MAINE/NEW HAMPSHIRE

SEA GRANT COLLEGE PROGRAM

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Edited by Steve Adams & Susan White
Designed by Maija Keleshian

Additional copies are available from:

Sea Grant Communications
5715 Coburn Hall #21
University of Maine
Orono, Maine 04469-5715
207/581-1440

Sea Grant Communications
Kingman Farm
University of New Hampshire
Durham, NH 03824
603/749-1565

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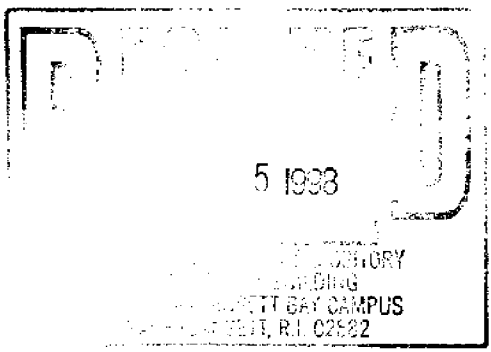

THE SEA GRANT COLLEGE PROGRAM IN MAINE AND NEW HAMPSHIRE

The University of Maine and the University of New Hampshire form a joint Sea Grant College Program that provides support, leadership, and expertise for marine research, education, and extension in northern New England. As part of the National Sea Grant College Program, the UM/UNH Sea Grant College Program is one of a network of 29 in the nation. All of the programs are dedicated to promoting the understanding, development, wise use, and conservation of ocean and coastal resources.

The UM/UNH Sea Grant College Program works with marine industries, government agencies, private organizations, and individuals to help identify and solve problems associated with the conservation and development of the region's marine resources. Through its information, education, and public service efforts, the program increases awareness of marine and coastal issues and promotes responsible use of the resources.

Contents

MANAGEMENT AND DEVELOPMENT OF LIVING MARINE RESOURCES

Commercial fishing is an important business in northern New England, playing a vital role in the region's economy as well as in its culture and history. Commercially valuable fish are at unsatisfactorily low levels, mainly as a result of overfishing, inadequate fisheries management, and habitat destruction. Principal groundfish species, such as cod, haddock, and yellowtail and winter flounder, have been suffering particularly serious stock declines, as have soft-shell clams. New approaches to fisheries management that will ensure sustainability are being sought. At the same time, the market demand for seafood has been rising. Culturing fish and shellfish can help meet the demand for a consistent supply of high quality seafood.

Bycatch and damage to habitat from fishing gear appear to be major problems for the Northeast fishing industry, as they are worldwide. One fishery receiving serious scrutiny regarding bycatch is the lobster fishery due to potential right whale interactions. And, work to assess the impacts of fishing gear on bottom habitat is under way.

Beyond the needs of the commercial fishing industry, there are several other living resource issues that must be addressed by Sea Grant. These include the increasing pressures on fish stocks from the sport fishing industry, the growing economic value of the cultivation of marine plants, and the developing potential of marine biotechnology.

The goal of the UM/UNH Sea Grant College Program in the management and development of living marine resources is to contribute to the wise use and conservation of these resources in the Gulf of Maine by focusing on a stronger scientific basis for management, an enlightened social context for management, and new production technologies for fisheries enhancement and aquaculture.

SCIENTIFIC BASIS FOR MANAGEMENT

Effects of Habitat Alteration on Fishery Recruitment Processes

Les Watling
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.3321
watling@maine.maine.edu

Richard Langton
Maine Dept. of Marine Resources
West Boothbay Harbor, Maine 04575
207.633.9500

Increasing evidence suggests that bottom trawling is having a strong effect on the bottom communities used by juvenile bottom-feeding fish. The exact nature of this impact is unknown, but it needs examination if intelligent management decisions are to be made for the Gulf of Maine's declining groundfish stocks. Using sites that are not known to be trawled either for shrimp or flatfish, Watling and Langton will examine the consequences of bottom trawling in shallow Gulf of Maine waters on the recruitment of juvenile fish.

Molecular Genetic Analysis of Current and Historical Stock Structure of Northwest Atlantic Haddock

Irving Kornfield
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.2548
irvk@maine.maine.edu

The Atlantic haddock fishery has long been of economic significance to a large community in the northeast United States and Canada. Information gained from long-term genetic characterizations of exploitation may permit modification of conventional models to better manage this and other heavily exploited resources. This study will investigate the

genetic correlates of long-term population flux in Georges Bank haddock. Highly polymorphic genetic markers will be examined from individual fish of known cohorts using archived haddock scale samples from U.S. and Canadian government collections.

Impacts of Rockweed Harvesting

Robert Vadas
School of Marine Sciences and
Dept. of Plant Biology and Pathology
207.581.2978
vadas@maine.maine.edu
Wesley Wright
Dept. of Plant Biology and Pathology
Univ. of Maine, Orono, Maine 04469
207.581.3346
wwright@maine.maine.edu

Rockweed, Ascophyllum nodosum, is a commercially important species in the North Atlantic and is increasingly being harvested in the Gulf of Maine. The effects of harvesting on the growth of rockweed has been studied, but little work has been done on the effect of harvesting on settlement and recruitment into its own understory or on associated species that utilize this alga as food or habitat. Vadas and Wright will impose a range of harvesting schemes to determine if harvesting affects the ability of Ascophyllum to settle and recruit in its own understory and whether this varies with different cutting heights. They will also determine the biomass recovery rates and structural characteristics of Ascophyllum after harvesting.

• Development of Predictive Capabilities for Lobster Catch in the Northeast: A Regional, Collaborative Research Effort

Resource management theory for the American lobster operates on the assumption that if landings fail, then populations will be seven to 10 years into a stock collapse. It would take decades to recover from a collapse. If commercial lobster landings can be predicted and techniques developed that help regulate the lobster industry, a stock collapse could be averted. In this collaborative project, lobster biologists, harvesters, and managers from throughout the region will work together to develop these techniques.

• Developing Indices Necessary for Predicting Commercial Catches of the American Lobster, Homarus americanus

Robert S. Steneck
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.563.3146
steneck@maine.maine.edu

W. Huntting Howell
Dept. of Zoology
603.862.2109
whh@christa.unh.edu
Winsor Watson
Dept. of Zoology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.1629
wnw@kepler.unh.edu

Stanley Cobb
Dept. of Zoology
Univ. of Rhode Island, Narragansett, R.I. 02882
401.792.2683

Richard Wahle
Bigelow Lab for Ocean Sciences
West Boothbay Harbor, Maine 04575
207.633.9600

Michael Fogarty
National Marine Fisheries Service, Woods Hole, Mass. 02543
508.548.5123

In this multi-institutional project, the researchers will develop and test techniques to predict lobster landings at study sites in coastal waters of Long Island Sound, Rhode Island, New Hampshire, and Maine. Using recently developed PVC collectors, the team will estimate the abundance of pre-recruit lobsters and develop and test modified lobster traps that have no escape vents. They will also determine if regional differences in the number of newly settled lobsters and pre-recruits corresponds to differences in catch. After developing the indices for local lobster populations, the researchers will examine predictive models, based on catch and sea-sampling data provided to NMFS, to determine if these local population indices improve predictive capabilities on a regional scale.

Socioeconomic Context for Management

Case Studies in Co-Management of Marine Fisheries

James Acheson
School of Marine Sciences and
Dept. of Anthropology
207.581.1898
acheson@maine.maine.edu
Ralph Townsend
Dept. of Economics
207.581.1854
ralpht@maine.maine.edu
James Wilson
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.4368
jwilson@maine.maine.edu

As a result of declining catches and stock sizes in the world's fisheries, there is increasing interest in co-management in which control over resources is distributed between industry, government, and local communities. Using important co-management efforts in the Maine lobster fishery and in three fisheries in eastern Canada, the researchers will analyze and critique practical applications of co-management.

Production Technologies and Aquaculture

Microbiological Optimization of Summer Flounder Culture in a Recirculating Aquaculture System

Stephen Jones
Dept. of Natural Resources and Jackson Estuarine Lab
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2175
shj@christa,unh.edu

Bacterial diseases can cause significant mortalities among young, cultivated fish in the aquaculture industry. While control of bacterial diseases with antibiotics and vaccination has many disadvantages, probiotic organisms may prevent the establishment of pathogens and promote fish survival. Utilizing facilities at both UNH and GreatBay Aquafarms, Jones will isolate and screen microorganisms from larvae and young summer flounder. Cultures of promising microorganisms will be tested to see if they enhance young flounder growth and survival via colonization of larvae and feed organisms.

Developing a Second, High-Quality Crop for the Northeastern Green Sea Urchin Using Land-Based Aquaculture

Charles Walker
Dept. of Zoology
603.862.2111
cwwalker@christa.unh.edu
Michael Lesser
Dept. of Zoology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.3442
mpl@christa.unh.edu

In the Gulf of Maine, unregulated harvesting has resulted in a projected collapse of the green sea urchin fishery. Also, as stocks dwindle in numbers and as demand increases, urchins with lower quality roe are taken and the average dollar value

of the harvest continually decreases. To improve existing technologies for developing modular, land-based aquaculture ventures that would help alleviate this loss of quality and profit, Walker and Lesser will build and test a modular tank unit. They will use this unit to generate an out-of-season, second crop of sea urchins using artificial food and photoperiod manipulation.

Impacts of the Parasite Bonamia ostreae on the European Oyster and Strategies for Commercial Culture

Bruce Barber
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.2783
bjbarber@maine.maine.edu

There is great interest in culturing European oysters, Ostrea edulis, in Maine due to their high market demand and price. However, growers have been reluctant to invest in the production of this species because of the potential impact of the pathogen, B. ostreae, which has recently been identified in Maine waters. Barber will determine the seasonal and geographical distribution of B. ostreae in Maine and the lethality of it to Maine-grown European oysters. He will also determine the time course of disease development as it relates to oyster growth and survival. This work is designed to lead to strategies for successful commercial culture of European oysters in Maine.

Genetic Improvement of Summer Flounder Broodstock

Thomas Kocher
Dept. of Zoology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2115
tdk@christa.unh.edu

Commercial hatcheries are being established to support tank culture, cage culture, and stock enhancement programs for a number of marine species. The selection of genetically superior broodstock animals will greatly enhance the profitability and success of these operations. This pilot study will determine genetic differences among summer flounder sires and dams. The relative performance of families will be examined by communally rearing the progenies, then determining parentage using microsatellite DNA markers. Kocher will identify differences in breeding value among parents for survival, growth rate, and pigmentation. This project will establish a paradigm for the genetic domestication of a number of marine finfish species.

Multiplex Polymerase Chain Reaction (PCR) Assay for Simultaneous Rapid Detection of Three Different Fish Viruses

Bruce Nicholson
Dept. of Biochemistry, Microbiology, and Molecular Biology and School of Marine Sciences
207.581.2810
brucen@maine.maine.edu
John Singer
Dept. of Biochemistry, Microbiology, and Molecular Biology and School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.2808
jsinger@maine.maine.edu

Effective control of infectious diseases is one of the most critical elements in successful aquaculture. There is a need for new and more efficient methods of testing for such viral fish pathogens as IPNV, IHNV, and VHSV. Extensive information has now accumulated about the genomic sequences of these viruses. Sophisticated computer programs are available for the selection of primers and target sequences for PCR amplification under a given set of reaction conditions. This study will modify a currently available PCR assay developed for the detection and identification of IPNV and other aquatic birnaviruses to simultaneously detect IHNV and VHSV.

· Development of Commercially Viable Groundfish Aquaculture Industries in the Northeast: A Regional, Collaborative Research Effort

The commercial groundfish industry in the Gulf of Maine is in decline. However, the technology and scientific knowledge to develop a sound finfish aquaculture industry in the region is available. This set of projects is designed to lead the way in the development of such an industry and to ease the transition from one form of fishing to another for all involved in and with the fishing community. This effort draws upon the expertise of scientists and educators from academic institutions throughout the region.

· Development of Commercially Viable Cod and Haddock Aquaculture Industries in the Northeast

W. Huntting Howell
Dept. of Zoology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2109
whh@christa.unh.edu

Linda Kling
Dept. of Animal, Veterinary, and Aquatic Sciences
and School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.2735

Terence Bradley
Dept. of Fish, Animal, and Veterinary Sciences
Univ. of Rhode Island, Kingston, R.I. 02881

Lawrence Buckley
Graduate School of Oceanography
Univ. of Rhode Island, Narragansett, R.I. 02882

Cod and haddock are prime candidates for aquaculture in the Gulf of Maine. The researchers will be addressing several aspects of raising these species commercially in New England. These include the development of techniques for collecting, holding, and manipulating broodstock, the evaluation of the Norwegian system for rearing larvae to see if it will work in the gulf, and the development and testing of feeds for all of the early life stages of the two species.

· Developing a Commercially Viable Seaweed Aquaculture Industry in New England: A Regional, Collaborative Research Effort

Whether or not seaweed aquaculture will ultimately succeed in the Northeast will depend on successful transfer and modification of Japanese nori cultivation technology to Maine coastal environments, development of genetically improved species of maketable nori that will extend the growing and harvest season in New England, and expansion of the area presently used for cultivation beyond Cobscook Bay in Washington County. This set of multi-institutional projects will provide research and development support for the growth of a sustainable nori aquaculture industry in the Northeast.

· Field and Culture Evaluations

Charles Yarish
Dept. of Ecology and Evolutionary Biology
Univ. of Connecticut, Stamford, Conn. 06903
203.322.3466

Arthur Mathieson
Dept. of Plant Biology
and Jackson Estuarine Lab
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2175

Ira Levine
Coastal Plantations International, Poland, Maine 04273
207.998.4909

The researchers will evaluate a variety of field and culture Porphyra species (nori) from Long Island Sound to the Canadian Maritimes in order to clarify their taxonomic status,

ecological requirements, and potential for enhanced mariculture. The different species of nori will be enumerated using a variety of morphometric, cytological, and genetic parameters, while detailed seasonal and spatial collections from diverse coastal and estuarine habitats will also help to delineate their seasonality and habitat preferences. Grow-out of the most promising plants will also be made at Coastal Plantation's facility in Eastport, Maine, utilizing "clean" seedstock produced in culture.

· Physiological Responses of Porphyra (nori) to Nutrient Limitation

Ian Davison
Dept. of Plant Biology and Pathology
and School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.2983
davison@maine.maine.edu

There is currently no simple, unambiguous method for assessing the nutrient status of Porphyra and other seaweeds growing in nature or in aquaculture facilities. This study will investigate the physiological response of P. yezoensis and native species of Porphyra to nitrogen and phosphorous limitation. This information can be used to develop diagnostic markers of nutrient limitation, which can be used in aquaculture and will also enhance our knowledge of seaweed physiology and ecology.

· Population Genetics

Christopher Neefus
Office of Biometrics
603.862.1990
chris.neefus@unh.edu
Arthur Mathieson
Dept. of Plant Biology
and Jackson Estuarine Lab
603.862.2175

Robert Eckert
Dept. of Natural Resources
603.862.1020
Anita Klein
Dept. of Biochemistry and Molecular Biology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2455
klein@colsa.unh.edu

Charles Yarish
Dept. of Ecology and Evolutionary Biology
Univ. of Connecticut, Stamford, Conn. 06903
203.322.3466

Using a combination of isozyme electrophoresis and DNA techniques to evaluate genetic composition, the researchers will investigate the genetic structure in native populations of Porphyra species from Nova Scotia to Long Island Sound. A detailed knowledge of population genetic structure and/or gene flow will significantly aid in the development and management of nori aquaculture in the Northeast. The results of the project will guide candidate selection and provide DNA markers for genetic manipulations of commercially important seaweeds.

· Strain Improvement by Protoplast Fusion-Somatic Hybridization

Donald Cheney
Marine Science Center
Northeastern Univ., East Point, Nahant, Mass. 01908
617.581.7370
dcheney@lynx.neu.edu

Ira Levine
Coastal Plantations International, Poland, Maine 04273
207.998.4909

The commercial success of nori farming in the Northeast depends on developing successful farming techniques and strains for local environmental conditions. This project will

provide the cornerstone for a strain improvement program by producing new, genetically improved cultivars of Porphyra adapted for local conditions using protoplast fusion-somatic hybridization technology. Putative somatic hybrids will be analyzed and screened for desirable traits using techniques developed in collaboration with Coastal Plantations International both in the laboratory and in the field.

• Strain Improvement by Genetic Engineering and Gene Cloning

Subhash Minocha
Dept. of Plant Biology
603.862.3840
sminocha@christa.unh.edu
Arthur Mathieson
Dept. of Plant Biology
and Jackson Estuarine Lab
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2175

Recently developed molecular techniques for genetic manipulation through recombinant DNA and genetic engineering provide new opportunities for improving commercially useful seaweeds by using specific genes from unrelated organisms. The researchers will identify genes that are differentially expressed in the haploid and the diploid phases of the life cycle of Porphyra spp. This information combined with the optimization of protocols for genetic engineering will contribute towards enhancing genetic engineering technology for cultivation of improved stocks of Porphyra.

• Technology Transfer and Aquaculture Extension

Ronald Beard
Sea Grant Extension Program
Univ. of Maine, Orono, Maine 04469
207.581.1422
rbeard@umce.umext.maine.edu

Ira Levine
Coastal Plantations International, Poland, Maine 04273
207.998.4909

The successful transfer and adaptation of nori cultivation technologies would increase the nori production and processing capacity in the Northeast. With the assistance of Japanese, Chinese, and Korean nori farmers and an exchange program of scientific researchers between the U.S. and Asia, the project team will transfer and adapt traditional and innovative Asiatic nori farming practices to the coast of Maine. Development of nori training courses and the training of Sea Grant extension staff in Maine will provide opportunities for the next generation of nori farmers in the Northeast.

• Field Collection for Joint Porphyra Cultivation Project

Arthur Mathieson
Dept. of Plant Biology and Jackson Estuarine Lab
Univ. of New Hampshire, Durham, N.H. 03824
603.862.2175

Mathieson will observe and collect Northwest Atlantic Porphyra taxa (i.e., nori) from Cape Cod to the Bay of Fundy in order to clarify their species composition and taxonomic status. The different species will be enumerated using a variety of morphometric (i.e., length, width, color, anatomy) and ecological traits. Mathieson will provide field collections of each taxon to colleagues conducting life history and population genetic evaluations. Such complementary investigations should help to clarify species relationships. The proposed taxonomic analysis of Porphyra taxa is fundamental to future genetic improvement and aquaculture of this important economic seaweed within the Gulf of Maine.

Coastal northern New England is an attractive area for both commercial and recreational pursuits. Recent growth rates in the coastal counties of both New Hampshire and Maine have been well above both states averages. This growth often threatens the values and qualities that stimulated it by changing the character of small coastal towns, destroying wildlife habitat and farmland, and straining facilities suchas sewer systems and waste disposal sites. Natural processes, such as rising sea level, also threaten the coastal zone.

To address these issues, the UM/UNH Sea Grant College Program focuses its efforts in four overlapping, programmatic areas: coastal engineering, ecosystem processes, water quality, and multiple/alternative uses. The broad goal of all these efforts is to discover the soundest methods and mechanisms with which to ensure thewise use, conservation, and development of our coastal region.

Coastal Engineering

Field Validation of a Harbor Wave Prediction Model

Vijay Panchang
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.4363
vijay_panchang@maine.maine.edu

Wave prediction is a vital ingredient in harbor design and boat operations. Spatial variations in wave heights and directions for various input conditions must be estimated for existing and modified harbor layouts, such as breakwater alignment and sediment movement. Energy amplication in standing waves and the associated horizontal and vertical motions can cause damage to small boats and lead to downtime in ship loading and unloading operations. Panchang will use CGWAVE, one of the most comprehensive harbor wave prediction models available, to perform rigorous comparisons of the wave models against field data for three harbors in Hawaii and California to identify weaknesses and strengths of the model. This research will help develop more accurate wave prediction models to be used in harbor design for coastal communities.

Ecosystem Processes

A Prototype Storm Response Monitoring and Forecast System for the Western Gulf of Maine

Wendell Brown
Institute for the Study of Earth, Oceans, and Space
603.862.3153
wsbrown@kelvin.unh.edu
Frank Bub
Institute for the Study of Earth, Oceans, and Space
Univ. of New Hampshire, Durham, N.H. 03824
603.862.3154
frankb@kelvin.unh.edu

This research addresses the issue of the importance of ocean waves and hydrodynamic nonlinearities for the accurate prediction of the response of the western Gulf of Maine to storms. The researchers will couple a surface wave model and a bottom boundary layer model to the three-dimensional, nonlinear Dartmouth numerical circulation model and evaluate the accuracy of the combined model hindcasts (past scenarios) in terms of archived data sets. The resulting model system will be the core element of a prototype ocean sea level monitoring and forecast system, which will be forced by an appropriate suite of real-time operational government meteorological, sea level, surface wave, and river discharge data and their products.

Physical Processes Between the Kennebec Estuary, Casco Bay, and the Inner Shelf: Potential Implications for Contaminant Transport and Red Tide

Neal Pettigrew
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.4384
nealp@maine.maine.edu

Maureen Keller
Bigelow Lab for Ocean Sciences
W. Boothbay Harbor, Maine 04575
207.633.9600
mkeller@bigelow.org

Red tide blooms of the dinoflagellate Alexandrium tamarense are responsible for paralytic shellfish poisoning (PSP), which threatens human health and the fisheries in the Gulf of Maine. Casco Bay in Maine has been identified as the source region for red tides in the western Gulf. The Kennebec plume controls the surface hydrography of Casco Bay and contributes to the coastal current responsible for transporting the red tide down the coast to Massachusetts Bay and Georges Bank. This project will investigate what mechanism generates the bloom in Casco Bay, and how the seed population in the Bay is sustained after bloom organisms are carried away by the coastal current. Researchers will also study the current hydrographic structure of the Kennebec River Estuary and its plume on the adjacent shelf in order to determine whether this region is the source of red tide blooms in Casco Bay.

Real-time Simulations of the Circulation in Penobscot Bay: A Study of the Predictability of a Coastal Embayment

Huijie Xue
School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.4318
bjx@athena.umeoce.maine.edu

Penobscot Bay, the largest bay in Maine, is under increasing pressure from coastal development, loss of valuable marine habitat, and depleted fish stocks. There are also concerns about toxic pollutants coming from water-dependent industries. Understanding the circulation in Penobscot Bay is fundamental since it constitutes the framework within which the entire ecological system operates. Xue will develop a comprehensive model that will simulate the circulation dynamics and physical environment of the Bay and examine the predictive capability of the model. A circulation model such as this, which would be able to predict with reasonable certainty and lead times, could be an important tool in policy making and management.

Marine Biotechnology

Molecular Basis of Virulence of Infectious Pancreatic Necrosis Virus (IPNV)

Bruce Nicholson
Dept. of Biochemistry, Microbiology, and Molecular Biology, and School of Marine Sciences
207.581.2810
brucen@maine.maine.edu
John Singer
Dept. of Biochemistry, Microbiology, and Molecular Biology, and School of Marine Sciences
Univ. of Maine, Orono, Maine 04469
207.581.2808
jsinger@maine.maine.edu

Paul Reno
Marine Science Center
Oregon State Univ.
Newport, Oregon 97365-5296
503.867.0100

Many aquatic birnaviruses, such as IPNV, have been proven or implicated to cause diseases in a variety of species used in fish farming. Currently, the only effective approach to controlling diseases caused by these viruses is to prevent exposure to the virus. Lack of information on the molecular mechanisms that determine virulence or pathogenicity of any viral pathogens has hindered the development of vaccines and other fish health management strategies. Researchers will make a detailed investigation to determine the specific genomic sequence variations of IPNV that determine high levels of virulence. The ability to identify high-virulence strains of IPNV would be very useful both to regulatory agencies and to the aquaculture industry by facilitating the development of vaccines and other disease control measures.

Nonindigenous Species

Effects of Nori Aquaculture on the Marine Flora of Cobscook Bay and Selected Sites within the Gulf of Maine

Anita Klein
Dept. of Biochemistry and Molecular Biology
603.862.2455
klein@colsa.unh.edu
Arthur Mathieson
Dept. of Plant Biology and Jackson Estuarine Lab
603.862.2175
Christopher Neefus
Office of Biometrics
Univ. of New Hampshire, Durham, N.H. 03824
603.862.1990
chris.neefus@unh.edu

Donald Cheney
Marine Science Center
Northeastern Univ., East Point, Nahant, Mass. 01908
617.581.7370

Invasions by nonindigenous species are complex events. Due to the diversity of vectors, taxonomy, life history, and habitats among the invading species as well as the possible environmental, social, and economic impacts involved, the results of these invasions can range from negligible to catastrophic. To assess the impact of the fledgling nori aquaculture industry on the marine flora of Cobscook Bay and selected sites within the Gulf of Maine, the researchers will examine the dispersal and persistence of Porphyra yezoensis at sites adjacent to current and new cultivation sites, develop genetic profiles, and establish baseline information regarding the distribution and abundance of indigenous Porphyra species.

Potential Impacts of a Nonindigenous Crab on Selected West Coast Commercial Invertebrates

Edwin Grosholz
Dept. of Zoology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.4803
tedg@kepler.unh.edu

The recent introduction of Carcinus to the West Coast portends substantive ecological impact in estuarine and marine systems. Working with colleagues at the University of Washington, Grosholz will study Carcinus response to two categories of invertebrate prey, the mobile Dungeness crab (Cancer magister) and sessile bivalves, in order to gauge the potential ability of this exotic crab to significantly perturb populations of these valued commercial species by direct predation and displacement from habitat. The resultant predator-prey dynamics will be quantified as a function of density, tidal elevation, and species mix.

NOAA Partnership

Quantifying the Range Expansion and Impacts of the European Green Crab

Edwin Grosholz
Dept. of Zoology
Univ. of New Hampshire, Durham, N.H. 03824
603.862.4803
tedg@kepler.unh.edu

In order to determine the abundance of green crabs at several West Coast sites where they are currently established (South Slough/Coos Bay, Elkhorn Slough/Monterey Bay, and Bodega Harbor), Grosholz will use sampling and monitoring methods to quantify their population distribution. He will also monitor the ongoing range expansion of the green crab along the West Coast and estimate the abundances of targeted invertebrate populations known to be reduced by green crab predation.

National Outreach

Sea Grant's Marine Science Careers WWW Site

Steve Adams
Maine/NH Sea Grant Program
Univ. of New Hampshire, Durham, N.H. 03824
603.749.1565
steve.adams@unh.edu

Tracey Crago
WHOI Sea Grant Program
Woods Hole, Mass. 02543
508.289.2665
tcrago@cliff.whoi.edu

The marine sciences are an attractive career choice for today's high school students. Unfortunately, very few high school students have a clear picture of the many career opportunities these fields offer. To address this problem, Adams and Crago will produce a Marine Science Careers WWW site based on their recent publication, **Marine Science Careers: A Sea Grant Guide to Ocean Opportunities**. The site will give students worldwide a place to explore career opporunities in the marine sciences and to develop realistic pictures of the working lives of marine scientists.

Dean John A. Knauss Marine Policy Fellowships

The Knauss Marine Policy Fellowship was established in 1979 to provide an educational experience for students in graduate or professional degree programs who have an interest in aquatic resources. The program is sponsored by the National Oceanic and Atmospheric Administration and the National Sea Grant College Program.

Selection is made competitively from the applications submitted by the nation's Sea Grant directors. Students in the program are matched with hosts in the legislative branch, the executive branch, or appropriate associations/institutions located in the Washington, D.C., area for a one-year fellowship.

The current Knauss Marine Policy Fellowship recipient selected from applications submitted by the UM/UNH Sea Grant College Program is:

• **Doug Hodum**, M.S. candidate, Department of Ecology and Environmental Sciences, University of Maine.

NOAA Coastal Zone Management Fellowships

• **Alison Ward,** a 1997 University of Alaska master's degree recipient, has been awarded a two-year fellowship from the U.S. National Oceanic and Atmospheric Administration to work on coastal zone management in Maine.

Working with John Sowles at the Maine Department of Environmental Protection, Ward will focus on the criteria used to regulate development in the coastal zone. Her goal is to design and implement a standardized assessment methodology that will improve habitat protection. Ward is also receiving support from Maine's Department of Marine Resources and State Planning Office.

Opportunities for Undergraduate Research and Development in Marine Science and Engineering

Larry Harris
Dept. of Zoology
603.862.3897
lharris@christa.unh.edu
M. Robinson Swift
Dept. of Mechanical Engineering
Univ. of New Hampshire, Durham, N.H. 03824
603.862.1837
mrswift@christa.unh.edu

The Undergraduate Ocean Research Program provides students with a year-long, hands-on introduction to the solution of marine problems. The students work in interdisciplinary teams with a faculty advisor. During the year, team members must deal with the corporate, business, and research communities to obtain advice, direction, information, and the equipment and materials required to complete their projects. The teams produce real solutions to real problems. Often, their work leads to the discovery of new knowledge and the development of new technology.

Ann Bucklin
Sea Grant Director
142 Morse Hall
603.862.0122
acb@kepler.unh.edu
Brian Doyle
Associate Director
Kingman Farm
Sea Grant College Program
Univ. of New Hampshire, Durham, N.H. 03824
603.749.1565
brian.doyle@unh.edu

Ian Davison
Interim Sea Grant Director
5715 Coburn Hall #14
Univ. of Maine, Orono, Maine 04469-5715
207.581.1433
davison@maine.maine.edu

The primary function of the leaders of the UM/UNH Sea Grant College Program is to focus the program's efforts and energies on the major issues and concerns in the region's marine and coastal sectors. An integrated approach has been established by developing an understanding of key marine issues and maintaining links with the research community, government agencies, industry, and other organizations. This work is carried out in a manner consistent with the mandate of the National Sea Grant College Program.

EXTENSION

Brian Doyle
Sea Grant Extension Program Leader
Univ. of New Hampshire, Durham, N.H. 03824
603.749.1565
brian.doyle@unh.edu

Ronald Beard
Interim Program Leader
Sea Grant Extension Program
5715 Coburn Hall
Univ. of Maine, Orono, Maine 04469-5715
207.581.1422
rbeard@umce.umext.maine.edu

The Sea Grant Extension Program serves as the link between the marine community and the university to help citizens and user groups solve problems related to marine resources. Through informal education programs and day-to-day contact, extension staff are able to assist individuals and groups in making informed decisions about the use, development, and conservation of these resources. The Extension Program's efforts are focused in three major areas: commercial fisheries and aquaculture, coastal resource development, and marine science education.

COMMUNICATIONS AND INFORMATION

Steve Adams
Sea Grant Communications Coordinator
Kingman Farm
Univ. of New Hampshire, Durham, N.H. 03824
603.749.1565
steve.adams@unh.edu

Susan White
Sea Grant Communications Coordinator
5715 Coburn Hall #21
Univ. of Maine, Orono, Maine 04469-5715
207.581.1442
susan.white@umit.maine.edu

The communications and information program is designed to increase public awareness of marine and coastal issues and to inform appropriate audiences of Sea Grant research results so that people can make informed decisions about the conservation, use, and development of coastal and marine resources. The communications program provides an effective and responsive system for serving the information needs of the marine community and the general public. Researchers, extension personnel, and administrators are supported by the communications staff through the production of reports, brochures, educational materials, audio-visual presentations, exhibits, newsletters, news and feature stories, print and electronic public information materials, and WWW sites that provide information regarding the program's activities and accomplishments.

DIRECTORY of the University of Maine

Ian Davison Interim Director	207.581.1433 davison@maine.maine.edu
Ronald Beard Interim Program Leader	207.581.1422 rbeard@umce.umext.maine.edu
Susan White Communications Coordinator	207.581.1442 susan.white@umit.maine.edu
Melissa Waterman Science Publications Specialist	207.581.1441 melissa.waterman@umit.maine.edu
Chris Bartlett Fisheries & Finfish Aquaculture Specialist	207.853.2518 chris.bartlett@umit.maine.edu
Robert Bayer Executive Director of the Lobster Institute	207.581.1443 rbayer@maine.maine.edu
MaJo Keleshian Graphic Artist	207.581.1446 majo@umit.maine.edu
Jean Day Administrative Associate	207.581.1448 jean.day@umit.maine.edu
Linda O'Clair Administrative Associate	207.581.1438 linda.oclair@umit.maine.edu
Lynn Wardwell Secretary	207.581.1440 lynn.wardwell@umit.maine.edu
Gilda Stratton Secretary	207.581.1435 gilda.stratton@umit.maine.edu

Sea Grant College Program
5715 Coburn Hall #14
University of Maine
Orono, ME 04469-5715
fax: 207.581.1426
MAP/Communications – fax: 207.581.1423

DIRECTORY of the University of New Hampshire

Ann Bucklin Director	603.862.0122, 749.1565 acb@kepler.unh.edu
Brian Doyle Associate Director	603.749.1565 brian.doyle@unh.edu
Steve Adams Communications Coordinator	603.749.1565 steve.adams@unh.edu
Marie Polk Editor/Information Specialist	603.749.1565 marie.polk@unh.edu
Roland Barnaby Extension Educator	603.679.5616 rollie.barnaby@unh.edu
Sharon Meeker Extension Educator	603.749.1565 sharon.meeker@unh.edu
Ann Reid Program Assistant	603.749.1565 ann.reid@unh.edu
Julia Peterson Extension Specialist	603.749.1565 julia.peterson@unh.edu
Jane Pittroff Business Manager	603.862.0268 janep@christa.unh.edu
Lori Lavac Administrative Secretary	603.749.1565 lori.lavac@unh.edu
Barbara Pinto-Maurer Secretary	603.749.1565

Sea Grant College Program
Kingman Farm
University of New Hampshire
Durham, N.H. 03824-3512
603.749.1565
fax: 603.743.3997

Ted Ames
P.O. Box 181
Stonington, Maine 04681
tel: 207.367.5907
fax: 207.367.2829

Erik Anderson
President
N.H. Commercial Fishermen's Association
38 Georges Terrace
Portsmouth, N.H. 03801
tel: 603.431.1779

Bruce Barber
School of Marine Sciences
5741 Libby Hall, Rm. 218
Univ. of Maine
Orono, Maine 04469-5741
tel: 207.581.2783
bjbarber@maine.maine.edu

David Bartlett
Associate Director
EOS
Morse Hall
Univ. of New Hampshire
Durham, N.H. 03824
tel: 603.862.0322
fax: 603.862.1915
david.bartlett@unh.edu

Barbaros Celikkol
Dept. of Mechanical Engineering
M212 Kingsbury Hall
Univ. of New Hampshire
Durham, N.H. 03824
tel: 603.862.1940
fax: 603.862.1865
celikkol@cisunix.unh.edu

David Duane
P.O. Box 923 (May-Oct.)
Wolfeboro, N.H. 03894
tel: 603.569.3477
18 Pier Pointe (Nov.-Apr.)
New Bern, N.C. 28562
tel: 919.636.5636

Kevin Eckelbarger
Director
Darling Marine Center
Univ. of Maine
Walpole, Maine 04573
tel: 207.563.3146
fax: 207.563.3119
kevine@maine.maine.edu

Jill Goldthwait
Senator
22 Albert Meadow
Bar Harbor, Maine 04609
tel: 207.288.5461
jillgold@acadia.net

Peter Horne
296 Washington Road
Rye, N.H. 03870
tel: 603.433.1316
fax: 603.427.5358

Wendy Lull
Executive Director
Seacoast Science Center
570 Ocean Blvd.
Rye, N.H. 03870-2104
tel: 603.436.8043, ext. 15
fax: 603.433.2235
seacentr@nh.ultranet.com

Daniel Lynch
Thayer School of Engineering
Dartmouth College
Hanover, N.H. 03577
tel: 603.646.2308

Linda Mercer
Maine Dept. of Marine Resources
PO Box 8, McKown Point
W. Boothbay Harbor, Maine 04575
tel: 207.633.9500
mrlmerc@state.me.us

George Nardi
GreatBay Aquafarms
153 Gosling Rd.
Newington, N.H. 03801
tel: 603.430.8057
fax: 603.430.8059
gaquafarm@aol.com

John Nelson
New Hampshire Fish & Game
37 Concord Rd.
Durham, N.H. 03824
tel: 603.868.1095
fax: 603.868.3305

Sandy Sage
Bigelow Lab for Ocean Sciences
McKown Point
W. Boothbay Harbor, Maine 04575
tel: 207.633.9600
fax: 207.633.9641
ssage@bigelow.org

Bruce Sidell
Director
School of Marine Sciences
5741 Libby Hall, Rm. 214
Univ. of Maine
Orono, Maine 04469-5741
tel: 207.581.4381
fax: 207.581.4388
bsidell@maine.maine.edu

John Singer
Dept. of Microbiology
Hitchner Hall
Univ. of Maine
Orono, Maine 04469-5735
tel: 207.581.2808
jsinger@maine.maine.edu

Robert Snover
Appledore Engineering
600 State St.
Portsmouth, N.H. 03801
tel: 603.433.8818
fax: 603.433.8988
aei@nh.ultranet.com

John Sowles
Maine Dept. of Environmental Protection
State House Station 17
Augusta, Maine 04333
tel: 207.287.6110
fax: 207.287.7191
john.sowles@state.me.us

Donald Sundberg
Vice President for Research
Thompson Hall
Univ. of New Hampshire
Durham, N.H. 03824
tel: 603.862.1997
fax: 603.862.3617
dcs@christa.unh.edu

Ione Hunt von Herbing
School of Marine Sciences
5741 Libby Hall, Rm. 217
Univ. of Maine
Orono, Maine 04469-5741
tel: 207.581.4362
fax: (207.581.4388
ivonherb@umenfa.maine.edu

Patten White
Executive Director
Maine Lobstermen's Association
41 Route 103
York, Maine 03909
tel: 207.363.6783
fax: 207.363.6783