

# MAINE DEPARTMENT OF MARINE RESOURCES

## 2011-2012 Research Plan



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## **OVERVIEW OF DEPARTMENT RESEARCH**

This research plan is intended 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. The plan is intended to be a description of research, monitoring, restoration, and outreach activities to be undertaken by the DMR with existing resources, not a comprehensive research plan that outlines all needed research. Some research needs are listed that have been identified through various research priority identification processes and will be addressed as sources of new funding are identified.

### **What do we mean by Research?**

DMR defines research broadly to include both hypothesis-driven research to answer specific questions and monitoring to collect long-term 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, resource status, management jurisdiction, value of the fishery, legislative mandates, and constituent interests determine the focus of DMR's research programs.

### **How is our research used and who uses it?**

Results from our research and monitoring are used by local, state, federal, international, academic and private parties. Research and monitoring results from DMR science contributes to better decision making by regulatory bodies and legislators. Data collected by DMR sampling programs are integral components of stock assessments used to make management decisions, inform private investment decisions, respond to oil spills, and guide development. Results of lobster, scallop, and urchin research and monitoring are used by the Lobster Zone Councils and Lobster Advisory Council, Scallop Advisory Council, and Sea Urchin Zone Council.

One of our most visible programs, Public Health, monitors water quality and biotoxins to ensure that shellfish products harvested in Maine are safe. Municipalities rely on data and information gathered by DMR's water quality monitoring and clam assessments to guide watershed land-use decisions, establish shellfish conservation areas, and set seasons and the number of licensees. Other state agencies such as the Department of Environmental Protection use DMR's water quality monitoring for identifying sources of pollution and prioritizing investments in sewage treatment.

Many of our species also migrate across state jurisdictional boundaries and become regulated by an additional layer of interstate, federal, and international bodies. For example, striped bass, shad and river herring, northern shrimp, and American lobster, that occur predominantly in the state territorial waters (0-3 mi), are managed by 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). These include the groundfish species complex, sea scallops, small pelagic species such as herring and mackerel, and large pelagic species such as sharks and tunas. Several species including Atlantic herring, bluefish, and winter flounder are managed jointly by the ASMFC and the NEFMC. Atlantic salmon and bluefin tuna are managed by international bodies such as the North Atlantic Salmon Conservation Organization (NASCO) and International Commission on the Conservation of Atlantic Tuna (ICCAT).

### **What types of research do we do?**

Research covers a range of activities, from protecting public health to helping to restore a single species, from testing new methods of management to identifying critical habitats, and

restoring populations to their historic ranges. Our research and monitoring is intended to be directly applied to management of our marine resources.

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 fishery resources. Long-term programs to evaluate the condition of and year-to-year changes in stocks, habitats, environmental conditions, and fisheries are of primary importance. We also invest in evaluating management techniques to assess how well they are working. And finally, we consider education and outreach to be integral to the delivery of our research results.

The following is a description of DMR research and monitoring efforts planned for 2011-2012. Many of these programs and projects are ongoing to meet management needs and legal mandates. Research needs that cannot currently be addressed by DMR are presented in the second half of this plan.

## **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. DMR has two public health laboratories, West Boothbay Harbor and Lamoine, where water quality and biotoxin samples are processed.

**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. DMR collected and processed over 14,000 seawater, well water, pollution source, and shellfish samples in 2010. 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. 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. Since MSC is not an NSSP approved indicator and the method is not an NSSP approved method, any data generated at this time will not be used for shellfish growing area classification.

**Volunteer Water Quality Monitoring** - The DMR Volunteer Coordinator coordinates over sixty 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** - The Marine Biotoxin Monitoring Program uses the standards outlined in the NSSP to monitor levels of Paralytic Shellfish Poison (PSP) and other marine biotoxins in the shellfish along the coast of Maine. When toxin is found at levels near or above where human illness may occur, DMR implements closures to the harvest of shellfish. Maine has historically had high levels of PSP, more commonly known as “Red Tide” during the warmer periods of the year. Shellfish samples are collected statewide between March and October and evaluated, for interpretation and appropriate closures are made when necessary.

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, federal funding appropriated by Congress following the 2005 Red Tide Disaster declaration allowed for intensive sampling in the Casco Bay area. As a result DMR left 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. Federal “Red Tide Relief” funding from 2008 has enabled DMR to continue the intensive fine-scale PSP sampling in Casco Bay and Cobscook Bay through 2011. This portion of the program will better define the distribution of toxic shellfish and minimize the extent of shellfish closures.

**Phytoplankton Monitoring** - The DMR Volunteer Coordinator trains 25-30 volunteers to participate in monitoring their coastal waters for potentially toxic algae. The volunteers report their findings to the DMR on a weekly basis during the sampling season and sample more frequently in areas when a toxic species is detected. We continue to work towards using phytoplankton monitoring as an early warning system for toxic blooms. In 2011 we will continue to use quantitative estimates of species abundance to complement offshore sampling conducted by Woods Hole Oceanographic Institute. A microscope with fluorescence capabilities is used in the Boothbay laboratory to conduct in situ hybridization on water samples throughout the season to confirm *Alexandrium* (the species responsible for PSP) numbers and establish baselines for the future. In addition, a flow cytometer (FlowCAM) was purchased in 2010 with funding from the Maine Outdoor Heritage Program, that has automated the identification and counting of phytoplankton samples. Other areas of research 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.

**Shellfish Dealer Certification and Inspection Program** - The Maine Shellfish Dealer Certification and Inspection Program uses the standards outlined by the NSSP to evaluate and certify all wholesale shellfish dealers in Maine. These dealers must be certified under the NSSP to ship, or process shellfish for shipment, within and outside the state of Maine. By making sure that wholesale shellfish dealers meet these standards, the safety and wholesomeness of the shellfish being purchased by consumers is ensured. DMR staff inspects and trains certified shellfish dealers throughout coastal Maine, and conducts food-borne illness investigations.

## **RESOURCE ASSESSMENTS**

DMR conducts a variety of sampling programs and approaches to collect information on the species of commercial, recreational, and socio-economic importance to Maine and on the fisheries for those species. Some surveys target a broad array of species while others focus on individual species and fisheries. Long-term monitoring efforts are generally used to track trends in abundance and condition of stocks from year to year. Shorter-term projects are designed to answer specific questions such as how fast fish are growing or where their spawning grounds are located. Surveys also are divided into fisheries independent and fisheries dependent. Fisheries

dependent surveys are used to collect information on landings by fishermen. However, because catches vary with the amount of time fished, gear used, weather, market price, and knowledge of where the fish are located, they are generally biased for use in comparing changes over time. To overcome that bias, fisheries independent surveys are done using a standard and consistent effort to minimize all other factors that effect catch and focus on actual abundance. Combined, all are integral to making recommendations on management measures.

### **Resource Surveys**

**Maine/New Hampshire inshore trawl survey** – Beginning in the fall of 2000, DMR initiated a survey of Maine’s marine resources in the nearshore waters of the Gulf of Maine bounded by the New Hampshire/Massachusetts border and the US/Canada border. Each spring and fall, the DMR charters a commercial dragger to survey groundfish and invertebrate stocks at approximately 115 locations in the coastal waters of Maine and New Hampshire from the 6 m contour to 12 mi offshore, excluding Cobscook Bay. The objective is to provide year to year indices of relative abundance and distribution patterns for over 100 species of marine organisms such as lobster, cod, monkfish, winter flounder, herring, whiting, and shrimp. Catch is sorted by species; counts, lengths, weights, sex, and maturity stage are recorded; and stomach and ageing samples are processed. The survey results are used by DMR, federal, state, and academic institutions throughout the Northeast for use in stock assessments and management.

**Juvenile recreational finfish study** – Juvenile winter flounder are tagged to determine their movements in representative habitat types such as intertidal mudflats, eelgrass beds, and channel areas <10 m in depth along the midcoast of Maine.

**Juvenile alosid and striped bass survey** - Beach seine surveys in the Kennebec/Androscoggin estuary monitor the abundance of juvenile alosids (shad, alewives, and blueback herring) 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.

**Groundfish** - Groundfish refers to the complex of species that includes 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. Many of 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 rebuilding of some groundfish stocks, but some species have failed to rebound. DMR initiated the Maine-New Hampshire trawl survey in 2000 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 NMFS, DMR, and ACCSP databases.

A DMR scientist represents the State of Maine in meetings of the NEFMC’s Multispecies Plan Development Team (PDT), participates in resource assessment and management activities, and participates 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 will be assembled and reviewed in preparation for active participation on the respective PDT.

**Groundfish port sampling** – DMR will continue a port sampling program in 2011-2012 for groundfish landed in selected Maine ports. Biological data will be collected including length, weight, and maturity, and otoliths for aging. DMR has established an age and growth laboratory, since ageing is a key component of groundfish assessments. Scientists will continue to age halibut and winter flounder along with cusk and Atlantic wolffish.

**Halibut** – DMR will continue a volunteer tagging study with halibut fishermen primarily fishing in state waters that began in 2000. Staff will document tag returns from previous years and current year releases. DMR is also working with the Halibut Alliance of Maine, a newly formed industry group, and the University of Maine to collect catch, effort and biological data from the state fishery.

**Conservation engineering** - 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 reduce bycatch of non-targeted species.

**Atlantic wolffish** – A study is underway to conduct a trap survey in midcoast Maine of Atlantic wolffish, a Species of Concern, funded by the NMFS. The study assessed the catchability of wolffish using modified lobster traps to collect data on habitat preferences of this species in year 1. Three satellite tags were also released in the first year, two have reported successfully and one will transmit data in early 2011. Year 2 will include acoustic tagging work to further increase our understanding of habitat use and movement.

**Redevelopment of a small mesh redfish fishery** – DMR is a partner with Massachusetts Division of Marine Fisheries and the University of Massachusetts Dartmouth's School of Science and Technology on a \$500,000 grant to redevelop the directed redfish fishery. Work will begin in the early part of 2011 and establish a baseline dataset of when and where redfish can be caught and what species co-occur and might pose potential bycatch problems. This project is designed to provide access to an allocation that sectors cannot currently catch due to large mesh regulations.

**Mortality and survival of cusk** – DMR received a federal grant to evaluate the extent and degree of cusk bycatch in the trap and longline fisheries. This project will begin in Spring 2011 and measure the condition and survival of cusk caught in non-directed fisheries. These data will be used in stock assessments and future management of this resource. Cusk is a Species of Concern and is being used as a climate model subject species by the NMFS Protected Resources Group.

**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.

**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 NMFS, DMR, and ACCSP databases.

A DMR scientist will represent the State of Maine on the NEFMC's Monkfish Plan Development Team (PDT). Amendment 6 is being initiated to institute catch shares in the monkfish fishery.

**Atlantic 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 and mid-Atlantic waters. Annually, catches are approximately 200 million lbs with the bulk of the fishery utilized for bait. In addition to their commercial importance, Atlantic herring are 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 conducting research, resource monitoring, and assessment for Atlantic herring. Data from these programs are utilized in stock assessments that are used to guide management actions developed under ASMFC and NEFMC fishery management plans. The goal for 2011-2012 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 NMFS.

**Bycatch program** - DMR conducts incidental catch surveys for vessels directly targeting Atlantic herring and landing at major New England and Mid-Atlantic ports. Confidential data are analyzed, summarized, and provided to managers in aggregate form for development of management measures for the targeted herring fishery. Additionally, biological samples are taken for other incidental species (river herring, American shad, menhaden, and others upon request.). DMR has initiated a new project to conduct at-sea sampling in the small mesh bottom trawl fishery for Atlantic herring.

**Herring stock assessment and management** – A DMR scientist participates in all aspects of interstate and federal management for Atlantic herring including ASMFC/NMFS stock assessments, Plan Development Team, Advisory Panel, and Management Board. Additionally, DMR has secured federal funding to work with Dr. Yong Chen at the University of Maine on alternative modeling of Atlantic herring populations with the intent of improving upon the current assessment methodology.

**American Lobster** - The DMR has been actively engaged in intensive studies of the American lobster 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 effective lobster management, not only for the State of Maine, but also the ASMFC and NMFS. Data collected in these sampling programs 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 boat trips per month are sampled 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 to collect catch/effort information and biological data (length, weight, and sex).

**Juvenile lobster settlement survey** - Dive surveys and suction sampling are 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** – DMR proposes to continue an industry-based trap survey to index juvenile lobster abundance from Maine to New York. Modified lobster traps with small mesh wire and no escape vents are set at randomly selected locations, stratified by statistical area and depth.

**Lobster stock assessment and management** - DMR's senior lobster scientist participates on ASMFC's Lobster Technical Committee, participates in stock assessments, and management meetings.

**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 (Northern Shrimp Section). 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 are slightly above average.

**Shrimp port sampling program** – DMR staff conducts dockside interviews 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 in the laboratory 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 each summer. 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, conducts the annual shrimp stock assessment to evaluate 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.

**Horseshoe Crab** – Annual surveys of horseshoe crab spawning populations and breeding sites have been conducted since 2001 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 horseshoe crabs, anecdotal information was collected which indicated that Maine populations experienced a

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.

**Horseshoe crab spawning survey** – A visual count of spawning horseshoe crabs is made at three sites along the coast during May and June spring tides. This survey relies heavily on volunteers who walk a standard survey transect at high tide counting crabs observed within a 1 m band. Since 2005, sites have been reduced from 14 to three for budget reasons. Horseshoe crabs are considered to be declining along portions of the Atlantic seaboard. The survey is intended to measure success of a ban, implemented in 2004, on taking Maine horseshoe crabs or eggs during the spawning season (May 1-October 30). However, because horseshoe crabs take upwards of six to eight years to reach maturity, we do not expect to note a resultant increase in population counts until about 2011-2012. A 10-year data set is currently being entered into the DMR biological database.

**Green Sea Urchin** - 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 management restrictions, and in 2009, only 3.5 million pounds were landed. Actions were not taken to manage the fishery during its boom years and it was not until 1995 that the state established the Sea Urchin Research Fund that has since funded a series of studies and long-term monitoring programs that have led to an improved understanding of Maine's sea urchin biology and fishery.

**Sea urchin port sampling program** - DMR samplers visit randomly selected Maine ports from Portland to Lubec where urchins are being landed, between September and March, depending on the fishing season. The 2010-2011 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 urchins in 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 periodic stock assessments of sea urchins and provide fishery sampling, survey and stock assessment information to the Sea Urchin Zone Council in their deliberations for recommendations on managing the resource.

**Sea Cucumber** - 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. Work will be done on trying to develop a protocol for evaluating maturity from a subsample of animals collected during the port sampling process.

**Sea Scallop** - Maine's scallop resource is currently at its lowest since 1977. It is difficult to say to what degree this decline in stock levels is due to natural factors or over-exploitation. Ten large closed areas along the coast were established in 2009 to help rebuild the scallop resource. The establishment of the Scallop Management Fund has enabled a statewide survey to characterize the coastal scallop population, initiation of 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. Biological data on the size of the catch are also collected.

**Coastal resource assessment** - DMR and industry partners survey the Maine scallop resource annually. Cobscook Bay and the St. Croix River were surveyed in 2010 and eastern Maine strata (Quoddy Head to eastern Penobscot Bay) will be surveyed in 2011. In 2012 the western strata (western Penobscot Bay to NH border) and Cobscook Bay/St. Croix R. are proposed for surveying. Sampling occurs in October-November prior to the start of the scallop season in December. The surveys provide 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. The 2011 and 2012 surveys will provide information on the effectiveness of the closed areas to help guide re-opening strategies.

**Northern Gulf of Maine scallop assessment** - A DMR/UMaine project entitled "Assessment of Sea Scallop Distribution and Abundance in Federal Waters of the Gulf of Maine" was awarded funding through the 2008 Research TAC Set-Aside (RSA) Scallop Exemption Program administered by NMFS. A survey to assess scallop distribution and abundance in the Northern Gulf of Maine Management Area was conducted in 2009. 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 to estimate a biologically sustainable TAC for the stock. A DMR/UMaine proposal has been funded by the 2011 RSA program for a second survey of the Northern Gulf of Maine area in 2012.

**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 of the resource will be conducted in 2011 in order to provide an update for the 2012 federal stock assessment and quota allocation. The purpose of the survey is to assess stock abundance and size composition of ocean quahogs from the primary quahog fishing grounds. Results are provided to the NMFS and Mid Atlantic Fishery Management Council in order to set quotas based on current resource information.

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

**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.

**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 and research.

**Managing rockweed harvesting in Cobscook Bay** – DMR staff will work with harvesters who declare an interest in harvesting in Cobscook Bay to monitor their annual harvest plans.

## COMMERCIAL AND RECREATIONAL STATISTICS

**Commercial Landings Program** - Harvest and effort data provide another estimate of resource condition. Landings also provide insights into the status and condition of the industry that fishes for those resources and is an opportunity for the DMR staff to hear directly from harvesters and dealers about emerging concerns. In 2008, DMR implemented a mandatory dealer reporting system for all commercial fisheries according to protocols established under the Atlantic Coastal Cooperative Statistics Program, a cooperative state-federal program including all of the Atlantic coast states, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the regional Fishery Management Councils.

**Dealer reporting program** – As defined in Chapter 8 regulations, DMR staff will collect mandatory landings information from all 1,600 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 over 11,500 licensed harvesters for the following fisheries: green crab, sea cucumber, seaweed, horseshoe crab, eel, halibut, whiting, herring, sea scallop, 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 was implemented

January 1, 2008, as required by Addendum VIII to Amendment III of ASMFC's Fishery Management Plan for American lobster and will continue with a new set of harvesters each year.

**Angler Surveys** - 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 Information Program (MRIP)**

May through October, DMR interviews anglers to estimate 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 in Maine. This part of a NMFS program to estimate the impact of recreational fishing on marine resources. Sampling in Washington County will continue with the assistance of Maine Sea Grant's Marine Extension Agent and students from the University of Maine at Machias.

**Large pelagics survey**

The DMR conducts the NMFS Large Pelagic Survey from July through October to monitor catch and effort of tunas and sharks. This survey consists of dockside vessel interviews and telephone calls to Atlantic Tuna permit holders.

**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.

**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.

**MARINE MAMMALS AND SEA TURTLES (PROTECTED RESOURCES)**

DMR has continually increased its role in the conservation and management of protected species, including pinnipeds (seals), 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 Atlantic Large Whale Take Reduction Program process and has since grown to include a comprehensive Conservation Plan that was drafted and implemented by the state in accordance with its Section 6 agreement with the Federal government. Additionally, DMR has assumed response responsibilities for strandings of pinnipeds, cetaceans and sea turtles from Kittery to Rockland to fill a need identified there by NOAA Fisheries.

**Marine Mammal Stranding Program** - 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 Networks** - DMR maintains a trained network of staff, Maine Marine Patrol Officers, commercial fishermen, Harbor Masters and volunteers to respond to live entangled whales and sea turtles. 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. This program is supported by the 24hr hotline maintained by the Stranding Program.

**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 and testing the use of longer trawls in place of short sets of gear, such as singles and pairs. Additionally, DMR is compiling baseline information on the densities and seasonality of vertical lines in lobster fishing areas from both surveys sent to license holders in, as well as fishery independent projects including aerial and boat based surveys. This information will allow DMR to frame a research plan for reducing the entanglement risk of these lines to whales as well as inform discussions regarding appropriate reduction levels. Entanglement risk reduction for vertical lines will continue to be discussed by the Atlantic Large Whale Take Reduction Team through 2011.

**Large Whale Foraging** - DMR continues to expand the large whale foraging research that began in 2006 with the formation of fruitful collaborations with the fishing industry, universities, and other academic institutions. These have included comprehensive CTD and plankton surveys statewide, a right whale habitat monitoring program and digitizing whale sightings data. Several projects were initiated in 2008, including a near-shore right whale prediction model, D-tagging humpbacks whales near Mount Desert Rock, passive acoustics to locate right whales and assessing historic photographic catalogues to determine the scarification and therefore entanglement rate of humpback whales in Maine coastal waters. Research planned for 2011 includes wrapping up several of these projects and disseminating the results, as well as expanding acoustic detection and support of right whale habitat projects off the Maine coast.

## **DIADROMOUS FISH RESTORATION RESEARCH AND MONITORING**

Anadromous fishes (alewife, blueback herring, American shad, striped bass, rainbow smelt, Atlantic salmon, Atlantic tomcod, sea lamprey, and Atlantic sturgeon) 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.

**Rainbow Smelt** - The Department is lead agency on a Gulf of Maine wide project to assess the status of and threats to sea-run smelt in Maine, New Hampshire and Massachusetts. Listed as Species of Concern by the National Marine Fisheries Service, 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 began in Maine to map the distribution of smelt, location of fish passage obstructions and habitat. We continue to assess population structure, endemic pathogens and parasites, and water quality. The 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.

**Atlantic Sturgeon** - Atlantic sturgeon is also listed as Species of Concern by the National Marine Fisheries Service. Sturgeon work began in 2008 and will continue in 2011 with emphasis on

estimating the size of the population and identifying important habitat. All fish will be implanted with uniquely coded PIT tags (passive integrated transponder) so individual fish can be identified when recaptured, allowing the size of the population to be estimated. Sonic tags will be implanted in fish in the lower Kennebec and fish movement monitored using an array of receivers that have been in place to monitor striped bass movement. Samples for genetics, toxic contaminants, and pathology will be collected to develop a baseline characterization on sturgeon.

**Shortnose Sturgeon** – Shortnose sturgeon is listed as endangered by the National Marine Fisheries Service. DMR is collaborating on a three-year research project with the University of Maine and the University of New England to estimate the population size of sturgeon in major river systems in Maine, characterize intersystem movements of sturgeon, determine feeding habitat and trophic position of sturgeon in each system, determine sex and stage of maturity, and investigate the possibility of scute elemental analysis as indicator of river of origin.

**Atlantic Salmon** - 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 Service 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, estimates of large parr; indices or estimates of smolt emigration; smolt physiology, marine and estuarine smolt trawling, and smolt tracking through estuaries. 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. Habitat work is important background for understanding freshwater productivity and over-winter parr survival.

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 hydrologists have developed a surface-water and ground-water (SW-GW) watershed model for the Narraguagus River that is being used to assess the effects of climate change scenarios on salmon habitat.

A series of cooperative research projects with the University of Maine will document the upstream migration of adult Atlantic salmon in the Penobscot River using Passive Integrated Transponder (PIT). The movements of individual adult salmon will be 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 are used to alter smolt stocking locations strategies.

**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 abundance data for juvenile Atlantic salmon throughout the geographic range of the Gulf Of Maine Distinct Population Segment (GOM DPS) using 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 manage 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 upper Piscataquis River, a Penobscot basin tributary and in the Narraguagus and Sheepscoot rivers.

Smolt trapping is designed to document emigration timing and estimate the smolt production from natural reproduction, and stocked fry and parr in rivers throughout the geographic range of the GOM DPS.

**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.

**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 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.

**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 brood stock 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 brood stock 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 distribute fry in their rivers of origin either by point or scatter stocking. Adults, parr, and smolts are point stocked by USFWS with DMR assistance.

### **Striped Bass**

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

### **American Eel**

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

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

### **Habitat, Environment, and Management**

**Penobscot River Diadromous Fishes Restoration Plan** - DMR, cooperatively with the Department of Inland Fish and Wildlife developed strategic and operational plans with the goal of enhancing and 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 plans recognizes that restoring ecosystem processes and integrated multi-species fish management will increase potential success.

**Diadromous fish restoration plans** - Diadromous fish restoration plans, cooperatively developed by DMR and other agencies between 1996 and 2002, guide restoration activity in the Kennebec River, Saco River, Union River, and Presumpscot River. A plan is currently being developed for the Androscoggin River.

**Hydropower Project review** – DMR staff review applications for federal licenses; provide written recommendations for fish passage, flow management protocols, and minimum flow requirements; and engage in comprehensive settlement discussions that often involve multiple projects within a watershed. Once a federal license has been issued, typically for 30 to 50 years, DMR staff review and comment on study plans and reports, make site visits, draft all or portions of annual reports, and participate in annual meetings.

**Environmental review** – DMR staff reviews applications for a variety of projects (point-source discharges, construction, road crossings, dredging, pipelines) and makes recommendations to reduce project impacts on diadromous fishes.

**Fish passage at non-hydropower dams** - DMR staff work with various federal, state, and local partners to obtain funding for dam removals, fish passage, and maintenance of fish passage at more than 20 locations on Maine rivers.

**Fishway monitoring** - DMR staff monitors the upstream and downstream passage of American shad, alewife, blueback herring, and Atlantic salmon at the Brunswick Project on the Androscoggin River, the Lockwood Project on the mainstem Kennebec River, and the Benton Falls Project on the Sebasticook River. All fish are identified and enumerated, and alewives and blueback herring are sampled weekly to obtain information on length, weight, age, and sex of fish throughout the season. 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.

**Alewife and blueback herring stocking** – DMR's stocking program is an interim management measure to initiate new runs or maintain existing runs of alewife and blueback herring (collectively river herring) prior to the provision of fish passage. Each year a portion of the adult river herring that utilize the Brunswick Project fishway and the Lockwood Project fish lift are captured by DMR and transported to lakes and ponds throughout Maine. In 2010, DMR stocked a total of approximately 90,000 fish into 24 lakes and ponds.

**Lower Kennebec juvenile finfish survey** - Beach seine surveys in the Kennebec estuary have been conducted annually since 1979 primarily to monitor the abundance of juvenile alosids (shad, alewives, and blueback herring) and striped bass. Sampling is conducted every other week from mid-May to the end of August 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. All fish are counted and the total length of a maximum of 50 of each species is measured.

**Upper Kennebec juvenile finfish survey** - A beach seine survey was initiated in 2000 on the Kennebec River between Augusta and Waterville to monitor changes in fish communities over time following the removal of the Edwards Dam and to monitor the shad restoration program on the Kennebec River. This survey complements the one being conducted in the lower Kennebec River..

**Penobscot juvenile finfish survey** - A beach seine survey was initiated in the Penobscot River in 2010 to monitor changes in the fish community before and after implementation of the Penobscot Project (removal of Veazie Dam and Great Works Dam). The sampling protocol is similar to that of the Kennebec, but fewer sites (8) are sampled.

**Evaluation of anadromous fish population restoration on the Sebasticook River** - DMR scientists are using 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.

**Large wood additions to streams** – Large wood is being 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 are felled and their placement adjusted to achieve either stability or geomorphologic effect. 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.

**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 by first documenting the spatial and temporal extent of overlapping habitat use in rivers.

## **HABITAT, ENVIRONMENT, AND MANAGEMENT**

**Low Tide Aerial Photography** – Intertidal and shallow subtidal habitats are photographed about once every 10 years. Their value in providing managers with a record of change over time has been especially useful in determining the extent of impacts from human development and resource harvest activities. They have also been key to documenting habitat conditions prior to oil spills so that the State can accurately assess damage. This photographic series has been especially valuable toward understanding and tracking changes in eelgrass habitat. Eelgrass habitat is critical for a number juvenile finfish species and blue mussels. In 2011, phot-interpretation and mapping will be completed based on 2009 and 2010 aerial photography from Biddeford Pool to the New Hampshire Border and from Schoodic Point to the Canadian border. Acquisition of new aerial photograph is planned in 2010 for Saco Bay and Casco Bay.

**Natural Resource Damage Assessment** - DMR staff responds to oil and hazardous waste spills in the marine and estuarine environment as needed to assist with assessment of damages to natural resources. These assessments are the basis for compensating the State for natural resource losses. The DMR 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>.

**Invasive Species** - 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.

**Environmental Reviews of Coastal Alteration Projects** - DMR reviews environmental permit applications for coastal alterations, energy development, dredging, docks, and marina projects. Technology and practices have evolved greatly over the past decade to the point where some

rules and guidelines may no longer be appropriate. In 2009 staff will begin testing the efficacy of specific practices for particular activities and impacts.

**Aquaculture Lease Program** - DMR administers a lease program in coastal waters for scientific research and for aquaculture of marine organisms. DMR staff conducts assessments of proposed sites and the surrounding area to determine possible effects of the lease on commercially and ecologically significant flora and fauna and conflicts with traditional fisheries and all other uses. DMR administers fish health rules for shellfish and finfish aquaculture.

**Taunton Bay Resource Management Plan** – A comprehensive resource management plan for Taunton Bay was developed and passed by the Legislature in 2007. This plan is a novel management experiment. A Taunton Bay Advisory Committee advises the Commissioner on implementing a science-based comprehensive resource management plan for Taunton Bay. The plan addresses principal resource user groups in the context of sustaining ecological processes, functions, and values of Taunton Bay. In 2008, new harvest regulations on urchins, mussels, scallops, and kelp went into effect. The Taunton Bay Management Area regulation expired on December 31, 2010 and a replacement regulation is being developed to simplify management of fisheries in Taunton Bay. A report to the Legislature on this experiment will be completed in 2011.

**Education and Outreach** – DMR's research and monitoring efforts are very much directed toward solving and preventing problems and improving management. Key to the success is making sure results are known and available, especially to managers, policy and decision makers. Disseminating research and monitoring findings are essential to results being useful. DMR operates the Marine Resources Aquarium in West Boothbay Harbor and the Burnt Island Lighthouse Live History Program 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. Both these facilities and education staff draw on research and monitoring results of the Department. Research and education staff conducts seminars and lectures on a variety of topics to Maine's school children, the public, and media. The Education Program provides teacher recertification training courses.

## **RESEARCH NEEDS**

The research programs described above illustrate DMR's focus on long-term monitoring programs that are essential to protect public health, and assess and restore populations of marine, estuarine, and diadromous species, their environments, and fisheries. There are many additional research and monitoring needs that cannot be addressed due to lack of funding and personnel. In addition, there are a number projects such as the Maine-New Hampshire inshore trawl survey for which DMR has not identified a stable source of long-term support.

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" ([http://www.maine.gov/dmr/research/table\\_of\\_contents.htm](http://www.maine.gov/dmr/research/table_of_contents.htm)); issues related to freshwater habitat identified in state, regional, federal, and international management, conservation, and recovery plans for Atlantic salmon; 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.

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

### **Public Health**

DMR's Growing Area Program component of the National Shellfish Sanitation Program underwent an external peer review in 2007 that made a number of recommendations for program improvements that have been implemented. Additional research is needed on the following:

- Monitoring for biotoxins other than Paralytic Shellfish Poisoning
- Water quality studies to address the length of rainfall closures and closures around sewage treatment plant outfalls
- Studies to determine shellfish meats vs. water quality, especially in colder, winter periods
- Hydrographic/drogue studies of river systems; Kennebec River, etc. (this would be good for PSP and WQ)
- Study of the feasibility of "automatic reopening" of rainfall closures based on historical data and shellfish meat vs. water quality studies
- Study to determine which areas of the coast are never, least, moderately or most impacted by FLOOD rainfall to determine closing/reopening sequence
- Hydrographic studies and alternative technologies to determine mixing of rivers and runoff with estuaries and bays
- Determining levels of *Vibrio parahaemolyticus* (pathogenic and nonpathogenic) in Maine coastal waters and the risk to shellfish industry
- Evaluate the risk of contamination of shellfish in wet storage units by *Campylobacter jejuni* from seabirds.

### **Resource Assessment**

Stock assessment includes all of the activities carried out to describe the conditions or status of a stock. This can be separated into fishery dependent information such as numbers of fishermen by gear type, amount of fish caught and fishing effort expended by individual harvesters over time, times and areas of fishing, and value. Biological data that is needed from the catches include the age structure of the population by each type of gear, age at first spawning, fecundity, sex ratios, growth rates, natural and fishing mortality, spawning time and location, habitats, migratory habits, and food habits. Fishery independent information describes the information collected by scientists from their own sampling programs such as from the Maine-New Hampshire Trawl Survey and the scallop and sea urchin surveys. Improved methods of biomass assessment are needed for many species including Atlantic herring and rockweed. Table 1 summarizes the information collected by DMR research programs and indicates where research is needed.

### **Diadromous Fish Restoration**

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 2010, these agencies developed a framework to guide Maine Atlantic Salmon Recovery and Restoration based on the following:

#### **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. The primary goal is to adaptively manage hatchery production and stocking based on the broodstock management plan and long-term and annual stocking plans that include explanations and justifications for each life stage stocking approach/methodology, identify stocking locations, and describe assessments.

### **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.

*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.

### **Aquaculture**

Marine aquaculture is a valuable industry in Maine and includes the culture of Atlantic salmon, trout, oysters, and mussels. The finfish aquaculture industry has undergone a period of consolidation, while the number of shellfish growers has increased. As of 2008, there are 69 standard shellfish leases, totaling 639.82 acres, 28 finfish leases, totaling 632.14 acres, and nine experimental leases totaling 15.85 acres, located in marine and estuarine waters along the Maine coast.

- Use of Aquaculture for habitat protection and water quality improvement (e.g., polyculture)
- Development of husbandry techniques to minimize benthic impacts to low energy sites
- Inventory of endemic disease organisms to form the basis for biosecurity zones
- Determine the severity of aquaculture operations on disturbance to nesting seabirds (work in progress)
- Development of storm resistant sea cages
- Assess extent to which mussel rafts contribute to local mussel sets

### **Life History**

Much is still unknown about the basic biology and life history of most of our marine resources. The following priorities for lobster, shrimp, scallops, and sea urchins were identified in a series of meetings with fishermen and scientists in 2000 ([http://www.maine.gov/dmr/research/table\\_of\\_contents.htm](http://www.maine.gov/dmr/research/table_of_contents.htm)):

- 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.
- Understand migration and movement of lobster post larvae, juveniles, and especially broodstock.
- 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?
- Describe shrimp juvenile life history, especially its duration, to provide better assumptions for stock assessment models.
- What factors regulate timing of juvenile shrimp migrations, sexual transformation (male to female) and female inshore/offshore migration?
- What factors such as density dependence are operating to determine shrimp sexual maturation (male)?
- What triggers scallop spawning? Is it density dependent?
- Document and understand scallop growth rates in different areas.
- Study predation on scallops at larval and juvenile life stages.
- Understand urchin spawning, settlement survival, size/age ratio, and other biological measures in a local context to support local management.

### **Habitat Characterization, Ecology, Monitoring, and Mapping**

- Eelgrass studies for BMP development to determine and minimize impact of fishing activities
- Conduct seafloor mapping of nearshore Gulf of Maine waters
- Effects of inter-tidal mussel dragging on benthic organisms
- What is the role of the clam flat in coastal ecology and the environment?
- What is the impact of harvesting methods on the ecology of the clam flat: pulling, turning over mud, clam digging, worm digging, nearshore dragging?
- What is impact of water quality, toxics, and exotics such as enteromorpha on clam flat health?
- What are the specific habitat needs of clams?
- Mechanisms that control clam settlement, survival, and growth.
- Effect of water quality on lobster reproduction, growth, and health including chlorine, herbicides and pesticides, and nutrients.
- Rockweed studies to evaluate habitat loss and change in structure, how rockweed as habitat changes with different harvest press, sustainability, nutrient budgets and trophic links.

### **Oceanographic Influences on Fisheries**

The influence of oceanographic currents and nearshore circulation on the delivery of larval stages of most marine resources are not well understood and have important implications for area-specific management and enhancement efforts. Specific areas of research have been identified for lobster, shrimp, scallops, sea urchins, and clams.

- Determine the lobster broodstock source for larval settlement and harvest areas and the relationship and relative contributions of the inshore and offshore broodstock.
- Study nearshore oceanography to understand its impact on larval transport and settlement for lobsters.
- Are there large-scale oceanographic or climatic influences that have caused the reduced lobster larval settlement in certain years? If so, through what factors or mechanisms are those influences operating?
- 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.
- Evaluate the physical and biological effects of oceanographic events relative to the shrimp population.
- Fine scale research and current modeling to determine scallop larval dispersion patterns.
- Where is the effective broodstock for each scallop area?

- What are the mechanisms that determine the relationship between adult scallop biomass and recruitment success?
- Do adult scallops or scallop larvae move inshore and/or offshore?
- What is the broodstock source for the clam larvae that settle in a specific cove?
- What are the oceanographic and sediment conditions that result in successful growth of clams after spat fall or reseeded?
- Document and explain local variability in clam growth rates, particularly the slow growth in eastern Maine.
- Study nearshore oceanography to understand its impact on urchin larval transport and the relationship between larval source and urchin settlement.

### **Impacts of Climate Change on Marine Resources, Habitats, and Fisheries**

While specific measurements, causes, and consequences of climate change continue to be debated, there is now nearly universal consensus that we are experiencing significant changes in global climate and that human activities are contributing to these changes. We do not understand definitively how fisheries will be impacted, but we can be certain that changes in temperature and circulation will impact the patterns of distribution and migration of species, their life history, their habitats, and the fisheries. DMR's long-term monitoring programs will be useful for tracking these changes.

### **Ecosystem-based Management**

Ecosystem-based management (EBM) is an integrated approach to management that considers the entire ecosystem, including humans. Approaches to implementing EBM in coastal and marine ecosystems focus on protecting their structure and function in order to sustain the services that humans want and need (food and livelihoods from fishing, storm protection, pollution mitigation, recreations, etc.). DMR has successfully carried out an EBM approach in Taunton Bay; however, the resources are not available to maintain or expand this approach. A critical need to support EBM is:

- Develop a human use inventory (i.e., mapping where people use the resource)

### **Large Whales**

**Entanglement risk in Maine coastal fishing habitats** - All of the work done by the Large Whale Conservation Program arm of the Protected Species Division stems from needs identified at the Atlantic Large Whale Take Reduction Team level. This may include questions directly addressed by the team or areas of concern identified by the DMR delegation as relevant and vital to management discussions. First and foremost in these discussions is the definition of entanglement risk, how it is identified, calculated, and reduced through the use of management regulations on certain commercial fisheries. These questions are of the utmost importance because they define the federal regulations put into place to reduce the risk that the Maine lobster and gillnet fisheries pose to endangered and threatened large whales.

- Determine the risk of entanglement due to different gear types in Maine coastal fishing habitats
  - Document baseline gear densities and configurations. How do those change seasonally and with the enforcement of new regulations regarding gear types and use?
  - What are the seasonal abundances and distributions of large whale species, specifically right, humpback and fin whales, in Maine near-shore habitats?

- What is an acceptable level of entanglement risk? What reductions in gear densities are needed to achieve those levels?
- Are there gear modifications or changes in fishing practices that can be done to decrease the level of entanglement risk without removing gear from the water?
- How can the effect of new gear regulations on the entanglement rate be measured and monitored?
  - How high is fishing industry compliance?
  - What is the baseline entanglement scarification rate on humpbacks in the Gulf of Maine and how has that changed after regulations were in place?
  - Can a method of documenting entanglement rate be developed for fin and right whales?

**Whale Habitat** - There is little known about large whale habitat use and needs along the rocky coastline of Maine. How this area of their range is used, how often and what the differences are between Gulf of Maine habitats and critical habitats that are well studied in other locations are all important parts of the discussion when regulating fisheries to reduce a perceived or proven risk in this area.

- What parts of the coast and in what seasons are habitats conducive to large whale abundance
  - What are the defining characteristics (oceanographic variables, prey occurrence) of those habitats and what are the inter-annual fluctuations associated with them?
  - Can these characteristics be used to construct a near-shore predictive model for the occurrence of right and other large whales?
- What parts of the water column are whales using during feeding? Do they go to the bottom and if so what is the nature of these dives (exploratory, feeding)?

### **Whale Behavior**

Large whale behavior while in Maine coastal waters is also of concern because certain behaviors put the whale more at risk for entanglement than others. Most research on right whales has been completed in their critical habitats of the Bay of Fundy, Cape Cod Bay, and the Great South Channel. Little is known about how they use the coastal parts of the Gulf of Maine and how the behaviors they exhibit here may influence their risk for entanglement in trap/pot or gillnet gear. Some work with humpback whales has occurred in Maine but that is mostly exclusive to Jeffery's Ledge in the south and Downeast. Little information is known about their feeding and diving behaviors in these regions. Fin whales are probably the least studied species because they are faster and harder to work with.

- What are the diving depths of right, humpback and fin whales in Maine's rocky coastal habitat and how close to the bottom do these dives take them?
- What are the feeding patterns and behaviors of right, fin and humpback whales in Maine?
- Is there an offshore winter/breeding ground for right whales in the Gulf of Mai

Table 1. Status of DMR research on Maine's marine resources.

	SPECIES																										
	American eel	American lobster	American shad	Atlantic halibut	Atlantic herring	Atlantic salmon	Atlantic sturgeon	Blue mussel	Crabs, Jonah & rock	Green crab	Groundfish	Hagfish	Horseshoe crab	Marine worms	Monkfish	Northern shrimp	Ocean quahog	River herring	Sea cucumber	Sea scallop	Sea urchin	Seaweed	Smelt	Soft-shell clam	Striped bass		
<b>RESEARCH TOPICS</b>																											
<b>Commercial &amp; recreational statistics</b>																											
Commercial landings						NA	NA																			NA	
Catch by harvester						NA	NA																				
Recreational harvest						NA	NA																				
<b>Resource assessment:</b>																											
Fishing effort by gear type						NA	NA																				
Bycatch by gear																											
Age and growth																											
Maturity																											
Fecundity																											
Sex ratio																											
Spawning time & location																											
Natural mortality																											
Fishing mortality						NA																					
Habitat by life history stage																											
Migratory habits																											
Food habits																											
Stock assessment models																											
Fish health monitoring																											
Stock structure																											
<b>Fishery independent surveys</b>																											
<b>Gear research to reduce bycatch of undersized target species and of non-target species</b>																											
<b>Impacts of fishing gear on habitat and development of BMPs</b>																											
Key:		No ongoing research						Some research						Fairly complete research													
NA	Not applicable																										