intention for incorporation into programs and curricula.
- Number of pre-K–12 educators per year who participate in N.H. Sea Grant education programs.

- Number of pre-K–12 educators per year who incorporate environmental curricula into syllabi to meet the expectations of the Next Generation Science Standards.

ELWD Goal 3: UNH Marine Docents increase their content knowledge and pedagogy to deliver environmental literacy content in formal and informal education settings.

How N.H. Sea Grant will address ELWD Goal 3: N.H. Sea Grant will continue to provide its nationally recognized training and professional development programs to volunteers who comprise the docent program. This training will include extensive in-class, field and experiential methodologies and will tap the expertise of the University and other environmental education individuals and organizations in the region.

ELWD Education – Goal 3: Learning Outcome:

3.1 UNH Marine Docents gain increased understanding of the Climate and Ocean Literacy Principles and pertinent Next Generation Science Standards.



Action Outcomes:

- 3.2** UNH Marine Docents incorporate the Climate and Ocean Literacy Principles and pertinent Next Generation Science Standards into program activities.
- 3.3** UNH Marine Docents develop experiential learning curricula using the Climate and Ocean Literacy Principles and pertinent Next Generation Science Standards learned through N.H. Sea Grant education training.

Consequence Outcome:

- 3.4** Pre-K–12 students and adults participating in UNH Marine Docent environmental education programs measurably increase their environmental literacy.

Performance Measures:

- Number of UNH Marine Docents per year who are assessed to determine pre- and post-training perception of literacy and intention for incorporation into programs and curricula.
- Number of volunteers per year who receive training in environmental science and graduate from the Marine Docent Program.
- Number of volunteer hours per year contributed by the Marine Docent Program.

ELWD Goal 4: A workforce skilled in science technology, engineering and other disciplines critical to the resolution of environmental issues.

How N.H. Sea Grant will address ELWD Goal 4:

N.H. Sea Grant will continue to support the National Sea Grant marine careers website (www.marinecareers.net) and associated materials. NHSG will also continue to support undergraduate development through the UNH Ocean Research Program (Tech 797), the Shoals Marine Laboratory partnership, the Brian Doyle Undergraduate Fellowship program, and other internship opportunities, and to support opportunities for graduate students through participation in the Knauss Fellowship and other National Sea Grant and NOAA fellowship programs.



**ELWD Education – Goal 4:
Learning Outcome:**

4.1 N.H. Sea Grant program participants gain skills and knowledge qualifying them for environmentally related career opportunities.

Action Outcomes:

4.2 N.H. Sea Grant program participants qualify and apply for environmentally related career opportunities.

4.3 Undergraduate program participants pursue graduate or post-secondary education or certification in environmentally related careers.

Consequence Outcomes:

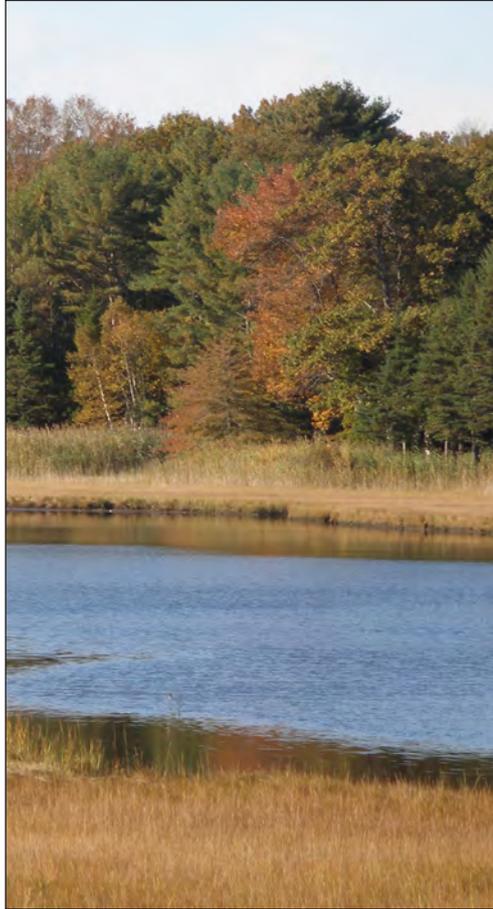
4.4 Environmentally related career opportunities are filled with qualified applicants.

4.5 A well trained, competitive and diverse work force exists.

Performance Measures:

- N.H. Sea Grant program participants are surveyed each year for intention to apply for ocean-, coastal- and climate-related career opportunities and are tracked to determine follow-through and success.

- Number of undergraduate and graduate students per year who participate in N.H. Sea Grant supported research, programs or internship opportunities.



Healthy Coastal Ecosystems

The New Hampshire coastline has been a highly desirable place to live and work since the early 1600s when European settlers first arrived. The area features two estuaries, the coastline, open ocean and coastal watershed ecosystems that have supported and evolved from fishing, industrial, commercial and residential development pressures. As a result of pollution abatement, fisheries management and ecosystem conservation regulations and activities, the N.H. seacoast has made great strides toward recovering from many historic impacts, yet human activities continue to pose challenges that require scientific study. Tourism, recreational and commercial activities, including fishing, aquaculture and shellfishing, and the quality of life in the seacoast all depend on balancing healthy ecosystems with these increasing demands.

Of particular concern is the rate of increase in impervious surfaces accompanying land use changes that is outpacing the regional population growth rate, along with wastewater treatment, transportation and other infrastructure needs that put

further pressure on our coastal ecosystems. Stormwater run-off is a major contributor of a variety of pollutants to coastal waters. These pollutants and other changes to aquatic conditions brought on by increasing levels of run-off pose threats to public health and are stressors to coastal ecosystems. New development is increasingly incorporating stormwater management strategies into construction design, yet

existing infrastructure requires significant resources to mitigate impacts. Communities are currently facing strict regulations on nutrient levels in discharged wastewater to protect coastal ecosystems that are affected in complex ways. Climate change has brought more rainfall in more intensive storms that exacerbates both the run-off and wastewater treatment problems.

Climate changes have also brought increased flooding in many coastal communities and sea level rise poses threats to human development and salt marsh ecosystems. Communities are just beginning to become actively involved in adaptation strategies to counter many of these expected climate change impacts. Protection of ecosystem health is more challenging. Anadromous fish returns and migration have dropped precipitously in the past few decades, while climate change-induced increases in

Our goal is to provide tools and knowledge to communities and their environmental, resource and public health managers that will inform their decisions on how best to restore and maintain the health of our coastal ecosystems, and to anticipate adaptation and mitigation strategies needed to address new challenges as they emerge.

rainfall and warming trends are factors in the onset of devastating oyster diseases, macroalgal species shifts and the emergence of human bacterial pathogens.

It is critical for scientists to continue to track changes in biological diversity, ecosystem processes and environmental conditions to provide deeper understanding of critical processes to inform management

decisions in light of invasive species and declines in economically important species. Environmental agencies, communities and individuals continue their efforts to protect pristine and productive habitats and recreational areas where possible.

N.H. Sea Grant targets research investments to address the most critical issues facing the N.H. seacoast region through large, two-year projects, smaller seed/development projects and collaborative efforts with local partners. Our goal is to provide tools and knowledge to communities and their environmental, resource and public health managers that will inform their decisions on how best to restore and maintain the health of our coastal ecosystems, and to anticipate adaptation and mitigation strategies needed to address new challenges as they emerge.

Overall Goal: Coastal ecosystems are clean, safe for human recreation, protected and resilient to future changes.

Research and Extension

HCE Goal 1: Critical coastal ecosystem functions and services are restored and protected.

How N.H. Sea Grant will address HCE Goal 1: N.H. Sea Grant will work with and participate in research and extension activities that address problems and limitations in water quality and critical resources like shellfish beds, salt marshes and anadromous fish habitats. N.H. Sea Grant Coastal Research Volunteer (CRV) Program volunteers will help augment the data-gathering capacity of scientific studies by direct participation in N.H. Sea Grant-funded and related projects. N.H. Sea Grant will work with other Northeast Sea Grant programs to identify potential invasive species habitat, train volunteers to monitor for mitten crabs and other invasive species, and report monitoring data to existing Northeast invasive species databases.



HCE Research – Goal 1:

- Develop new techniques and optimize strategies for restoring and preserving coastal habitats and ecosystem services, and for evaluating the effectiveness of these new approaches.
- Develop methods for quantifying and predicting changes in critical ecosystem processes, biological responses and conditions within coastal habitats.
- Understand distribution, incidence and impacts of invasive species on coastal ecosystem health, biological systems and economies.

HCE Extension – Goal 1:

Learning Outcomes:

- 1.1** Scientists recruit and train volunteers as effective collaborators to augment field science activities.
- 1.2** Volunteers understand and value scientific methods and science's contribution to healthy coastal ecosystems.
- 1.3** Volunteers, management organizations, conservation groups and citizens understand the impact of marine invasive species and the benefits of habitat restoration on coastal ecosystem health, biological systems and economies.

Action Outcomes:

- 1.4 Researchers effectively utilize volunteers to enhance field and laboratory research.
- 1.5 Volunteers participate in coastal research projects.
- 1.6 Management organizations make decisions regarding invasive species and habitat restoration based on the best available science.
- 1.7 Volunteers, conservation groups and interested citizens participate in invasive species and habitat restoration programs.

Consequence Outcomes:

- 1.8 Coastal researchers utilize volunteers to augment field research and volunteers participate in and value marine science.
- 1.9 Coastal marine invasive species incidences are prepared for and mitigated through a well-informed management and citizen community.

Performance Measures:

- Number of locally critical coastal habitats per year in which improvements in ecosystem function, conditions and services are accomplished.
- Number of tools for tracking changes in ecosystem processes, biological responses and conditions that are developed and/or used by local agencies or organizations.
- Number of volunteers in the CRV Program per year who participate in scientific projects addressing multiple environmental issues.

HCE Goal 2: Coastal waters are safe and clean for recreation, and locally harvested seafood is safe for consumers.

How N.H. Sea Grant will address HCE Goal 2: N.H. Sea Grant will work with academic researchers, local shellfish and fish farmers, and environmental managers to develop tools for improving the quality of locally harvested seafood and coastal ecosystems. Volunteers will help augment the data gathering capacity of scientific studies by direct participation in N.H. Sea Grant-funded and related projects. NHSG will also support and participate in research activities that address ecosystem impact of ocean-based debris and will support and participate in outreach activities designed to minimize these impacts through the clean-up of marine debris.

HCE Research – Goal 2:

- Develop tools to identify, and strategies to reduce, pollutants in coastal waters and seafood.
- Determine the incidence, public health risks 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.
- Investigate the ecological impacts of ocean-based debris and associated chemical contaminants.

- Investigate the distribution and sources of marine debris that impact the marine ecosystem.
- Develop best management practices for fishermen to minimize the generation of marine debris.

HCE Extension – Goal 2:

Learning Outcomes:

- 2.1 Fishermen (recreational and commercial) and the interested public understand the effects/impacts/problem of marine debris and integrating technology (side-scan sonar, GPS, GIS) for underwater surveys of marine debris and data collection and interpretation.
- 2.2 Coastal research volunteers understand coastal pollution processes, sources and mitigation strategies.

Action Outcomes:

- 2.3 Fishermen and the interested public participate in mapping and collecting marine debris during directed and undirected debris-removal activities.
- 2.4 Researchers effectively utilize volunteers to augment water quality research programs.



- 2.5 Volunteers participate in coastal research programs.
- 2.5a Coastal research volunteers help identify pollution sources in multiple coastal municipalities.
- 2.5b Coastal research volunteers participate in and help manage marine debris cleanup efforts.

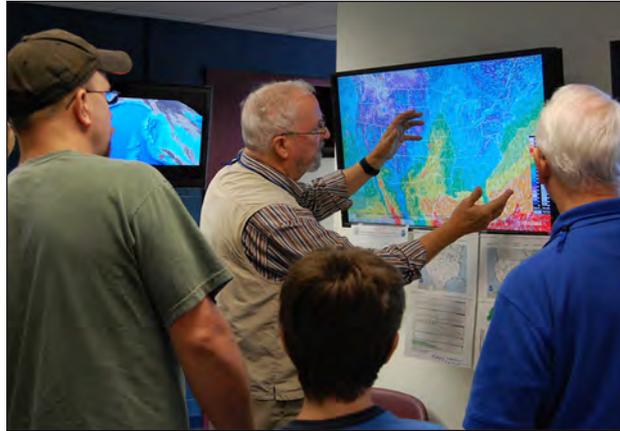
Consequence Outcomes:

- 2.6 There is less marine debris on N.H. shorelines and coastal waters, and fishermen are using best management practices to reduce the generation of debris.
- 2.7 Coastal pollution is reduced.
- 2.8 Coastal researchers utilize volunteers to enhance field research and volunteers participate in and value marine science.

Performance Measures:

- Number of projects per year supported by NHSG that detect contaminants of concern to public and ecosystem health.
- Number of sources and/or causes of coastal contamination per year identified and reduced through NHSG-supported activities.
- Number of tools or strategies per year developed and optimized for reducing contaminants that harm coastal ecosystems and seafood consumers.

- Number of researchers per year who participate in the CRV program.
- Number of volunteers per year who participate in the CRV program.
- Number of seafood consumers per year who are informed about the health benefits and quality of locally harvested seafood.
- Number of N.H. fishermen per year who participate in NHSG-sponsored marine debris programs and remove and dispose of marine debris.
 - ◆ Number of volunteers per year participating in beach cleanups.
 - ◆ Number of miles of shoreline cleaned per year.
 - ◆ Number of tons of marine debris removed per year on land and under water.



HCE Goal 3: Coastal communities effectively plan for the future and mitigate existing problems associated with human disruptions of coastal ecosystems.

How N.H. Sea Grant will address HCE Goal 3: Through research and extension efforts, N.H. Sea Grant will work with

local and state agencies and organizations like the UNH Stormwater Center to help coastal communities assess needs, then develop strategies to meet identified needs, for restoring natural resources, adapting to climate change, and managing critical habitats to protect and enhance coastal ecosystem health.

HCE Research – Goal 3:

- Develop methods for quantifying and predicting ecosystem impacts of climate change and sea level rise.
- Work with government agencies to

provide clear information on the potential ecosystem impacts, planning needs and responses to increased incidence and severity of stormwater run-off and natural disasters.

- Develop cost and benefit estimates for different approaches to mitigate the effects of land use and stormwater/wastewater treatment strategies on the health of coastal ecosystems.

Learning Outcomes:

3.1 Local, regional and state agencies and organizations working in the coastal watershed will know about relevant data, technical tools and technical assistance that can be used to enhance habitat restoration projects and ecosystem management within the region.

3.2 Local, regional and state agencies and organizations working in the coastal watershed will gain knowledge about effects of current and projected climate conditions on coastal ecosystems.

3.3 Local, regional and state agencies and organizations working in the coastal watershed will recognize contaminant management options, associated costs and benefits, and likely ecosystem health outcomes from different approaches.

Action Outcomes:

3.4 Local, regional and state agencies and organizations working in the coastal watershed will request and/or use relevant data, technical tools and technical assistance for habitat restoration projects and ecosystem management within the region.

3.5 Local, regional and state agencies and organizations working in the coastal watershed will incorporate the anticipated effects of current and projected climate conditions into ecosystem planning and management activities.

3.6 Local, regional and state agencies and organizations working in the coastal watershed will promote, support and employ contaminant management options that are considered most



economically and ecologically feasible and effective.

Consequence Outcome:

3.7 New Hampshire's coastal ecosystems are managed and coastal communities are resilient and prepared for current and projected changes in climate conditions and contaminants.

Performance Measures:

- Local, state or regional agencies or organizations gain knowledge about the effects of contaminants or climate conditions on ecosystem health.
- Local, state or regional agencies or organizations gain knowledge about ecosystem management options to address threats from contamination or climate effects.



Resilient Communities and Economies

New Hampshire's coastal watershed comprises 42 towns. The relatively small coastline is commercially, historically, recreation-ally, scientifically and ecologically significant and encompasses both coastal shoreland and the nation's most recessed estuary, Great Bay. The Great Bay watershed also includes 10 municipalities in Maine. As in many coastal areas, development pressure and nonpoint source pollution potential are high along this coastline where effluent from 20 wastewater treatment facilities and hundreds of stormwater pipes release into the coastal waters, bay and tributary rivers. In 2005, about 7.5% of the watershed's land area was impervious cover. About one quarter of the coastal subwatersheds contained greater than 10% impervious cover, indicating the potential for water quality degradation.

In addition to development pressure and impacts, the serious economic, environmental and social effects of severe weather and changes in climate behoove communities to do what they can to prevent damage and become more resilient. However, planning and readiness activities at the municipal level are often

usurped by immediate threats, budgetary restraints, political pressures and discomfort accessing or applying scientific data.

Communities within the region have experienced tightening municipal budgets, a series of severe and damaging storms, and pollution impairments in Great Bay. They are looking for practical and sound tools and techniques that will assist them to grow while remaining attractive places to live, work and play. Municipal leaders are influenced by many different forces – economic, environmental, social, political and cultural – and are often being drawn in different directions. More than ever, N.H. Sea Grant’s work with communities calls for high degrees of engagement and the ability to draw from multiple disciplines in order to be responsive to communities’ needs.

NHSG’s work focuses on engaging with local land use decision-makers to make sure they have access to the science-based information, tools and resources they need to reduce vulnerabilities and increase their resilience to environmental, climatic, social and economic stressors. NHSG enjoys the benefits of having a nationally recognized stormwater treatment evaluation center on campus, the UNH Stormwater Center, and has

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worked to create and strengthen formal ties with the center in order to collaboratively provide cutting edge technical information to community leaders, state and federal agencies, watershed and similar organizations, and business leaders in construction and landscaping. In collaboration with its partners, NHSG is helping coastal communities make progress in climate

preparedness and hazard resiliency. Sea Grant’s hazard resilience work benefits from collaborations with faculty in UNH’s Institute for the Study of Earth, Oceans and Space, leaders in climate research. NHSG’s approach includes community engagement over a period of time, which has resulted in successes in the past and plays a critical role in promoting resilience.

NHSG’s approach also highlights multiple benefits of more innovative and science-based resource management techniques. Techniques for reducing risks associated with severe weather and coastal hazards are also often techniques that provide stormwater management benefits. In addition, some techniques that result in better environmental outcomes are more economical, especially over the long term. This approach helps build broader constituencies of support for adopting more effective practices.

N.H. Sea Grant and its partners use facilitation in conjunc-

tion with education to make sure that community processes are inclusive, that communities get what they need, and that the outcomes are community based. While projects vary in specifics, they are all related to helping communities protect the coastal resources that provide environmental, social and economic benefits. NHSG's work is grounded in providing communities with the best available data and helping community leaders apply the information to their priorities with confidence.

Overall Goal: Through supported research and extension programs, coastal communities in New Hampshire are able to resist and rebound from economic, climatic, social and environmental stressors.

Research and Extension

RCE Goal 1: Coastal communities in New Hampshire protect and enhance marine and coastal natural resources through better land use practices, thereby supporting the associated social, economic and environmental benefits and beneficiaries.



How N.H. Sea Grant will address RCE Goal 1: In collaboration with faculty, agency, community and organizational partners, NHSG will promote proven strategies for natural resource protection, including land conservation, maintaining and enhancing riparian buffers, minimizing effective impervious cover, and incorporating low impact development techniques with coastal community-based audiences. Sea Grant extension specialists will work with researchers and communications specialists to produce high quality, factual, compelling products and processes to inspire interest and disseminate related information.

RCE Research – Goal 1:

- Identify and evaluate impacts of land cover, different land care practices, site design standards, and conventional and low impact development options on 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 and incentives to adoption of effective natural resource protection strategies.

RCE Extension – Goal 1:

Learning Outcomes:

1.1 Community leaders (municipal employees, volunteer board members) and conservation organizations will be familiar with, value and have the ability to access and use relevant data, technical tools and technical assistance related to land use decision making and land development practices.

1.2 Design professionals working in communities will be familiar with, value and have the ability to access and use relevant data, technical tools and technical assistance related to land development practices.

1.3 Community leaders will have the ability to engage appropriate technical experts, facilitators and communities of interest in coastal resource decision making.

1.4 Community leaders will know about impacts of different land uses and development techniques on coastal resources and consider them in developing plans, policies, regulations and practices in ways that protect environmental, economic and social benefits of coastal resources.

Action Outcomes:

1.5 Community leaders and conservation organizations will seek and apply relevant data, technical tools and technical assistance to improve land use decision making and land development practices.

1.6 Design professionals working in communities will incorporate better land development practices into designs.

1.7 Community leaders will engage appropriate technical experts, facilitators and communities of interest in coastal resource decision making.

1.8 Community leaders will promote, request or require land use patterns and development techniques that protect environmental, economic and social benefits of coastal resources through planning documents, policies, regulations and practices.



Consequence Outcome:

1.9 Coastal communities in New Hampshire have high quality marine and coastal natural resources that provide social, economic and environmental benefits.

Performance Measure:

- Number of communities per year that initiate or expand an effort to apply better land use

and land care principles through special projects or changes to community plans, policies and practices with assistance from NHSG and program partners.

RCE Goal 2: Coastal communities in N.H. are better prepared for current and projected climate conditions and are able to reduce risks to life, health, property and infrastructure from severe weather, sea level rise, flooding and other climate effects.

How N.H. Sea Grant will address RCE Goal 2: In collaboration with faculty, agency, community and organizational partners, NHSG will identify strategies that help communities recognize climate impacts and adapt to current and projected climate conditions. NHSG will work with partners to promote adaptive strategies, when possible, by building upon existing technical tools, community-driven policies and effective processes to reduce climate-related risks. Sea Grant extension specialists will work with researchers and communications specialists to produce high quality, factual, compelling products and processes to inspire interest and disseminate related information.



RCE Research – Goal 2:

- Assess current and projected regional climate impacts on ecosystems, coastal resource sectors, municipal infrastructure and socioeconomic factors.
- Assess risks associated with current and projected climate effects such as sea level rise, storm surges, changes in intensity, frequency and type of

precipitation, public health threats and drought.

- Explore risk perception and associated decision making in target audiences.
- Assess feasibility, appropriateness and effectiveness of implementing climate adaptation techniques, including hard and soft shoreline stabilization, redesign and planned relocation for different places, times and situations.
- Assess barriers and incentives to adoption of climate adaptation strategies.
- Develop tools, technologies and techniques to improve recognition of vulnerabilities and potential solutions for reducing risks from climate effects on municipalities, enterprises, ecosystems and individual health and property.

RCE Extension – Goal 2:

Learning Outcomes:

2.1 Community leaders (municipal, business and organizational) will increase their knowledge of climate conditions, impacts and associated vulnerabilities and assets.

2.2 Community leaders will increase their knowledge of tools and techniques that can be used to reduce climate-related risks to life, health, property and infrastructure.

2.3 Community leaders will recognize how climate-related risks affect their own communities.

2.4 Community leaders will be motivated to incorporate climate adaptation into plans, policies and practices.

2.4a Community leaders will recognize what climate adaptation would look like for their community.

2.5 Community leaders will increase their contacts with sources of technical, human and financial assistance for climate adaptation.

Action Outcomes:

2.6 Community leaders will participate in opportunities for capacity building to increase technical, financial and human resources that can be applied to climate preparedness.



2.7 Community leaders will incorporate current and projected climate trends into planning processes and documents.

2.8 Community leaders will adapt regulations and policies to account for current and projected climate trends and promote adaptation through protection, accommodation and retreat as befitting community priorities.

Consequence Outcome:

2.9 Coastal communities in N.H. will reduce risks to health, life, property and infrastructure from the impacts of a changing climate.

Performance Measures:

- Number of communities per year that seek information about climate conditions, climate effects, hazard resiliency, adaptation tools and strategies from N.H. Sea Grant and program partners.
- Number of communities per year that initiate or expand an effort to apply hazard resiliency principles through special projects or by modifying community plans, policies and practices with assistance from N.H. Sea Grant and program partners.



Sustainable Fisheries and Aquaculture

The total economic activity generated from New Hampshire's commercial fishing industry is currently estimated at \$106 million annually and it supports 5,000 full- and part-time jobs. According to National Marine Fisheries Service (NMFS) logs, 180 New Hampshire boats had commercial fishing permits in 2009. However, the number of boats dropped by about 50% from 2009 to 2010, while the value of New Hampshire's landings decreased by approximately 40%.

Three times as much catch-share allocation (quotas) was sold out of state than came into N.H. (U.S. EDA, 2011). This is partly because New Hampshire does not have a processing or distribution network for its locally caught fish, outside of farmers' markets, community supported fisheries and a handful of retail local fish markets. As a result, the costs of handling fish (ice, transportation, etc.) are disproportionately higher in New Hampshire than surrounding states.

To add further stress to the situation, recent federal regulations have contributed to a reduction in New Hampshire's total

catch and its fleet size. The Northeast Groundfish Fishery transition to sector management imposes a total allowable catch or annual catch limit (ACL) to manage the fishery. Each Groundfish Sector, of which there are two in N.H., is allocated a share of this ACL at the beginning of the season as an annual catch entitlement (ACE) and must manage the fishing of this ACE throughout the season on a real time, day-to-day basis.

Adjusting to the new management structure has been particularly challenging for the smaller day-boats that make up the state's fleet. According to statistics from the National Oceanic and Atmospheric Administration (NOAA), Maine and Massachusetts groundfish fisheries increased their revenue under sector management, while N.H. revenues declined by one-third during the first year of the new system. New Hampshire's drop in revenues largely reflects the disproportionate losses in income realized by smaller boats, which dominate New Hampshire's fleet, as compared to larger boats. In addition, smaller sectors (like those in N.H.) face unique challenges relative to larger sectors, especially relating to lower economies of scale and capitalization, but smaller sectors also have unique opportunities. In particular, smaller sectors have intimate relations

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with their local fish dealers and shore-side businesses, providing opportunities to work together more cohesively to account for landings, to brand and trace local landings through the supply chain, and to develop new local markets.

Lobstermen face similar challenges, with rising costs of fuel and dramatically plummeting boat prices, which fell 15% in 2009 compared with the average price between 2006 and 2009. Boat prices for lobster in 2012 have fallen to their lowest prices in recent memory.

Unlike wild fisheries, seafood aquaculture has been identified as a U.S. economic sector with great potential for growth. Currently, global populations have risen to above seven billion and as a result, new protein sources will need to be developed. The United Nations Food and Agriculture Organization predicts a 40mmt shortfall in seafood availability by 2030. It is widely believed that ocean aquaculture has the best potential to meet future protein demands. As the rest of the world expands marine aquaculture production, the U.S. continues to purchase seafood from other countries at a rate of \$10 billion per year. Although the U.S. is the third largest consumer of seafood in the world behind China and Japan, we have no legislation in place for farming the open ocean. At present, the U.S. imports 85%

of its seafood, half of which is aquaculture products. Seafood produced overseas does not always adhere to strict oversight on farm practices or environmental standards. As U.S. consumers demand safe and sustainable seafood, the U.S. needs to develop responsibly managed, environmentally safe and sustainable aquaculture.

Given the challenges facing N.H. fishermen and lobstermen, finfish and shellfish aquaculture offers a business alternative for the small vessel owner to either transition from wild harvest fisheries to farming or to subsidize loss of income resulting from limitations placed on individual landings. Recently, the state permitting process was streamlined through N.H. Fish and Game to encourage shellfish production in state waters. Since these changes, oyster production has tripled in the Great Bay Estuary. Over six million oysters are in bottom culture with a crop value worth approximately \$3.4 million. To support ecologically sustainable production, N.H. Sea Grant continues to pursue the development and demonstration of multi-trophic aquaculture systems that combine macro-algae, shellfish and finfish culture. Permitting has since been initiated at six sites for the N.H. Commercial Fishermen's Association to focus on integrating the production of steelhead trout and mussels on a single float platform where the mussels can bio-filter nutrients from the fish waste.

One of the greatest questions challenging effective fisheries management today is how best to inform and design management with available science and management tools. For ex-

ample, scientific uncertainty and the inflexibility of standard management mechanisms to accommodate emerging understanding of stock complexity, the importance of spatial scale, climate change, and dynamic and complex ecosystem relationships challenges scientists, law-makers and fishermen to find reliable means to reach goals of sustainable marine fisheries. N.H. Sea Grant sees its role as a convener and facilitator supporting environmental research and bringing researchers, managers and fishery stakeholders to the table to discuss critical issues, develop research priorities and design policy.

Overall Goal: To support responsible stewardship of marine resources through a healthy domestic seafood industry that harvests, produces, processes and markets seafood responsibly to meet public demand.

Research and Extension

SFA Goal 1: New Hampshire fishermen harvest wild seafood in ways that minimize environmental impacts and support long-term marine ecosystem health.

How N.H. Sea Grant will address SFA Goal 1: N.H. Sea Grant will support and participate in research and outreach activities that develop fishing gear and practices that improve selectivity of fishing operations, thus allowing fishermen to target abundant species while avoiding populations and size-classes that

are protected from harvesting pressure. In addition, N.H. Sea Grant will support research and outreach that seeks to develop and/or evaluate techniques and strategies that increase operational and fuel efficiency of commercial operations, lower the carbon footprint and support ecosystem functions. N.H. Sea Grant will also support and participate in research activities that understand the ecosystem impact of marine debris such as derelict fishing gear and will support and participate in outreach activities designed to minimize these impacts through clean-up of marine debris.

SFA Research – Goal 1:

- Design and investigate the effectiveness and feasibility of gear and fishing practice modifications that are designed to improve selectivity and/or reduce non-target landings.
- Investigate the ecological impacts of marine debris.
- Investigate the distribution and sources of fisheries related marine debris that impact the marine ecosystem by linking results to healthy coastal ecosystem program goals.



SFA Extension – Goal 1: Learning Outcomes:

- 1.1** Improved understanding among scientists, fishermen and managers of the effectiveness of gear and fishing practice modifications that are designed to reduce the negative impact of fishing operations on marine species and habitat.
- 1.2** Fishermen have a greater awareness of appropriate and available gear and fishing practices that improve selectivity and reduce habitat impacts through their fishing operations.
- 1.3** Fishermen (recreational and commercial) and the interested public understand the effects/impacts/problem of marine debris and integrating technology (side-scan sonar, GPS, GIS) for underwater surveys of marine debris and data collection and interpretation.

Action Outcomes:

- 1.4** Fishermen adopt modifications of gear and fishing practices that improve selectivity and reduce habitat impacts of fishing operations.

1.5 Fishermen and the interested public participate in mapping and collecting marine debris during directed and undirected debris-removal activities.

Consequence Outcomes:

1.6 Seafood production has a reduced impact on habitat and non-target populations.

1.7 There is less marine debris on N.H. shorelines and coastal waters.

Performance Measures:

- Number of regional fishermen per year employing gear or fishing practices that improve selectivity and/or reduce habitat impacts from their fishing operations.
- Number of regional fishermen per year that begin to participate in removing and disposing of marine debris at available bins.
 - ◆ Number of volunteers per year participating in beach cleanups.
 - ◆ Number of miles of shoreline cleaned per year.
 - ◆ Number of tons of marine debris removed each year on land and under water.

SFA Goal 2: New Hampshire fishermen and entrepreneurs develop aquaculture practices that are both economically viable and environmentally sound.

How N.H. Sea Grant will address SFA Goal 2: N.H. Sea Grant will support research and outreach activities that develop emerging and innovative shellfish and finfish aquaculture that is demonstrably environmentally sound. Activities will also be supported that improve the transparency, efficiency, coordination and effectiveness of permitting and regulatory requirements for establishing and maintaining aquaculture activities.

SFA Research – Goal 2:

- Investigate the environmental impacts and benefits (e.g., contaminant impacts, disease incidence, nitrogen balance and ecosystem effects) of innovative and emerging aquaculture operations.
- Investigate best management practices and explore technical development of appropriate aquaculture methods and techniques for N.H.
- Explore market potential for development of N.H.-based aquaculture programs.

SFA Extension – Goal 2:

Learning Outcomes:

2.1 New and existing fishermen understand the permitting and technical requirements for engaging in successful aquaculture practices in N.H.

2.2 Permitting agencies develop a process for dealing with permitting requests to initiate aquaculture activities in N.H.

2.3 Local businesses understand how to process and market locally produced aquaculture products.

2.4 Scientists, fishermen and policy makers understand new and existing methods for engaging in environmentally sound and economically viable aquaculture, some of which is appropriate as an enterprise in conjunction with wild fisheries activities.

2.5 Fishermen have the skills and knowledge to engage in relevant aquaculture activities.

Action Outcomes:

2.6 N.H. fishermen diversify their activities to include aquaculture and wild fisheries while maintaining their fishing heritage.

2.6a A streamlined permitting process develops from cooperation among fishermen, permitting agencies and other necessary or interested groups.

2.6b Local businesses develop markets for seafood produced via N.H. aquaculture.

2.7 New participants begin economically and environmentally successful aquaculture practices in N.H.

2.8 Riparian land owners support sustainable and appropriate aquaculture practices.

Consequence Outcomes:

2.9 N.H. aquaculture production increases.

2.9a N.H. fishermen diversify into aquaculture while maintaining their fishing heritage, and their businesses are stronger and more resilient to changing markets and ecosystems.

2.9b N.H. entrepreneurs engage in environmentally responsible and economically viable aquaculture enterprise.

Performance Measures:

- Number of newly established aquaculture operations in New Hampshire.
- Number of new fishermen per year successfully engaging in aquaculture as part of their business.
- Number of new aquaculture techniques per year available to fishermen that are both economically viable and environmentally sound.

SFA Goal 3: New Hampshire fishermen and related businesses develop operational efficiencies (reporting, information systems, fishing practices, business management) that enable fishermen to improve access to fish and that enable strong profitable business management practices.

How N.H. Sea Grant will address SFA Goal 3: N.H. Sea Grant will support the development and industry uptake of technologies that improve operational efficiencies, increasing the profitability of seafood harvesting by reducing input costs

such as fuel, labor required for reporting compliance and business management, and improving the capacity of fishermen and sector managers to efficiently manage N.H. fishing operations to maximize profits.



SFA Research – Goal 3:

- Research of technologies designed to improve fuel and operational efficiency of N.H. fishing operations.
- Facilitate the development of innovative, efficient, traceable reporting, business management, sector management and marketing software for fishermen, sector managers and related fishing businesses.

SFA Extension – Goal 3:

Learning Outcomes:

3.1 Improved understanding by scientists, fishermen and policy makers of the cost-benefit of available technological modifications of fishing operations to improve fuel and opera-

tional efficiency of fishing operations.

3.2 Improved awareness of available innovative reporting, business management and marketing software by fishermen, sector managers, and members of related and supporting businesses.

3.3 Improved awareness of available technology and fishing practice modifications to improve fuel and operational efficiency of fishing practices.

Action Outcomes:

3.4 Fishermen and related fishing businesses utilize new information systems that streamline reporting, business management and sector management, and support innovative marketing opportunities for the

fishing industry.

3.5 Fishermen reduce operational costs and improve value added by selecting more efficient technology, gear or fishing practices.

Consequence Outcomes:

3.6 Fishermen and related fishing businesses operate more streamlined and efficient reporting, sector management and business management information systems that require less labor and create opportunities to direct business activities toward innovative business practices.

3.7 Fishermen save money by realizing reduced costs from modifying their vessels, gear or fishing practices.

Performance Measures:

- Number of fishermen or related business managers per year who adopt new business management, reporting or information systems.
- Labor costs saved by N.H. fishermen and related businesses from adopting new information systems.
- Number of fishermen per year who adopt gear, vessel or fishing practice modifications to improve their operational efficiency.
- Money saved by fishermen from adopting gear, vessel or fishing practice modifications to improve their operational efficiency.



SFA Goal 4: The New Hampshire fishing community develops market outlets that return a value to fishing boats and related businesses sufficient to support strong, resilient fishing businesses and communities.

How N.H. Sea Grant will address SFA Goal 4: N.H. Sea Grant will support and participate in research activities that identify challenges and opportunities through state-of-the-art seafood industry management, fisheries science, harvesting and market analysis. Special attention will be given to market analysis, feasibility studies and case studies that assess opportunities for accessing new or innovative markets by the N.H. fishing community. N.H. Sea Grant will support and participate in outreach activities that provide information to fishermen and related

businesses about innovative and emerging alternative marketing practices, such as local branding and traceability initiatives. N.H. Sea Grant will also support and participate in efforts to educate consumers about the health implications of eating

seafood as well as the fisheries science, management and fishing practices that characterize the N.H. commercial fishery, and the community benefits of purchasing locally harvested and processed seafood.

SFA Research – Goal 4:

- Conduct analysis of fisheries economic data indicators as part of a state-of-the-industry assessment that can identify challenges and opportunities for the N.H. seafood industry.
- Conduct marketing studies, case studies and feasibility studies that assess opportunities for accessing new or innovative markets by N.H. fishermen and N.H.-based fishing businesses.

SFA Extension – Goal 4:

Learning Outcomes:

4.1 Scientists, policy makers, fishermen and others in fisheries-based industries understand the vulnerabilities and opportunities that current situations present to their businesses.

4.2 Consumers have better information on the management, fishing practices and cultural heritage linked to their seafood supply.

4.3 Consumers know where and how to access N.H.-sourced seafood.

4.4 Consumers understand the health benefits and costs and the community benefits of eating locally sourced seafood.

4.5 Fishermen and seafood businesses know about innovative approaches to marketing seafood to bring higher prices to fishermen and other businesses in the N.H. fishing community.

Action Outcomes:

4.6 Consumers seek out and purchase more locally caught seafood in ways that direct a fair wage to fishermen's businesses and other related businesses in the N.H. fishing community.

4.7 Fishermen and related businesspeople develop new relationships and make changes in their businesses to develop new markets that direct a fair wage to fishermen's businesses and other related businesses in the N.H. fishing community.

Consequence Outcome:

4.8 N.H. fishermen and related businesses access new markets that direct a fair wage to fishermen's businesses and other related businesses in the N.H. fishing community.

Performance Measures:

- Number of new market opportunities developed per year that direct more money to N.H. fishermen and related fishing businesses.
- Number of restaurant and local business partners per year that actively market N.H. branded seafood.
 - ◆ Value received for seafood landed, processed and marketed in N.H.
 - ◆ Number of fishermen per year reporting increased profits because of access to alternative markets for their seafood.
- Number of seafood consumers per year that begin to participate in community supported fisheries, farm-to-market venues, and other seafood opportunities that are traceable back to the "boat."

SFA Goal 5: Integrated fisheries policy, science and management that allows sustainable management of marine fisheries and supports a healthy and resilient fishing community.

How N.H. Sea Grant will address SFA Goal 5: N.H. Sea Grant will support the development of innovative approaches to science and management that accommodate emerging and histori-

cal knowledge of stock complexity, the importance of spatial scale, and the implications of dynamic and complex ecosystem relationships. N.H. Sea Grant will support and facilitate discussion and workshops among scientists, managers, lawmakers and fishermen that aim to conduct relevant scientific work and to explore alternative management models that support sustainable marine ecosystems and fishing communities.

SFA Research – Goal 5:

- Science that improves the understanding of stock complexity, population dynamics, ecosystem impacts of fishing and climate change and the importance of spatial scale.
- Research that contributes to the understanding of social and cultural impacts of fisheries management.
- Innovative fisheries population modeling that incorporates emerging understanding of spatial scale and other ecological complexities.
- Innovative approaches to management that support sustainable marine ecosystems and meet the social and economic needs of fishing communities.

SFA Extension Goal – 5:

Learning Outcomes:

- 5.1 Scientists, policy makers and fishermen have an improved understanding of stock structure and the factors that influence fish population dynamics.
- 5.2 Scientists, policy makers and fishermen have a better un-

derstanding of management alternatives that incorporate emerging complexities in fisheries ecology.

5.3 Scientists, policy makers and fishermen have a better understanding of the social and economic implications of fisheries management practices.

Action Outcome:

5.4 Scientists, policy makers and fishermen adopt innovative approaches to management that result in more successful management of fisheries from an ecological, social and economic perspective.

Consequence Outcome:

5.5 Scientists, policy makers and fishermen successfully manage fisheries from an ecological, social and economic perspective.

Performance Measure:

- Number of meetings per year among scientists, policy makers and fishermen that result in recommendations for innovative approaches to fisheries science and management.

