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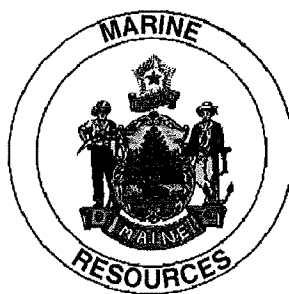
MAINE DEPARTMENT OF MARINE RESOURCES

2008 Research Plan

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January 2008

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Introduction

This research plan has been developed to meet the Department of Marine Resources (DMR) statutory responsibility to report annually on the research of the department to the DMR Advisory Council (§6024. 5). After reviewing the plan, the Council reports the plan, and any recommendations or comments, to the Joint Standing Committee on Marine Resources.

DMR is the State agency responsible for conducting and sponsoring scientific research in order to conserve and develop the utilization of marine and estuarine resources of the state; restoring diadromous fish (species that migrate between fresh and saltwater) resources to the rivers of Maine; protecting public health by ensuring sanitation of shellfish harvesting areas, harvesting, processing, and distribution; and providing education and outreach. These research programs are carried out by scientists and technical staff in the Bureau of Resource Management (Appendix 1) and the Bureau of Sea Run Fisheries and Habitat (Appendix 2).

More than 70 marine, estuarine, and diadromous species are harvested commercially, caught by saltwater anglers, or reared by aquaculture. Maine ranked second in both pounds and value of marine resources landed in commercial fisheries in 2006 in New England. Landings were stable in 2006 at about 278 million pounds with a value of \$383 million (Appendix 3, Fig. 1 & 2). Lobster continued to be the most valuable species landed in the region and the state with Maine accounting for 75% of coast wide revenues (\$297 million) from the 2006 lobster harvest (Appendix 3, 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 as striped bass and other species have rebounded. An estimated 489,000 anglers made over a million individual fishing trips in Maine saltwater in 2006 (Appendix 3, Tables 2 and 3). Participation has increased steadily from 2000 when an estimated 309,000 anglers fished in Maine saltwater. Striped bass is the primary targeted species for private boat, shore and charterboat anglers with an estimated 4.1 million fish caught in 2006, of which 73,540 were harvested (Appendix 3, Tables 4 and 5).

Marine aquaculture is a valuable industry in Maine and includes the culture of Atlantic salmon, trout, oysters, and mussels (Appendix 3). The finfish aquaculture industry has undergone a period of consolidation, while the number of shellfish growers has increased. As of December 2007, there are 75 shellfish leases, totaling 719.29 acres, 30 finfish leases, totaling 615.33 acres, and 35 limited purpose licenses totaling .35 acres, located in marine and estuarine waters along the Maine coast.

The status of our marine resources varies. The Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon is listed as Endangered under the Endangered Species Act (ESA) (60 FR 50530). This listing includes a large portion of the species range in Maine. Federal fisheries agencies are conducting population status reviews for Atlantic and shortnose sturgeon to assist in decisions relating to ESA listing. A number of the marine and diadromous species 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 increased to record levels from 2004 to 2006. 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. The North Atlantic Salmon Conservation Organization manages high seas fisheries for Atlantic salmon. DMR scientists participate on technical and stock assessment committees for species managed by these organizations, including Atlantic salmon, 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 (ACCSPP) 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 and diadromous species of ecological, economic and social importance 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 evaluating year-to-year changes in the resources, habitats, 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, scallops, groundfish, and sea cucumbers for use in stock assessments; collection of commercial catch statistics; recreational fisheries sampling; aquaculture lease investigations; habitat mapping; seaweed management; oil spill response activities; and fishery independent surveys of marine, estuarine, and riverine fisheries resources.

2008 Research Plan

The following is a description of DMR research and monitoring efforts proposed for 2008. Many of these programs and projects are ongoing efforts to meet management needs and state, regional, federal, and international 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, Special Environmental Project funds from the Maine Department of Environmental Protection, federal grants through the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (USFWS), and the National Fish and Wildlife Foundation, 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, recreational, and social 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 recommend management 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.

Maine/New Hampshire Inshore Trawl Survey

The DMR is lead researcher in this very extensive and intensive multi-species survey to estimate abundance and distribution of marine resources in the inshore waters of the Gulf of Maine from New Hampshire to Canada. Trawl tows are made during five weeks each spring and fall following a stratified random sampling design. 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 2008 survey will complete eight 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 harvesters that held over 16,000 fishery licenses and 1,600 dealers accounting for over 2,400 licenses obtained in 2006. Beginning in 2008, DMR has instituted 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. This will provide a more complete picture of Maine landings.

Dealer Reporting Program – As defined in Chapter 8 regulations, DMR staff will collect mandatory landings information from all licensed dealers. Information includes dealer name, date purchased/& landed, harvester identification & vessel identification, species, amount, grade & market category, gear type, disposition, and port landed.

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, spiny dogfish, shellfish bait, and bait gillnet. A new program to collect mandatory catch and effort reports from at least 10% of the lobster fishery has been implemented for January 1, 2008, as required by Addendum VIII to Amendment III of ASMFC's Fishery Management Plan for American lobster.

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 2008 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.

Atlantic Salmon Logbooks

The one month fall Atlantic salmon season on the Penobscot River has a mandatory logbook program to collect catch and effort data. Anglers record information about salmon caught and released during each trip, time spent fishing, pool fished, and non-target species. DMR staff compiles information from returned logbooks at the end of each season.

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 are 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 of the seven Lobster Management Zones in October of each year.

Lobster Ventless Trap Survey - The third year of a trap survey will be conducted to index juvenile lobster abundance from Maine to New York. Modified lobster trap (small mesh wire, no escape vents) are set at randomly selected locations, 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. A lobster stock assessment will be conducted in 2008.

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 2008 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 – Samples of 50 fish each 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, American 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, 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 - 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 management 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 2007-2008 fishing season has 10 days of fishing in Zone 1 and 45 days of fishing in Zone 2. Dockside interviews of urchin divers, draggers, 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, ocean pout, halibut, and windowpane flounder. This complex is managed by the NEFMC. The NMFS is the primary agency responsible for monitoring the status of these species since most of the catch is taken from federal waters. These 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 management - DMR will continue 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, DMR, and ACCSP.

A DMR scientist will represent the State of Maine in meetings of the NEFMC's Multispecies Plan Development Team (PDT), participate in resource assessment and management activities, and participate in development of resource monitoring activities such as industry-based surveys. Relevant information relating to the groundfish fishery and the status of exploited stocks in the Gulf of Maine, especially the Gulf of Maine cod stock, will be assembled and reviewed in preparation for active participation on the respective PDT.

Port sampling – DMR will initiate a comprehensive port sampling program for groundfish landed in Maine ports. Biological data will be collected including length, weight, maturity when possible and otoliths will be collected for aging. This initiative will begin with the state waters Atlantic halibut fishery in April 2008. Since ageing is a key component of groundfish assessments DMR will finish setting up an ageing lab in 2008 at the Boothbay Harbor facility. A collection of halibut otoliths collected over the past several years will be processed and aged following the protocols established by the Department of Fisheries and Oceans in Halifax, Nova Scotia.

Gear research - A DMR scientist will participate on the ASMFC Fishing Gear Technology Working Group. This group was convened to look at state managed fisheries and develop a prioritized list of which fisheries need gear improvement work. In addition, the members of this group are tasked with evaluating all state fisheries and recommend suggestions on how gear modifications can improve catch of targeted species and bycatch of non-targeted species.

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/cusk survey – The second year of a survey will be conducted to determine abundance and distribution for Atlantic halibut and cusk funded by the Northeast Cooperative Research Partners Program. This project seeks to estimate halibut and cusk abundance in the nearshore Gulf of Maine using a hook survey involving three industry participants. 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. Information on Atlantic halibut will also be collected through our continued collaborative effort with the Maine state waters halibut fishery.

Proposed research – Two proposed studies are in the grant review process through the Northeast Consortium. If these proposals are accepted, they will provide funding in 2008 for a fish trapping project and a wolffish tagging study. These projects will collect valuable data on the feasibility of trapping groundfish in state waters and the viability of satellite tagging wolffish to better understand their habitat preferences and migration behavior.

Monkfish

The monkfish fishery currently represents about 30% of the Maine groundfish fishery revenue. Monkfish is not considered a part of the NEFMC Multispecies Complex, but is managed under its own plan. The stock status of monkfish in both management areas (Mid-Atlantic and Northern Gulf of Maine) is uncertain. Using an index based assessment both stocks were considered overfished in 2006. In 2007, a new model was used and both stocks appear to be in fair condition. With this obvious uncertainty and the economic importance of monkfish to the Maine economy, DMR takes an active role in its research and management.

Monkfish management - DMR will develop a description of Maine's monkfish 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, DMR, and ACCSP.

A DMR scientist will represent the State of Maine in meetings of the NEFMC's Monkfish Plan Development Team (PDT), participate in resource assessment and management activities, and participate in development of resource monitoring activities such as industry-based surveys. Relevant information relating to the monkfish fishery will be assembled and reviewed in preparation for active participation on the respective PDT.

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.

Fishery monitoring program - DMR will continue a port sampling initiative to collect catch, effort and biological data from the sea cucumber fishery in 2008. Work will be done on trying to develop a protocol for evaluating maturity from a subsample of animals collected during the port sampling process. Growth studies will be conducted by placing sea cucumbers in cages in Boothbay Harbor and Lamoine to provide data needed for a stock assessment purposes.

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 kelps 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 - DMR samplers visit randomly selected Maine ports from Portland to Lubec where scallops are being landed between December and April. Dockside interviews of divers and draggers 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.

Resource assessment - DMR and industry partners survey the Maine scallop resource annually. In 2007 The Cobscook Bay strata were surveyed, and in 2008 the Eastern Maine strata are proposed for surveying. Sampling occurs before the start of the scallop season on December 1st. 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. Work will also be done on developing a method for evaluating the Northern Gulf of Maine Management Area scallop resource. This area was defined by the NEFMC in Amendment 11 and a “stand-in” total allowable catch limit was implemented until a survey could be conducted.

Scallop management - DMR will continue to develop a description of Maine’s scallop 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, DMR, and ACCSP.

A DMR scientist will represent the State of Maine in meetings of the NEFMC’s Scallop Plan Development Team (PDT), participate in resource assessment and management activities, and participate in development of resource monitoring activities such as industry-based surveys. Relevant information relating to the scallop fishery will be assembled and reviewed in preparation for active participation on the respective PDT. The scallop scientist will participate in meetings of the DMR 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.

Resource assessment - A survey will be conducted late winter/early spring to assess stock abundance and size composition of ocean quahogs from the primary quahog fishing grounds. The results of the survey will be compared with previous surveys to assess the status of the ocean quahog resource in Maine waters. Results will be provided to the NMFS and Mid Atlantic Fishery Management Council in order to set quotas based on current resource information.

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.

Soft-shell Clams

The Shellfish Management Program is responsible for the oversight of coastal communities with Municipal Shellfish Conservation Programs for soft-shell clams. 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 towns 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.

Sea Run Fisheries and Habitat

Diadromous Fish Restoration

Anadromous fishes (alewife, blueback herring, American shad, striped bass, rainbow smelt, Atlantic salmon, Atlantic tomcod, sea lamprey) 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 water 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. Atlantic salmon, shad, and alewives are stocked in waters that historically supported these species. Fish passage requirements at hydroelectric dams, a DMR fishway construction program, and other habitat connectivity projects over the past 30 years have significantly increased the amount of habitat available to diadromous fishes.

Research on Atlantic salmon is directed at determining the causes of the precipitous decline in Atlantic salmon returning to Maine waters. Ongoing DMR research projects are aimed at determining survival among freshwater life stages and understanding the biological and environmental factors affecting survival. NOAA-Fisheries salmon research focuses on the same questions in estuarine and marine waters. The two agencies conduct cooperative research designed to link freshwater rearing conditions and smolt emigration to better understand the biotic and abiotic factors affecting the freshwater-marine transition. Components of the cooperative projects are currently underway on the Pleasant, Narraguagus, Dennys, and Penobscot Rivers. These include: parr density and growth, basin-wide estimates of large parr; indices or estimates of smolt emigration; smolt physiology, marine and estuarine smolt trawling, and smolt tracking through estuaries. As part of this collaborative effort, DMR works with the Mitchell Center at the University of Maine to monitor water quality within Downeast rivers. DMR staff is measuring cobble embeddedness in juvenile rearing habitat and permeability in spawning habitat to evaluate the relative quality of these across Maine salmon rivers. The water quality and habitat work are important background for further studies of over-winter parr survival and smolt physiology.

DMR is investigating the effects of physical habitat and hydrology on juvenile salmon survival. As part of this effort DMR is working with USGS (United States Geological Service) to gauge Atlantic salmon rivers and increase the data available to link hydrology, habitat, and juvenile production and survival. USGS is also conducting analyses of historic data to determine if the timing and duration of summer and winter low flow periods has changed over the last century. USGS hydrologists have developed a surface-water and ground-water (SW-GW) watershed model for the Dennys River that is being generalized to apply in other watersheds. These models may prove valuable tools for assessing the effects of surface-water and groundwater withdrawals, and the land use/land cover changes on river flows, groundwater, and salmon habitat.

A series of cooperative research project with the University of Maine have documented the upstream migration of adult Atlantic salmon in the Penobscot River using Passive Integrated Transponder (PIT) and acoustic tag technologies. The movements of individual adult salmon were used to evaluate upstream movements, thermal refuge use, the probability that fish were able to access spawning habitat, and the distribution of

salmon within the drainage prior to spawning. These assessments, in conjunction with return rates of marked smolts, and survival of acoustically tagged smolts were used to alter smolt stocking locations strategies.

Fish passage installation and maintenance - DMR staff work with federal, state, and local partners to obtain funds to replace impassable culverts, remove dams, and install, improve, and maintain fish passage facilities 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. Alewife stocking is an interim measure to establish spawning populations prior to fish passage being installed throughout the watershed. 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.

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.

Atlantic salmon stocking - The USFWS is responsible for the spawning and culture of Atlantic salmon at two hatcheries in Maine. However, the operation of these hatcheries depends on DMR collecting parr for captive reared broodstock. from throughout drainages containing the GOM DPS, with extra care taken to include areas where natural spawning occurred in previous years. Without these collections USFWS hatcheries could not maintain the "living gene bank" for the DPS. Stocking in the Penobscot River and other rivers using that stock depend on DMR broodstock collections at the Veazie fishway. DMR is responsible for planning annual releases of hatchery-reared adults, eggs, fry, parr, and smolts in all Maine waters. DMR staff distributes Penobscot and GOM DPS fry in their rivers of origin either by point or scatter stocking. Adults, parr, and smolts are point stocked by USFWS with DMR assistance.

Fishway monitoring - DMR staff monitors the upstream and downstream passage of American shad, alewife, and Atlantic salmon at the Brunswick and Lockwood fishways and conduct video studies of fish behavior at Brunswick to determine how to improve fish passage. Trapping facilities to intercept, count, and collect biological data from migrating adult Atlantic salmon are operated by DMR staff on the Narraguagus, Dennys, and Penobscot rivers. Atlantic salmon and other species are also captured and handled at fishway traps operated by cooperators (St. Croix Waterway Commission, or dam operators) on the Aroostook, Saco, St. Croix, Penobscot, and Union rivers.

Juvenile Atlantic salmon population assessment – DMR staff conducts routine monitoring of the abundance and status of juvenile salmon in most of Maine's Atlantic salmon watersheds. Staff collects detailed abundance data for juvenile Atlantic salmon on the Narraguagus River and estimates the Atlantic salmon parr population for the entire drainage using a basin wide Geographic and Ecologic Stratification Technique. DMR also annually samples a set of index sites in all salmon rivers and use a Catch per Unit Effort electrofishing protocol and sampling scheme to provide a broad index of population abundance and distribution. Data are used to adaptively managing stocking, and assess alternative stocking strategies, hatchery fish quality, and habitat improvement projects. Maine data are used in a range wide juvenile abundance index for US Atlantic Salmon Assessment Committee status of stock reporting.

Atlantic salmon smolt emigration monitoring – DMR staff trap smolt on the Pleasant River, a Penobscot basin tributary and in the upper Narraguagus River. The objective of the Pleasant River study is to understand the influence of parr size at stocking on smolt emigration timing and either improve use of the current hatchery product or request a more consistent sized parr from the hatchery program. On the Narraguagus, smolt trapping is designed to document emigration timing and estimate the smolt production in the upper river from natural reproduction, and stocked fry and parr.

Atlantic salmon redd surveys - DMR staff conducts redd counts on rivers within the geographic range of the GOM DPS, and on selected habitat segments in other drainages. Redd counts are an index of adult salmon abundance and distribution at spawning time, and are related to known spawning escapement to provide sub-reach level estimates of egg deposition within a basin. Relating redd counts to trap counts allows redd counts to be used as a stock assessment tool for rivers without salmon trapping facilities.

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.

Young-Of-Year (Glass) American 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.

Co-evolved anadromous species - The question being addressed is whether survival of Atlantic salmon smolts emigrating from a river is greater in the presence of a significant alewife population. This project is intended to test the hypothesis that restoration of native alewives will benefit Atlantic salmon smolt emigration using several approaches: a retrospective review of salmon returns and alewife harvest within the DPS where data are available; identify and prioritize the 15 most important barriers to alewife passage in the DPS and facilitate removal of a minimum of three such barriers during the course of the contract period by partnering with other state agencies, federal agencies, towns and other affected parties; count retuning alewives on one additional system within the DPS; and draft a study design to test whether the presence of a healthy alewife population serves as a predator buffer for migrating Atlantic salmon.

Striped Bass spawning and overwintering habitat survey - DMR scientists are locating, mapping, and characterize striped bass spawning habitat and overwintering habitat in the Kennebec, Androscoggin, and Sheepscot estuarine complex using a targeted sampling with gill nets and ichthyoplankton nets (D-nets), and ultrasonic telemetry.

Atlantic salmon habitat surveys - DMR conducts field inventories to classify and map juvenile rearing habitat in rivers where Atlantic salmon occur. Habitat data for GIS applications are data housed on the web by the Maine Office of Geographic Information Services. DMR is adding information on habitat quality to these basic surveys; measuring cobble embeddedness, gravel permeability, the occurrence of large woody debris, channel geomorphology, water quality, thermal conditions, leaf processing rates, and fish and invertebrate communities.

Large wood additions to streams – Large wood was added to moderate sized streams in the East Machias, Machias, and Narraguagus drainages at a rate of approximately 12 pieces per 100m. Trees in the riparian zone were felled and their placement adjusted to achieve either stability or geomorphologic effect. All large wood (existing and added) in the treatment sites was tagged with metal numeric tags and marked with spray paint. All sites were surveyed for fish populations immediately prior to the habitat work, and will be surveyed annually for wood movement and fish populations. The objectives of the study are to increase the complexity of habitat and test hypotheses about the links among habitat quality and salmon populations that will lead to habitat restoration prescriptions.

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 is a five year project intended to identify and eliminate threats to the species to improve status of the species and 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.

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

Research will continue on 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.

Marine 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 2008.

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 at: <http://www.maine.gov/dmr/rm/environmentaldata.html> and <http://www.gomoos.org/dmr/>.

Environmental Reviews of Coastal Alteration Projects

DMR reviews environmental permit applications for coastal alterations, energy development, dredging, docks, and marina projects. In 2008 staff will develop and refine Maine specific standards for particular activities and impacts.

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.

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. The moratorium will be repealed July 1, 2008, as a result of the Taunton Bay Resource Management Plan.

Taunton Bay Resource Management Plan

DMR will continue to work with the Taunton Bay Advisory Committee to implement the 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. Local participation, stewardship, and adaptive management form the basis for the plan.

Penobscot River Diadromous Fishes Restoration Plan

DMR, cooperatively with the Department of Inland Fish and Wildlife developed a strategic plan with the goal of enhancing, restoring, diadromous fish populations and managing resident fish populations, aquatic resources and the ecosystems on which they depend, for their intrinsic, ecological, economic, recreational, scientific, and educational values for use by the people of the State. The plan recognizes that restoring ecosystem processes and integrated multi-species fish management will increase potential success.

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 2008. 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 2008, 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 2008 we will continue to use quantitative estimates of species abundance to complement offshore sampling conducted by Woods Hole Oceanographic Institute. A new microscope with florescence capabilities was 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 2008 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.

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 live and dead stranded cetaceans, pinnipeds and sea turtles along the coast of western Maine. The project maintains staff that triages response through a 24hr hotline and coordinates a volunteer animal response network including training of volunteers. This program also provides public outreach and education on what to do when they may come upon a marine mammal that may be in distress.

Disentanglement Network

DMR maintains a trained network of Maine Marine Patrol Officers, commercial fishermen, Harbor Masters and volunteers to respond to live entangled whales and sea turtles. Many kits of specialized 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. Additional funding for this program has been sought to expand the reach of turtle disentanglement training and kits.

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. This project will culminate in 2008 as DMR seeks NOAA approval to use this experimental rope in specific areas of lobster fishing, thereby making it commercially available by the fall. Supplemental funding has been sought for additional testing and outreach as the final product of this experimental gear is approved. Additionally, baseline information on the densities and seasonality of vertical lines in lobster fishing areas will allow DMR to frame a response and research plan for reducing the entanglement risk of these lines to whales. It is expected that risk reduction for vertical lines will be begin to be discussed by the Atlantic Large Whale Take Reduction Team in 2008.

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 continues to expand the large whale foraging research that began in 2006 with the formation of many fruitful collaborations with the fishing industry, Universities and other academic institutions. In 2007 these included a comprehensive CTD and plankton survey statewide, a right whale habitat monitoring program, digitizing whale sightings data, and tagging right whales in Maine coastal waters. All of these projects are ongoing and will continue through 2008. Additionally, DMR has applied for funding for additional projects that would include state-wide aerial surveys and tagging right, fin and humpback whales in coastal fishing waters.

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 and Funding Needs

Research Needs

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, estuarine, and diadromous 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 due to lack of funding and personnel. 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 4. 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.

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

- Seasonal environment effects on shellfish veliger survivability

The DMR (e.g. Atlantic Salmon Commission), USFWS, and NOAA Fisheries have a long history of working cooperatively for the conservation of Atlantic salmon. Cooperation and coordination among federal and state agencies is critical to ensuring that available resources are used in the most efficient and effective manner to further the protection and recovery of Atlantic salmon in Maine. Even the combined resources of the DMR (then the Atlantic salmon Commission), NOAA, and USFWS, cannot accomplish all of the important research and management activities for Atlantic salmon. In 2005, these agencies developed joint priorities for Maine Atlantic Salmon Recovery and Restoration (Appendix 5). These Joint Priorities included three broad areas of research:

- Investigate potential causes and magnitude of early marine survival
- Operate and evaluate conservation hatchery programs for DPS and Penobscot River stocks
- Conduct and evaluate projects that protect, restore, and enhance freshwater habitat

Funding Needs

DMR research and monitoring programs are funded from a variety of funding sources including State funds that primarily support the Public Health Program, federal funds, and special revenue accounts. Federal funding comes primarily through programs such as the Interjurisdictional Fisheries Act administered by the National Oceanic and Atmospheric Administration (NOAA), Sport Fish Restoration Program through the Department of the Interior/U.S. Fish and Wildlife Service, and the National Fish and Wildlife Foundation. DMR researchers also submit proposals and receive funding through a variety of competitive programs such as the Northeast Consortium. Special revenue accounts are generally fishery-specific funds that come from license fees such as the Sea Urchin Research Fund.

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 DMR will continue to seek funding opportunities to address priority issues identified in interstate and federal fishery management plans; "Coastal Fisheries Research Priorities for the State of Maine" (Appendix 4); issues related to freshwater habitat identified in state, regional, federal, and international management, conservation, and recovery plans for Atlantic salmon (Appendix 5); and other issues as they are identified. DMR scientists will continue to work collaboratively with other scientists in the region and with the fishing industry to conduct research to improve the management of Maine's marine and diadromous fish resources and DMR's programs will continue to be an important avenue of communication with fishermen and the public.

APPENDIX 1

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. A second microbiology and biotoxin laboratory is located at Lamoine State Park. In 2007, the Bureau of Sea Run Fisheries and Habitat was formed by combining the Stock Enhancement Division with the Atlantic Salmon Commission. Activities to restore diadromous fish species to Maine rivers are conducted by this new Bureau. The Bureau of Resource Management now consists of four divisions:

The ***Biological Monitoring & Assessment Division*** is responsible for long-term monitoring programs for the lobster, northern shrimp, sea urchin, herring, groundfish, scallop, and sea cucumber fisheries; development of new fishing techniques and gear; fishery-independent assessments of newly settled lobsters, sea urchins, scallops, and ocean quahogs, and collection of commercial landings statistics. Ageing studies are conducted on Atlantic herring, winter flounder and Atlantic cod. Bycatch data are collected from the Atlantic herring fishery. 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 subtidal 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.

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.

APPENDIX 2

Bureau of Sea Run Fisheries and Habitat

In 2007, the Bureau of Sea Run Fisheries and Habitat was formed by combining the Stock Enhancement Division with the Atlantic Salmon Commission. The purpose of the new Bureau encompasses the missions of the two units consolidated to create it: to conserve, manage and restore anadromous (sea-run) fish populations to Maine's rivers; and to protect, conserve, restore, manage and enhance Atlantic salmon and its habitat in all waters of the State; to secure a sustainable recreational fishery for anadromous species in Maine, and to conduct and coordinate projects involving research, planning, management, restoration, or propagation of Atlantic salmon and other diadromous fishes. In addition to Hallowell, the Bureau has offices in Bangor and Jonesboro and manages a field station at Little Falls on the Narraguagus River in Cherryfield.

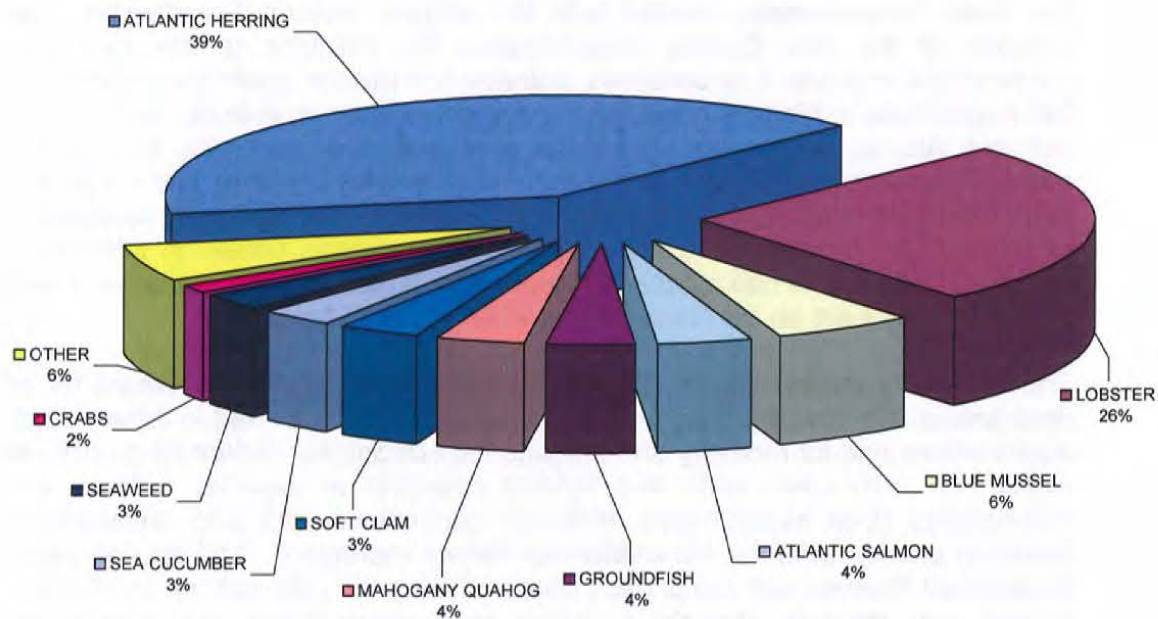
The Bureau is responsible for **Biological Monitoring and Assessment** for all diadromous fish species. Data from these assessments are used in fishery stock assessments and for recovery and management decisions. Scientists participate extensively with other state and federal scientists in regional, federal, and international stock assessments, technical committees, and plan development teams to provide scientific information for fishery managers. Staff also conducts **Ecological Studies** with the primary goal of having the best science available to protect and manage Maine's exploited and non-exploited diadromous fish species. Projects range from water quality and physical habitat assessments to understanding interactions among biotic and abiotic habitat and diadromous species population dynamics, life histories, and distributions. Many of these studies are done in collaboration with academia, other state and federal agencies, non-government organizations, and small business. The Bureau considers **Environmental Project Reviews** at all levels as a major method for habitat protection. These reviews are generally a requirement of either a state or federal permitting process, and the permitting agency develops permit conditions based on comments from a variety of natural resource agencies, state and federal. The Bureaus' goal is to ensure that permitting agencies have adequate information to determine each projects' environmental consequences, and that permits, if granted, reflect the best approach to ensure that there are no diadromous fish mortalities and no loss or degradation of habitat for any diadromous fishes.

APPENDIX 3 Commercial Landings and Recreational Statistics

Preliminary 2006 Maine Commercial Fishing Landings By Live Pound

Total: 278,673,682

Last Updated: 7/23/07



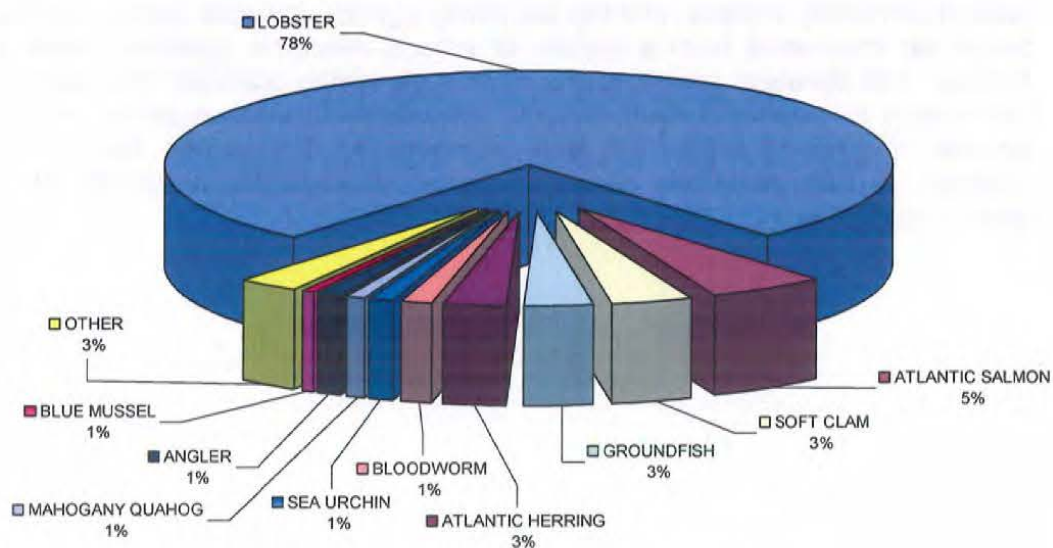
Data collected jointly by the Maine Department of Marine Resources and NOAA Fisheries

Figure 1. Preliminary 2006 Maine landings by pounds.

Preliminary 2006 Commercial Fishing Landings By Ex-vessel Value

Total: \$383,602,051

Last updated: 7/23/07



Data collected jointly by Maine Department of Marine Resources and NOAA Fisheries

Figure 2. Preliminary 2006 Maine landings by value.

Table 1. Preliminary 2006 landings by species.

Preliminary 2006 Landings By Species			
Species	Landed Pounds	Live Pounds	Value
ALEWIFE	1,235,080	1,235,080	\$183,622
ANGLER (MONKFISH/GOOSEFISH)	1,365,070	3,666,126	\$3,237,896
BLOODWORM	449,700	449,700	\$5,037,272
CLAM, SOFT	1,867,384	9,150,112	\$13,165,097
COD	1,202,587	1,419,158	\$2,382,728
CRAB (ROCK, JONAH, UNSPECIFIED)	4,490,646	4,490,644	\$1,662,902
CUSK	43,724	49,194	\$41,415
DOGFISH SPINY	179,740	183,891	\$35,701
EEL, AMERICAN (ELVER)	7,436	7,436	\$458,061
EEL, AMERICAN (YELLOW/SILVER)	18,619	18,619	\$54,270
FLOUNDER, AMERICAN PLAICE	784,021	784,021	\$1,384,192
FLOUNDER, WINTER	72,212	72,212	\$128,031
FLOUNDER, WITCH	945,435	945,435	\$1,811,286
FLOUNDER, YELLOWTAIL	29,008	29,008	\$47,043
HADDOCK	902,445	1,028,761	\$1,612,203
HAKE, WHITE	1,253,770	1,672,826	\$1,843,753
HALIBUT, ATLANTIC	26,118	29,997	\$139,152
HERRING, ATLANTIC	112,774,719	112,774,719	\$10,613,946
LOBSTER	72,666,861	72,666,846	\$297,164,288
MACKEREL, ATLANTIC	22,344	22,344	\$13,649
MUSSEL, BLUE	2,898,051	16,982,514	\$2,618,847
OTHER	312,276	382,495	\$99,220
OTHER GROUND FISH	6,646	6,646	\$14,783
OYSTER	46,225	691,357	\$1,407,057
PERIWINKLES	48,068	200,437	\$167,606
POLLOCK	3,203,308	3,677,626	\$2,309,048
QUAHOG (HARD CLAM)	48,421	363,639	\$364,843
QUAHOG, OCEAN (MAHOGANY)	1,213,530	10,012,106	\$3,919,276
REDFISH	334,810	334,810	\$245,121
SALMON, ATLANTIC	10,303,944	10,303,944	\$20,607,888
SANDWORM	306,640	306,640	\$1,603,387
SCALLOP	94,136	783,864	\$836,856
SEA CUCUMBER	8,770,309	8,770,309	\$1,870,552
SEA URCHIN	3,378,998	3,378,998	\$4,589,533
SEAWEED	7,550,572	7,550,572	260,363
SHRIMP	4,178,750	4,178,750	\$1,504,585
TUNA, BLUEFIN	16,066	20,089	\$139,048
WOLFFISH	27,291	32,756	\$27,531
Total	243,074,961	278,673,682	383,602,051

*Last updated 7/23/07

Table. 2 Numbers of anglers recreational fishing in Maine saltwater.

Year	Coastal	PSE	Non-Coastal	PSE	Out-of-State	PSE	Total	PSE
2000	139,100	9.6	20,128	18.4	150,442	11.9	309,670	7.3
2001	126,105	8.2	16,099	15.4	166,015	10	308,220	6.4
2002	126,636	7.7	16,768	17.5	172,154	10.8	315,558	6.7
2003	165,280	10.6	23,060	19.6	169,763	13.6	358,103	8.2
2004	113,446	12.7	21,193	20.6	147,649	14.6	282,287	9.3
2005	190,101	11.6	20,214	21.5	173,106	16.2	383,422	9.4
2006	182,332	10.2	22,053	25.5	284,994	16	489,379	10.1

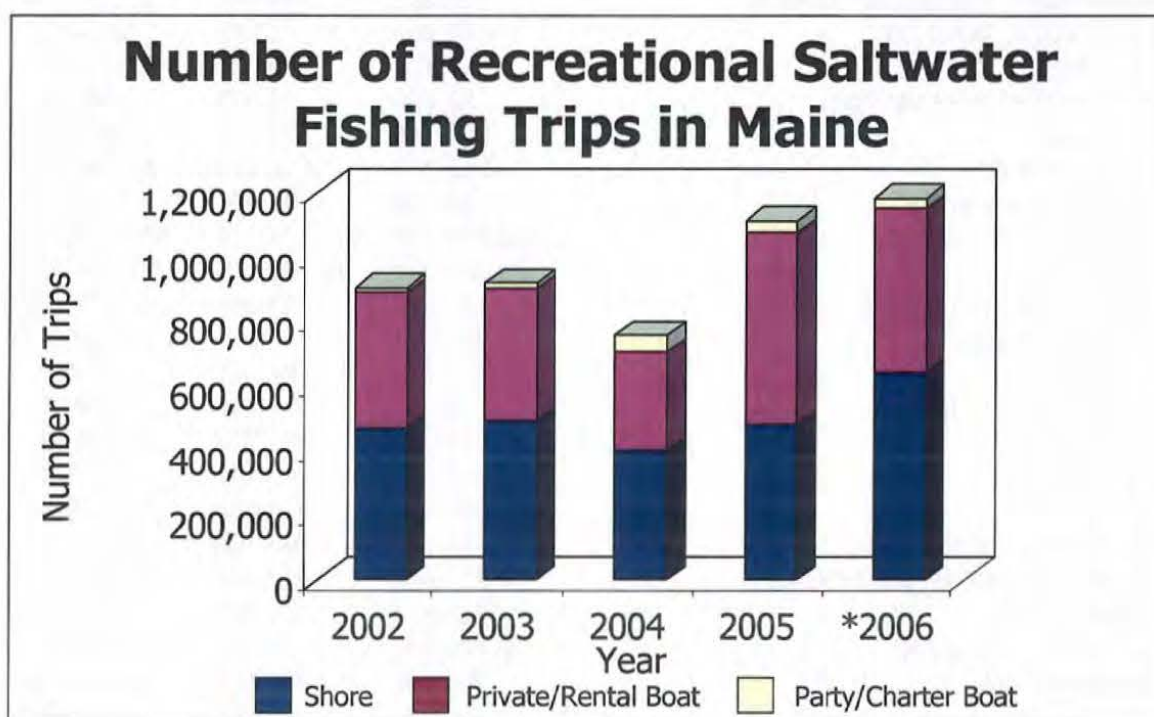
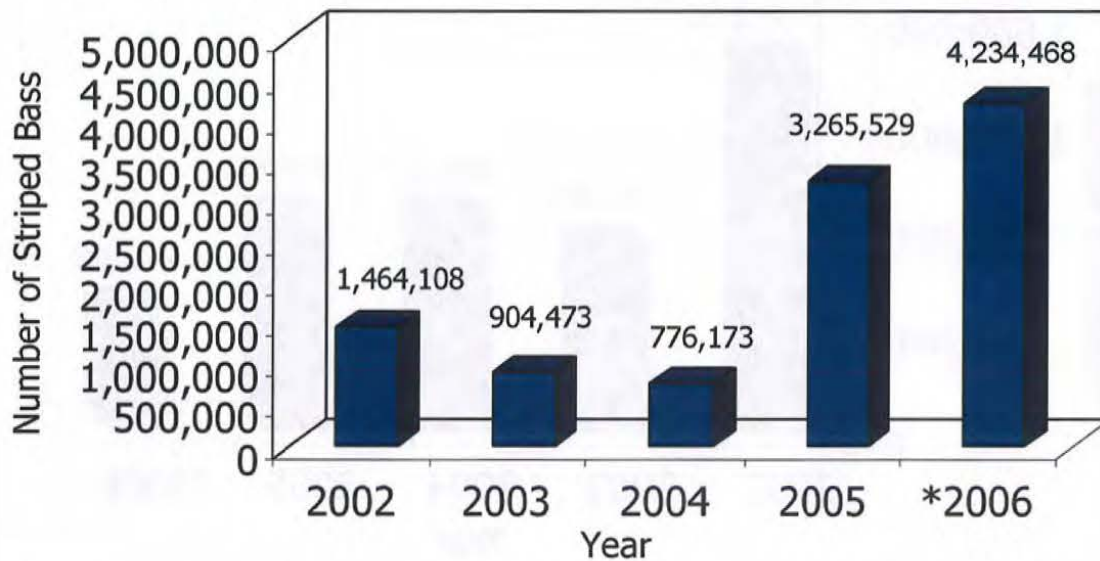
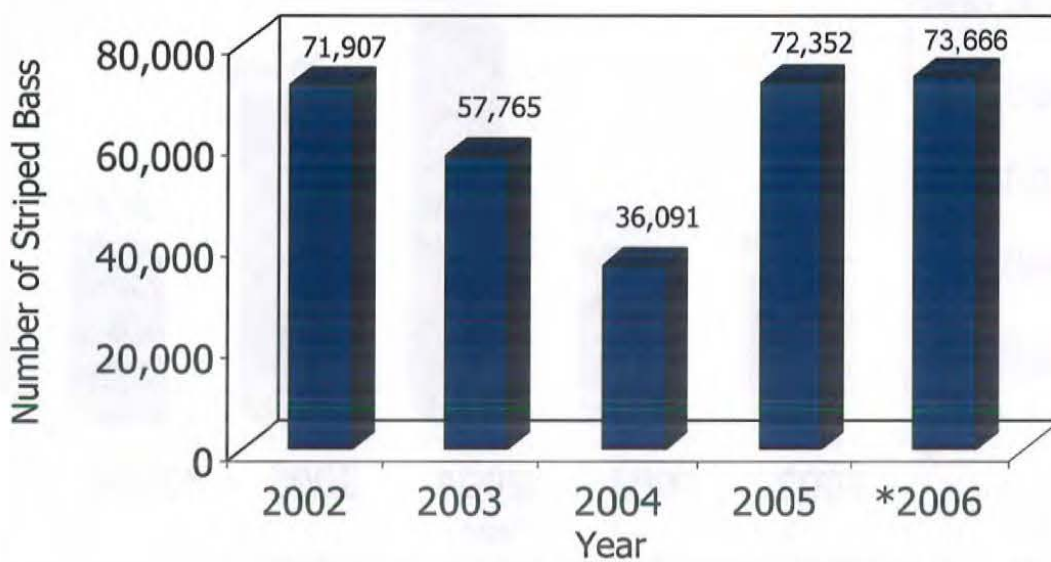


Figure 3. Individual saltwater fishing trips in Maine from 2002 to 2006.

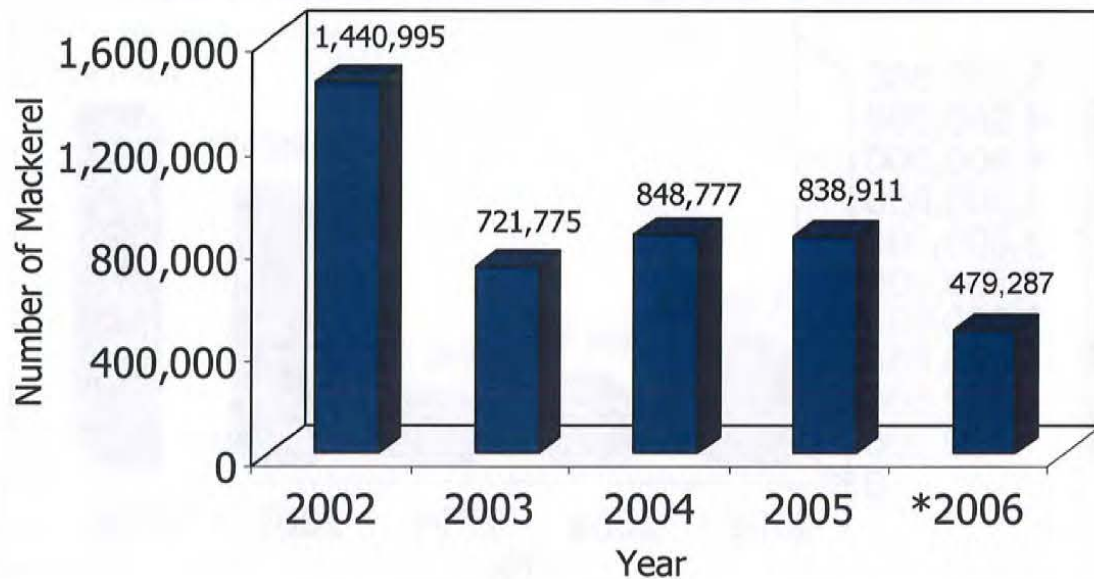
Maine's Striped Bass Total Catch



Maine's Striped Bass Harvest



Maine's Mackerel **Total Catch**



Maine's Atlantic cod **Total Catch**

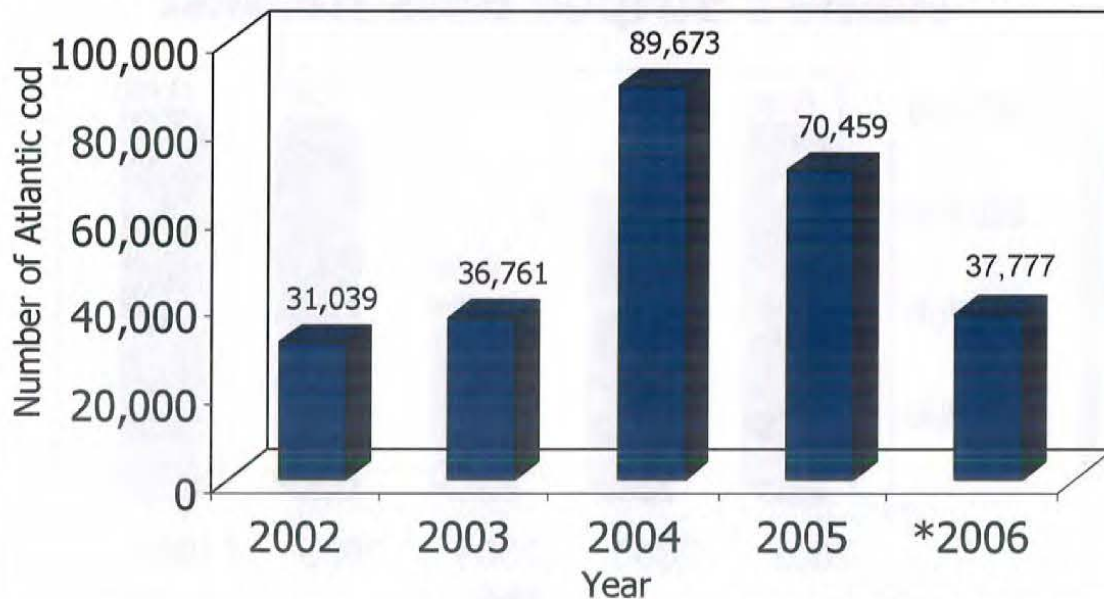
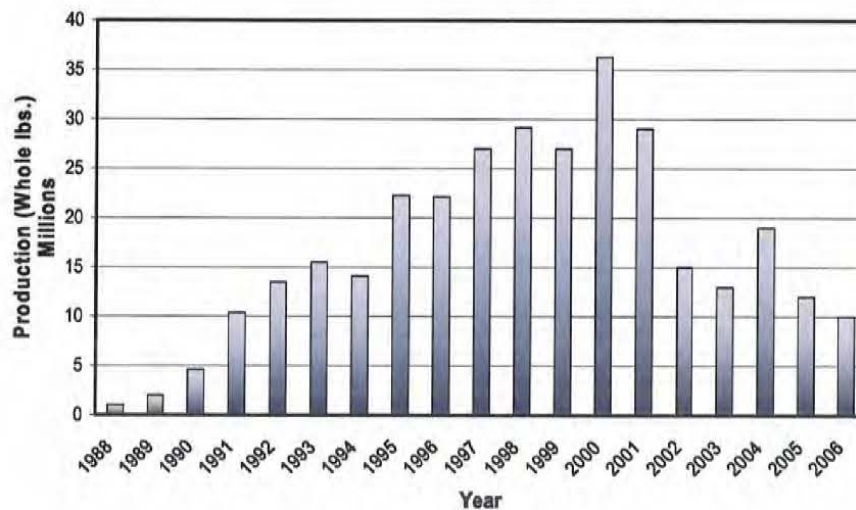


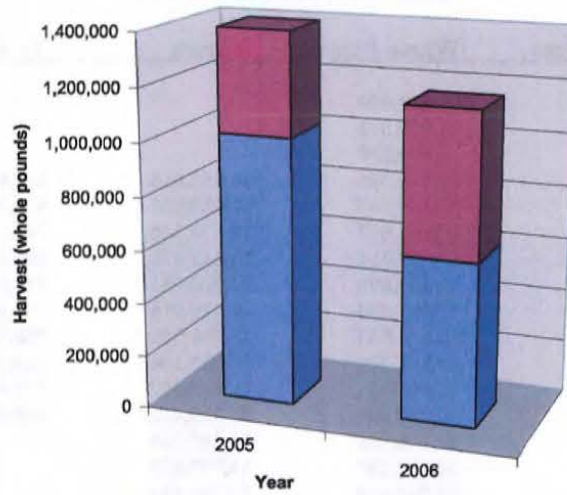
Table 3. Reported harvest of aquaculture-reared salmon, trout, blue mussels, and oysters.

Maine Finfish Aquaculture Harvest 1988 - 2006

Year	#Sites	Whole Pounds	Salmon	Trout
1988	10	~1,000,000		
1989	10	1,990,548		
1990	17	4,589,809		
1991	19	10,374,585	10,032,655	341,930
1992	21	13,489,197	12,869,732	619,464
1993	19	15,481,847	14,740,106	741,742
1994	23	14,097,532	13,511,472	586,060
1995	25	22,249,676	22,000,651	249,025
1996	29	22,093,536	22,020,910	72,626
1997	23	26,964,843	26,706,548	258,295
1998	28	29,149,301	28,965,124	184,177
1999	29	26,998,403	26,826,457	171,946
2000	28	36,290,154	36,049,476	240,678
2001	31	29,105,536	29,105,536	0
2002	12	14,987,837	14,987,837	0
2003	14	13,243,419	13,243,419	0
2004	15	18,773,038	18,773,038	0
2005	08	11,602,436	11,602,436	0
2006	06	10,303,944	10,303,944	0

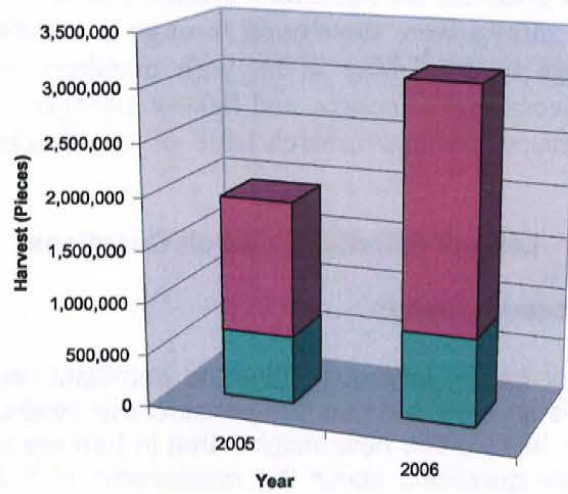


Farm-raised Blue Mussels (*Mytilus edulis*)



	2005	2006
Rope Culture	387,608	547,963
Bottom Culture	1,011,900	615,800

Farm-raised American Oysters (*Crassostrea virginica*)



	2005	2006
Damariscotta River	1,291,494	2,306,290
Other	650,044	837,138

APPENDIX 4

Coastal Fishery Research Priorities for the State of Maine

The following research priorities for American lobster, soft-shell clam, sea scallops, sea urchins, and northern shrimp were developed through a collaborative process during seven daylong meetings in April-May 2000, with members of the fishing industry, academic scientists, government scientists, and fishery managers. The full report can be found at: http://www.maine.gov/dmr/research/table_of_contents.htm.

Lobster Priority Research Questions

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

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

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

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 clambers 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

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 reseeding 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 reseeding 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 reseeding 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 reseeding 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 reseeding 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 reseeding 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.

APPENDIX 5

Joint Priorities for Atlantic Salmon Restoration

The information below represents the agreed upon joint priorities of the Maine Atlantic Salmon Commission, NOAA Fisheries Service, and the US Fish and Wildlife Service. **We recognize that recovery efforts cannot be completed without reaching beyond current agency bounds. We must look to the commonalities of other agencies and NGO's to accomplish many of the tasks listed. As requests for research and programmatic changes come forward they will be need to fit within this new focus area to receive any consideration of funding or staff resources.**

Investigate Potential Causes and Magnitude of Early Marine Survival

Monitoring and assessing early marine survival is a core responsibility of the National Marine Fisheries Service. Ongoing activities include documenting and describing the distribution of post smolts. Efforts are being expanded to monitor the coastal environment more broadly including reviewing and analyzing data sets on environmental variables, food availability, and changes in ecosystem structure and dynamics. Accomplishing this requires cooperation and collaboration with other personnel within NOAA and with state, federal and international resource agencies and academia, as well as non-traditional parties such as NGO's and the commercial industry. Future program areas include testing hypothesis that fish, bird or marine mammal predation reduces survival of smolts leaving rivers and passing through estuaries.

Operate and Evaluate Conservation Hatchery Programs for DPS and Penobscot River

Operating federal fish rearing facilities needed for recovery of the DPS and Penobscot are part of the core responsibilities of FWS. A broodstock management plan will be completed by the end of the 2005 calendar year. Annual stocking plans will also be available by January 2006 that include explanations and justifications for each life stage stocking approach/methodology, identify stocking locations, and describe assessments. An independent review of hatchery goals and objectives, production practices, the use of river specific facilities and demographic effects of stocking for the DPS and the Penobscot River will be conducted. Existing data will be used to review hatchery practices. The primary goal is to develop adaptive management approaches to hatchery production and stocking.

Habitat

Activities associated with habitat assessment, protection, restoration and enhancement were the most diffuse across the agencies as well as conservation organizations, and private individuals. Greater technical assistance is needed to guide habitat efforts, coordination to ensure priority habitat issues are addressed, and evaluation of habitat restoration and enhancement projects.

Physical Habitat: Greater attention will be focused on improving our understanding of how current physical habitat characteristics (hydrology, substrate, embeddedness and permeability) affect salmon production. We will work with USGS to (a) determine the sediment budget of streams and rivers; (b) assess the impacts of large-scale landscape change on watershed processes; and (c) determine "natural" channel of streams prior to historic alterations.

The primary agencies will continue to work with the recovery team and other agencies (e.g. NRCS) to seek opportunities to reconnect habitat through the removal of barriers and improved passage. This includes getting involved early in DOT and Maine Forest Service planning processes to prioritize critical crossings for bottomless arches. Finally, a working group/team will be created to facilitate adaptive habitat management experiment(s) addressing one or more of the following: (a) experimentally manipulate embeddedness levels; (b) adding large woody debris to streams; and/or (c) restore a stream to a natural channel.

Water Quality and Quantity: Identifying water quality issues that have the potential to cause over-winter mortality is a high priority and EPA's expertise and involvement will be sought. The TAC habitat working group and Recovery Team habitat working group will be asked to determine effective/efficient methods to increase productivity and manipulate river productivity. A commitment by USGS to maintain stream gages at points along the rivers within the DPS is a recovery priority.

Biological Communities: Restoration of diadromous species assemblages that co-evolved with salmon is a priority so that they can serve as predator buffers and improve nutrient exchange. Working with IFW to promote aggressive management practices against populations of exotic fish species in salmon rivers is also necessary. The new TAC habitat working group will be requested to identify what is known about optimal habitat conditions (physical habitat, water quality, food) that can serve as background for the design of experiment(s) to create and evaluate optimal habitat. The new TAC habitat working group will also be asked to facilitate adaptive management experiment(s) that manipulates predators and evaluates the effect of this on salmon.