

MAINE DEPARTMENT OF MARINE RESOURCES

Bureau of Resource Management

2007 Research Plan

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Introduction

DMR bears the statutory responsibility to conduct and sponsor scientific research in order to conserve and develop the utilization of marine and estuarine resources of the state; to restore diadromous fish (species that migrate between fresh and saltwater) resources to the rivers of Maine; to protect public health by ensuring sanitation of shellfish harvesting areas, harvesting, processing, and distribution; and to provide education and outreach. More than 70 marine, estuarine, and diadromous species are harvested commercially, caught by saltwater anglers, or reared by aquaculture. Maine ranked second in value of marine resources landed in commercial fisheries in 2005 in the Northeast Region (Maine-Virginia). Landings were stable in 2005 at about 263 million pounds with a value of \$413 million (APPENDIX 1, Figures 1 & 2).

Lobster continued to be the most valuable species landed in the region and the state with Maine accounting for 77% of the revenues (\$312 million) from the 2005 lobster harvest (APPENDIX 1, Table 1). Other species of importance include the groundfish complex, soft-shell clam, Atlantic herring, sea urchin, and blood worm. Maine's saltwater recreational fishery is valued in excess of \$27 million by about 362,000 anglers as striped bass and other species have rebounded. The aquaculture industry is undergoing a period of change but is still a valuable industry, including the culture of Atlantic salmon, oysters, mussels, trout, and freshwater species.

The status of our marine resources varies. A number of the fisheries in the Gulf of Maine are over harvested, many are fully exploited at current levels of fishing effort, others are rebounding, and still others are of concern because we have such little understanding of them. Many groundfish species are no longer over fished although Gulf of Maine cod remain at low levels. Landings of sea urchins have declined dramatically in recent years and there is ample evidence that they are seriously depleted in the western part of the state and portions of eastern Maine waters. Lobster landings have increased to record levels but have declined in the most recent years. Atlantic herring, which is an underutilized resource throughout its entire range, has been showing availability problems in the usual harvest areas in the Gulf of Maine in the summer and fall.

Management of Maine's marine resources occurs at various and multiple levels including municipal for soft-shell clams and state for species that occur primarily in state waters such as sea urchins and sea cucumbers. Management of species that occur mainly in state waters but migrate across state jurisdictional boundaries (striped bass, shad and river herring, northern shrimp, American lobster) occurs through the Atlantic States Marine Fisheries Commission (ASMFC). The New England Fishery Management (NEFMC) and National Marine Fisheries Service (NMFS) are responsible for management of species that occur primarily in the EEZ (3-200 mi from shore) such

as the groundfish species complex, sea scallops, small pelagics such as herring and mackerel, and large pelagic species such as sharks and tunas. DMR scientists participate on technical and stock assessment committees for species managed by these organizations, including American lobster, northern shrimp, Atlantic herring, striped bass, Atlantic menhaden, spiny dogfish, bluefish, shad and river herring, American eel, winter flounder, groundfish, monkfish, whiting, sea scallops, and ocean quahogs. Data collected by DMR sampling programs are integral components of stock assessments used to manage these species. DMR scientists participate in municipal shellfish committee meetings, the Soft-shell Clam Advisory Council, Lobster Zone Council meetings, the Lobster Advisory Council, Scallop Advisory Council, and Sea Urchin Zone Council. DMR is also a member of the Atlantic Coastal Cooperative Statistics Program (ACCSP) that is implementing a plan to cooperatively collect, manage and disseminate fishery statistical data for commercial and recreational fisheries.

DMR defines research broadly to include both hypothesis-driven research to answer specific questions and monitoring to collect long-term scientific data on species, the environment, and fisheries. Our research and monitoring programs target an increasing, but still relatively small, number of the marine species harvested in the Gulf of Maine. Factors such as funding availability and source, resource status, management jurisdiction, value of the fishery, legislative mandates, and constituent interests determine the focus of DMR's research programs. Our focus is on long-term monitoring in order to evaluate year-to-year changes in the resources, habitats and environment, and fisheries. Research programs include coast-wide water quality monitoring for the classification of shellfish growing areas; biotoxin monitoring of shellfish; commercial catch sampling of lobsters, sea urchins, shrimp, herring, and scallops for use in stock assessments; collection of commercial catch statistics and port landings; recreational fisheries sampling; aquaculture lease investigations; habitat mapping; seaweed management; oil spill response activities; activities to restore diadromous fish species to Maine rivers; and fishery independent surveys of marine and estuarine resources.

Bureau of Resource Management

The Bureau of Resource Management was established administratively in 1946 and is the oldest continuously operating marine research agency in the Gulf of Maine. A state-of-the-art fishery research laboratory and public aquarium are located on McKown Point, a peninsula in Boothbay Harbor. This laboratory consists of a marine aquarium, microbiology and biotoxin laboratories, GIS mapping facilities, wet lab, and a scientific and fishermen's library. The Stock Enhancement Division, which is responsible for diadromous fish activities, is located in Hallowell, and a second microbiology and biotoxin laboratory is located at Lamoine State Park. The Bureau is organized into five divisions.

The ***Biological Monitoring & Assessment Division*** is responsible for long-term monitoring programs for the lobster, northern shrimp, sea urchin, and herring fisheries; studies on groundfish, scallops, ocean quahogs, Jonah crabs, green crabs, and sea cucumbers; use of acoustic survey methodology for herring resource assessment; whiting and shrimp gear research; multispecies stock assessment model development and collection of commercial landings statistics. Data from these studies are used in fishery stock assessments and for fishery management decisions. Scientists participate extensively with other state and federal scientists in interstate and federal stock

assessments, technical committees, and plan development teams in order to provide scientific information for fishery managers.

The **Ecology Division** is responsible for research and monitoring of marine plants, animals and their habitats. Its primary function is to apply science to the protection and management of Maine's exploited and non-exploited marine and estuarine resources. Projects range from water quality and habitat assessments to describing population biology, life histories, and species distributions. Many of these studies are done in collaboration with outside entities including academia, non-government organizations, and small business. Studies to characterize sub-tidal habitats of marine species in Maine's coastal waters are conducted to delineate Essential Fish Habitat and groundfish spawning areas. Sensitive habitat identification and mapping is conducted, including eelgrass mapping, using Geographic Information System (GIS) as part of a project to document marine resources that would be endangered by spills of hazardous materials in the marine environment. Aquaculture lease site reviews are conducted to ensure that new leases are compatible with existing uses and the natural environment. Recently, the responsibility for assessing environmental impacts from finfish aquaculture was transferred by the Legislature to the Department of Environmental Protection. However, to facilitate the transition, the Division is assisting the DEP through research on benthic impacts, toxicology, and use of environmental performance standards. Research and management needs for the harvesting of seaweed have been identified and harvest regulations continue to be developed with industry members. Surveys are conducted to characterize Maine's marine recreational fishery and a spring-fall trawl survey to assess most of our bottom dwelling species. Atmospheric and oceanographic conditions in Boothbay Harbor are monitored, continuing a data series that was started in 1905.

Stock Enhancement Division activities include surveys to evaluate spawning success of American shad, alewife, and striped bass, fishway operation and maintenance at various dams throughout the state; stocking of American shad fry; alewife stocking; participation on interagency working groups to protect and restore diadromous fish runs throughout the State; review of hydropower projects and activities that could impact diadromous fish resources; technical assistance to municipalities with alewife fisheries; and participation on the Atlantic Salmon Technical Committee.

The **Public Health Division** is responsible for evaluating open shellfish harvesting areas on a continuing basis to protect the public's health and prohibiting harvest in all areas not within standards; identifying pollution sources that may be corrected in order to increase the amount of shellfish-producing areas open to harvesting; biotoxin sampling to monitor the occurrence of PSP or "Red Tide" in shellfish and close shellfish harvest areas as necessary to protect public health; coordination of volunteer monitoring for water quality and phytoplankton; and conducting wholesale shellfish dealer evaluation and certification under the National Shellfish Sanitation Program.

The Shellfish Management Program is responsible for the oversight of coastal communities with Municipal Shellfish Conservation Programs. The primary role is to assist and ensure the municipalities manage their shellfish resources through conservation measures. Conservation measures include limits on town licenses, limits on quantity of harvest, planting of flats, "brushing" of flats, and closure or rotation of flats. Area Biologists work directly with town officials and local harvesters to provide technical assistance and scientific knowledge on shellfish management, biology, mariculture, and stock enhancement techniques. Area Biologists also train their communities to do

shellfish surveys for establishing their conservation measures best suited to the town. Other roles include the training and certification of all Municipal Shellfish Wardens in the State of Maine, environmental review of any coastal alteration project, and assistance with water quality and marine biotoxin monitoring.

The ***Marine Education Division*** operates a public aquarium and education programs from Memorial Day weekend through the end of September to provide visitors with the opportunity to learn about Maine's marine resources. Other education programs include teacher workshop, coordination of the Officer SALTY Program that trains Marine Patrol officers to teach marine resource conservation in the classroom, and the development of the Burnt Island Lighthouse educational facility.

2007 Research Plan

The following is a description of DMR research and monitoring efforts proposed for 2007. It should be noted that many of these programs and projects are ongoing in order to meet management needs and state, interstate, and federal mandates. While all of these programs are considered a priority, it is clear that there are additional priorities that cannot be addressed by DMR due to a lack of resources. Some of those research needs are briefly addressed at the end of the plan; however, this is not meant to be a comprehensive plan that outlines and prioritizes all of the marine research needs of the state. Funding for these research programs comes from many sources including Maine's General Fund, numerous federal grants through the National Oceanic and Atmospheric Administration and the Fish and Wildlife Service, and Special Revenue funds (Sea Urchin Research Fund, Scallop Management Fund, Shrimp Management Fund, Toxin Monitoring Fund, Aquarium Fund, Aquaculture Monitoring Fund, Seaweed Research Fund).

Fisheries Management and Biology

Effective management of fisheries depends on an understanding of the biology of the organisms – their life history, distribution, habitat, and population dynamics – and the fisheries that harvest them – the fishermen, gear, areas fished, and fishing effort. DMR conducts a variety of sampling programs to collect information on the species of commercial and recreational importance in Maine waters and on the fisheries for those species. Several programs are targeted for a broad array of species while others are focused on individual species and fisheries. The information gathered from these programs is used in stock assessments that describe the condition or status of a stock and management decisions to regulate the fisheries. DMR's scientific research programs are focused on both long-term monitoring efforts to understand these factors and how they change over time and shorter-term projects to address specific questions as they arise and funding is available.

Maine/New Hampshire Inshore Trawl Survey

The DMR is lead researcher in this very extensive and intensive multi-species survey that requires 5 weeks each in spring and fall. Random stratified trawl surveys are conducted for five weeks in the Spring and Fall to estimate abundance and distribution of marine resources in the inshore waters of the Gulf of Maine from New Hampshire to Canada. Approximately 100 stations are sampled in 20-minute tows each season, distributed among 15 regional and depth strata. The catch is separated by species, enumerated, and individual fish are examined for length, weight, sex, and maturity stage. The Spring 2007 survey will complete seven years of survey work that is providing critical management information for state, interstate, and federally managed species such as lobster, cod, monkfish, winter flounder, herring, whiting, and shrimp.

Nearshore Recreational Finfish Survey

A long-term sampling program has been established to determine occurrence, life history stage, and relative abundance of recreational finfish species such as cod, winter flounder, and pollock in representative habitat types such as intertidal mudflats, eelgrass beds, and channel areas less than 10 m in depth waters less along the coast of Maine.

Additional sampling is focused on winter flounder and striped bass distribution, movements and life history.

Commercial Landings Program

Complete and accurate reporting of landings is essential for effective fisheries management. There were 12,000 accounting for over 2,400 licenses obtained in 2006. harvesters that held over 16,000 fishery licenses and 1,600 dealers accounting Maine's current landings program provides an incomplete picture of Maine landings. Therefore, DMR will continue to work with industry members to institute a mandatory dealer reporting system for all commercial fisheries according to protocols established under the Atlantic Coastal Cooperative Statistics Program, a cooperative state-federal program including all of the Atlantic coast states, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the regional Fishery Management Councils.

Dealer Reporting Program – As defined in Chapter 8 regulations, DMR staff will collect mandatory landings information from licensed dealers for the following fisheries: shellfish, lobster, urchin, marine worm, elver and herring. Addendum VIII to Amendment III of ASMFC's Fishery Management Plan for American lobster requires mandatory trip-level reporting of landings by dealers by January 1, 2008.

Harvester Reporting Program – As defined in Chapter 8 regulations, DMR staff will collect mandatory catch information from licensed harvesters for the following fisheries: green crab, sea cucumber, seaweed, horseshoe crab, eel, halibut, whiting, herring, shrimp, shellfish bait, and bait gillnet. Mandatory reporting of elver catches will be required by harvesters beginning in 2007 to maintain compliance with the ASMFC Fishery Management Plan for American Eel. Addendum VIII to Amendment III of ASMFC's Fishery Management Plan for American lobster requires mandatory catch and effort reports from at least 10% of the fishery by January 1, 2008. Additional reporting requirements may be adopted in 2007 under Addendum X.

Recreational Fisheries Program

Saltwater recreational fishing has become an increasingly important component of Maine's marine fishery. DMR conducts several marine recreational fishery sampling programs to determine the extent of recreational fishing effort for saltwater species, the impact on marine species, and the economic importance to the state.

Marine Recreational Finfish Statistics Survey

During May through October, DMR conducts angler interviews to develop estimates for Maine of the total number of fish caught, released and harvested; the weight of the harvest; total number of angler trips; and number of people participating in marine recreational fishing. This is a nationwide program implemented in 1979 by the NMFS as a means to establish a reliable database for estimating the impact of recreational fishing on marine resources. DMR provides additional resources to the program to collect statistically reliable results. Expansion of sampling effort in Washington County will continue in 2007 with the assistance of Maine Sea Grant's Marine Extension Agent and students from the University of Maine at Machias.

Tackle-Busters

DMR staff maintains records of fish and weights from saltwater anglers who have landed a fish that meets the minimum qualifying weights and lengths of the program in Maine.

Large Pelagics Survey

The DMR conducts the NMFS Large Pelagic Survey, a program designed to monitor the catch and effort of the tunas and sharks. This survey has two components; dockside vessel interviews and telephone calls to Atlantic Tuna permit holders, and is conducted from July through October.

Striped Bass Logbook Survey

The Volunteer Logbook Program targets avid striped bass fishermen to collect additional length data. In this program, anglers record information about fish harvested or released during each trip, time spent fishing, area fished, number of anglers and target species. DMR staff compiles information from returned logbooks at the end of each season and returns the logbooks to the anglers.

Lobster

The DMR has been actively engaged in intensive studies of the American lobster, Maine's most valuable commercial species, and the coastal fishery it supports, since 1966. The biological, catch/effort and socio-economic information derived from these investigations has provided a sound basis for the formulation and continued evaluation of an effective lobster management plan, not only for the State of Maine, but also the ASMFC and NMFS. Moreover, information obtained in Maine studies is likely to have important implications for other jurisdictions due to the migratory behavior of large adult lobsters, in particular gravid females, the extensive larval drift patterns, and Maine's high lobster landings (about 70% of total U.S. catch).

Data collected in these sampling programs will allow the DMR to assess current resource and fishery conditions and to evaluate important biological characteristics and issues such as reproductive potential, stock-recruitment relationships, and sources of recruitment, and to evaluate gear performance and selectivity.

Lobster sea sampling program - Lobster catch, effort, and detailed biological data (sex, presence of eggs, stage of egg development, molt stage, V-notch, etc.) are collected on a trap-by-trap basis onboard fishermen's boats. A minimum of three samples per month are collected from each of the seven lobster zones from May through November. Winter sampling has been added in recent years, but on a more limited basis.

Lobster port sampling program - This project began in 1967 as Maine's first comprehensive survey of the lobster fishery. Ten dealers are randomly selected each month from April through December. Dockside interviews were conducted on the sampling days to collect catch/effort information and biological data (length, weight, and sex).

Juvenile lobster settlement survey - Dive surveys and suction sampling will be conducted by DMR to sample the number of newly settled lobsters at set locations along the coast. A minimum of four sentinel sites are sampled in each Lobster Management Zone in October of each year.

Lobster Ventless Trap Survey - Modified lobster trap (small mesh wire, no escape vents) survey to index juvenile lobster abundance from Maine to New York. Traps are set at randomly selected location and stratified by statistical area and depth.

Lobster stock assessment and management - DMR's chief lobster scientist participates and previously chaired ASMFC's Lobster Technical Committee, participates in stock assessments, and management meetings.

Herring

The Atlantic herring is one of the most biologically and economically important species in the Gulf of Maine. Herring are oceanic plankton-feeding fish that occur in large schools, and inhabit coastal and continental shelf waters from Labrador to Cape Hatteras. The fishery has changed since the mid 1980's from one that targeted juvenile herring (ages 1 to 2) along the coasts of Maine and New Brunswick to large-scale fisheries for adult herring, primarily occurring in the Gulf of Maine, on Georges Bank, and in southern New England waters. Annual commercial landings are currently around 200 million pounds with 60 percent of the catch utilized for lobster bait and 40 percent for the processing facilities in Maine and New Brunswick. In addition to the commercial importance of Atlantic herring, they are also an important food source for many species of fish, mammals, and seabirds.

The DMR is the primary state agency in the New England and Mid-Atlantic regions for Atlantic herring research, resource monitoring, assessment, and management. Data from these programs are utilized in stock assessments that are used to guide management actions developed under ASMFC and NEMFMC fishery management plans. The goal for 2007 is to continue resource monitoring and assessment activities for the U.S. Atlantic coastal stock complex and to provide biological information and advice for resource management purposes.

Herring Catch program - Herring catches are monitored and compiled through the federal Interactive Voice Response System and from federally-mandated Vessel Trip Reports, and state only herring catches.

Biological sampling program - Fifty-fish samples are collected from commercial catches throughout the range of the fishery (Maine-New Jersey) and the fishing season, and processed to determine size, age, sex, and sexual maturity. This program also collects samples from the mackerel fishery for the National Marine Fisheries Service.

Incidental catch program - DMR staff conducts incidental catch surveys for vessels directly targeting Atlantic Herring and landing at major New England Ports. Confidential data are then analyzed, summarized, and then passed on to managers, in aggregate form, for development of management measures for the targeted herring fishery. Additionally, biological samples are taken for other incidental species (e.g. River Herring, Shad, Menhaden, and others) upon request.

Herring stock assessment and management - DMR scientists participate in all aspects of interstate and federal management for Atlantic herring including ASMFC/NMFS stock assessments, Plan Development Team, and Advisory Panel, and Management Board.

Northern Shrimp

The northern shrimp fishery is an important winter fishery in the Gulf of Maine that is managed under an ASMFC interstate management program with the states of Maine, New Hampshire, and Massachusetts. The states' sampling programs provide essential data for annual stock assessments and management actions. The Gulf of Maine fishery has seen wide variations in landings with current estimates of stock abundance at a high level.

Shrimp port sampling program - to monitor the status of the northern shrimp fishery. Dockside interviews are conducted to determine the total catch of each vessel sampled and effort information such as total drag time, or total number of traps and soak time. Shrimp samples are collected as the vessels unload and are processed to determine the size, sex, and stage composition of the catch. Since Maine fishermen harvest 85% of the New England catch, information provided by the DMR is crucial to the shrimp assessment and management process.

State/federal cooperative summer shrimp survey - scientists from NMFS, Maine, New Hampshire, and Massachusetts collaborate to conduct a series of tows for shrimp in the Gulf of Maine. The survey data provide fishery independent data that are an important component of the assessment of the Gulf of Maine shrimp stock.

Annual shrimp assessment - ASMFC's Northern Shrimp Technical Committee, comprised of scientists from NMFS, New Hampshire, Massachusetts, and the Maine DMR (chair), conduct the annual shrimp stock assessment and report that evaluates the current status of the Gulf of Maine shrimp stock and recommends management measures for the next fishing season to the Northern Shrimp Advisory Committee and Northern Shrimp Section.

Sea Urchins

The fishery for green sea urchins developed rapidly in the late 1980s as a result of expanding export markets, and peaked at 39 million pounds in the 1992-93 fishing season. Landings declined steadily because of overfishing and in 2005, only 3.5 million pounds were landed. Actions were not taken to manage the fishery during its boom years and it was not until 1995 that the state established the Sea Urchin Research Fund that has since funded a series of studies and long-term monitoring programs that have led to an improved understanding of Maine's sea urchin biology and fishery.

Sea urchin port sampling program - DMR samplers visit a randomly selected Maine port (from Portland to Lubec) where urchins are being landed between September and April, depending on the fishing season. The 2005-2006 fishing season has 10 days of fishing in Zone 1 and 45 days of fishing in Zone 2. Dockside interviews of urchin divers, druggers, and buyers are conducted for catch and fishing effort data and information on

market trends and fishing practices, and biological data on the size of the catch are collected.

Sea urchin dive survey - DMR and industry divers count and measure urchins at 144 sites each spring from Kittery to Eastport. This survey provides fishery independent data that are used in stock assessments to describe the status of the resource and provide a scientific basis for the development of management measures.

Larval sea urchin monitoring - DMR divers deploy settlement plates at Pemaquid Point each spring, collect them during the summer, and examine the plates in the laboratory to enumerate the number of new young-of-the-year sea urchins. This continues a time series begun at that site in the mid 1990s by the University of Maine, which tracks annual sea urchin larval settlement.

Sea urchin assessment and management - DMR personnel conduct stock assessments of sea urchins and provide fishery sampling, survey and stock assessment information to the sea urchin management council in their deliberations and decisions in managing the resource.

Groundfish

Groundfish refers to the complex of species that include cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, redfish, white hake, and windowpane flounder, and is managed by the NEFMC. The NMFS is the primary agency responsible for monitoring the status of this fishery since most of the catch is taken from federal waters. The resources were overexploited by the foreign fleets prior to the establishment of the Exclusive Economic Zone (EEZ) under the passage of the Magnuson-Steven Fishery Conservation and Management Act in 1977. As the stocks began to rebuild, there was a rapid buildup in the domestic fleet which led to further overfishing. Fishing capacity reduction programs and a series of management actions have led to some rebuilding of fishery stocks, but some stocks such as cod have remained at low levels. DMR initiated the Maine-New Hampshire trawl survey in 1999 to collect data on the status of groundfish and other marine resources in the nearshore waters of the Gulf of Maine that are not sampled by the NMFS surveys.

Groundfish, Monkfish and Skate Assessment and Management - DMR will begin to develop a description of Maine's groundfish fishery by compiling data on number of licenses and permit types, demographics, fleet composition, sectors, capacity, effort, catch and bycatch. These data will be collected and compiled using databases NMFS Service, DMR, and ACCSP.

A DMR scientist will represent the State of Maine in meetings of the NEFMC's Multispecies, Monkfish and Skate Plan Development Teams (PDT), participate in resource assessment and management activities, and participate in development of resource monitoring activities such as study fleets and industry-based surveys. Relevant information relating to the groundfish, monkfish and skate fisheries and the status of exploited stocks in the Gulf of Maine, especially the Gulf of Maine cod stock and the monkfish resource in the Northeast Fishery Management Area, will be assembled and reviewed in preparation for active participation on the respective PDTs.

Gear Research - A DMR scientist will complete analysis of data collected in 2006 in cooperation with a Maine groundfish industry member testing a bottom friendly New Generation Trawl design intended to improve fuel efficiency, reduce bycatch of undersized market species, reduce bycatch of non-market species, and lessen contact with the bottom.

Small mesh fisheries plan development (Silver hake) - DMR participates on NEFMC's PDT for small mesh multispecies fisheries (silver hake, red hake, offshore hake).

Grate raised footrope whiting fishery sea sampling program - The DMR will continue to monitor this new fishery for bycatch of regulated species, July – November. Continued NEFMC approval for this fishery is dependent upon the results of this program. Participation in this fishery continues to be extremely limited to date.

Halibut Survey - A survey will be conducted to determine abundance and distribution for Atlantic halibut funded by the Northeast Cooperative Research Partners Program. This project seeks to estimate halibut abundance in the nearshore Gulf of Maine using a hook survey involving up to five industry participants. Information will also be collected through our continued collaborative effort with the Maine state waters halibut fishery. Conduct a longline survey in the nearshore waters of the Gulf of Maine. The project will collect data on size, distribution and sex of captured halibut, document bycatch species, numbers and sizes, and tag all halibut with conventional tags and release a subset with archival tags and satellite tags. We will continue a voluntary state waters tagging effort and otoliths collection.

Sea Cucumbers

Sea cucumbers were first harvested in Maine in 1988, but it was not until 1994 when the fishery began to increase to meet the Asian market demand. Concern about overfishing and the lack of knowledge about this resource led to the enactment of emergency regulations under the 1999 Sustainable Development of Emerging Fisheries Act that limited the fishing season, drag size, and number of harvester endorsements, and required the submission of harvester logbooks. DMR worked with Dr. Yong Chen and a graduate student at the University of Maine on a federally-funded study to assess the stock status in the Frenchman's Bay region, examine spawning times, and conduct depletion studies.

Stock assessment and depletion study - DMR will work with Dr. Chen to complete the stock assessment and depletion study in Frenchman's Bay.

Fishery monitoring program - DMR will initiate port sampling to collect catch, effort and biological data from the sea cucumber fishery in 2007. Growth studies will be conducted by placing sea cucumbers in cages in Boothbay Harbor and Lamoine to provide data needed for a stock assessment.

Seaweed

In Maine, the 3,000-plus miles of rocky coast, nutrient-rich waters, climate, and large tidal flow all contribute to one of the most productive seaweed growing areas in the world. The dense vegetative stands of dominant plants such as rockweed, Irish moss,

and helps provide habitat for juvenile fish and crustaceans and food for many invertebrates and microorganisms. Currently there are ~11 species harvested commercially, mostly by hand with cutting rakes or knives, although there is at least one mechanical rockweed harvesting vessel. The Seaweed Fund is used to conduct periodic assessments of rockweed biomass at three locations along the Maine coast.

Management - DMR staff attends meetings of the Maine Seaweed Council to discuss industry issues and develop regulation proposals.

Sea Scallops

The scallop resource is currently at low levels in Maine coastal waters. Landings have gradually diminished since 1995 and recent landings have been the lowest since 1977. It is difficult to say to what degree this recent in stock levels is due to natural factors or over-exploitation. The establishment of the Scallop Management Fund has enabled a statewide survey to characterize the coastal scallop population, initiation of sea and port sampling programs for scallops, and gear research to develop less damaging and more selective gear.

Port sampling - Catch, effort, and meat counts are obtained from dockside interview of fishermen.

Resource assessment - Results of the 2006 fishery-independent survey of the scallop resource will be analyzed and presented to the Scallop Advisory Council.

Ocean Quahog

The ocean or mahogany quahog fishery began in 1976 in Maine state waters around Machias Bay, but began to expand into federal waters in the 1980's, in part because of paralytic shellfish poison (PSP) closures of several areas in state waters. The fishery is now managed under the Mid-Atlantic Council's Amendment 10 to the Surf Clam and Ocean Quahog Fishery Management with a maximum quota allocation of 100,000 bushels. Additional quota can be obtained by purchasing ITQ shares from mid-Atlantic fishermen. DMR monitors the resource for PSP and has conducted two stock assessment surveys to determine the status of the resource.

Age and Growth Study - Quahog shells were retained from previous stock assessment surveys. Ageing techniques will be researched and age composition of the samples will be determined to improve future stock assessments.

Horseshoe Crab

Beginning in 2001, annual surveys of horseshoe crab spawning populations and breeding sites were undertaken through a joint effort of the DMR, several coastal watershed volunteer monitoring groups, and a private contractor. Following the drastic depletion of the resource in the mid-Atlantic states, and the resultant increased harvesting of Maine crabs, anecdotal information was collected which indicated that Maine populations have experienced decline in recent years. These surveys are intended to provide a much-needed update to the last significant assessment of Maine horseshoe crabs and breeding locations, which was conducted in 1977 for the Maine State Planning Office.

Spawning Survey - DMR staff and volunteers will continue to conduct a survey of known horseshoe crab spawning areas along the coast of Maine during the May and June spring tides to monitor changes in the spawning population. For budget reasons, study sites have been reduced from 14 in 2005 to six: Thomas Point Beach, Harpswell; Day's Cove and Great Salt Bay, Damariscotta; the Bagaduce River; and two in Taunton Bay in Franklin.

Blue Mussel

Management - DMR staff will continue to work with the mussel dragging industry to identify and close areas to dragging in order to protect sensitive habitat such as eelgrass.

Diadromous Fish Restoration

Anadromous fishes (alewife, blueback herring, American shad, striped bass, rainbow smelt, Atlantic salmon) and catadromous fish (American eel), collectively referred to as diadromous fishes, historically occurred in most major and minor coastal watersheds in the state. Declines in these populations were caused by the construction of dams and heavy pollution, which rendered many waters unsuitable for their migration into freshwater production areas. The successful water pollution abatement program of the 1970s re-established a clean environment that now enables the restoration of these species to their historic habitats. Waters stocked with anadromous fish species, including alewives, are those that historically supported these species. Fish passage requirements at hydroelectric dams, a fishway construction program by DMR, and fish stocking efforts over the past 30 years have significantly increased the amount of habitat available to anadromous fishes.

Fish Passage Installation and Maintenance - DMR staff work with various federal, state, and local partners to obtain funding for dam removals, fish passage, and maintenance of fish passage on Maine rivers.

Alewife Stocking - Returning adult alewives are captured by a fish pump installed at the base of the Fort Halifax Dam in Winslow for the Kennebec River Alewife Restoration Program. Alewives are transferred to 10 lakes and ponds outlined in the Kennebec River Anadromous Fish Restoration Plan, and to other lakes and ponds in the Kennebec and other drainages located throughout the State. The stocking of alewives is an interim management measure to enhance alewife runs prior to the provision of fish passage. Fish passage became available on the Sebasticook River in 2006 with the completion of the fish lifts at the Benton and Burnham dams. DMR reduced the stocking effort in 2006 and sorted and passed alewives directly into the Fort Halifax Dam headpond. Adult alewives are captured at the Brunswick fishway on the Androscoggin River and transferred to six lakes and ponds and other suitable river segments.

Brunswick Fishway Monitoring - DMR staff monitors the upstream and downstream passage of American shad, alewife, and Atlantic salmon at the Brunswick fishway and conduct video studies of fish behavior to determine how to improve fish passage.

American Shad Stocking - DMR contracts the Waldoboro Fish Hatchery to raise American shad fry to release in the Kennebec and Androscoggin rivers as part of DMR's

shad restoration efforts. DMR staff collects adult shad from the Saco and Kennebec Rivers when possible and from the Merrimack River in Massachusetts for broodstock.

Kennebec River Monitoring - A beach seine survey on the Kennebec River between Augusta and Waterville is conducted to monitor changes in fish communities over time with the removal of the Edwards Dam and to monitor the shad restoration program on the Kennebec River.

Juvenile Alosid and Striped Bass Survey - Beach seine surveys in the Kennebec/Androscoggin estuary monitor the abundance of juvenile alosids and striped bass at 14 permanent sampling sites in the tidal freshwater portion of the estuary and six additional sites in the lower salinity-stratified portion of the river, every other week from mid-May to the end of August. All fish are counted and the total length of a maximum of 50 of each species is measured.

Striped bass spawning and overwintering habitat - DMR scientists will locate, map, and characterize striped bass spawning habitat and overwintering habitat in the Kennebec, Androscoggin, and Sheepscot estuarine complex, using a combination of targeted sampling with gill nets and ichthyoplankton nets (D-nets) and ultrasonic telemetry.

Young-of-year (Glass) Eel Survey - Each spring, DMR scientists install three eel passageways at the entrance of West Harbor Pond (located in West Boothbay Harbor), enumerate all young-of-year (glass) eels that migrate upstream for a period of six weeks, and collect biological information (length, weight, pigmentation) on subsamples. This survey provides an annual index of recruitment of a single year class, and is a requirement of the ASMFC Fishery Management Plan for American Eel.

Yellow Eel Survey in the Kennebec River Watershed - From June to September each year, DMR scientists enumerate all yellow eels that migrate upstream at passageways installed at two hydropower facilities on the Sebasticook River and one facility on the Kennebec River. In addition, length and weight are measured on a subsample of eels. This survey provides an annual index of recruitment (multiple year classes) to the Kennebec River watershed.

Evaluation of Anadromous Fish Populations on the Sebasticook River - DMR scientists will use fish counters and PIT tagging to evaluate upstream passage efficiency, determine migration rates, and document life history traits (spawning escapement, percentage of repeat spawners) of anadromous fish populations that have been restored to the Sebasticook River.

Species of Concern

Three anadromous fishes are listed as species of concern by the National Marine Fisheries Service; rainbow smelt (*Osmerus mordax*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and non-distinct population segment (DPS) Atlantic salmon (*Salmo salar*). These species are found within the Gulf of Maine (GOM), occupy overlapping habitats at some points in their life history, and are part of a common food web. The Department is lead agency on a Gulf of Maine wide project to assess the status of and threats to these species in Maine, New Hampshire and Massachusetts. This project is for five years and intended to avoid listing these species as federally

threatened and endangered. In 2007, work begins in Maine to map the distribution of smelt, location of fish passage obstructions and habitat. We will also begin to assess population structure, endemic pathogens and parasites, and water quality. Sturgeon and salmon work is scheduled to begin in 2008. One outcome of this work will result in a habitat model that will enable Maine to identify populations most at risk, likelihood for restoration for former populations and identify what management measures are needed to hold or regain populations.

Shellfish Management

The Shellfish Management Program is responsible for the oversight of coastal communities with Municipal Shellfish Conservation Programs. Area Biologists will continue to provide technical assistance and scientific knowledge on shellfish management, biology, mariculture, and stock enhancement techniques to town officials and local harvesters. Area Biologists will train their communities to do shellfish surveys for establishing their conservation measures best suited to the town and provide annual training and certification of all Municipal Shellfish Wardens in the state.

Soft-shell Clam Recruitment, Protection and Grow-out

There are several continuing and planned small research projects taking place with town's with conservation ordinances. The projects involve the monitoring the effectiveness of techniques for soft-shell clam recruitment, protection and grow-out. Some of these projects involve various forms of Municipal Aquaculture, from town controlled aquaculture, i.e. upwellers to towns leasing, limited areas, inter-tidal flats to private individuals for soft-shell clam culture. This research will help communities determine the best methods to manage and increase their harvest of shellfish. Some of these research projects involve work being done by the Downeast Institute and the University of Maine system.

Harvest Impacts on Clam Flats

A larger research project on impacts to a clam flat at varying intensities of harvest to the mortality, recovery, growth and recruitment of soft-shell clams and other marine harvested organisms is in the planning stages. This would be a long term study involving research and educational institutions along with a depuration company and potentially worm harvesters. The goal is to determine the feasibility of a working model to better manage intensities and quantities of harvested clams at varying densities for flat sustainability.

Evaluation of Municipal Shellfish Programs

Analysis of research data from the Municipal Shellfish Annual Review database will continue to determine the effectiveness of the program. Diverse management techniques and shellfish habitats of each community make this a challenge. Yearly and seasonal environmental changes can have devastating results to any form of natural or human manipulated recruitment. There are data showing improved harvest quantities in communities with active shellfish enhancement programs.

Aquaculture

Finfish and Shellfish Lease Application Review

Aquaculture staff conducts environmental reviews at lease application sites, prepare reports for public hearings, and present results of reviews at hearings.

Aquaculture Research

In 2007, research concentrates in two areas; shellfish impacts and seabird interactions. Begun in 2006, work continues to evaluate bottom impacts of shellfish aquaculture, testing new methods of field analyses for compliance monitoring.

The impacts of aquaculture on seabirds and vice versa have been identified as research priorities for 2007 through 2010. A science advisory committee led by DMR consists of seabird biologists from Inland Fisheries and Wildlife, US Fish and Wildlife Service, and Army Corps of Engineers to advance understanding of seabird interaction with aquaculture. The University of Maine's Cooperative Wildlife Research Unit will be contracted to participate.

Fish Health

DMR contracts with Inland Fish and Wildlife and Department of Agriculture fish health scientists to conduct biosecurity audits on net pen sites and vessels servicing net pen operations. DMR works with finfish and shellfish growers and other researcher in Maine and New Brunswick to identify issues, provide assistance to, and regulate the industry.

Habitat Characterization and Monitoring

Eelgrass Mapping

Continue to re-map eelgrass beds, habitat identified as critical for a number juvenile finfish species and blue mussels, are mapped on a frequency of about once every 10 years. Understanding the dynamics of eelgrass beds and causes of changes is hampered by the expense of photo acquisition. Research to develop a more affordable and hence more frequent method of mapping has been funded by the Maine Coastal Program for 2007.

Natural Resource Damage Assessment

DMR staff responds to oil spills in the marine and estuarine environment as needed to assist with assessment of damages to natural resources. The Bureau is funded and participates in conducting research into prevention techniques and impact assessment.

Long-term Physical Environmental Monitoring

Observations of air temperature, barometric pressure, precipitation, sea surface and bottom temperature, solar radiation, relative humidity, tide height, wind speed and wind direction are recorded at hourly, and daily intervals. Monthly and yearly summaries of the first six observations listed above are compiled and distributed. Near real-time data can be accessed on both the DMR

(<http://www.maine.gov/dmr/rm/environmentaldata.html>) and GoMOOS (<http://www.gomoos.org/dmr/>) websites.

Environmental Reviews of Coastal Alteration Projects

DMR reviews environmental permit applications for coastal alterations, energy development, dredging, docks, and marina projects. In 2007 staff will develop and refine Maine specific standards for particular activities and impacts.

Invasive Species Monitoring

Green Crab - DMR conducts an intertidal green crab survey along the Maine coast at 12 sites from Kittery to Perry in the fall.

Invasive Species Task Force - DMR staff participates in the Maine Invasive Species Task Force and the Northeast Aquatic Nuisance Species Panel and monitors activities and reports of invasive species in the state.

Protected Resources

DMR has continually increased its role in the conservation and management of endangered and threatened large whales and sea turtles that occur in Maine coastal waters. The Maine Whale Plan began in response to conservation and research needs that arose as a result of the federal Take Reduction process and has since grown to include a comprehensive Conservation Plan that was drafted and implemented by the state in accordance its Section 6 agreement with the Federal government.

Marine Mammal Stranding Program

DMR receives federal funds to respond to, document, and collect data regarding stranded or deceased cetaceans and pinnipeds along the coast of western Maine. The project maintains a volunteer animal response network including training of volunteers.

Disentanglement Network

DMR maintains a trained network of Maine Marine Patrol Officers and commercial fishermen to respond to live entangled whales. Many kits of disentanglement tools are located throughout the state for this purpose. DMR has the authority to disentangle minke whales and sea turtles and maintains a supportive role for endangered whales that include finback whales, humpback whales and right whales.

Gear Research and Development

DMR works with commercial fishermen statewide to conduct research and develop new fishing gear and practices that decrease the risk of entanglement to large whales in lobster gear. This has included several years of development and testing of a low profile groundline that will yield some flotation over a rocky bottom as an alternative to sink line. Additionally, a comprehensive vertical line survey was used to assess the gear densities and configurations throughout the state and will be used in the future to come up with entanglement risk reduction measures for these types of lines.

Sightings Network

DMR maintains a near real time sightings network for large whales sighted in Maine fishing waters. Boat-based and aerial surveys, whale watch boats, fishermen, researchers, and others regularly update this. Sightings are updated on an interactive website that allows the user to track the movement of whales and therefore avoid them during normal fishing practices.

Large Whale Foraging

DMR has received federal funding to begin doing research in Maine coastal waters regarding the foraging behavior of large whales, specifically over rocky bottom habitats. Collaborations are being developed now and studies will include a comprehensive CTD and plankton survey statewide in collaboration with lobster fishermen. DMR also has the potential to participate in some right whale tagging studies that will yield much needed data on the diving behavior of these highly endangered whales over rocky habitats.

Ecosystem Based Management

DMR and the State Planning Office has just completed a two-year study “to explore and document potential new and innovative concepts for the management of Maine’s embayments” at the direction of the Maine Legislature. A separate but related initiative by DMR was to develop a comprehensive resource management plan for Taunton Bay that resulted from a dragging moratorium imposed in 2000.

Taunton Bay Resource Management Plan

DMR has developed a science-based comprehensive resource management plan for Taunton Bay. The plan addresses principal resource user groups in the context of sustaining ecological processes, functions, and values of Taunton Bay and will be presented to the Legislature early in 2007. Local participation, stewardship, and adaptive management form the basis for the plan. If adopted DMR staff will participate and monitor the plan’s progress.

Public Health

DMR’s Public Health program operates under the guidelines of the National Shellfish Sanitation Program (NSSP). The NSSP is the federal/state cooperative program recognized by the U. S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC) for the sanitary control of shellfish produced and sold for human consumption. The purpose of the NSSP is to promote and improve the sanitation of shellfish (oysters, clams, mussels and scallops) moving in interstate commerce through federal/state cooperation and uniformity of state shellfish programs. DMR has been a member of the ISSC since 1982. The ISSC provides the formal structure wherein state regulatory authorities with FDA concurrence can establish updated guidelines and procedures for sanitary control of the shellfish industry.

Growing Area Monitoring Program

Water Quality Monitoring - This program is responsible for properly classifying the state's shellfish growing areas to allow for the commercial and recreational harvest of marine bivalve mollusks. Samples include seawater, well water, pollution sources and shellfish. Most sampling is done from shore with a few sites on offshore islands and at deep water fishing areas. Approximately 60 water samples are processed daily in two DMR laboratories, with well waters and shellfish samples tested as needed.

Both DMR laboratories are equipped to conduct male specific coliphage tests (MSC) on shellfish and water samples. FDA trained the Northeast Shellfish Laboratories in their proposed method in 2004. DMR research began in 2004 but was suspended in 2005 due to staffing changes. It will begin again in 2007. The MSC test is a cost effective method for determining coliphage levels. MSC is not an NSSP approved indicator and the method is not an NSSP approved method; therefore any data generated at this time will not be used for shellfish growing area classification. The FDA has submitted a proposal to the ISSC for acceptance of coliphage as an indicator of viral pollution associated with wastewater treatment plants (WWTP) and the method has been proposed to the ISSC for acceptance as an approved method for the quantification of male specific coliphage. The DMR is participating in research to determine if it is an effective indicator test for viruses associated with WWTPs and to determine background levels in Maine coastal shellfish. Future use of the indicator and method will depend on the actions of the ISSC and results of ongoing research in Maine and other areas of the United States.

Volunteer Water Quality Monitoring - The DMR Volunteer Coordinator coordinates over fifty volunteers throughout Maine's coastal communities to aid staff in the annual collection of water samples for the program. Each year volunteers are trained and site certified for their areas while also reporting any new pollution issues that may affect water quality.

Biotoxin Monitoring Program

Biotoxin Monitoring - The DMR collects shellfish samples from approximately 100 primary stations along the coast weekly and from offshore islands. Secondary stations are added as toxin rises and spreads. In 2006, outside funding allowed for intensive sampling in the Casco Bay area, leaving more than 11,000 acres of surface waters open (except for existing pollution closures) for the harvest of soft-shell clams during the entire PSP event. A small portion of the Federal "Red Tide Relief" monies will be used to continue the same level of PSP sampling in Casco Bay for the next two years, as well as to expand the fine-scale sampling program to Cobscook Bay and other major bays in Maine that suffer from regular PSP closures. This portion of the program will better define the distribution of toxic shellfish and potentially minimize the extent of shellfish closures.

Phytoplankton Monitoring - The DMR Volunteer Coordinator trains volunteers to participate in monitoring their coastal waters for potentially toxic algae. The volunteers report their findings to the Department on a weekly basis during the sampling season and sample more frequently in areas when a toxic species are detected. We continue to work towards using phytoplankton monitoring as an early warning system for toxic

blooms. In 2007 we will be developing quantitative estimates of species abundance to complement offshore sampling conducted by Woods Hole Oceanographic Institute. A new microscope with fluorescence capabilities will be purchased and housed in Boothbay to conduct in situ hybridization on water samples throughout the season to confirm Alexandrium numbers and establish baselines for the future. Other areas of research being explored in 2007 include DNA sequencing to identify species level toxins and high profile liquid chromatography for toxin profiling in coordination with the University of Maine and Bigelow laboratories.

We will also continue collaborations with Woods Hole Oceanographic Institute collecting samples for a three year study of *Pseudo-nitzschia* sp. We will continue the second year of a pilot study to determine the effectiveness of a rapid response test kit that will verify with greater accuracy the presence of Alexandrium spp. for early detection.

Shellfish Plant Inspection Program

DMR staff inspects and trains certified shellfish dealers throughout coastal Maine, and conduct food-borne illness investigations.

Marine Education

Maine State Aquarium

DMR operates the Marine Resources Aquarium in West Boothbay Harbor to provide visitors with an opportunity to learn about Maine's marine fisheries. A collection of regional fish, invertebrates, and interactive exhibits are maintained to allow for quality interactive learning. Admission fees are used to hire summer staff and support Aquarium operations.

Burnt Island Lighthouse Live History Program

DMR operates a marine science and living history program on Burnt Island to provide lessons in the areas of fisheries, ecosystems, maritime history, navigation, literature, music, and art; and provides public access for use as an outdoor recreational site. Admission fees are used to hire summer staff and support Burnt Island operations.

Educational Outreach

DMR provides opportunities for marine education to Maine's school children and the public through the marine aquarium, touch-it-tank exhibits, and presentations. DMR maintains the Officer Salty Program that trains Marine Patrol officers to teach marine resource conservation in the classroom.

Research Needs

In 2000, DMR with assistance from Maine Sea Grant and the Gulf of Maine Research Institute undertook a priority-setting initiative to identify research priorities for American lobster, green sea urchin, northern shrimp, sea scallop, and soft-shell clam. A summary of those research priorities are presented in Appendix 2. A number of these priorities have been addressed by DMR and other researchers in the state. For example, for lobster a fishery independent index of abundance has been developed from the trawl

survey, a new stock assessment model was developed by Dr. Yong Chen at the University of Maine, a ventless trap survey has been initiated by DMR and other states to measure juvenile recruitment, and the Gulf of Maine Research Institute is conducting a socio-economic study of the fishery. For shrimp, studies have been conducted to examine the relationship of shrimp movements to environmental factors and to improve selectivity of shrimp trawls. DMR has conducted scallop surveys in Cobscook Bay and along the coast for stock assessments. A study has been initiated by Dr. Brian Beal at the Downeast Institute for Applied Marine Research and Education. Reseeding experiments were carried out for green sea urchin, a stock assessment was developed and an annual dive survey is conducted to determine distribution and abundance.

DMR is committed to continuing long-term monitoring programs that are essential to protect public health and understand year-to-year changes in population abundances of marine species, their environments, the fisheries, and other human activities that affect these species. It is clear, however, that there are many additional research and monitoring needs that cannot be addressed. Funding and personnel are the major factors constraining the development of new research programs. Several recently initiated projects such as the inshore trawl survey are essential for monitoring the status of Maine's marine resources. However, DMR has not identified a stable long-term source of support for the trawl survey and continues to rely on year-to-year funding from various federal sources. A source of long-term funding is a critical need for this program.

The following is a list of other areas of concern for the DMR, that are not currently being addressed and for which additional new resources will be required.

- Monitoring for biotoxins other than PSP to protect public health
- Water quality studies to address the length of rainfall closures and closures around sewage treatment plant outfalls
- Fish health monitoring
- Full implementation of the Atlantic Coastal Cooperative Statistics Program for improved landings statistics
- Groundfish fishery monitoring
- Gear research to reduce bycatch of undersized target species and of non-target species
- Impacts of mussel dragging and development of alternatives or BMPs
- Ecosystem-based (fisheries) management
- Human use inventory (i.e., mapping where people use the resource)
- Risk analysis of various activities (e.g. pesticides, chlorine)
- Eelgrass studies for BMP development to minimize impact of fishing activities and research to even know what the impact is
- Use of Aquaculture for habitat protection and water quality improvement (e.g., polyculture)
- Refinement of regulations on aquaculture
- Effects of inter-tidal mussel dragging on benthic organisms
- Do Soft-shell clams have gregarious setting tendencies
- Development of a wider more static national market of Maine Soft-shell clams
- Seasonal environment effects on shellfish veliger survivability

The DMR will continue to seek funding opportunities to address priority issues such as those listed above as well as those identified in interstate and federal fishery management plans, and “Coastal Fisheries Research Priorities for the State of Maine” (Appendix 2) (http://www.state.me.us/dmr/research/table_of_contents.htm). DMR scientists will continue to work collaboratively with other scientists in the region and the fishing industry to conduct research to improve the management of Maine’s marine resources. DMR’s programs will continue to be an important avenue of communication between fishermen, the public, and DMR scientists.

APPENDIX 1

Preliminary 2005 Landings By Live Pound

Total: 263,276,121
Last Updated 11/30/06

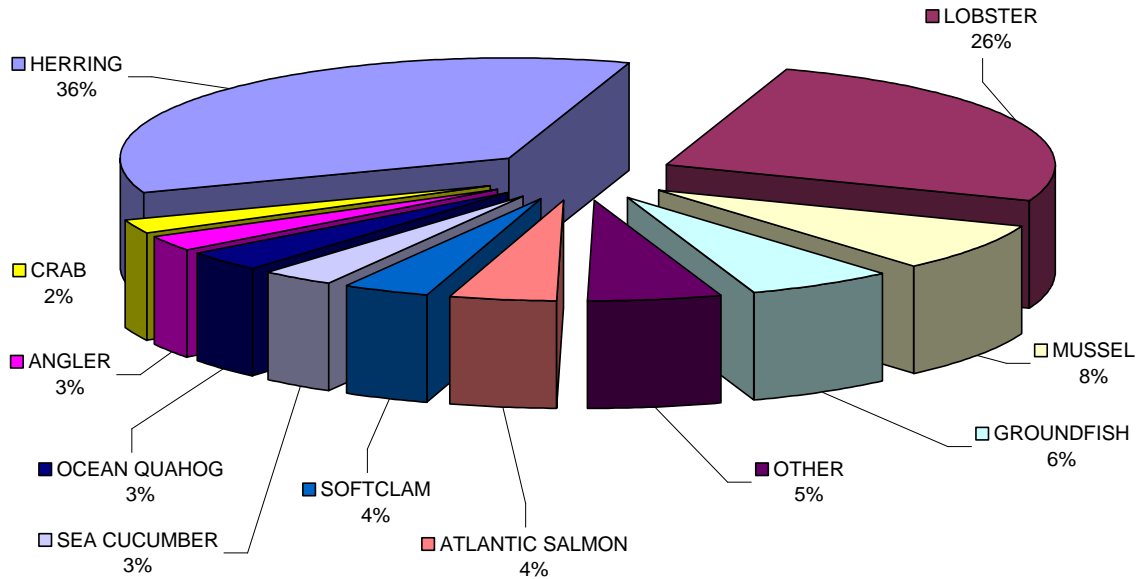


Figure 1. Preliminary 2004 Maine landings by pounds.

Preliminary 2005 Landings By Value

Total: \$413,147,428
Last updated 11/30/06

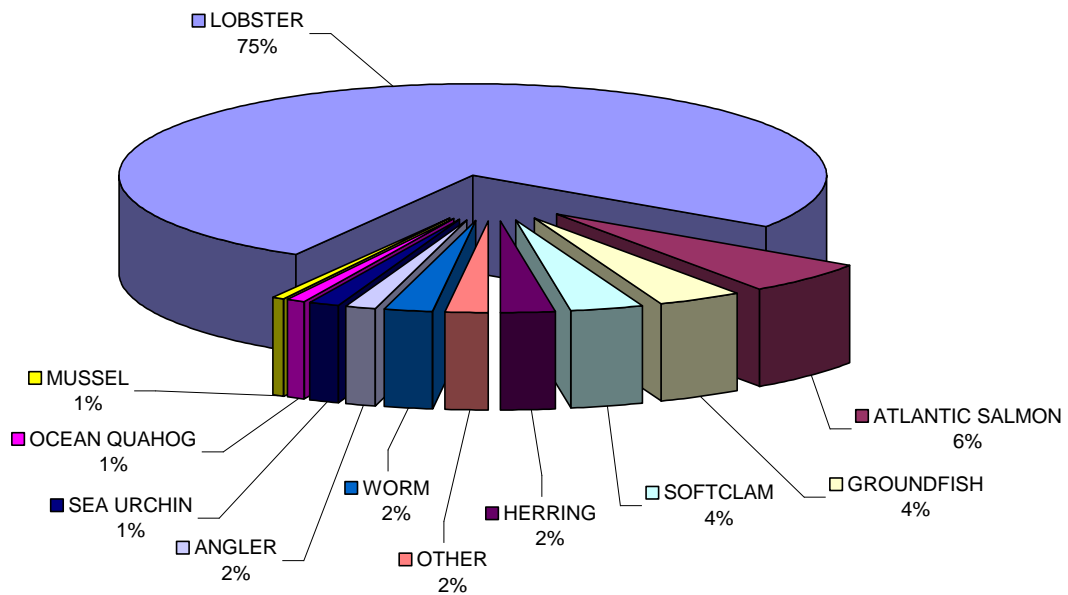


Figure 2. Preliminary 2004 Maine landings by value.

Table 1. 2005 Maine landings by species.

Species	Landed Pounds	Live Pounds	Value
alewife	340,060	340,060	\$56,744
angler	2,409,533	7,115,223	\$6,220,182
bloodworms	458,017	458,017	\$6,064,168
bluefish	242	250	\$157
clam northern quahog / hard	15,622	117,323	\$173,341
clam soft	1,929,297	9,453,553	\$14,629,920
cod	1,649,938	1,952,246	\$2,797,076
crab, unclassified	5,628,627	5,631,497	\$2,175,151
cucumber sea	7,901,218	8,567,468	\$601,899
cusck	47,279	53,098	\$33,822
eel, adult	17,189	17,189	\$47,463
eel, elver	5,476	5,476	\$1,299,252
flounder, am. Plaice	1,240,775	1,240,775	\$1,747,374
flounder, winter	44,968	44,968	\$63,987
flounder, witch	1,777,320	1,777,320	\$2,537,231
flounder, yellowtail	7,705	7,705	\$5,688
founders	3,516	3,516	\$5,424
haddock	1,830,818	2,087,138	\$2,371,107
hake, silver	2,505	2,524	\$462
hake, white	2,509,130	3,359,227	\$2,880,981
halibut	21,660	24,825	\$70,198
herring atlantic	93,818,322	93,818,322	\$9,980,979
lobster american	68,167,063	68,167,063	\$315,002,729
mackerel, atlantic	84,468	84,468	\$13,544
Mahogany quahogs	1,001,150	8,260,035	\$3,606,500
mussel blue sea	3,415,086	20,012,401	\$2,680,245
oyster eastern / american	34,654	522,289	\$1,051,044
periwinkles	58,396	243,510	\$185,825
pollock	4,624,554	5,258,613	\$3,104,294
redfish	400,978	400,978	\$247,174
salmon atlantic	11,602,437	11,602,437	\$23,204,874
sandworms	440,750	440,750	\$2,260,526
scallops	21,441	178,432	\$182,264
sea urchins green	3,517,048	3,517,048	\$5,142,213
seaweeds	4,760,572	4,760,572	\$207,184
shad, american	261	261	\$101
shark, unclassified	1,377	1,723	\$1,198
shrimp northern	3,524,564	3,524,592	\$1,964,411
skates	12,473	25,851	\$6,198
smelt rainbow	470	475	\$537
tuna, bluefin	60,007	74,986	\$454,262
wolffishes	59,254	70,228	\$42,888

APPENDIX 2

Lobster Priority Research Questions

Research Context and Group Research Priorities

Lobster research priorities are driven by the tension between the federal/ASMFC determination that the lobster fishery is overfished and the increase in abundance and landings in the last 20 years. Overfishing is defined as that stock level where the estimate of egg production per recruit (EPR) is 10% or less of that in an unharvested population. Currently the Gulf of Maine is at 3.2% EPR and is deemed to be overfished. Simultaneous predictions of stock collapse and record abundance result in fundamental questions: Why do we have this abundance? Where are the bottlenecks for this population? Does the population really have egg production that is too low? What is driving recruitment? What effect do large and fine scale oceanographic events have on the population?

At both meetings participants stressed the need to integrate Canadian research efforts and findings into our own.

Lobster Priority 1: Oceanography

The source and sink for lobster larvae remains the dominant research question for the lobster industry. This is an area that has had considerable research attention in the last 15 years and that work has yielded new insights that in turn are producing new areas of research. Management questions about the relationship of the inshore and offshore lobster stocks and the value given in the assessment to the V-notched and oversize lobsters off the Maine continue to make this research directly pertinent to the future of the Maine lobster industry.

Priority research needs are:

- a) Determine the lobster broodstock source for larval settlement and harvest areas and the relationship and relative contributions of the inshore and offshore broodstock.
- b) Study nearshore oceanography to understand its impact on larval transport and settlement for lobsters.
- c) Study the effect of water quality on lobster reproduction, growth, and health including chlorine, herbicides and pesticides, and nutrients.
- d) Are there large-scale oceanographic or climatic influences causing the reduced lobster larval settlement in the last five years? If so, through what factors or mechanisms are those influences operating?

Lobster Priority 2: Assessment

The lobster stock assessment is the focal point of all of the disagreement about lobster population dynamics. As a result, for the lobster industry, the assessment provides the lens through which they see lobster science questions. There is interest in both improving the data and assumptions that go into the model and developing new models. In the process of improving data, there is interest in developing new ways to monitor the health of the lobster population.

New indices that were discussed included larval surveys, post settlement surveys, and ventless trap juvenile surveys. Fishermen are interested in participating in the ongoing monitoring and concerned that the modelers involved in the assessment be able to use the information.

Maine dominates the fishery in New England but until recently, little data from the Maine fishery was integrated into the federal stock assessment. Two types of data were missing: biological information about the make-up of the stock and fishery independent data. In the last few years, that has started to change. Sea sampling is particularly important in the lobster fishery because the fishery is regulated to prohibit landing juveniles, breeders, and large adults. For this reason, port sampling or landings data will not provide information about those elements of the population. Maine has had a limited sea sampling program for years, but data from it was not used in the federal process. Now Maine has expanded its sea sampling, including an ongoing experiment with electronic data gathering and is providing the information to the assessment process.

Fishery independent data is meant to provide an index of abundance and normally comes from a trawl survey. Maine and New Hampshire have been the only New England states without an inshore trawl survey. Furthermore, the federal survey does not come very far inshore in the eastern Gulf of Maine because of the bottom topography. As a result, fishery independent information has been missing from the most productive area for lobster in the Gulf of Maine. In 2000, Maine is initiating an inshore trawl survey.

Priority research needs are:

- a) Document lobster abundance in Maine fishing areas through fishery independent means such as a trawl survey.
- b) Research lobster stock structure and migration patterns so that management areas can be made consistent with stock structure.
- c) Explore new models for lobster assessment and incorporate into models multiple indicators of stock health including results of new collaborative monitoring.
- d) Systematically improve research on inputs to the lobster assessment model such as natural mortality, growth rates and age, size composition of population and catch, measurement of fishing effort, lobster behavior and migration.

Lobster Priority 3: Life History and Behavior

As with all crustaceans, there is no established technique to age lobster. This puts a premium on studies of lobster growth because without better understanding growth rates, there is no way to link the settlement survey information to later harvest information.

Research in the last five years has demonstrated a strong positive relationship between the number of lobster post larvae in the water, and the number of juvenile lobsters on the bottom in that area. That work, and another time series that started in 1989, has shown a downturn in abundance starting in 1996. Does this predict a downturn in the fishery in the next few years? If so, why is it occurring?

Priority research needs are:

- a) Improve the understanding of lobster growth rates, particularly of juveniles, in order to be able to link strength of post settlement year classes to future catch.
- b) Improve/develop better sampling procedures to monitor juvenile lobster abundance: fishery independent and fishery dependent.
- c) Understand migration and movement of lobster post larvae, juveniles, and especially broodstock.

Lobster Priority 4: Socio-economic Issues

If lobster landings fall even to the long-term average, they will be reduced by more than 50% of current landings. This situation will pose serious social and economic problems for the coastal communities that are now so dependent on lobstering.

Articulation of economics and policy research questions is not as familiar turf for the industry as are biological and oceanographic questions. Economic contingency planning for an almost guaranteed eventual downturn received highest priority from the group. A first step in this planning process is information gathering about debt load in the industry, since that will determine the capacity of the industry to respond to lower landings.

In addition, considerable discussion occurred about the fact that normal economic studies of the industry miss significant subtleties about the business that, in fact, determine behavior. The industry wants policy makers to understand the nature and significance of the variation that exists within the industry: there are many different business strategies, situations, and expectations that occur. It also wants documentation of the profound changes in lobstering since the 1950s. Those changes include the shift from making a living to seeking the good life, dramatic changes in technology from haulers to wire traps to electronics. When combined with technological changes, the abundance of lobster resulted in it being much easier to succeed lobstering, so the business saw a pulse of new effort. These changes have undermined a number of the traditional checks on the business, including the integrity of the informal territories.

The democratic zone process is a huge experiment in democratic resource management decision-making. It has had a rocky start, yet the participants at the lobster meetings did not place a high priority on improving the functioning of zones. Much of the discussion was about zone issues, but the group did not identify types of socio-economic work that could assist the process.

Priority research needs are:

- a) Prepare a comprehensive response plan in the event of a sharp decrease in lobster landings and recommend actions to prepare the industry and coastal communities prior to a downturn with particular analysis of the impact of current debt load.
- b) Strengthen industry input and participation in science from the lobster management zones so that it becomes a continuous, ongoing process.
- c) Describe the lobster fishery: economics, the many different businesses and fishing strategies that exist within the industry, effect of loss of alternative fisheries, and changes since 1950s.

- d) Provide social and economic descriptive material about the lobster fishery to support state interests in federal and interstate management arenas.

Northern Shrimp Priority Research Questions

Research Context and Group Research Priorities

The discussion at the shrimp meeting focused on four subject areas: basic biological and oceanographic questions, habitat, and access issues. Although quite detailed discussion took place about specific improvements to the shrimp assessment models, no one at the meeting -- the scientific community, managers, or fishermen -- gave any priority to development of new assessment models. Instead, the focus was on understanding the underlying mechanisms of oceanography and shrimp biology and behavior that affect the shrimp population. Habitat and access issues rose to the top of the priority setting exercise despite the fact that there was no presentation or extensive discussion on either topic. Prioritization of the many oceanographic and biological questions was done by the group using the filter of the immediacy of its use in management, either in restructuring survey or model design, or in explaining bottlenecks in the shrimp lifecycle that can provide a direction to management. Questions in areas of socio-economic, habitat, and gear-related research were not articulated as fully as were questions in the other areas because of the interests and expertise of those who attended this particular meeting. Habitat and gear research both were rated as high priority, despite the lack of development of the ideas in discussion.

Shrimp Priority 1: Shrimp Life History and Behavior

Much is still unknown about the basic biology and behavior of Northern shrimp. (D. Schick, Appendix.) Little is known about timing, release, and subsequent behavior of shrimp larvae. Likewise it is not known even how long a shrimp is a juvenile -- one year or two -- a problem that is compounded by the inability to age a crustacean. Little is known about the inshore/offshore migration of juveniles, or the age at sexual maturity as a male. Migration is poorly understood for all life stages, of particular importance both for the design of the summer shrimp survey and for understanding the relationship between population size and availability to the gear. Finally, there is evidence that as the population is stressed, some males are making the transition to females in the same season that they normally would be males, something that has serious implications for management.

Research priorities are:

- a) What are the key factors in shrimp larval survival? Can environmental conditions at the time of larval release be used as a predictor of shrimp year class strength?
- b) Describe shrimp juvenile life history, especially its duration, to provide better assumptions for stock assessment models.
- c) What factors regulate timing of juvenile shrimp migrations, sexual transformation (male to female) and female inshore/offshore migration?
- d) What factors such as density dependence are operating to determine shrimp sexual maturation (male)?

Shrimp Priority 2: Effects of Large-scale Oceanographic Events on Shrimp

Shrimp is a cold-water species that is at the southern extent of its Atlantic range in the Gulf of Maine. It has long been known that shrimp are highly sensitive to temperature.

In fact, for many years, it was assumed that environmental factors far outweighed fishing pressure in determining year-class strength and that the predominant role of management was to optimize the value of the year classes. Modern oceanographic tools are providing us with a much more sophisticated understanding of the Gulf's oceanography and it is now possible to ask more detailed questions about the relationship between temperature and shrimp.

The flow of warm, salty slope water through the Northeast Channel into the deep basins in the gulf and the flow of relatively fresh, cold Scotian Shelf water into the gulf at the surface (>50 m) set up a pattern that can roughly be described as cold on the bottom and warm on top in the western Gulf of Maine and warm on the bottom and cold on top in the eastern half of the Gulf from Penobscot Bay east into the Bay of Fundy. These flows, in turn, are affected by the North Atlantic Oscillation, which is a periodic (about every 10-years) flip-flop of atmospheric pressure between Iceland and the Azores. When the difference is positive, it increases the flow of cold Labrador Slope water down the coast of North America, which appears to limit the amount of warm slope water that enters the deep Gulf of Maine. The information gathered from large-scale oceanographic research provides a foundation from which it is possible to ask basic questions about how temperature, salinity, and nutrient levels operate in the shrimp life history.

Research priorities are:

- a) Refine our understanding of the effects of large-scale oceanographic events such as the North Atlantic Oscillation, El Nino, and global warming on the Gulf of Maine.
- b) Evaluate the physical and biological effects of oceanographic events relative to the shrimp population.

Shrimp Priority 3: Habitat and Gear

Habitat issues ranked very high despite minimal discussion at the meeting. Questions included the impact of trawl gear on the bottom communities, environmental issues, and the issue of refuges. Given the polarization that exists over trawling, attention to the objectivity and credibility of trawl impact research is most important. Despite little discussion of these issues, bycatch and gear design issues in the fishery include the potential need for gear modification when and if groundfish (including redfish) populations rebound.

Research priorities are:

- a) Conduct objective, collaborative research on the effect of shrimp trawl gear on benthic habitats, substrate, and animals.
- b) Do shrimp have any refuges from gear in the Gulf of Maine and if so, what is their significance to the shrimp population?
- c) Continue conservation engineering for shrimp traps and trawls as needed to meet changing fishery conditions and new knowledge.

Shrimp Priority 4: Access Issues

Access issues are a high priority because shrimp is one of the few fisheries left in Maine that does not have some form of controlled or limited entry. The fishery is seasonal, and

is virtually entirely a secondary fishery. For this reason, access issues raise serious discussion of what multi-species management is and the importance of flexibility to fishermen. The fishery is important to Maine groundfish boats for which it provides a profitable alternative fishery when they are limited by their federal allotments of groundfish days-at-sea. The fishery has also traditionally provided an important winter fishery for inshore fishermen and lobstermen throughout the state. Last year, a bill to control entry was defeated in the Maine Legislature.

Research priorities are:

- a) Develop and evaluate options for multi-species management that considers the interests of all Maine shrimpers and gear types.
- b) Develop a framework to aid evaluation of the impact of limited entry proposals on the Maine fishing industry when and if such proposals come forward.
- c) Document the economic and social consequences of loss of flexibility to Maine's commercial fishermen as they have lost access to other fisheries under limited entry.

Shrimp Priority 5: Communication and Collaboration in Shrimp Assessment

Communication and participation were a strident theme at the shrimp meeting, particularly between industry and management. The gradual shift in shrimp management from the state and Northern Shrimp Section to Washington as ASFMC staffers work on a major revision of the shrimp plan has caused dismay and disillusionment among those fishermen who have traditionally participated in shrimp management. Fishermen stated they felt relegated to merely commenting, and being represented by one advisor on the plan development team, rather than having responsibility for the fishery.

The industry wanted more fundamental inclusion in research priority setting, collaboration on shrimp survey design and execution, and wanted better explanation of the assessment. Fishermen want to have a formal role in deciding uses of the Shrimp Fund funded by the Maine shrimp license fees.

Research priorities are:

- a) Provide a catalyst for shrimp industry collaboration in setting research priorities, making decisions on research funding, survey design and execution, and the development of a larval survey.

Sea Scallop Priority Research Questions

Research Context and Group Research Priorities

The issues discussed at the scallop meeting were confined entirely to inshore Maine scallop issues and did not cover questions about the offshore Gulf of Maine or Georges Bank fishery. Scallops have been a cyclical species in inshore Maine, occurring in patches that tend to be fished out quickly. Research questions focus on techniques to understand the mechanisms that control abundance of scallops, thereby providing insight for actions to harvest within the constraints of the species.

Because the Maine scallop fishery has been managed largely to avoid gear conflict with the lobster fishery, rather than for biological purposes, it exists in an unusual vacuum. On the scientific side, unlike urchins, scallops do not have a research fund and there has been little or no research done on Maine scallops in the recent past. There is no one in DMR or the University whose primary interest is scallops, although DMR is in the process of committing staff to scallops. Fishermen involved in spat collection for enhancement are having difficulty finding scientific advisors with capacity to help them. On the management side, fishermen and managers have little history of interaction on resource, as opposed to gear or gear conflict, issues. This provides an opportunity for collaboration with a relatively clean slate.

The Governor's Marine Fellowship program was suggested as one way to address the shortage of principal investigators focused on scallops. It was suggested that fishermen be included in the mailings about the availability of fellowships, so that the fishermen, as potential one-third funders of a fellowship, could initiate ideas, seek out researchers with students, and stimulate local scientific interest in scallop questions.

In the traditional fishery, interest in rotational management, spawning refuges, and other measures to reduce the boom and bust features of the fishery increasingly call for scientific guidance that is non-existent at this point.

Scallop Priority 1: Nearshore Oceanography

As with clams and urchins, using enhancement as a lens focuses scallop research questions on understanding nearshore oceanography and scallop life history at a most basic and local level. If spat is to be collected, the very nearshore currents need to be understood, as does the transport of spat. The desire to collect scallop, as opposed to starfish or any other spat, focuses questions on scallop spawning behavior, triggers, and location of broodstock.

Research priorities are:

- a) Fine scale research and current modeling to determine scallop larval dispersement patterns.
- b) Where is the effective broodstock for each scallop area?
- c) What are the mechanisms that determine the relationship between adult scallop biomass and recruitment success?
- d) Do adult scallops or scallop larvae move inshore and/or offshore?

Scallop Priority 2: Life History

Life history, growth, and behavior questions also rise to the top. What is the growth rate in scallops in different parts of Maine? What are the significant determinants of growth? The role of predators also emerges as important because of both the spat collection and the distribution of seed later.

Research priorities are:

- a) What triggers scallop spawning? Is it density dependent?
- b) Document and understand scallop growth rates in different areas.
- c) Study predation on scallops at larval and juvenile life stages.

Scallop Priority 3: Gear

With the national focus by environmental groups on the effects of dragging, scallopers place a high priority on credible studies of the impact of scallop gear on the bottom and its impact on the scallop resource and discard rate. Conservation engineering on scallop gear emerged as a very high priority.

Research priorities are:

- a) Improve the design of scallop gear to better select out juveniles, reduce discards, and reduce bottom impacts.
- b) Develop and communicate credible methods for doing gear impact research.
- c) Research impact of dragging on bottom and bay ecology with credible methods.
- d) Study cumulative effect of dragging on Cobscook Bay.

Scallop Priority 4: Enhancement

Scallop enhancement activities are stimulating an unprecedented level of discussion, both about enhancement and management of the traditional fishery. The discussion includes basic science questions, new opportunities for monitoring and assessment, and numerous policy questions. The discussion seeks information on a very fine scale, about local phenomena rather than statewide or Gulf of Maine wide issues.

A May 1998 trip to Japan provided information about spat collection, bottom aquaculture and wild reseeding that supports the scallop industry in that country. Since then, local efforts by fishermen to collect spat have started in a number of locations including Cobscook Bay, Stonington, and Saco. The effort is in a very early stage of development. The development of enhancement techniques provides an opportunity for collaborative work that links basic questions with specific gear and activities. As for any reseeding or restocking effort, evaluation of its effectiveness is essential.

Scallop enhancement is bringing to the fore policy issues about aquaculture and the wild fishery. Enhancement is being used by some local groups to involve fishermen in stewardship of the local resource. Enhancement techniques may prove useful to scallop aquaculturists. There is concern about the ultimate ownership of the scallops that grow from collected spat. A number of regulatory issues will need resolution.

Research priorities are:

- a) Refine scallop spat collection methodologies: gear, oceanographic monitoring, seeding techniques and timing.
- b) Create standard evaluation techniques for scallop spat collection, reseeding efforts.
- c) Study the socio-economic issues of governance, community capacity, and necessary new regulatory structure for enhancement and wild scallop management.

Scallop Priority 5: Monitoring and Assessment

Maine does no assessment of scallops in the inshore area and has very little data that could be used in a formal assessment. What emerged from the discussion was a recognition that statewide work may not be the best use of limited resources and that focus on specific areas, such as Cobscook Bay which is the center of much of the scallop fishing activity now, could provide more useful information. Potentially enhancement could create a demand for a number of monitoring programs, including spawning, spat abundance, and currents. Experimenting with a local, collaborative approach emerged as a good strategy.

Research priorities are:

- a) Do a Cobscook Bay scallop assessment.
- b) Use spat bags to develop a spawning index for scallop assessment.
- c) Develop local scallop gonadal indices and local oceanographic monitoring.

Clam Priority Research Questions

Research Context and Group Research Priorities

The clam meetings produced a particularly rich set of questions and observations. The dominant themes of both meetings were the importance of very local, site-specific investigation and the fact that collaboration with diggers and town committees provides a mechanism for such study.

Clam Priority 1: Nearshore Oceanography and Clam Biology

The soft-shell clam is a difficult animal to study. It is intertidal, subject to many different environmental stresses, and many predators. More than any other important commercial species, clams require fine scale, site-specific research. Clammers, clam biologists, and sediment scientists all understand that conditions on flats within a single cove can vary widely. In order to develop an understanding of the mechanisms that operate on soft-shell clam behavior and population structure, research on currents, salinity, nutrients, and sediment must be done at the level of individual coves. The close observation that diggers do, working a specific set of flats over many years, provides a source of natural history information that could be very important in deciphering the underlying mechanisms of clam populations.

Priority research needs are:

- a) What is the broodstock source for the clam larvae that settle in a specific cove?
- b) What are the oceanographic and sediment conditions that result in successful growth of clams after spat fall or reseedling?
- c) Document and explain local variability in clam growth rates, particularly the slow growth in eastern Maine.

Clam Priority 2: Ecology and Habitat

It is impossible to look at clams outside of a complete examination of their habitat: the structure and chemistry of mud itself, the impact of pollution on flats, the role of green algae, and the interactions with other species and fisheries. The discussion clearly pushed toward multi-species, intertidal studies that go beyond the pursuit of information about a single species such as clams.

Priority research needs are:

- a) What is the role of the clam flat in coastal ecology and the environment?
- b) What is the impact of harvesting methods on the ecology of the clam flat: pulling, turning over mud, clam digging, worm digging, nearshore dragging?
- c) What is impact of water quality, toxics, and exotics such as enteromorpha on clam flat health?
- d) What are the specific habitat needs of clams?
- e) Link natural history observations with science to discover the mechanisms that control clam settlement, survival, and growth.

Clam Priority 3: Enhancement

Clam enhancement provides a lens to focus a number of basic research questions about clam biology, nearshore oceanography, and the mud clams live in (benthic ecology). The term clam enhancement actually encompasses a spectrum of activity. It can mean adding brush, rocks, or other structures to the flats to enhance wild spat fall, moving small wild clams to high growth or clean water areas, planting hatchery seed, or pounding legal clams for sale at better market prices. Each of these activities raises questions about local circulation patterns, the chemistry and make-up of the mud, the growth rates and behavior of clams at various life stages.

Priority research needs are:

- a) Evaluate clam reseeding in a statistically sound manner with evaluations of small areas (e.g. 1 acre.)
- b) Evaluate the economic viability of clam reseeding.
- c) Develop a guide for determining the optimal time for clam reseeding dependent on local conditions.
- d) Develop a production model that would give guidance about how many clams you need to move or reseed in order to get a certain yield in the future, factoring in natural and fishing mortality.

Clam Priority 4: Predators

Clams have numerous predators that include a range of organisms. The group specifically named moon snails, ribbon worms, blood worms, sand worms, green crabs, Japanese crabs, horseshoe crabs as well as seagulls and ducks. They also discussed the clam disease, neoplasia. Each presents a different challenge to clammers and managers. The green crabs and moon snails function on top of the mud and, at least for the crabs, may be vulnerable to physical barriers. The milky ribbonworm, however, eats from below taking both juvenile and adult clams.

Discussion of predators included very pragmatic approaches: information sharing about predator population levels along the coast, destruction or commercial harvest of predators, destruction of their habitats such as destroying green crab burrows, and releasing sterile males into predator populations. The discussion also approached predators from a population biology and ecology point of view with questions about the life history and the role of human activities in enhancing or discouraging the growth of predator populations.

Priority research needs are:

- a) Create a market for green crabs, moon snails, and even milky ribbonworms.
- b) Evaluate the ways that human activities (digging, dragging, water quality) impact the population levels of clam predators?
- c) Invest in developing better predator control methods such as green crab fences and nets.
- d) Develop collaborative tracking of predator abundance.

Clam Priority 5: Assessment

Clam assessments are currently used to make the most difficult fishery management decisions: allocation of rights to fish. This is done at the town level, where things are local, personal, and highly visible. This puts tremendous pressure on the methods and credibility of clam assessment techniques. Furthermore, the conditions that contribute to the accuracy of an assessment -- such variables as growth rates and natural mortality -- are highly variable, even within town boundaries. Improvements both of survey techniques and of the assumptions that go into the model about growth and natural mortality were discussed. However, especially given the expense of assessment, participants placed highest priority on developing ways to survey and ground truth surveys working with diggers to enhance the credibility and usefulness of assessments.

Priority research needs are:

- a) Improve the clam assessment survey methods working with diggers.
- b) Develop seasonal and regional clam volumetric ratios and/or length/weight ratios.
- c) Develop clam growth rates for different areas using volunteer sampling cove-by-cove.

Green Sea Urchin Priority Research Questions

Research Context and Group Research Priorities

Research priorities in the urchin fishery are both well-grounded in immediate, practical management questions and at the same time require answers to basic scientific questions about oceanography, life history, ecology, and disease. The evolution of urchin co-management with the state also presents a number of avenues for policy work.

Process questions around management decisions were expressed less urgently than they were in some other fisheries such as clams. Nonetheless, there were many specific suggestions and a focus on the need for better communications between scientists and the industry, particularly in designing and carrying out reseeded experiments. Reconciling the desire for action and experimentation on the part of the industry with the need to collect information in a scientifically rigorous way will require considerable investment in communication and mutual education. There was a recognition that communication needs to improve in both directions between the industry and the SUZC.

Urchin Priority 1: Reseeding Urchins and Closed Areas

The overwhelming interest in urchin research expressed at the meetings lies in those basic and practical questions that surround development and evaluation of both rotating closures and reseeded urchins for public stock enhancement. Scientific work has shown that the cycle of urchin barren and macroalgal community (kelp forest) does not necessarily rotate but instead may be two alternative steady states that do not switch without some external stimulus. Without intervention, it is not clear whether urchins are able to reestablish themselves after macroalgae such as kelp has grown. This may seem counterintuitive, since urchins prefer kelp as feed. However, at small sizes, it appears urchins have difficulty becoming established in the mature algal beds, which provide habitat for many small urchin predators.

Participants expressed strong interest in evaluating rotational closures as a way to avoid overfishing and prevent the change in habitat from urchin barren to kelp forest. The question is still unanswered whether urchins would reestablish themselves if fishing pressure were removed without any other intervention. There is strong interest in reseeded for three distinct purposes (in order of priority): 1) to change the environment by shifting a kelp forest to an urchin barren to reestablish productive urchin bottom, 2) to enhance reproduction in the area, and 3) to enhance quality or fatten urchins.

Research priorities are:

- a) Evaluate urchin rotational closures both before and after overfishing and habitat shift:
 - Can closures prevent overfishing?
 - Can closures prevent habitat shift?
 - Will closures enable urchins to reestablish themselves after a habitat shift?
- b) Create adequate experimental design for urchin reseeded that fishermen can participate in, in 2001.
- c) Develop effective urchin reseeded techniques: timing, disease and urchin source issues, choice of area, handling.

- d) Conduct onsite collaborative experimentation to evaluate the biological and ecological aspects of urchin reseeded and closed areas relative to the three purposes:
- To change ecology by harvesting kelp;
 - To provide reproduction in that area;
 - To enhance quality, "fatten" urchins.

Urchin Priority 2: Urchin Health Issues

Health concerns ran a close second to the closure and reseeded issues. Urchin health and urchin diseases are neither well understood nor well defined in the scientific literature, particularly in light of the possibility of significant regional differences. Urchin populations experience periodic die-offs. Environmental stress is known to be one significant variable in these episodes but what the specific stressors are and how they operate within urchin populations is unknown. In addition to the oceanographic changes contributing to environmental stress, participants considered a number of human activities including harvesting methods and pollution. The traditional elements of the urchin fishery: shipping, processing, and dumping waste across habitats all provide opportunity for the spread of a disease. Now, as the fishery becomes involved with reseeded urchins from both hatchery operations and wild stocks, the disease issues become more complex. The state health infrastructure is unable to do significant monitoring, diagnostics, or management.

Research priorities are:

- a) Define and prioritize disease issues raised by urchin aquaculture.
- b) Examine health issues raised by reseeded urchins from one locale to another.
- c) Examine effects on urchin health of human activities such as harvest method, disposal of processing wastes, dredging, and pollution.
- d) Document the capacity of the current health management infrastructure and make recommendations for change.
 - Can the urchin industry collaborate in health monitoring?
 - Best management practices for the urchin industry.

Urchin Priority 3: Local Management

The Sea Urchin Zone Council (SUZC) has provided the fishery with a rudimentary form of co-management. Fishermen of both major gear types, dealers, processors, and scientists have participated in management decisions and research planning. Now, as the fishery is looking seriously at enhancement through reseeded and closures, the policy issues that occur in any enhancement fishery are emerging as high priority. These issues include an evaluation of the benefits and costs of different types of ownership of areas where culture techniques are being used: private aquaculture versus community enhancement. At the same time, as the SUZC process gains some maturity, and as local closures and reseeded projects are undertaken, all of which are place-based, there is interest in the issues involved with refining both collaborative research and local management.

Research priorities are:

- a) Evaluate the costs/benefits of public versus private access to urchin resource.
- b) Evaluate the potential for local urchin management and its impact on questions of privatization.
- c) Develop collaborative urchin research proposals that respect both fishermen's need for action and results and appropriate scientific method.
- d) Get cooperation and participation locally in stewardship activities such as urchin reseedling or kelp clearing.

Urchin Priority 4: Oceanography and Life History

For urchins, as for most commercial species, the interface between oceanography and reproductive success is a mystery still unsolved. The ecological questions about predators, food, and competition link with questions as basic as the behavioral and chemical stimuli for reproductive behavior. Other ecological questions include the role of large urchins, urchin barrens, and urchin movement. Ultimately, fishermen who are taking care of closed and/or reseeded areas need to gain understanding about where the larvae produced there will settle, and the source of the natural settlement they receive. Because of the local nature of the urchin fishery, and because local management is partially implemented, the questions are being asked at a very fine scale, such as local bays and the characteristics and behaviors of urchins in those areas.

In recent years both fishermen's observations and scientific developments have suggested that reducing fishing pressure alone may not be enough to rebuild the urchin resource. A complex ecological interaction between urchins, macroalgae such as kelp, and micropredators such as sea fleas, is emerging. Questions that will expand this knowledge of urchin life history and its interactions with its biological, chemical, and physical habitat dominate the urchin research agenda.

Research priorities are:

- a) Study nearshore oceanography to understand its impact on urchin larval transport and the relationship between larval source and urchin settlement.
- b) Understand urchin spawning, settlement survival, size/age ratio, and other biological measures in a local context to support local management.

Urchin Priority 5: Urchin Stock Assessments

The state is not currently doing any assessment of the urchin population, in contrast to New Brunswick, which conducts a regular assessment. (Robinson, Appendix) Given Maine's coastline, an urchin assessment would be costly, not to be undertaken without considerable evaluation. Participants at the meeting were most interested in the predictive qualities of an urchin larval survey, another expression of the questions that exist about larval source and sink. Improvement of landings information is a priority for DMR right now, although it did not emerge as a high priority from the meeting. It could emerge from a collaborative effort to arrive at an assessment strategy for the state.

Research priorities are:

- a) Collaborate with industry in the design and execution of an urchin assessment.
 - Clarify the purpose of the assessment.
 - Ensure information used is credible.
 - Evaluate the result for reliability.
 - Decide appropriate mix of fishery dependent (landings, effort, etc.) information and fishery independent (surveys, samples etc.) information.
- b) Develop urchin larval surveys to be useful for assessment.