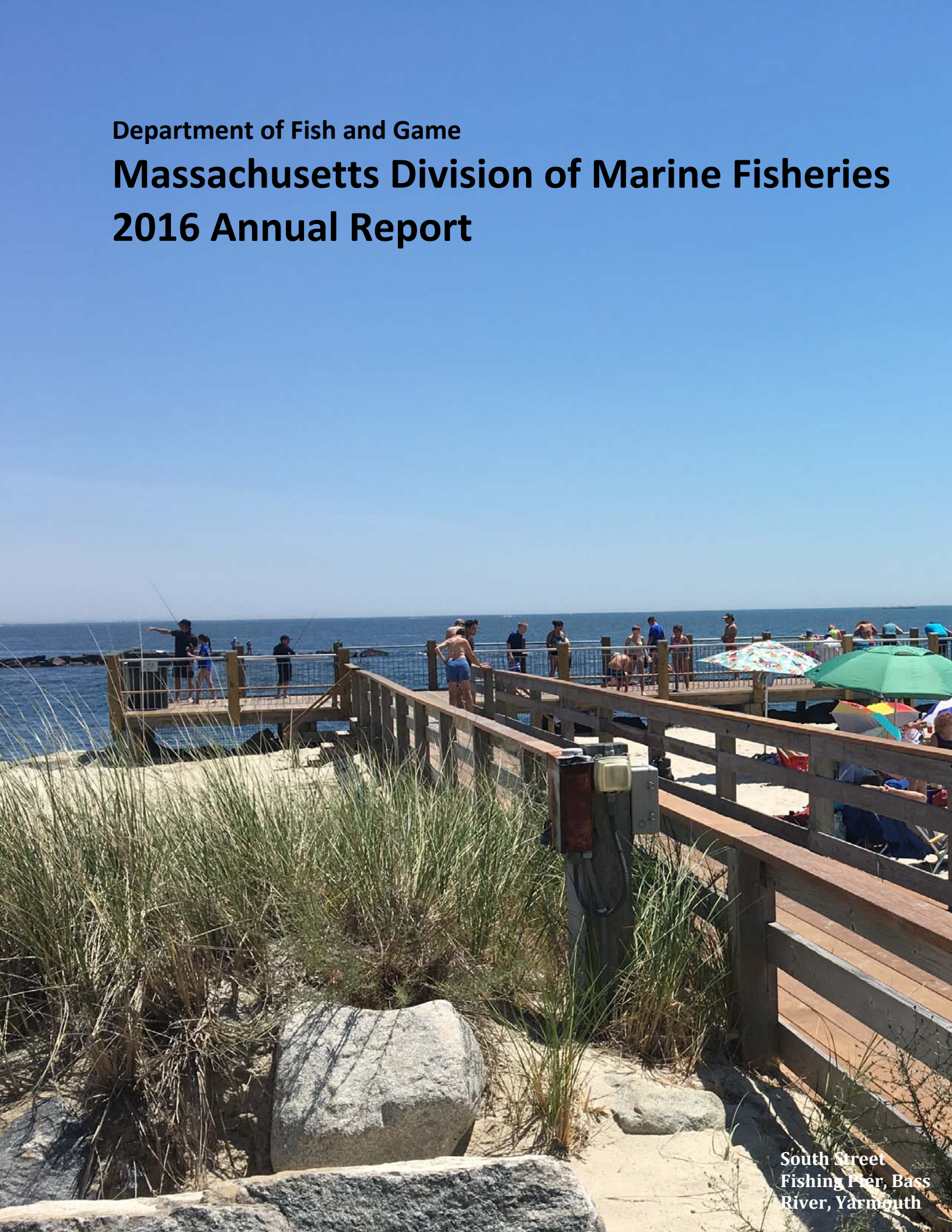
Department of Fish and Game

Massachusetts Division of Marine Fisheries 2016 Annual Report



South Street Fishing Pier, Bass River, Yarmouth

Department of Fish and Game

Massachusetts Division of Marine Fisheries

2016 Annual Report

Commonwealth of Massachusetts
Governor Charles D. Baker
Lieutenant Governor Karyn E. Polito

Executive Office of Energy and Environmental Affairs
Secretary Matthew A. Beaton

Department of Fish and Game
Commissioner George N. Peterson, Jr.
Deputy Commissioner Mary-Lee King

Division of Marine Fisheries
Director David E. Pierce, Ph.D.
Deputy Director Daniel J. McKiernan
Chief Financial Officer Kevin Creighton

www.mass.gov/marinefisheries

January 1–December 31, 2016

Table of Contents

Introduction

The Massachusetts Division of Marine Fisheries (*MarineFisheries)* of the Department of Fish and Game is the Commonwealth's marine fisheries management agency. *MarineFisheries* is responsible for the development and promulgation of the Commonwealth's regulations governing commercial and recreational fishing activity conducted in the marine environment. The Division promotes and develops commercial and recreational fisheries through research, technical assistance, and the collection of statistics. Guidelines for managing marine fisheries come through Chapter 130 of Massachusetts General Law, the Atlantic Coastal Fisheries Cooperative Management Act, the Interjurisdictional Fisheries Management Act, and the Magnuson-Stevens Fishery Conservation and Management Act.

To successfully fulfill its responsibilities, the Division has established the following mission, vision, and goals.

Mission

To manage the Commonwealth's living marine resources in balance with the environment resulting in sustainable fisheries and contributions to our economy, stable availability of diverse, healthy seafood and enriched opportunities that support our coastal culture.

Vision

Sustainable fisheries and a healthy marine ecosystem achieved through innovation, collaboration, and leadership enriching the public's way of life.

Goals

Improve fisheries sustainability, promote responsible harvest and optimize production of our living marine resources.

Promote and support our commercial and recreational fisheries.

Promote and support industry and community involvement in the fisheries management process.

Foster partnerships that help accomplish the Division's mission.

Support continued development of an ecologically sustainable marine aquaculture industry.

Promote a high level of staff commitment and professionalism.

Ensure that marine spatial planning activities are compatible with fisheries management.

Frequently Used Acronyms and Abbreviations

Army Corps	US Army Corps of Engineers
ACCSP	Atlantic Coastal Cooperative Statistics Program
ALWTRP	Atlantic Large Whale Take Reduction Plan
ASMFC	Atlantic States Marine Fisheries Commission
CCB	Cape Cod Bay
CE	Conservation Engineering
CZM	Massachusetts Office of Coastal Zone Management
EOEEA	Executive Office of Energy and Environmental Affairs
EPA	Unites States Environmental Protection Agency
FMP	Fishery Management Plan
GIS	Geospatial Information System
GOM	Gulf of Maine
ILF	In-lieu Fee
ISSC	Interstate Shellfish Sanitation Conference
LCMA	Lobster Conservation Management Area
*Mass*DAR	Massachusetts Department of Agricultural Resources
*Mass*DCR	Massachusetts Department of Conservation and Recreation
*Mass*DEP	Massachusetts Department of Environmental Protection
*Mass*DFG	Massachusetts Department of Fish and Game
*Mass*DOT	Massachusetts Department of Transportation
*Mass*DPH	Massachusetts Department of Public Health
Massport	Massachusetts Port Authority
*Mass*Wildlife	Massachusetts Division of Fisheries and Wildlife
MAFMC	Mid-Atlantic Fishery Management Council
MFAC	Marine Fisheries Advisory Commission
MRIP	Marine Recreational Information Program
NEFMC	New England Fishery Management Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
NSSP	National Shellfish Sanitation Program
OCC	Outer Cape Cod
OLE	Office of Law Enforcement (Massachusetts)
PCCS	Provincetown Center for Coastal Studies
PDT	Plan Development Team
PSP	Paralytic Shellfish Poisoning
SAFIS	Standard Atlantic Fisheries Information System
SMAST	School for Marine Science and Technology (at UMass Dartmouth)
SNE	Southern New England
USCG	United States Coast Guard
USFDA	United States Food and Drug Administration
USFWS	United States Fish and Wildlife Service
VTR	Vessel Trip Report
YOY	Young-of-year

FISHERIES MANAGEMENT SECTION

Fisheries Policy and Management Program

Personnel

Dr. David Pierce, Director
Daniel McKiernan, Deputy Director
Melanie Griffin, Fisheries Management Specialist
Nichola Meserve, Fisheries Policy Analyst
Dr. Catherine O'Keefe, Marine Science and Policy Analyst
Story Reed, Permitting and Statistics Administrator
Jared Silva, Regulatory Coordinator
Samantha Andrews, Economic Fishery Assistance Specialist
Kristina Dubuque, Administrative Assistant (April–August)

Conservation Engineering Project
Michael Pol, Project Leader
David Chosid, Marine Fisheries Biologist

Overview

MarineFisheries is responsible for managing the Commonwealth's commercial and recreational fisheries. Management of marine resources unique to state waters and which cross state/federal boundaries is a constant, ongoing endeavor. A core of fisheries management professionals, with many years of practical experience and knowledge of Massachusetts fisheries, composes the team that initiates, evaluates, and selects fisheries management policy and strategies to implement rules and regulations. These rules and regulations frequently result from participation on, and in support of, federal fisheries management through the New England Fishery Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC), and interstate fisheries management through the Atlantic States Marine Fisheries Commission (ASMFC).

Our fisheries policy and management staff gathers and analyzes biological and economic data, communicates with the media and public on state, interstate, and federal fisheries management issues, and ensures adherence to administrative and regulatory protocols and procedures. This process also relies on our technical staff to provide biological analyses and other technical reviews of management options to ensure sustainable fisheries and fisheries habitat protection.

Frequent communications with commercial and recreational fishery participants is another important element of policy and management development. This effort directly involves a diverse array of fishermen, dealers, processors, and many other stakeholders. Public hearings to propose regulation changes are held by the Commonwealth's Marine Fisheries Advisory Commission (MFAC) established by the Legislature in 1961. The MFAC and the Commissioner of the Department of Fish and Game must approve regulatory changes that *MarineFisheries* proposes in order for them to be implemented.

Advisory Groups

Following below is a summary of 2016 proceedings by groups advising *MarineFisheries* on fishery management issues.

Marine Fisheries Advisory Commission

The Massachusetts Marine Fisheries Advisory Commission (MFAC) is a nine-member board, representing recreational and commercial fishing interests, from various parts of the Massachusetts coast. Commissioners are appointed by the Governor to three-year terms and attend monthly business meetings as well as public hearings. Proposed regulatory changes are approved or disapproved by a majority vote at the Commission's monthly business meetings.

The Governor made eight new appointments to the MFAC in 2016. The new Commissioners include: Kalil Boghdan of Hamilton, William Doyle of Plymouth, Michael Pierdinock of Plymouth, Charles Quinn of South Dartmouth, Gus Sanfilippo of Gloucester, Arthur Sawyer of Gloucester, Andrew Walsh of Stoughton, and Louis Williams of Salem. Raymond Kane of Chatham was re-appointed, and elected MFAC Chairman.

The MFAC held ten business meetings and nine public hearings during 2016. Regulatory revisions and fishery specifications that were approved by the Commission or became effective during 2016 are included in the summary of fisheries management actions in the following pages. A subcommittee of the MFAC also met twice to review law enforcement and compliance issues. Where possible, Commissioners also attended six Massachusetts-based ASMFC public hearings on interstate management plans that were hosted by the Division, and other informational meetings.

Marine Recreational Fisheries Development Panel

Pursuant to provisions of "An Act Instituting Saltwater Fishing Licenses", a Marine Recreational Fisheries Development Panel was established in 2010 to recommend how annual appropriations from the Marine Recreational Fisheries Development Fund should be spent. All fees collected from the sale of recreational saltwater fishing permits are deposited into this fund for the dedicated purpose of improving recreational fisheries or recreational fishery research in the Commonwealth, with a requirement that one-third of the annual appropriation be used for "improved public access to marine recreational fisheries."

The Panel met during July 2016 to review spending of the Fiscal Year (FY) 2016 fund appropriation and make recommendations for spending of the expected FY2017 fund appropriation of roughly $1.3 million. The approved spending plan included, but was not limited to: a property acquisition in Wareham on the Weweantic River to provide shore and car-top vessel access; permitting and engineering (year 1) for a refurbished or replaced Salem Willows Fishing Pier; engineering (year 2) for a new Deer Island Fishing Pier in Boston Harbor; rehabilitation of two fishing piers on the Wareham River in Wareham; continuation of a Small Grants Program through which municipalities can compete for funds (up to $15,000 per project) to finance public access improvement projects within their jurisdictions; continuation of expanded and enhanced sampling and assessment of the recreational fishery; public informational and educational materials and programs; monitoring diadromous fish populations; and monitoring fish populations at artificial reefs. Actual spending, particularly with regards to public access infrastructure projects, was subject to change due to host-town priorities and timelines, design and engineering constraints, and other possible complications.

Members of the Panel attended an August 4 media event to celebrate the placement of the Harwich Artificial Reef and its designation for recreational fishing use. The event included a dock-side

commencement and reef-bound fishing trip aboard the Division's *R/V Mya* (Figure 1). The project was financed, in part, by FY2016 funds from the Marine Recreational Fisheries Development Fund.

Figure 1. Panel member Michael Pierdinock spoke on behalf of the Panel at the Harwich Artificial Reef event (left); Director David Pierce reels in a black sea bass at the reef (right).

Seafood Marketing Steering Committee

On August 13, 2014, then Governor Patrick signed into law "An Act Promoting Economic Growth Across the Commonwealth," which, in part, established a Seafood Marketing Program within *MarineFisheries*. The legislation lays out initial objectives of the program, requires the appointment of a 19-member steering committee to guide *MarineFisheries* in the administration of the marketing program, and designates funding of up to $250,000 per fiscal year from commercial harvester and dealer permit revenues. The steering committee, chaired by *MarineFisheries,* was appointed early in 2016, and met twice during the year. See *Seafood Marketing* (page 115) for more information.

Shellfish Advisory Panel

MarineFisheries formed a Shellfish Advisory Panel in 2014 to provide guidance to the agency on emerging issues, matters of concern, and possible solutions with regards to the shellfish industry in the Commonwealth. The group includes harvesters, dealers, researchers, aquaculturists, and municipal shellfish officials. The panel met once in November of 2016 to discuss and provide industry input on a range of issues including *Vibrio parahaemolyticus* control measures, shellfish closures related to a Norovirus illness outbreak and potentially toxic phytoplankton bloom, permitting of seed hatcheries, emerging issues in the shellfish dredge fisheries, and proposed regulations for razor clams.

Fisheries Management Actions

American Eel

Commercial Quota System: For compliance with Addendum IV to the Interstate FMP for eel, *MarineFisheries* adopted regulatory language establishing quota management of the commercial eel fishery, should its use be triggered. The addendum set a coastwide quota, but if it is exceeded by more than 10% in any year or by any amount in two consecutive years, state-specific quotas will be implemented (including the default minimum of 2,000 pounds for Massachusetts). Public hearings were held in July and the rule was codified October 21.

Recreational Bag Limit: *MarineFisheries* amended the American eel regulations to specify the daily recreational limit as a harvest limit rather than a harvest and possession limit. The Division's initial interpretation of this Addendum III to the Interstate FMP requirement resulted in some individuals purchasing a commercial eel permit endorsement so that they could possess eels that they legally obtained (e.g., bought from a bait store) in excess of the recreational limit during a fishing trip. Public hearings were held in July and the rule was codified October 21.

American Lobster and Jonah Crab

American lobster and Jonah crab are managed under the same interstate FMP; their management actions are thus grouped.

Southern New England Lobster Trap Allocations and Trap Allocation Transfer Program: At the end of 2015, *MarineFisheries* enacted emergency regulations that implemented the interstate FMP's trap allocation reduction schedule for Lobster Conservation Management Area 2 and a more liberal trap transfer program. The ASMFC adopted these management approaches in 2012 in response to the depleted status of lobster in Southern New England, but their implementation awaited the development of a centralized database, joining both state and federal trap allocation data, which became available in 2015. The trap allocation reduction schedule for LCMA 2 is 25% for 2016, followed by 5% annual reductions for five years (2017–2021). The new transferability regulations allow permit holders to more easily obtain trap allocation and permits from other fishermen exiting the fishery to mitigate the mandatory trap allocation reductions. By the end of the six-year reduction schedule, reductions in participants and overall traps fished are expected commensurate with the decline in stock productivity due to ocean warming in the southern range of lobster. Final regulations became effective March 25, following a public hearing in January.

In July, *MarineFisheries* and NMFS co-hosted two workshops on the Lobster Trap Allocation Transfer Program in advance of the application period that began on August 1 for transfers effective May 1, 2017.

Offshore Lobster Team Meeting: In April, *MarineFisheries* hosted a meeting of the Area 3 Lobster Conservation Management Team (LCMT). The meeting served to update the LCMT on the latest stock assessment and allow team members to discuss and recommend conservation and management strategies, particularly for the southern New England and Mid-Atlantic area where population declines have been observed.

Jonah Crab Interstate FMP: *MarineFisheries* held a public hearing on January 23 and implemented final regulations effective March 25 for compliance with the first-ever interstate FMP for Jonah crab, which responded to concerns about increasing targeted fishing pressure for the species. *MarineFisheries* first implemented emergency regulations effective at the end of 2015 applicable to both Jonah crabs and rock crabs (because of their physical similarity), including a prohibition on egg bearing crabs, a requirement to land crabs whole, a non-trap gear crab trip limit, a recreational limit, and a commercial minimum size. Only commercial lobster permit holders were authorized to commercially harvest the crabs, and any trap gear fished for the crabs was required to conform to existing lobster trap gear rules. To address the use of rock crabs as bait, the final regulations included exemptions to the minimum size and non-trap trip limit for this species.

Jonah Crab Addendum I: *MarineFisheries* hosted two ASMFC public hearing on Draft Addendum I to the Interstate FMP for Jonah crab in March. As approved by the ASMFC in May, Addendum I caps incidental landings of Jonah crab across all non-directed gear types with a uniform bycatch allowance: 1,000 crabs per trip for both non-trap gears (e.g., otter trawls, gillnets) and non-lobster trap gears (e.g., fish, crab, and whelk pots) effective January 1, 2017. The FMP had set a 200 crab per calendar day/500 crab per trip bycatch limit

for non-trap gear; there was no bycatch limit for non-lobster trap gear. *MarineFisheries* expected to go to public hearing and implement new bycatch limits by the end of 2017.

Jonah Crab Addendum II: *MarineFisheries* hosted an ASMFC public hearing on Draft Addendum II to the Interstate FMP for Jonah crab in December. Draft Addendum II proposes to establish a coastwide standard for claw harvest and a definition of bycatch (based on a percent composition of catch).

Atlantic Herring

Spawning Closure Protocol: In January, *MarineFisheries* hosted an ASMFC public hearing on Draft Amendment 3 to the Interstate FMP for Atlantic Herring. The ASMFC initiated the amendment to propose management measures in Area 1A (inshore Gulf of Maine) which reflect changes in the stock structure, integrate recent data into management decisions particularly with regard to spawning closures, and respond to changes in the fishery. As approved by the ASMFC in February, Amendment 3 refined the spawning closure system, modified the fixed gear set-aside allowance, and established an empty fish hold provision contingent on federal adoption (later disapproved by NMFS and hence not part of Amendment 3). The only element effecting Massachusetts' management relates to the spawning closure system, specifically how and when the Massachusetts/New Hampshire spawning area is closed. To implement the new closure protocol, *MarineFisheries* held a public hearing in June and adopted regulations effective September 9.

Days Out Schedule and Spawning Protection: Consistent with ASMFC action, *MarineFisheries* declared the days out schedule for the directed herring fishery in Management Area 1A, including a three day/week fishery from June 1–June 30, a four day/week fishery from July 1–July 14, a five day/week fishery from July 15–July26, a two day/week fishery from July 27–September 14, and a four day/week fishery from October 1–October 17. Vessels were otherwise restricted to the 2,000-pound incidental landing limit, unless participating in the Research Set-Aside Program with a valid Letter of Authorization from *MarineFisheries*. Based on spawning condition sampling of sea herring from within the Massachusetts/New Hampshire Spawning Area, *MarineFisheries* closed the area to the directed fishery from October 2–October 29.

Atlantic Menhaden

Amendment 3 to the Interstate FMP: The ASMFC initiated Amendment 3 to the Interstate FMP for Atlantic menhaden in 2015 to pursue the development of ecological reference points (ERPs) and revisit allocation methods. As the first step in the amendment development process, the ASMFC held hearings in 2016 on the Public Information Document to scope the following issues: reference points for determining stock status; quota allocation methods and timeframes; quota transfers, overage payback, and unused rollover; the incidental catch allowance; the episodic events set aside program; the Chesapeake Bay reduction fishery cap; and research programs and priorities. *MarineFisheries* hosted two ASMFC hearings in December.

Fluke, Scup, and Black Sea Bass

Summer flounder (fluke), scup, and black sea bass are managed as part of a joint federal and interstate multispecies FMP; their management actions are thus grouped.

Fluke Commercial Winter Weekly Limit Program: For the sixth year, *MarineFisheries* authorized interested fluke permit endorsement holders to land a weekly limit of fluke rather than the standard daily limit during the winter (Period I) fishery. The pilot program was created at the request of offshore trawl vessel fishermen to assist the fleet in achieving its seasonal quota allocation with the goal of also reducing discards. Whereas the regulations establish a 500-pound daily limit beginning February 1 (preceded by a January closure),

participants of the 2016 pilot program were allowed to land 1,000 pounds per week beginning February 1. The Division issued 57 Letters of Authorization for the 2016 program.

Fluke Commercial Measures: In response to two substantial reductions (of 30%) in fluke quotas in 2016 and 2017 *MarineFisheries* held meetings to gauge industry interest in adjusting the trip limits and fishing days for the summertime fishery. With industry input largely in favor of no changes, the agency did not propose or make any changes to the 2016 or 2017 regulations. The 2016 fishery closed effective August 15, roughly one month earlier than in 2015. Both years' cuts were based on stock assessments indicting that the resource is experiencing overfishing and biomass is trending downwards towards the overfished threshold.

Fluke Recreational Measures: In January, *MarineFisheries* hosted an ASMFC public hearing on Draft Addendum XXVII, which proposed the continuation of a regional approach to manage the coastwide recreational fluke fishery. The ASMFC later approved the addendum, through which Massachusetts remained its own region and was able to maintain status quo regulations.

Scup Commercial Trip Limits: Effective October 21, the regulations were amended to increase the fall commercial scup limits for all gears, so as to promote more utilization of the Summer Period quota. The rule-change followed multiple years of similar action taken through the Director's declaration authority. Beginning on the Tuesday following Labor Day each year (beginning in 2017), the commercial fishery will be open seven days per week at a 1,500-pound trip limit (through October 31 or a quota closure). Public hearings were held in July. Because of the rule-change's effective date, for 2016, the Director used his declaration authority to lift the closed fishing days and increase the trip limit to 2,000 pounds for all gears, effective September 19–October 31. Two additional declarations set the 2016 Winter II and 2017 Winter I trip limits at 18,000 pounds and 50,000 pounds, respectively, complementing the federal limits. Public comment was collected prior to each declaration.

Scup Trawler Weekly Aggregate Program: *MarineFisheries* continued for a third year its pilot program exempting draggers endorsed to land scup from the daily trip limit in favor of a weekly aggregate trip limit during the Summer Period (May 1–October 31). The weekly limit is intended to reduce bycatch and discard mortality and was requested by industry participants. The weekly limit equaled the daily limit times the number of open days per week. The Division issued 40 Letters of Authorization for the 2016 program.

Black Sea Bass Recreational Measures: In January, *MarineFisheries* hosted an ASMFC public hearing on Draft Addendum XXVII, which proposed the continuation of a regional approach used to management the coastwide recreational black sea bass fishery since 2012. The ASMFC later approved the addendum, and because of an increase in 2015 harvest, required the states in the Northern Region (Massachusetts–New Jersey) to implement regulations projected to reduce harvest by 23%.

To comply with Addendum XXVII, *MarineFisheries* reduced the recreational possession limit for black sea bass from eight fish to five fish and increased the minimum size from 14" to 15"; in doing so, six days could be added to the season (May 21–August 31). Because of the delayed nature of the federal and interstate management processes, the Division held a public scoping meeting in February to collect comment on how best to meet the mandatory reduction before taking emergency action to implement regulations (effective April 29) prior to the season start. A formal public hearing was held in June, followed by final rule-making.

The Division also held an informational meeting in December on the timeline for developing recreational black sea bass measures for 2017.

Gear Issues and Other Conservation Measures

Atlantic Large Whale Take Reduction Plan Consistency: On March 25, final regulations became effective that prohibited the use of single pots in certain waters north of Cape Cod; required all single pots be rigged with endlines that do not exceed 3/8" diameter; required trawls of two or three traps be rigged with one end line only; and established specific vertical line marking requirements for single pots and trawls. Federal rules implementing these aspects of the recently amended Atlantic Large Whale Take Reduction Plan became effective June 1, 2015 and apply to both state and federal permit holders. *MarineFisheries* complemented the federal rules so as to reduce potential negative impacts on enforcement resulting from different state and federal rules. Initially implemented by emergency action effective December 30, 2015, a public hearing was held January 23.

Large Whale Seasonal Trap Gear Closure: A final regulation amending the Large Whale Seasonal Trap Gear Closure to apply to recreational fishermen (in addition to commercial fishermen) also became effective on March 25. This closure, in an area north and east of Cape Cod, requires the removal of all trap gear during the period of February 1–April 30. *MarineFisheries* implemented the commercial closure (primarily affecting lobstermen, but applicable to other pot/trap fishermen) in January 2015 for compliance with the Atlantic Large Whale Take Reduction Plan, and optionally extended it to apply to recreational fishermen to further reduce the risk of entanglement and to streamline enforcement and compliance. Initially implemented by emergency action effective December 30, 2015, a public hearing was held January 23.

Harwich Recreational Fishing Reef: *MarineFisheries* established the newly-placed artificial reef (in Nantucket Sound, roughly two-miles south of Saquatucket Harbor, Harwich) as a recreational fishing reef. This designation reflects the use of recreational saltwater permit fees to fund the project, and aims to avoid user conflict. The regulations prohibit—in a 40-acre area around the reef—all commercial fishing, recreational traps, and any buoyed vertical lines. Emergency regulations were implemented early in the year, prior to the reef's deployment in March, and were followed by final rules after public hearings in March and June.

Mobile Gear Vessel Replacement: Effective October 21, *MarineFisheries* liberalized the vessel replacement rules for mobile gear fishermen by eliminating the horsepower and tonnage baselines and providing a further exemption to the length baseline for small vessels (<50 feet). The regulatory language was also clarified to indicate that the term "baseline vessel" refers to the vessel listed on the permit when first issued in 1992 or the most recently upgraded vessel. The goal of these actions was to allow the inshore mobile gear fleet to more readily upgrade their vessels based on the available vessel market and find themselves in safer, more modern vessels (without a negative impact on stocks). Three public hearings were held in July.

Surf Clam Dredge Width: Effective October 21, and after three public hearings in July, *MarineFisheries* adopted a 48-inch maximum dredge width for the harvest of surf clams in all state waters, striking the prior allowance for dredges with a maximum width of 100 inches in certain waters south of Cape Cod. Given the nature of the inshore surf clam dredge fishery, which moves throughout state waters targeting discrete abundances of surf clams, the rule-change was requested by a harvester with concern that larger vessels utilizing larger dredges could come into state waters and quickly deplete sets of surf clams. Having received general support at public hearing, the Division agreed with this rationale.

Conch Pot Trap Tags: *MarineFisheries* increased the initial allocation of extra conch pot trap tags from 10% to 20% to address routine trap loss. Replacements beyond this allowance will require the harvester to obtain permission from the agency to purchase an entire new set of tags and remove all previously issued tags for the year from their gear. Due to how and where they are fished, conch pots are subject to higher rates of gear loss than lobster pots, the fishery on which the conch pot trap tag replacement allowance was initially

modeled. The rule-change seeks to reduce administrative burden of tag replacements. Public hearings were held in July and the rule was codified October 21.

Sink Gillnet Endline Marking Requirements: Effective October 21, and after public hearings, *MarineFisheries* updated the sink gillnet endline marking requirements to match the requirements of the Atlantic Large Whale Take Reduction Plan by having buoy lines be marked with a 12" green mark at the top, middle, and bottom of each endline.

Kelp Aquaculture: New interest in kelp aquaculture in Massachusetts required *MarineFisheries* to consider gear conflicts and protected species interactions that could result from the Division's permitting of these typically open water aquaculture operations. By years' end, the Division had issued three scientific permits for kelp aquaculture projects in Manchester by the Sea, Chilmark, and Falmouth. Prior to issuing the permit for the Manchester by the Sea project, which sought to set gear on a previously unlicensed site, the Division held a public hearing in September to evaluate stakeholder concerns and determine if modifications to location, gear marking and design, or other features of the project were warranted. The Division also issued its first-ever commercial permits for kelp aquaculture (all on existing licensed sites) in Oak Bluffs, Chilmark, and Fairhaven at the end of 2016. See *Aquaculture Project* (page 47) for more information.

Temporary Fish and Conch Pot Closure: *MarineFisheries* enacted a temporary closure of Cape Poge Bay, Edgartown to fish and conch pots to allow the U.S. Army Corps of Engineers to conduct work identifying and removing unexploded munitions left from WWII training exercises. This closure was in place June 12–December 31 by way of permit condition. The identification of munitions buried in the sediment required the towing of underwater sensors; the presence of fixed fishing gear in the area was found to interfere with the operation of this equipment.

Groundfish

American plaice, cod, haddock, halibut, ocean pout, pollock, redfish, windowpane flounder, winter flounder, witch flounder, wolfish and yellowtail flounder are managed as part of a multispecies FMP. *MarineFisheries* also includes monkfish in its definition of multispecies groundfish. These species' management actions are thus grouped.

Recreational Gulf of Maine Cod and Haddock: Through Framework 55 to the federal Northeast Multispecies Fishery Management Plan, the Fishing Year 2016 (FY16) recreational catch limits for GOM cod and haddock were increased by 30% and 149%, respectively, compared to the harvest limits for FY15. As a result, NMFS liberalized its recreational limits for both stocks. *MarineFisheries* enacted complimentary, although not entirely consistent, regulations. The differences in the state regulations reflected the history of prior state regulations, continued recreational access to a public resource, and the availability of these species in state waters. The rules were first implemented by emergency action to take effect by the May 1 start date to the fishing year, and were followed by final regulations after a public hearing in June.

For GOM cod, anglers fishing from shore or a private or rental vessel ("private anglers") retained their ability to harvest one fish at a minimum size of 19" year-round, while the rule prohibiting anglers aboard for-hire vessels to harvest any cod was liberalized. These anglers became allowed to harvest one cod, at a minimum size of 24", between August 1 and September 30.

Regarding GOM haddock, the possession limit for all anglers was increased from three fish to 15 fish (at the minimum size of 17"). The season remained year-round for private anglers, but a new closed season of March 1–April 14 was adopted for anglers aboard for-hire vessels.

Quota Transfers

Atlantic Menhaden: In September, *MarineFisheries* transferred 35,986 pounds of 2016 Atlantic menhaden commercial quota to Rhode Island to help mitigate an unintended overage of the state's quota. Given the timing and size of the transfer, it had no impact on Massachusetts' menhaden fishery. In November, *MarineFisheries* transferred 100,000 pounds of 2016 Atlantic menhaden commercial quota to Rhode Island in order for the state to reopen its fishery based on reports of continued menhaden availability in Narragansett Bay. However, the precise location of the fish precluded their harvest and all 100,000 pounds of quota were transferred back to Massachusetts in December.

Bluefish: During August and September, *MarineFisheries* requested and received 225,000 pounds of 2016 bluefish commercial quota via transfer from Delaware (50,000 pounds), Virginia (50,000 pounds), Florida (50,000 pounds), and North Carolina (75,000 pounds) to keep the fishery open throughout the season of local bluefish availability.

Fluke: Between January and March 2016, Massachusetts accepted transfers of commercial fluke quota from Virginia (6,525 pounds) and North Carolina (17,155 pounds) to account for landings made by four vessels headed to unload in those states but granted safe harbor here due to mechanical or medical emergencies.

Sharks

Spiny Dogfish Experimental Short-soak Gillnet Fishery: *MarineFisheries* reauthorized, for a fifth year, the experimental short-soak gillnet dogfish fishery in the October–November groundfish closure in state waters (Plymouth north to Marblehead). The action was intended to promote more use of the dogfish quota. The Division already allows longlining for spiny dogfish during this time-area closure. One Letter of Authorization was issued to participate in the experimental fishery with conditions including net tending and monitoring requirements. Access to the area was subject to revision if regulatory discards became problematic.

Spiny Dogfish Trip Limit: Consistent with ASMFC action, *MarineFisheries* declared a 5,000-pound possession and landing limit for the 2016/2017 commercial spiny dogfish fishery, effective May 1, 2016. The Director raised the trip limit to 6,000 pounds effective August 15, consistent with action by NMFS.

Shellfish

2016 Vibrio Control Plan for Oysters and Implementing Regulations: Since 2012, the U.S. Food and Drug Administration has required Massachusetts to develop and implement a plan to minimize the risk of illness associated with the pathogenic bacteria, *Vibrio parahaemolyticus*, related to the consumption of raw oysters. These plans are crafted by *MarineFisheries* and the Massachusetts Department of Public Health (*Mass*DPH) and establish certain time-to-temperature, labeling, and reporting standards for the commercial harvest of wild and aquaculture-raised oysters to safeguard public health. Updates to the Vibrio Control Plan and its implementing regulations were needed for 2016 to address unacceptable illness rates in 2015 from shellfish originating in certain coastal areas, and liberalize requirements where possible based on new Division research.

During March, the MFAC and Division held two public hearings on Vibrio management, followed by MFAC approval of the Division's proposal. In April, the Division held four public meetings to announce the 2016 Vibrio Control Plan, which applied to all commercial harvest of oysters in Massachusetts during the period of May 21–October 16. See *Vibrio Management* (page 51) for more specific information on the regulations. The effective date was May 20.

Aquaculture-Raised Shellfish Minimum Sizes: *MarineFisheries* adopted new regulations affecting the harvest and sale of certain aquaculture-raised shellfish. Effective October 21, both the out-of-state and in-state sale of aquaculture-reared oysters measuring at least 2 ½" longest diameter and surf clams measuring at least 1 ½" longest diameter became allowed (only the out-of-state sale of these oysters was previously authorized). Permitting the in-state sale of these "petite" shellfish was requested by industry to help increase supply throughout the year, grow the market, and diversify the supply of shellfish. All aquaculture-raised shellfish product that do not conform to the wild fishery minimum sizes must bear a tag identifying it is "aquaculture raised." A similar in-state sale allowance for undersized aquaculture-reared quahogs had been proposed at public hearing but was not adopted due to strong opposition from wild harvesters; the out-of-state sale of aquaculture-raised quahogs measuring at least ⅞" hinge width remained lawful.

Surf Clam Minimum Size Exemption: *MarineFisheries* adopted a regulation allowing surf clam dealers to possess and sell surf clams below the state's 5-inch minimum size provided they were legally harvested outside of Massachusetts state waters. The Commonwealth is home to a large surf clam processing industry. This rule reflects the industry's interest to receive, process, and sell surf clams legally harvested in federal waters, where the minimum size is routinely rescinded by NMFS, and from the waters of other states with less than a 5-inch minimum size. The rule took effect October 21, after public hearings in July.

Whelk Management: Effective October 21, *MarineFisheries* adopted several measures to further regulate the state waters whelk fishery. First, a daily commercial whelk limit of one fish tote for the SCUBA/hand harvest fishery was established to address concerns about an emerging fishery on a depleted stock. Second, a daily recreational limit of 15 whelks per person per day was established to create a threshold for a commercial permit. Third, the immediate discard of undersized whelk onto fishing grounds was required to prevent negative unintended consequences of some harvesters retaining undersized whelks and relocating them near-shore to seed areas less abundant with whelk. And fourth, the method of measurement was refined and clarified to enhance compliance with and enforcement of the minimum size. How to improve the method for measuring whelks, as well as gear loss and trap tag replacement, was the subject of two public meetings held in January and March, prior to the Division finalizing its proposal for public hearing. Public hearings were held in July.

The Division held an additional two public meetings in September focusing on the condition of the whelk resource including the need for improved conservation measures as well as compliance issues with many aspects of the state's fisheries management program. These include recent size-at-maturity studies, trends in landings, minimum size compliance, alternative measuring techniques, trap tag replacement issues, and summertime sea turtle entanglements in fixed gear endlines. It was expected that a number of proposals on these issues would be taken to public hearing during winter 2017.

Scallop Exempted Fishery: In October, *MarineFisheries* held a public meeting to take comment on a possible state waters exempted scallop fishery in the Northern Gulf of Maine (NGOM) scallop management area. The Division was petitioned by an industry member to make an application to NMFS for an exempted fishery under which eligible federal permit holders could continue fishing for scallops in the Massachusetts state waters portion of the NGOM after the NGOM total allowable catch is harvested. Federal regulations allow that "(a) state may be eligible for a state waters exemption if it has a scallop fishery and a scallop conservation program that does not jeopardize the biomass and fishing mortality/effort limit objectives of the Scallop FMP." Following the hearing, the Division concluded it would request the exempted fishery, and submitted the necessary paperwork to NMFS in November. NMFS initially projected that the request could be processed by around March 2017, after allowing for the required public comment and rulemaking process; however, it is likely the Presidential transition and subsequent Executive Orders affecting federal rulemaking may lengthen this timeline.

Squid

Seasonal Small Mesh Exception South of Cape Cod: By regulation, the Director may extend the small-mesh squid trawling season south of Cape Cod after June 9 if he determines that continued fishing with small mesh will not result in large catches of small squid less than five inches mantle length and/or juvenile scup, black sea bass, or fluke. In 2016, due to the year's late run of squid and continued commercial interest in the squid fishery, the Director extended the fishery in the waters under the jurisdiction of the Commonwealth within Martha's Vineyard and Nantucket Sounds through June 16.

Incidental Possession Limit: The Director declared a longfin squid trip limit of 2,500 pounds for the period of July 12–August 31. This action complemented the federal incidental trip limit established June 24 due to 90% of the federal Trimester 2 (May 1–August 31) longfin squid quota being harvested. The Division's declaration had no effect on the seasonal prohibition of small mesh trawls to target squid in state waters in place since June 17.

Tautog

Discontinuation of Potting Exemption Program: For the 2016 tautog fishery, the Division ceased the issuance of letters authorizing the commercial harvest of tautog with black sea bass pots due to incompatibility with current management of the fish post fisheries. *MarineFisheries* created the Tautog Potting Exemption program in 2009 to allow the continuation of historic tautog potting activity that occurred primarily during the overlapping spring black sea bass season while also preventing new effort given the gear's efficiency and the state's small quota. Annual LOAs were offered to certain black sea bass pot fishermen to commercially harvest tautog with tagged black sea bass pots under the existing tautog possession, minimum size, and season rules. Eligibility was limited to only those black sea bass pot permit holders who landed at least 100 pounds of tautog by black sea bass pot during any three years from 2003 to 2007. This LOA allowed *MarineFisheries* to clarify that the taking of any species of finfish other than scup and black sea bass by a fish pot was otherwise prohibited.

Since the LOA program's inception, the Division's management of the commercial black sea bass fishery evolved, including the elimination of the spring black sea bass fishery (2013), and the establishment of a black sea bass pot haul-out period extending from three days after the close of the fishery until three days prior to the start of the fishery (2014). *MarineFisheries* determined that allowing black sea bass pots to be set for tautog during the gear's haul-out period undermined the effectiveness and enforcement of the haul-out period. This decision affected very few individuals; an average of only three fishermen received an LOA the prior three years.

Other

Aquaculture-Raised Finfish Minimum Sizes: *MarineFisheries* adopted new regulations affecting the harvest and sale of aquaculture-raised finfish. Effective October 18, aquaculturists could harvest and sell and dealers could receive and sell aquaculture-reared finfish that do not conform to the state's wild caught minimum size for the species, provided the product is properly tagged and accompanied by a bill of laden. The rule seeks to promote aquaculture and enhance the supply of sustainable seafood. The Division previously allowed this activity on a case-by-case basis through a Letter of Authorization without an effect on compliance in the wild caught fisheries or other difficulties. Three public hearings were held in July.

Re-organization and Clarification of Regulations: In response to Executive Order 562, *MarineFisheries* undertook a major initiative to review all of the agency's regulations to determine whether any could be amended, simplified, or rescinded in in order to reduce unnecessary regulatory burden on the public.

Effective October 21, and after three public hearings in July, widespread changes to 322 CMR took effect, including, but not limited to: listing all permits and permit endorsements issued by the Division in one section; striking outdated and redundant rules; consolidating all regulations of a similar type (e.g., gear-related, catch-related) into single chapters; establishing a single procedure for adjusting quota managed fishery limits; and using terms consistently throughout the regulation.

Recreational Fishery Compliance Forum: In January, *MarineFisheries* invited charter and party boat permit holders to attend either of two meetings with the Division and Environmental Police to devise ways to improve fishery monitoring programs and angler compliance with conservation measures. The Division sought to: 1) emphasize the importance of angler and vessel operator cooperation in the sampling of the for-hire fishery for purposes of characterizing angler catch and participate; and 2) discuss the effectiveness of regulations designed to improve compliance aboard for-hire vessels and generate any recommendations for changes.

Free Saltwater Fishing Days: The Director declared the weekend of Father's Day (June 18 and 19) as the 2016 Free Saltwater Fishing Days. The law that established the Commonwealth's recreational saltwater fishing permit requirements also authorized the designation of not more than two days annually when the permit is not required to recreationally harvest finfish.

Conservation Engineering Project

Conservation Engineering (CE) collaborates with commercial fishing industry members and others to improve the design and performance of fishing gear and fishing practices. The Project focuses on reducing impacts of fishing gear on non-target species by understanding the behavior of fish around fishing gear. CE's stature continues to grow regionally and internationally through strong relationships with industry members, collaborative projects, peer-reviewed publication, and participation in national and international organizations.

Revision of Whiting Special Access Areas

In late 2015, working with policy and management staff and funding from federal groundfish disaster aid, CE began developing a research plan to help groundfishermen collect data to potentially support alteration (times and areas) of existing whiting small-mesh areas in response to changing distributions of fish. Under federal rules, no one may fish using a trawl mesh smaller than 6.5" in the Gulf of Maine unless participating in a specific exempted fishery. To be approved and implemented by NOAA Fisheries, exemption programs must have demonstrated that incidental catch of regulated groundfish species is less than 5% of the total catch, by weight, and that the exemption will not jeopardize fishing mortality objectives.

Figure 2. Fisherman Frank Mirarchi checks over his raised footrope trawl net before participating in an early opening of the whiting season.

In 2016, a questionnaire was distributed to fishermen to assess locations and times of primary interest for potential revised access. Ipswich and Cape Cod Bay were selected for study based on input from nine fishermen. Small Mesh Area 1 (currently open July 15–November 15) and the western Raised Footrope Exemption Area (currently open September 1–November 20) provide the existing access in these areas. Observer data from 2010–2015 for these areas were analyzed to support a successful application for an Experimental Fishing Permit from NOAA Fisheries. Field sampling was planned, including assignment of trips to participating fishermen, gear inspection (Figure 2), net mensuration evaluation, and allocation of observer coverage.

The experimental fishery began on July 1, with five vessels participating in Small Mesh Area 1, northeast of Cape Ann. Twenty-nine out of an allowed 30 trips were conducted and sampled. The fishery in Cape Cod Bay was less successful; three out of the four recruited vessels dropped out and the remaining participant only fished two trips before deciding it was unprofitable to continue.

Data from the fishery indicated that bycatch of haddock was common, above 5%, and most fish were below minimum legal size. Analysis did not indicate any trends by depth, time, or season to suggest haddock could be avoided. Bycatch of other species was low. The data were presented at a meeting with fishermen and NOAA Fisheries representatives, and it was proposed that another year's worth of data be collected, but not from Cape Cod Bay. Additional comparisons of the experimental fishery data with observer data from the opening of the fishery were also planned.

Development of an Ultra-low-opening Groundfish Trawl to Avoid Cod

In 2015, CE and the Gulf of Maine Research Institute (Steve Eayrs) initiated a project to develop a trawl with a very low headline height, with the idea of fishing under cod while targeting flatfish. This Saltonstall-Kennedy Grant funded project brings together a team of fishermen including Dan Murphy and Jim Ford, gear-maker Jon Knight (Superior Trawl), and researchers Chris Glass (University of New Hampshire), Pingguo He (University of Massachusetts), and Paul Winger (Memorial University of Newfoundland).

During 2016, multiple trawl designs were tested at Memorial University's flume tank. The research team collectively chose a low opening design, where the headrope is less than 10% longer than the footrope, for field testing, which occurred out of Newburyport in May. (Other ideas developed by fishermen remained under evaluation or testing by other means.)

Results indicated a 47% reduction in cod catch with no loss of grey sole or large dab; sublegal dab were reduced in catches. A loss of larger yellowtail was under further investigation. Fuel consumption was also reduced. A draft manuscript was initiated. Additional gear modifications and outreach were planned.

Additionally, innovative sonar work imaging the topless trawl, along with net mensuration, was conducted in December on the F/V Mystic, with help from the Division's R/V Michael Craven. Sonar was successfully collected with the goal of providing quantitative measurements of net geometry, and confirmation of acoustic sensor readings. Planning for further sonar work was underway at year's end.

Development of Side-scan Sonar Methodology to Survey Derelict Lobster Pots

With funding from the National Fish and Wildlife Foundation (NFWF), *MarineFisheries* initiated a project in 2015 to establish the efficiency of side-scan sonar to identify derelict lobster pots in simple and complex bottom types and conduct a pilot survey. It involves several DMF groups, including CE, Habitat, and Invertebrate Fisheries.

Figure 3. David Chosid (CE) and Kathryn Ford (Habitat Program) prepare the sidescan sonar towfish on the F/V Andrea C. in Fairhaven before searching for lobster pots in March.

The study got underway in early 2016 with the conclusion of the project's design, contracting of fisherman Aaron Cebula and his F/V Andrea C., preparation of all equipment, and completion of field work in Buzzards Bay for site selection, sonar testing and calibration, and a baseline sidescan survey for existing derelict pots. Six field days in late March and early April were conducted to scan for pots inserted into the study area (Figure 3). A pilot survey area in Cape Cod Bay was then selected and scanned using the Division's R/V Mya in June.

Visualization and analysis of the data was complex, but clearly indicated that pot detection rates were low in habitat of different complexities. Additionally, the rate of false detections was also high. Overall, the results contraindicate the use of sidescan sonar to efficiently detect derelict lobster pots.

Reducing Flatfish Bycatch in the Sea Scallop Fishery

In partnership with the Provincetown Center for Coastal Studies, the F/V Glutton (Beau Gribben), and Paul Tasha of Provincetown, *MarineFisheries* began a project in 2015 to evaluate a simple modification to a scallop dredge to reduce flatfish bycatch. The intent is to disturb flatfish that are on the bottom, causing them to swim away from the approaching dredge. Funding comes from a federal Saltonstall-Kennedy Grant.

CE's involvement is dredge design, field testing /sea sampling video, data analysis, and report writing. In preparation for the project, CE's camera system was reconditioned and updated. Video was successfully collected of the so-called "tickle dredge" in operation during two days of fieldwork out of Provincetown in August; however, filming and testing were cut short due to equipment damage.

An initial review of film clips suggested that the dredge chains were in contact under the bail and that fish were being contacted and could swim out of the path of the dredge. Further fieldwork was postponed until the spring of 2017, as the participating fisherman switched over to commercial lobster fishing during the fall and winter.

Redeveloping a Sustainable Redfish Trawl Fishery in the Gulf of Maine

Two journal articles were published in 2016 that resulted from this NOAA Fisheries-funded project which brought together a network of gear researchers, net makers, fishermen, NOAA Fisheries and NEFMC staff, fish processors and others working to re-establish the redfish trawl fishery in the Gulf of Maine. The final grant report was also completed, and additional analysis of results was ongoing at year's end.

Pol, M. V., B. Herrmann, C. Rillahan, and P. He. 2016. Impact of codend mesh sizes on selectivity and retention of Acadian redfish (Sebastes fasciatus) in the Gulf of Maine trawl fishery. Fisheries Research 184: 54–63.

Pol, M. V., B. Herrmann, C. Rillahan, and P. He. 2016. Selectivity and retention of pollock (Pollachius virens) in a Gulf of Maine trawl fishery. Fisheries Research 184: 47–53.

Reducing Juvenile Haddock and Cod Catch in the Georges Bank Haddock Fishery

Project partners including *MarineFisheries,* Pingguo He (SMAST), fisherman Mike Walsh, and Reidar's Manufacturing kicked-off this Saltonstall-Kennedy Grant funded project in December 2015. The goal is to design and test a "dual-grid" system for eliminating small haddock from a trawl net before they reach the codend, as a means of reducing mortality. While planning meetings were held in 2016, fieldwork was delayed until the spring of 2017 to align with the presence of haddock.

Other CE Activities

Grant Applications: A proposal to the Saltonstall-Kennedy Grant Program to investigate off-bottom trawls for haddock was recommended for funding by NOAA Fisheries and is expected to begin in 2017.

Appointments: Michael Pol continued serving on the ICES-FAO Working Group on Fishing Technology and Fish Behaviour and co-chairing a topic group examining hurdles to adoption of new fishing gears by the fishing fleet. He continued serving on the NEFMC Research Steering Committee, the ASMFC Fishing Gear Technology Workgroup, and the NEFMC/MAFMC Northeast Trawl Advisory Panel. He also served on the Editorial Board of the journal *Fisheries Research*.

Video Digitization: CE has now digitized approximately two-thirds of its extensive collection of fishing gear video (over 1,300 individual recordings). Video/camera hardware and software were also updated.

Outreach: Pol was invited to speak about local fisheries onboard the Polynesian voyaging canoe, Hokule'a, during its visit to New Bedford.

Other Publications:

Bayse, S.M., M.V. Pol, and P. He. 2016. Fish and squid behaviour at the mouth of a drop-chain trawl: factors contributing to capture or escape. ICES Journal of Marine Science 73: 1545–1556.

Breen, M., N. Graham, M. V. Pol, P. He, D. Reid, and P. Suuronen. 2016. Selective fishing and balanced harvesting. Fisheries Research. doi:10.1016/j.fishres.2016.03.014

He, P., M. Pol, and P. Suuronen. 2016. Selective fishing and balanced harvest: Means, methods and implications. Fisheries Research 184: 1.

Reid, D.G., N. Graham, P. Suuronen, P. He, and M. Pol. 2016. Implementing balanced harvesting: practical challenges and other implications. ICES Journal of Marine Science 73: 1690–1696.

Other Activities

Marine Fisheries Institute

The Massachusetts Marine Fisheries Institute (MFI) is a cooperative venture between *MarineFisheries* and the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST). Founded in 2002 by former Division Director Paul Diodati and former SMAST Dean Dr. Brian Rothschild, the MFI exists to promote sustainable fisheries through scientific study and the provision of timely information to protect, conserve, and manage Massachusetts and New England marine fisheries and their habitats in a manner that balances the economic, environmental, and cultural interests of the citizens of the Commonwealth. Director David Pierce serves as Co-Chair alongside SMAST Dean Steven Lohrenz.

The MFI secured $416,600 in earmarked state funds in 2016 for collaborative research that applies innovative technology to assess the biomass of fish in the region managed by the NEFMC. Specifically, the

funds supported continued development and application of the open cod-end video trawl survey system to estimate stock size for cod and yellowtail flounder. The new groundfish survey technology combines traditional fishermen's knowledge with advanced video imaging techniques. The objective is to explore and develop a non-intrusive, efficient survey to investigate the abundance, spatial distribution and size structure of fish stocks in the Gulf of Maine and on Georges Bank.

In April, the MFI Advisory Council, a source of external guidance on MFI research priorities, received presentations about the status of the *MarineFisheries* Industry-Based Survey and the SMAST open cod-end video trawl survey for Gulf of Maine cod. Follow-up presentations in November provided an opportunity for the Advisory Council to offer recommendations for integrating the two surveys. Dr. Jon Hare, the Director of the Northeast Fisheries Science Center, replaced Dr. Bill Karp on the Advisory Council and provided input on strategies for incorporating the cod surveys into future stock assessments.

The MFI continued and expanded collaborative research projects in 2016, including the river herring/shad bycatch avoidance program for the Atlantic herring fishery; the yellowtail/windowpane flounder bycatch avoidance program for the scallop fishery; post-release mortality research for cod, haddock, and cusk; conservation engineering for trawl and dredge fisheries; and review of scallop survey methodology. As a research body, the MFI has provided additional opportunities for collaboration in securing research funding.

Publications

Advisories: *MarineFisheries* released 91 electronic advisories to subscribers of our listserv on various rule changes, public hearings, quota closures, and other important information.

DMF News: *MarineFisheries* published its newsletter twice in 2016 (Figure 4). A more modern look for the newsletter was launched for the second 2016 edition. These editions of "DMF News" were mailed to subscribers and are available through the Division's website.

Annual Report: *MarineFisheries* published its 2015 Annual Report.

Figure 4. The covers of the two 2016 editions of the DMF News.

Committee Work and Leadership Positions

David Pierce served as a NEFMC Council Member and ASMFC Commissioner. Pierce, Melanie Griffin, and Cate O'Keefe served on various NEFMC committees and teams, with Pierce having the role of vice-chair of the Spiny Dogfish Committee and Risk Policy Working Group. Pierce, Daniel McKiernan, and Nichola Meserve served on various ASMFC Management Boards and other committees. Story Reed contributed to several ASMFC and Atlantic Coastal Cooperative Statistics Program committees. Pierce was co-Chair of the Massachusetts Marine Fisheries Institute (MFI) and member to the MFI Executive Committee, served as the state's representative to the Stellwagen Bank Advisory Council, and participated on the Governor's Informal Fishery Advisory Panel. McKiernan chaired the agency's Shellfish Advisory Panel.

Coordination of NEFMC Nominations

MarineFisheries coordinated the process of gubernatorial nominations to vacant seats on the NEFMC, including solicitation of potential candidates and submission of nominations by the Governor's office.

Fisheries Statistics Program

Personnel

Anna Webb, Program Manager & Harvester Reporting Coordination
Kim Lundy, Dealer Reporting Coordination & Quota Monitoring
Erich Druskat, Fisheries Data Analyst
Mary Ann Fletcher, Fisheries Data Entry
Story Reed, Permitting & Support for Fisheries Statistics
Rosemary Mitchell, Permitting & Support for Fisheries Reporting
Whitney Sargent, Permitting & Support for Fisheries Reporting
Thomas Hoopes, Contractor

Overview

The **Fisheries Statistics Program** collects fisheries dependent data from both commercial harvesters and dealers designated as primary buyers. Both data sets are collected in a standardized trip-level format from all commercial permit holders. These data have broad applications and uses, both within *MarineFisheries* and to fulfill requests made from outside the agency. Program personnel also participate in the planning and development of the ASMFC's Atlantic Coastal Cooperative Statistics Program (ACCSP) and provide support to administrative staff for policy and permitting. In addition, Program staff act as a liaison to the Administration's Energy and Environmental Affairs Information Technology Group for the Gloucester facility and, along with other agency personnel, continue to maintain the agency's websites and Oracle databases.

Program Activities

Dealer Landings Data Collection

Landings or purchases of all marine species by seafood buyers from commercial fishermen were collected as part of the dealer reporting program. Since 2005, all primary buyers not already required by federal law to report electronically have been required to report under state regulations. All data from these state-reporting dealers were submitted to *MarineFisheries* via paper forms and entered into the ACCSP Standard Atlantic Fisheries Information System (SAFIS) database by project personnel or entered directly into SAFIS electronically by the dealers. All quota-based fisheries were monitored using these dealer data stored in the SAFIS database.

In 2016, 1,853 businesses obtained a Massachusetts seafood dealer permit. Of those, 473 (or 26%) were categorized as primary buyers, which meant they intended to purchase marine species directly from fishermen. These dealers were required to report their primary purchases, including products retailed themselves. Of the 473 dealers, 227 had a federal dealer's permit which required reporting electronically either to the SAFIS database or to another federal reporting system. These dealers were categorized as "federal-reporting" and the remaining 246 dealers were categorized as "state-reporting."

Even though many of the primary buyers in 2016 had been primary buyers in years past, all were required to complete paperwork to confirm their buying intentions and their commitment to the dealer reporting requirements. This registration process not only provided a signed statement for enforcement purposes, if necessary, but also provided the means to monitor reporting compliance and track quotas.

Throughout the year, 155,560 transactions were entered into the SAFIS database, covering 322,877 individual species landings, an increase of approximately 12,000 trips compared to 2015. Federal-reporting dealers electronically submitted 73% of these transactions. Of the remaining transactions submitted by state-reporting dealers, roughly one-third was entered electronically by dealers, and two-thirds were submitted on paper-based forms.

Total landings (in whole pounds), as reported through the SAFIS database or other federal reporting programs, amounted to 612 million pounds, valued at $551 million (ex-vessel). The top five species in order of value were sea scallop, American lobster, Eastern oyster, Atlantic surf clam, and haddock totaling $417 million, or 76% of the total value. Offshore shellfish (sea scallop, Atlantic surf clam, and ocean quahog), made up more than half of the total value landed in Massachusetts, whereas inshore and intertidal landings of shellfish, such as soft shell clam, northern quahog, blue mussel, and oyster amounted to less than 10% of total value landed. Landings of invertebrate species (lobster, crabs, and whelk) amounted to 36 million pounds, valued at $99 million, or 18% of the total value landed. Cumulative finfish landings, including both pelagic and benthic species, made up 19% of the total value with groundfish species amounting to 13% of the total value. Landed species with an individual gross value over $2 million are shown in Table 1; in aggregate, these species accounted for approximately 97% of the total value of all species landed.

Table 1. 2016 Massachusetts Landed Species with Value Greater than $2 Million.

Species	Landings (whole pounds)	Value
Sea Scallop	190,481,135	$281,444,643
American Lobster	17,686,653	$82,006,555
Eastern Oyster	8,433,295	$22,630,713
Atlantic Surf Clam	103,808,150	$17,938,166
Haddock	10,721,496	$12,754,284
Goosefish	12,474,467	$11,293,987
Ocean Quahog	*	*
Jonah Crab	10,657,548	$8,183,704
Atlantic Herring	46,969,494	$7,558,865
Winter Flounder	2,057,333	$6,581,447
Soft Shell Clam	3,250,536	$6,163,024
Bluefin Tuna	1,076,337	$5,847,502
Silver Hake (Whiting)	7,146,972	$5,735,833
Longfin Squid	4,591,704	$5,667,158
Atlantic Cod	2,723,765	$5,164,284
Acadian Redfish	8,355,150	$4,963,895
Channeled Whelk	1,971,153	$4,873,715
Northern Quahog	4,488,294	$4,722,173
American Plaice (Dab)	1,829,821	$4,569,905
Pollock	4,544,549	$4,497,585
White Hake	2,569,808	$3,933,658
Striped Bass	938,224	$3,812,268
Spiny Dogfish	14,346,423	$3,510,251
Deep-sea Red Crab	*	*
Winter Skate	11,447,940	$2,476,902
Witch Flounder (Gray Sole)	795,027	$2,449,461
Atlantic Mackerel	9,893,889	$2,425,841
Summer Flounder (Fluke)	585,637	$2,337,340

Source: ACCSP Data Warehouse, as of May 30, 2017. *Indicates confidential data

Certain species are managed by quota in Massachusetts and were monitored in 2016 using the dealer reported landings in the SAFIS database. Automated analyses ran on a nightly basis and the results were displayed on both the *MarineFisheries* internet website (Figure 5) and the internal Statistics Project intranet website. On a weekly basis during the open season, staff reviewed compliance and estimated projections separately for each quota-managed species. Data from dealers that had already purchased during the year or had in past years were included in order to account for potential landings if a dealer had not yet reported purchases. An estimated closure date was calculated based on a regression analysis run at least once per week for each open fishery.

QUOTA MANAGED SPECIES
2016 Landings and Quota Information
as of Feb 17, 2017 - 10:21 A.M.

Species	2016 MA Landings	2016 Quota	Quota Type	Percent Landed
Black Sea Bass	353,602	352,525	MA	100.3%
Bluefish	499,935	553,096	MA	90.4%
Dogfish	14,215,775	23,409,241	CW	to NMFS
Fluke	584,237	577,777	MA	101.1%
Horseshoe Crab*	100,095	165,000	MA	60.7%
Menhaden	3,061,930	3,405,423	MA	89.9%
Scup *(Winter I)*	253,309	9,232,987	CW	to NMFS
Scup *(Summer)*	1,143,988	1,720,818	MA	66.5%
Scup *(Winter II)*	154,220	6,454,943	CW	to NMFS
Striped Bass	938,224	869,813	MA	107.9%
Tautog	58,095	57,985	MA	100.2%

MA = Massachusetts-specific quota
CW = Coast-wide quota shared between MA and other Atlantic states prompt
*Horseshoe Crab quota and landings reported as count of individual crabs harvested for non-biomedical purposes.

Figure 5. Example display of quota monitoring data available on *MarineFisheries'* website.

Fisherman Catch and Effort Data Collection

Since 2010, all commercial fishermen have submitted, on a monthly basis, comprehensive, standardized trip-level data for all commercial trips conducted under the authority of a Massachusetts commercial fisherman permit. Those individuals holding a federal permit with reporting requirements to NOAA Fisheries (e.g., Vessel Trip Report or VTR), were exempt from reporting to *MarineFisheries* for those activities occurring on their federally-permitted vessel. All other individuals were required to report to *MarineFisheries*.

This change eliminated the suite of species- and gear-specific annual catch reports that were collected for years, some since the late 1960s, and has greatly enhanced the agency's capabilities to monitor catch and effort information in all commercial fisheries conducted by Massachusetts commercial fishermen. It also meets the interstate standards promoted by ASMFC through ACCSP.

Fishermen either submitted their trip-level reports in paper form or on-line using the SAFIS eTrips application, a web-based program developed jointly by ACCSP staff and program partners. Project staff used the same application or a bulk upload process called eTrips upload to enter data submitted on paper forms. Thus, the primary repository for all trip-level data, except those reported to NOAA Fisheries, was the SAFIS

database. Data were easily downloaded from the SAFIS database and used for compliance and fisheries analyses.

In 2016, *MarineFisheries* issued 7,424 commercial harvester permits, of which 15% were for federal reporting vessels, and the remaining 6,310 commercial permits were designated as "state-reporting." Thirty-two percent of the permit holders reported electronically using the SAFIS eTrips application, representing a 2% increase in electronic reporting participation since 2015. This left 53% of all harvesters submitting paper reports to *MarineFisheries*. Of the 113,385 commercial trips that were entered in the SAFIS database to date for 2016, approximately 26% were entered by commercial permit holders using the SAFIS eTrips application, with the remaining trips were entered by *MarineFisheries* staff.

Data Analysis and Dissemination

Project staff provided a wide variety of data and technical support during 2016. Significant time was dedicated to ensuring correct harvester reporting methods and compliance during the permit renewal period. Staff levels were reduced compared to previous years, and considerable effort continued to be spent restructuring the program to maintain critical functions with fewer staff members. Compliance metrics were maintained for harvester and dealer reporting, and work was distributed to accommodate more real time data entry than was achieved in 2015. Additionally, project staff focused on creating more efficient ways to disseminate data internally and provide regular updates to agency staff. This included improving Visual Basic programming skills and utilizing them to create real-time interactive spreadsheets for other *MarineFisheries* staff to view and use.

Northern Gulf of Maine State Waters Sea Scallop Fishery Analysis: Stemming from a request to petition NOAA Fisheries to exempt the state waters fishery from the sea scallop closure once the Northern Gulf of Maine (NGOM) TAC had been reached, Program staff conducted a thorough analysis of the Massachusetts state waters sea scallop fishery in the NGOM from 2010–2015. Extensive data audits were conducted to resolve a variety of issues including but not limited to misreporting of the designated shellfish growing area and accurately connecting landings to the appropriate vessels, state permits, and federal permits.

Massachusetts Lobster Fishery Spatial Analysis: Analysis of lobster landings and effort is conducted annually, and in 2016, project staff concentrated on analyzing and updating historical spatial trends in effort. Data summaries of trap hauls, maximum traps fished, activity levels, and landings were broken down by statistical reporting area, lobster management area (LMA), and stock. The analysis, once updated with 2016 data, will be used in stock assessments and to characterize the effect of regulatory closures and actions to reduce effort in LMA 2.

Striped Bass Tagging Program: 2016 was the third year of a commercial fishery tagging program mandated by ASMFC. The goal of the tagging program is to increase accountability in the supply chain and give law enforcement a tool to detect poaching. Under the Division's point-of-sale program, dealers acting as primary buyers of striped bass are required to affix a tag to all striped bass purchased directly from commercial fishermen. *MarineFisheries* supplied these tags to dealers at no charge. Program staff estimated the 2016 tag requirements for individual dealers and distributed tags prior to the season and throughout as needed. The tags were imprinted with the species, minimum size, year, state, and unique identification number traceable to the Primary Buyer to whom they were issued (Figure 6). At the end of the season, unused tags and an

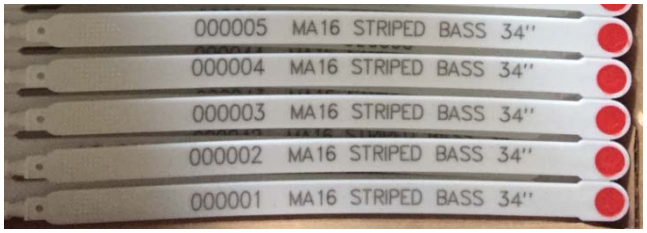


Figure 6. 2016 commercial striped bass tags.

accounting report were required to be submitted to the agency. Program staff were responsible for identifying any discrepancies and following up with dealers as needed. The compliance rate was high and, in general, the program ran smoothly in its third year (Table 2).

Table 2. 2016 Striped Bass Tagging Statistics (as of April 2017).

# of Dealers Receiving Tags	# of Tags Purchased	# of Tags Distributed	# of Tags Returned	# of Tags Used	# of Tags Missing
110	80,000	65,120	16,737	48,044	339

Striped Bass and Black Sea Bass Commercial Fisheries Performance Evaluation: In an effort to determine the effect of recent regulatory actions on the striped bass and black sea bass commercial fisheries, Program staff conducted a characterization of landings from 2010–2015. The analysis for striped bass showed improved quota management, some stabilization in ex-vessel price, and an overall increase in the average price after regulations were implemented. The black sea bass regulations resulted in more consistent landings and average price. The characterizations were presented at two separate MFAC meetings.

Temporal Variation in Effort in the Channeled Whelk Fishery: In an effort to discern the potential effect of a closure to the whelk pot fishery during the late summer, Program staff analyzed the temporal variation in effort and landings. This analysis confirmed that landings are significantly reduced and the impact to the fishery is decreased during this time period. The data were presented to the MFAC in August and during scoping meetings in September.

ACCSP Participation and Planning

MarineFisheries staff continued to participate on all partner-based committees within ACCSP, particularly as *MarineFisheries* relies more and more on the services provided. A. Webb assumed the chair position on the Information Systems committee in 2016. Staff worked with programmers to address program bugs and long-term solutions to ongoing issues as well as provided technical advice in areas such as data quality and standards, application design, outreach, and policies, particularly with regard to addressing issues presented in an Independent Program Review (IPR) conducted in 2012. In 2016, ACCSP initiated the planning stage of a SAFIS redesign as a result of committee and partner specific discussions and the IPR, which ultimately will require a strong commitment from partners to successfully implement this project in the coming years.

Swipe Card Pilot Project: Project staff and ACCSP reached the conclusion of the pilot phase of the swipe card project when SAFIS eDR/mobile launched in production in both Massachusetts and Maine in August 2016. The conceptual idea behind the SAFIS eDR/mobile application is that a transaction card is used to consummate a point-of-sale transaction between the harvester and dealer. At the time of a transaction, a permit holder presents the dealer with his transaction card that contains pre-coded information associated with his permit both in a barcode and a magnetic stripe. The dealer uses a card reader attached to a device (mobile, tablet or Windows desktop) that has the free eDR/mobile application installed to extract the information from the card. The dealer records all additional attributes about the transaction, including species, quantity, and price, as well as those typically provided by the harvester on a separate report, such as area fished, gear used, and time spent fishing. Once the transaction is complete, the data are sent directly to the SAFIS database, or queued for later submission if the device is temporarily offline.

The application runs on Windows, iOS, and Android platforms, and dealers and harvesters can log-in to the online SAFIS eDR and eTRIPS applications, respectively, immediately afterward to access and review those records. *MarineFisheries* initially had one dealer begin to use the application, and by the end of 2016, several others were queued for setup. Project staff continuously facilitated the feedback loop between the

users and the programmers to ensure timely resolution to new issues and worked closely with *Mass*DPH and law enforcement officials to ensure all regulatory agencies were updated with any program changes.

This project launched the process of creating a single-ticket commercial data collection system in Massachusetts for inshore shellfish dealers and harvesters, where dealers collect and submit all information about the commercial trip. Expected benefits include: eliminating the cost of data entry for reports submitted by commercial harvesters who sell to participating dealers; eliminating the burden on these harvesters to report (although it will increase the burden on dealers to collect the additional data attributes typically submitted by harvesters, but, at least in the shellfish industry, these are minimal, as area fished is already required to be reported by dealers for public health reasons); immediate submission of data into the SAFIS database (rather than a month or longer delay); eliminating the need to reconcile differences that occur in a two-ticket system; and enhanced accuracy of the data submitted due to the application's ability to read the stored information on the transaction card and link it to additional data in SAFIS.

Looking beyond the immediate benefits, this technology could potentially be expanded to other fisheries in Massachusetts, and other ACCSP partners could take advantage of it, or similar technology. Discussions between state and federal partners of ACCSP began in late 2016 to codify this process. Other long term benefits include greatly enhanced law enforcement capabilities, as a completed transaction could be available to law enforcement officers through special access to the SAFIS database. In addition, other data attributes were collected at the point of sale for the purpose of meeting requirements for Public Health, and the consolidation of common reporting requirements benefits all parties involved. The application also opens the door to other technologies, such as tracing product electronically from harvester, down through the distribution chain to consumer. This could have significant ramifications towards improvements in seafood quality, marketability and value, a potential win-win for both industry and consumers.

Management Information Systems

In 2016, the Management Information Systems (MIS) Project, which originally provided many services to *MarineFisheries* under the umbrella of information systems/technology, was primarily conducted through the Energy and Environmental Affairs Information Technology Group (EEA-IT) due to the Administration's agency-wide consolidation of information technology support and consequent restructuring of the Fisheries Statistics Program. Program staff focused instead on providing assistance to EEA-IT on local information systems issues when needed and continued to work on specific tasks (below). These responsibilities, formerly ascribed to the MIS Project, will hereafter be classified as Fisheries Statistics Program activities.

Website Maintenance: The *MarineFisheries* website (www.mass.gov/marinefisheries) continued to be an extremely useful means of distributing public information as did an internal Intranet site using Wiki technology, which provided both agency-wide as well as project-specific functionality to agency personnel. A Statistics Project Intranet site was also maintained for the display of quota information, reporting compliance, and both harvester and dealer reporting information. Much of what was displayed on the Statistics Project site was produced from automated scripts that ran on a regular basis. Maintaining those scripts to add new data and accommodate changing requirements is an ongoing task.

Oracle Database / Application Development & Maintenance: *MarineFisheries* continued to use and enhance four production databases and associated applications during 2016: Commercial Permits and Statistics; Lobster Sampling; Shellfish Sampling & Area Management; and Time Tracking for Federal Grants. Minor updates were made to the Commercial Permits and Statistics application during the year, and development and testing began on the addition of Oracle-based aquaculture permits and associated applications to this database. After completion of testing, these new elements were anticipated to go live in 2017.

SHELLFISH AND HABITAT SECTION

J. Michael Hickey, Section Leader

Shellfish Sanitation and Management Program

Personnel

J. Michael Hickey, Program Manager

Gloucester
Jeff Kennedy, Gloucester Regional Shellfish Supervisor, Shellfish Purification Plant Manager
Jack Schwartz, NPDES-Contaminants Coordinator
Florence Cenci, Shellfish Lab Supervisor
Gregory Bettencourt, Biologist II
Glenn Casey, Biologist II
Ryan Joyce, Biologist II
David Roach, Jr., Biologist II
Devon Winkler, Biologist II
Melissa Campbell, Biologist I
Ashley Lawson, Bacteriologist I

Newburyport
Diane Regan, Shellfish Lab Supervisor
Ralph Stevens Jr., Depuration Coordinator (through July)
Kevin Magowan, Depuration Coordinator (beginning November)
Richard Hardy, Wildlife Technician II
Peter Kimball, Wildlife Technician II
Paul Thistlewood, Laborer II (through February)

New Bedford
Thomas Shields, New Bedford Regional Shellfish Supervisor, Hughes Hatchery Manager
Susan Boehler, Shellfish Lab Supervisor
Gregory Sawyer, Biologist III
Neil Churchill, Biologist II
John Mendes, Biologist II
Terry O'Neil, Biologist II
Christopher Schillaci, Biologist II, Aquaculture Specialist
Christian Petitpas, Biologist I, Aquaculture Project
Kelly Kleister, Biologist I
Jim Rossignol, Biologist I
Gabriel Lundgren, Fisheries Technician

Overview

The Shellfish Sanitation and Management Program (Shellfish Program) focuses on public health protection, as well as the direct and indirect management of the Commonwealth's molluscan shellfish resources. Public health protection is ensured through the sanitary classification and the monitoring of marine biotoxins within state waters, including Nantucket Sound.

Nationally, the harvest and handling of all bivalve molluscan shellfish is regulated by the National Shellfish Sanitation Program (NSSP). The NSSP was established in 1925 by the United States Public Health Service for the harvest and handling of shellfish in interstate commerce for human consumption. The NSSP "Guide" is developed and administered today by the United States Food and Drug Administration (USFDA) and the Interstate Shellfish Sanitation Conference (ISSC), a federal/state cooperative. The Commonwealth of Massachusetts is a voting member of the ISSC.

Shellfisheries management is accomplished by direct *MarineFisheries* regulation of the commercial surf clam, ocean quahog, and quahog dredge boat fisheries. In addition, regulations cover the harvest of contaminated shellfish for depuration and relay, and establish size, trip limit, and season for many shellfish species. *MarineFisheries* regulates commercial shellfish aquaculture and is required to certify that operation of private shellfish aquaculture projects at sites licensed by coastal municipalities will not have an adverse impact on shellfish or other natural resources of the city or town. Indirectly, *MarineFisheries* manages shellfish resources through a partnership with coastal communities by providing technical assistance to local management authorities in the development of management plans and local regulations for control and conservation.

Shellfish Sanitation and Public Health Protection Project

Shellfish Growing Area Classification

Surveys: Public health protection is accomplished with the use of sanitary surveys to determine a shellfish growing area's suitability as a source of shellfish for human consumption. Sanitary surveys include: 1) identification and evaluation of all actual and potential pollution sources which may affect a shellfish growing area; 2) evaluation of hydrographic and meteorological characteristics that may affect distribution of pollutants; and 3) assessment of overlying water quality. Each shellfish growing area must have a complete sanitary survey every 12 years, a triennial evaluation, and an annual evaluation report to maintain a classification allowing shellfish harvesting. Minimum requirements are set by the *NSSP Guide for the Control of Molluscan Shellfish*.

To satisfy NSSP requirements in 2016, staff biologists in the Gloucester and New Bedford offices completed 297 annual evaluation reports, 94 triennial evaluations, and 30 sanitary survey reports (Table 3). Thirty-one conditional area management plans were re-evaluated. A total of 9,306 water samples were collected and analyzed for fecal coliform bacteria from 251 shellfish growing areas, in 65 cities and towns of the Commonwealth. All samples were tested at either of *MarineFisheries'* shellfish laboratories in Gloucester and New Bedford using the mTEC method. Of these, 8,720 samples were taken at classification stations, 514 were pollution source samples, while an additional 72 ad-hoc samples were collected.

USFDA evaluates Massachusetts annually for compliance with the NSSP. Shellfish growing area files are reviewed for compliance with the NSSP standards for minimum sampling frequency, completion of required growing area reports, conditional area management plan updates, and conformity with appropriate classification area water quality criteria requirements. The USFDA determined Massachusetts remained in compliance with the NSSP during 2016.

Table 3. Summary of 2016 Shellfish Growing Area Report and Sampling Activity.

	North Section	South Section	Total
Annual Evaluation Reports	30	267	297
Triennial Evaluations	28	66	94
Sanitary Surveys	3	27	30
Management Plans/MOUs Reviewed	14	17	31
Total Water Samples	2,695	6,611	9,306
Classification Station Water Samples	2,492	6,228	8,720
Pollution Source Water Samples	131	383	514
Ad-hoc Water Samples	72	0	72
Shellfish Growing Areas Sampled	20	231	251
Classification Sub-Areas sampled	104	400	504
Cities/Towns Sampled	21	44	65
Vp Shellfish Samples	0	37	37

Shellfish Classification: The NSSP defines five area classification schemes:

1. APPROVED: Open to shellfish harvesting for direct human consumption subject to local rules and regulations. Closed only during major coast-wide events (e.g., hurricane, oil spill, red tide event).
2. CONDITIONALLY APPROVED: Closed some of the time due to rainfall or seasonally poor water quality or other predictable events. When open, it is treated as an Approved area.
3. RESTRICTED: Contains a limited degree of contamination at all times. When open, shellfish can be relayed to a less contaminated area or harvested for depuration.
4. CONDITIONALLY RESTRICTED: Contains a limited degree of contamination at all times, subject to intermittent pollution events and may be closed some of the time due to rainfall or seasonally poor water quality. In Massachusetts, when open, only softshell clams may be harvested by Master/Subordinate Diggers for depuration at the *MarineFisheries* Shellfish Purification Plant.
5. PROHIBITED: Closed to the harvest of shellfish under all conditions, except the gathering of seed for municipal propagation programs under a *MarineFisheries* permit.

Massachusetts utilizes all five classifications throughout 1,744,236 acres (Figure 7). During 2016, the Shellfish Program was involved in a number of initiatives to increase shellfish harvesting opportunities including upgrades in classification as well as changes in area status.

Newbury Shellfish Area N2.1 in the Merrimack and Plum Island Rivers estuaries was reopened in April to the Conditionally Restricted commercial harvest of softshell clams (*Mya arenaria*) for depuration. Once considered among the top clam producing flats in Massachusetts, bacterial contamination had shut down these highly productive beds for the last 30 years. A new, comprehensive Contaminated Area Management Plan developed with the Town of Newbury, combined with restrictive state and local harvesting regulations ensure clams harvested from the area are safe for human consumption. The reopening encompassed approximately 215 acres of the Plum Island River and northern approaches south of Woodbridge Island, as well as most of the Basin on Plum Island. These Newbury flats added to the 1,000+ acres of Merrimack River estuary clam flats in Newburyport and Salisbury previously reopened in 2006 and 2013.

Hingham conditionally restricted areas for depuration were reopened for the first time in two years providing Master and Subordinate diggers additional harvesting opportunities over the summer.

There was also a number of status changes resulting in the temporary closure of 161 acres of shellfish growing area open to shellfishing. Most of these closures were due to high concentrations of water fowl resulting in elevated bacterial counts. A summary of the impacted areas are provided in Table 4. The impacted areas included: 91 acres in BB3.31 West Branch-Westport River; 9.6 acres in MB 2.6 Marshfield East Coastal; 20.7 acres in MB 10.5 Cohasset Harbor; 19.7 acres in CCB 39.11 Plymouth South Coastal; and 20 acres in CCB 7 Pamet Harbor/River.

Overall, Massachusetts saw a very modest increase in shellfish areas with a classification of Approved, with slight decreases in areas classified as Conditionally Approved, Restricted and Prohibited. There was no change in the acreage of Conditionally Restricted areas.

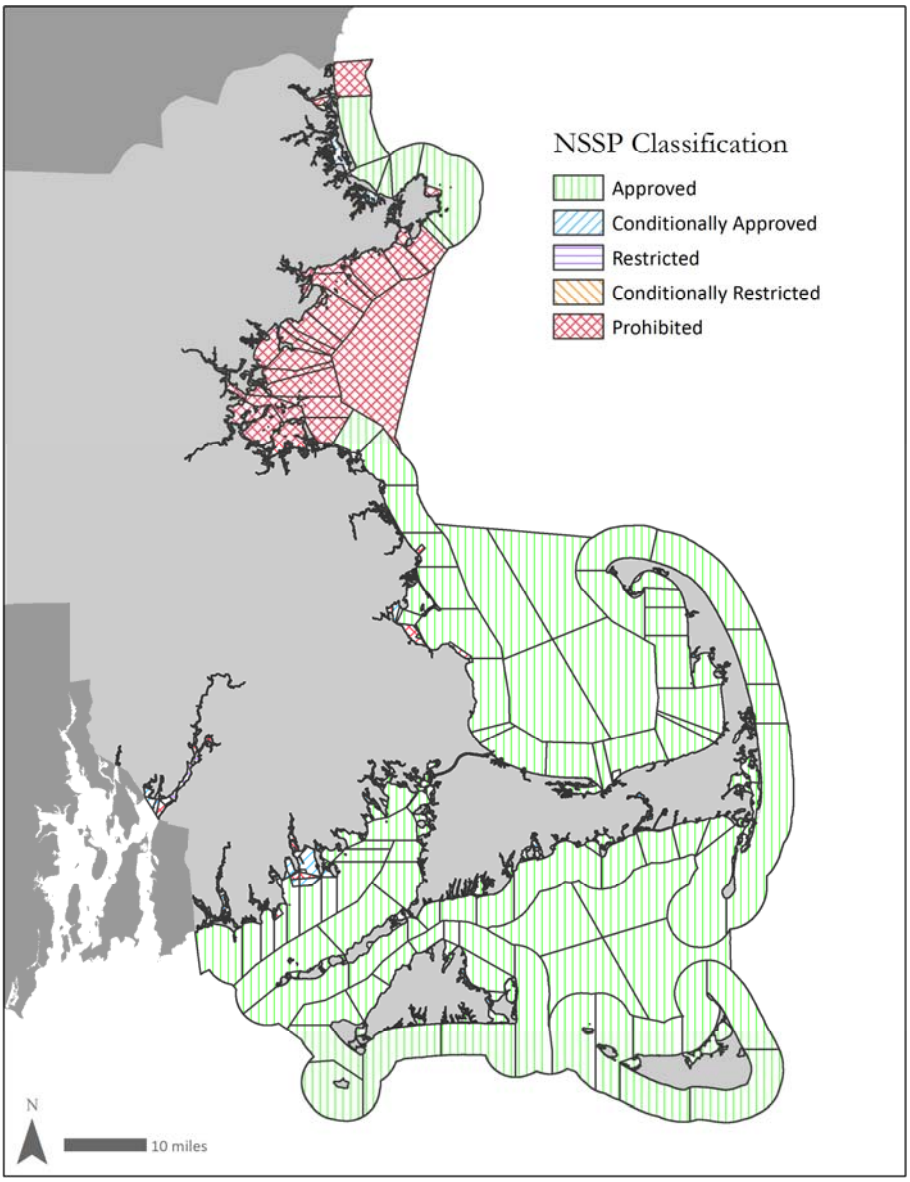


Figure 7. 2016 NSSP classification map of Massachusetts shellfish growing areas.

Table 4. Change in Massachusetts shellfish growing area classification, 2015 to 2016.

Area Classification	Acreage		
	2015	2016	Change
Approved	1,476,247	1,476,305	58
Conditionally Approved	25,173	25,138	-35
Restricted	3,343	3,321	-22
Conditionally Restricted	4,653	4,653	0
Prohibited	234,820	234,819	-1
Total	1,744,236	1,744,236	

Notification: A legal notice is required by *MarineFisheries* for each change in a shellfish growing area's classification or status. These notices reflect the type of opening or closure, the dates, the reason, and other pertinent descriptive information. Copies are sent to municipal managers, the state Office of Law Enforcement, *Mass*DPH, USFDA, and other interested parties. In 2016, 396 legal notices were generated by Shellfish Program staff and distributed for sanitary reclassification, rainfall closures and re-openings, paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP) events, a Norovirus event, oil spills, and more typical emergency closures (i.e., raw sewage discharge).

Pollution Discharge and Contaminant Assessment

Program biologists comment and make recommendations regarding United States Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) Permits. In 2016, eight permits required review, including discharges from one animal boarding facility that was discharging animal fecal bacteria to marine waters, three industrial discharges, and two waste water treatment plants, of which one plant review included consultation with USFDA for a dye study. Two other NPDES permits involved the intake and discharge of non-contact cooling water. Direct consultation with EPA and the Massachusetts Department of Environmental Protection (*Mass*DEP) was provided to address shellfish staff concerns before issuance of final permits. A draft NPDES permit for a desalination plant was reviewed with *Mass*DEP, EPA, and the Massachusetts Office of Coastal Zone Management (*Mass*CZM). Ongoing monitoring of a second desalination plant was reviewed as requested by the Massachusetts Water Resources Commission and the Executive Office of Energy and Environmental Affairs (EOEEA).

Program biologists also conducted assessments of chemical contaminants in fishery resources. Shellfish biologists participated in a collaborative program to support the NOAA National Status and Trends Program (Musselwatch) with their effort to monitor and quantify newly identified contaminants of emerging concern (CECs) in near shore marine waters of the United States. This was a joint program with the contaminant monitoring program of the Gulf of Maine Council (Gulfwatch) to obtain mussel samples throughout the territorial waters of Massachusetts, in coordination with field sampling in New Hampshire, Maine, and Nova Scotia. The samples were necessary for laboratory analysis of CECs NOAA identified as a potential human health and ecological concern. Shellfish biologists successfully obtained the requisite samples at Musselwatch and Gulfwatch stations along the Massachusetts coast from the Merrimack River in Newburyport to Nauset Harbor in Chatham. An overview of current research on CECs in the marine environment was provided to the Marine Fisheries Advisory Commission (MFAC). New PCB data for Chesapeake Bay striped bass was reviewed to advise DMF striped bass fishery managers concerned with human consumption of Chesapeake Bay striped bass that enter the Massachusetts fishery. Massachusetts Legislation filed in 2016 relative to labeling commercially caught striped bass with a health warning for contaminants was reviewed to inform and advise the Director.

Biotoxin Monitoring

Paralytic Shellfish Poisoning Monitoring: A major aspect of the Shellfish Program is monitoring for naturally occurring marine biotoxins produced by microscopic algae that can cause paralytic shellfish poisoning (PSP) or "red tide". Consumption of shellfish containing certain levels of PSP toxin can cause severe illness and even death. Shellfish Program personnel collect shellfish from 13 primary stations weekly from March through October. Samples are analyzed at the *MarineFisheries* Gloucester lab where bioassays determine the levels of toxin in shellfish. If toxin is found, both the frequency of sampling and the number of sample sites are increased. Shellfish areas are closed if toxin levels exceed safe limits.

The 2016 PSP sampling season began on March 13 with blue mussel and ended October 3, for a duration of 30 weeks. A total of 395 shellfish samples were processed through the Gloucester Shellfish Laboratory for PSP during 2016. The majority of samples was of the indicator species, blue mussel; although five other species were also sampled (Table 5). Toxicity and closures were limited to the Nauset system (Figure 8); the closure of 1,540 acres in OC2–OC6 was enacted on April 6 and most areas were reopened on May 27 (51 days), although Salt Pond (OC6) remained closed until June 23. No other state primary sampling sites displayed toxicity above the detection limit. Once again in 2016, there were no reported illnesses due to PSP from Massachusetts shellfish.

Table 5. 2016 PSP Analyses Processed.

Species	Samples
Blue mussel	371
Quahog	13
Atlantic Sea Scallop	5
Stimpson Surf Clam	5
American Oyster	1

Amnesic Shellfish Poisoning Event, Monitoring, and Closure: Massachusetts experienced its first-ever Amnesic Shellfish Poisoning (ASP) closure in 2016. *Pseudo-nitzschia* are naturally occurring planktonic diatoms, with over 14 species present in the Gulf of Maine. Seven are known to produce the neurotoxin, domoic acid. The consumption of seafood with an accumulation of domoic acid—whether frozen, raw, or cooked—can cause the life-threatening ASP. The USFDA guidance on domoic acid levels requires regulatory action at 20 ppm. The identification of toxic *Pseudo-nitzschia* species requires electron microscopy or genetic analysis. The presence of toxic species does not necessarily mean that domoic acid is actively produced; toxin production is related to a variety of environmental factors.

The timeline for the event began with Rhode Island closing Narragansett and Mount Hope Bays on October 7. On October 8, *MarineFisheries* closed Buzzards Bay after sampling revealed *Pseudo-nitzschia* levels of >700,000 cells/liter while Rhode Island confirmed toxicity in their samples. *MarineFisheries* extended the closure to include Nantucket Sound and the South Cape on October 10, with *Pseudo-nitzschia* levels >100,000 cells/liter (Figure 9).

On October 11, water samples from Cape Cod Bay, Buzzards Bay, Mount Hope Bay, and Nantucket Sound were shipped to Florida for species identification and 15 shellfish samples were shipped to Bigelow Lab, Maine for domoic acid analyses. Results were negative. After purchase of Scotia Rapid Test kits, on October 19, Buzzards Bay quahog samples tested positive for domoic acid. Sampling conducted between October 24–27 identified *Pseudo-nitzschia* levels in most areas at <5,000 cells/liter with no toxicity detected in shellfish meat samples. Subsequently, *MarineFisheries* reopened all waters closed due to the threat of ASP on October 31, but continued to monitor the bloom and test shellfish meats for toxicity to ensure public safety.

In total, *MarineFisheries* collected shellfish meats from shellfish growing areas in 20 towns for testing. Forty-eight samples were tested using the Scotia Rapid Test, which only provides presence-absence of toxicity. The two samples with positive Scotia screenings were tested with HPLC at the Bigelow Lab for a discrete toxicity level. Fifteen additional samples were analyzed by Bigelow Lab for toxicity prior to *MarineFisheries*

receiving Scotia Test kits (all negative). The Division's rapid response, including the closure and monitoring, prevented a public safety issue as no illnesses were reported.

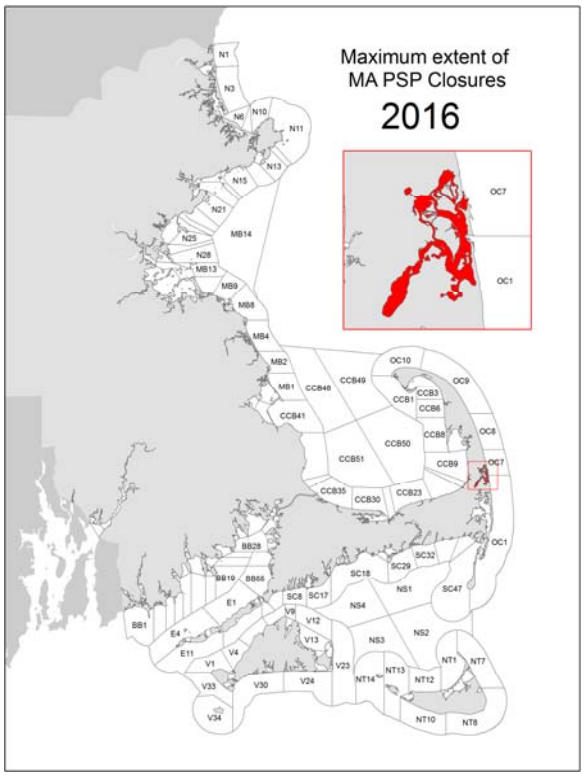


Figure 8. Geographical limit of PSP shellfish area closures in spring 2016.

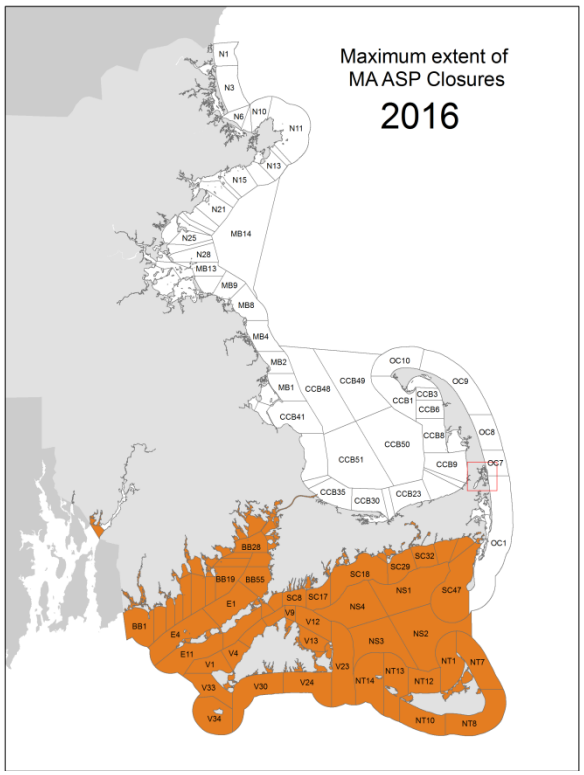


Figure 9. Geographical limit of ASP shellfish area closures in fall 2016.

Phytoplankton Monitoring: Monitoring for other potentially toxic phytoplankton species co-occurs with PSP sampling. On the north shore, 113 phytoplankton samples were collected from the four primary regional stations in Newburyport, Ipswich, Essex, and Gloucester beginning April 1 and concluding December 27. *Alexandrium* was present on five dates in four different locations, from a period of May 6 until June 3. On the South Shore, 74 phytoplankton samples were collected during the monitoring season from eight regional stations in Cohasset, Scituate, Plymouth, Sandwich, Wellfleet, Orleans, and Falmouth (2). No species of concern were observed at actionable levels.

Additional phytoplankton tows were performed in several embayments in Buzzards Bay and along the south shore of Cape Cod in response to reported visible plankton blooms. In each of these cases *Cochlodinium sp.* was identified as the source of the bloom. Reports of these often dramatic rust colored blooms have become commonplace along the southern Massachusetts coast from Rhode Island northward into Cape Cod Bay, including on the islands of Martha's Vineyard and Nantucket, during the warm summer months.

Wellfleet Norovirus Closure

On October 13, *MarineFisheries* closed all waters within Wellfleet Harbor to shellfishing with the exception of bay and sea scallop adductor muscles and carnivorous snails including conchs and whelks (Figure 10). The closure of designated shellfish growing areas CCB11–CCB14 was a result of a determination by *Mass*DPH that multiple illnesses had been linked to the consumption of shellfish harvested from the area. Public health officials received reports of approximately 75 suspect cases of Norovirus over two days, primarily associated with eating raw shellfish at events and at restaurants in the Outer Cape Cod area. Further investigations by *Mass*DPH epidemiologists following the closure confirmed that the cause of the illness outbreak was Norovirus.

Removal of any shellfish (seed or market size) from aquaculture sites for offsite culling was initially prohibited. This prohibition on offsite culling was amended on October 25 to allow aquaculturists to transfer seed shellfish to offsite locations. Work to maintain gear on shellfish aquaculture sites was allowed provided the grower gave prior daily notice to the local shellfish department. Sale of seed shellfish from Wellfleet Harbor for purposes of aquaculture or propagation was also prohibited except for within Wellfleet Harbor.

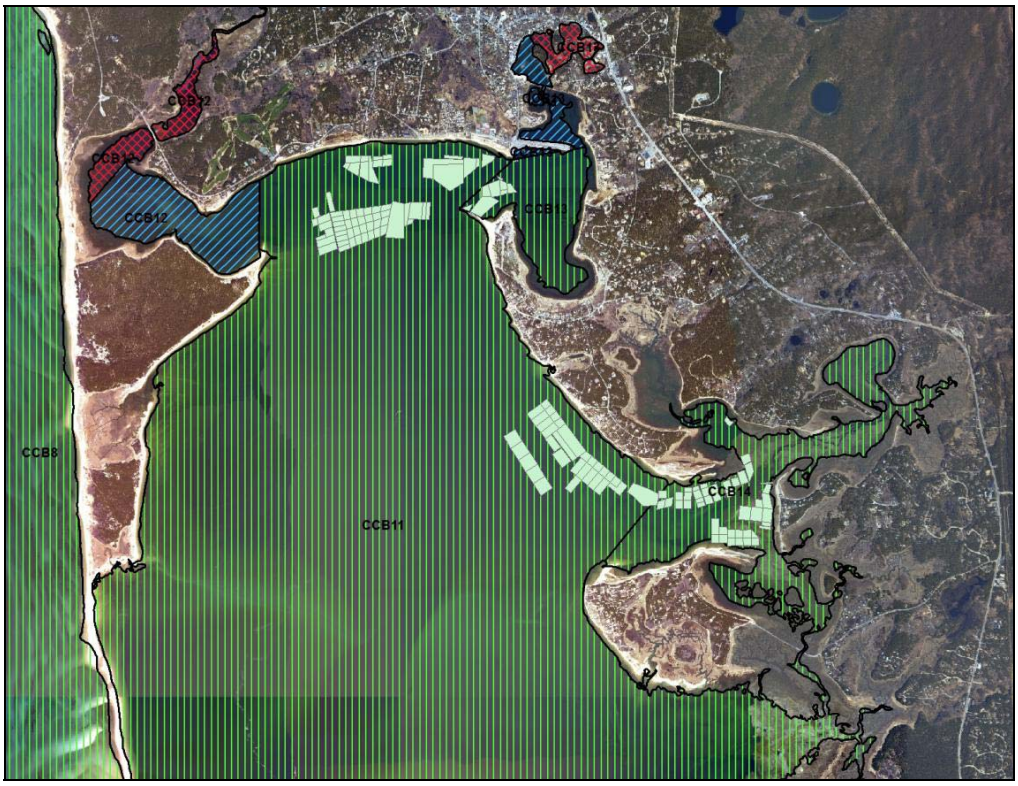


Figure 10. Shellfish Growing Areas impacted by the Norovirus Closure in Wellfleet.

Officials from *MarineFisheries* notified the Town of Wellfleet and shellfish harvesters in the area about the closure. *Mass*DPH notified all businesses wholesale dealers to recall any affected shellfish that was harvested on or after September 26.

Noroviruses are easily spread through food, person-to-person contact, contact with contaminated surfaces such as countertops or door knobs, or exposure to domestic sewage. These viruses can cause vomiting, diarrhea, abdominal cramps, headache, fever, chills, and muscle aches. For most people, Noroviruses cause a very unpleasant but brief (1–2 days) illness; however, the elderly, the very young, and those with

weakened immune systems are at higher risk of more serious illness. The greatest danger is from dehydration.

Wellfleet supports 71 shellfish aquaculturists who culture oysters, quahogs, and soft shell clams on over 259 acres of tidal lands throughout the harbor. Wellfleet ranks among the top three Massachusetts communities in terms of cultured shellfish production (6.7 million oysters and 5.9 million quahogs in 2015) and value (over $5 million in 2015). In addition, 138 commercial and 891 recreational shellfishing permits were issued in 2016. When secondary support businesses are added to the picture, access to shellfish is critical to maintaining the economic engine within the community.

With this in mind, *MarineFisheries* and *Mass*DPH personnel quickly formulated an action plan to assess the norovirus outbreak, and try to identify the source of the virus. The Division conducted a thorough investigation of all impacted shellfish harvest areas; including a complete shoreline survey of Wellfleet Harbor to re-evaluate known pollution sources and to identify any new or potential pollution sources, and a complete review of Wellfleet's marina management and boat live-aboard policies. Staff also conducted extensive water quality sampling in Wellfleet Harbor that indicated water quality exceeded minimum standards for shellfishing. As a result, *MarineFisheries* concluded that the illness outbreak was likely the result of a discrete transient introduction of Norovirus into the waters of Wellfleet Harbor, possibly by the overboard discharge of infected waste or vomit.

Federal requirements mandate a minimum 21-day closure following a confirmed Norovirus outbreak within shellfish growing areas in order to ensure adequate flushing of both water and shellfish. This timeline was adjusted based on water temperature, tidal exposure, and other hydrographic considerations of Wellfleet Harbor. Based on analysis conducted by *MarineFisheries* and in consultation with FDA, it was determined that by November 14, sufficient flushing had occurred to ensure that shellfish in the closed areas were safe for harvest and consumption. Upon re-opening, no new cases of illness were reported.

Following the mandated recall of shellfish harvested from Wellfleet waters between September 26 and October 13, approximately 165,000 oysters and 50,000 quahogs were returned to aquaculturists for segregation and re-submergence on aquaculture sites in Wellfleet. These shellfish remained segregated for an additional re-submergence period prior to harvest. Harvest and sale of shellfish re-submerged on October 13 and October 14 was allowed on November 27.

Shellfisheries Management Project

Contaminated Shellfish Resources

MarineFisheries directly manages the contaminated shellfish resources for commercial bait harvest, relay, and depuration.

Commercial Bait Harvest: In 2016, 17 dredge boat permits were issued for the contaminated surf clam bait fishery off Nantasket Beach in Hull. Due to low participation and confidentiality restrictions, landing statistics for this small fishery cannot be reported for this period.

Contaminated Relay: *MarineFisheries* permits municipalities to relocate, between and within communities, bacterially contaminated shellfish to Approved and Conditionally Approved waters for natural purification and propagation. All activities are conducted under strict NSSP guidelines and are heavily supervised by state and local enforcement authorities. The Division requires that shellfish remain in the water through at least one spawning season: contaminated shellfish must remain at the transplant site until at least September 15 if relocated by June 15; if the shellfish are transplanted after June 15, the shellfish must remain in the transplant site until September 15 of the following year. No shellfish can be harvested until

bacterial testing has been completed on each lot. Quahogs are the most frequently transplanted species followed by oysters.

Disease monitoring of quahogs from within the Taunton River was conducted in March 2016. Disease monitoring of oysters collected from donor sites in New Bedford (Clarks Cove) and Falmouth (Little Pond) was conducted in March and October, respectively. Shellfish samples were sent to Kennebec Marine Biosciences in Maine for analysis. Pathology tests indicated that quahogs and oysters from all donor sites were disease free.

Three dredge boats contracted by the towns were permitted to commence relay harvesting in the Taunton River in mid-April. The majority of shellfish transplanting was completed by June 15 except for Westport. The three boats moved a total of 13,068 bushels of quahog to 14 coastal communities.

The Town of Falmouth and a hatchery in New Bedford transplanted seed oysters to Falmouth, Yarmouth, and Orleans. A total of 962 bushels of oysters were relocated to the three towns.

See Tables 6 and 7.

Table 6. 2016 Contaminated Quahog Relays.

Harvest Site	Transplant Town	Transplant Site	Area	Bushels	Last Day Planted
Taunton River	Yarmouth	Lewis Pond	SC:31.20	1,200	May 27
Taunton River	Eastham	Salt Pond	OC:6.21	194	May 6
Taunton River	Eastham	Town Cove	OC:4.25	206	May 4
Taunton River	Barnstable	Cotuit Bay (Cordwood)	SC:21.21	464	May 20
Taunton River	Barnstable	Cotuit Bay (Bluff Point)	SC:21.20	436	May 18
Taunton River	Westport	E. Branch (Halfmoon Flat)	BB:4.21	1,232	May 14
Taunton River	Westport	E. Branch (Ram Island)	BB:4.24	1,499	Jun. 15
Taunton River	Westport	E. Branch (W. side of Ram Is)	BB:4.32	550	Jul. 15
Taunton River	Westport	Grasshopper Point (BB:3.12)	BB:3.12	980	Jul. 7
Taunton River	Westport	Judy Island (BB:3.19)	BB:3.19	739	Jul. 5
Taunton River	Truro	Pamet Harbor	CCB:7.1, 7.2	257	Apr. 20
Taunton River	Oak Bluffs	Sengekontacket (2,3,6,7)	V:16.22,26,4,29	603	Apr. 29
Taunton River	Mattapoisett	Hiller Cove	BB:30.20	70	Jun. 10
Taunton River	Fairhaven	Round Cove	BB:18.20	500	Jun. 7
Taunton River	Fairhaven	Senior Cove	BB:18.21	500	May 24
Taunton River	Bourne	Buttermilk Bay	BB:44.20	265	Jun. 9
Taunton River	Bourne	Back River	BB:47.20	365	Jun. 3
Taunton River	Bourne	Phinney's Harbor	BB:46.23	370	Jun. 3
Taunton River	Swansea	Cedar Cove	MHB:4.25	700	Jun. 13
Taunton River	Swansea	Inverness Road	MHB:4.24	1,000	Jun. 15
Taunton River	Sandwich	Sandwich Harbor	CCB:37.20,.21	350	Jun. 9
Taunton River	Provincetown	Provincetown Inner Harbor	CCB:4.20	278	May 3
Taunton River	Dennis	Bass River Center	SC:34.7	200	Jun. 9
Taunton River	Swansea	Lees River	MHB:3.25	72	Sep. 9
Taunton River	Falmouth	Green Pond (Menauhant Road)	SC:12.23	22	Nov. 9
Taunton River	Falmouth	West Fal. Harbor (Middle)	BB:54.24	16	Nov. 15

Table 7. 2016 Contaminated Oyster Relays.

Harvest Site	Transplant Town	Transplant Site	Area	Bushels	Last Day Planted
Little Pond	Orleans	Kescayogansett Pond	SC63.20	112	Jun. 22
Clarks Cove	Yarmouth	Lewis Pond	SC31.20	39	May 19
Little Pond	Falmouth	Green Pond (Partridge Lane)	SC12.24	102	Nov. 5
Little Pond	Falmouth	Green Pond (Menauhant Rd)	SC12.23	102	Nov. 5
Little Pond	Falmouth	Green Pond (mouth)	SC12.22	102	Nov. 5
Little Pond	Falmouth	West Fal. Harbor (Associates)	BB54.23	101	Oct. 29
Little Pond	Falmouth	West Fal. Harbor (Middle)	BB54.24	101	Oct. 29
Little Pond	Falmouth	Bournes Pond (Crowell)	SC13.20	101	Nov. 14
Little Pond	Falmouth	Bournes Pond (Central Ave)	SC13.21	101	Nov. 14
Little Pond	Falmouth	Bournes Pond (Gayle Ave)	SC13.22	101	Nov. 14

Depuration: *MarineFisheries* has operated the Shellfish Purification Plant in Newburyport since 1961. The commercial harvest of mildly contaminated soft-shell clam (*Mya arenaria*) is made possible through depuration at the plant. During the purification process, seawater pumped from a saltwater well is used to flush pathogens (disease-causing bacteria) out of the shellfish, making them safe for market. The management and oversight of this process is a sizeable and critical activity for *MarineFisheries*.

Clams are harvested from Conditionally Restricted areas in Boston Harbor, the Pines River in Revere and Saugus, and the Merrimack River in Newburyport and Salisbury, and then transported by licensed and bonded Master Diggers under strict enforcement to the Shellfish Purification Plant. The plant has nine depuration tanks which are filled with seawater from two 130-feet deep wells; the water is maintained at a constant temperature and salinity and is continuously disinfected with ultraviolet light. Each tank can hold 108 dealer bushels/racks of clams. The depuration process is typically three days, during which analysis of shellfish and tank water is accomplished by daily testing in the on-site certified laboratory. Upon completion, the clams are returned to the harvesters who pay a depuration fee. The purified clams are them sold into commerce.

During 2016, the plant received shellfish on 106 days down from 134 in 2015 primarily due to staff reductions (see below). In terms of racks, depuration landings increased 18% over 2015 in part due to the receipt of clams from depuration areas in Maine under a multi-state Memorandum of Understanding. All lots met release criteria with no product recalls. Conditionally Restricted harvesting accounted for 3.3% of all Massachusetts softshell clam harvest and 0.9% of the national harvest. Overall Massachusetts softshell clam state landings increased 78% in 2016. Combining clams depurated from Maine areas with Massachusetts product, the plant processed 2.2% of the national harvest of softshell clams.

Eight Master Diggers delivered clams to the Purification Plant in 2016 up from seven the previous year; the issuance of Subordinate Digger permits issued from 59 to 76.

In 2016, the loss of two plant staff members (the Depuration Coordinator and the Plant Laborer) lead to a reduction in depuration harvest scheduling from five days/week to three days/week. The coordinator position was ultimately backfilled in November.

Wet Storage

2016 marked the fourth year that Shellfish Purification Plant has offered wet storage processing to wholesale shellfish dealers. Wet storage processing at Newburyport utilizes the same tanks, seawater, ultraviolet sterilizers, and biological flushing as the depuration process to flush sand, mud, and grit out of shellfish harvested from NSSP-classified Approved areas. As these shellfish are already at safe bacterial levels, the focus of wet storage is on enhancing them for market and extending shelf-life. While there is no mandatory process time or microbiological testing like for depurated shellfish, wet stored shellfish are also regulated by the NSSP, overseen by *Mass*DPH and USFDA, and must comply with strict controls and standards, like traceability.

In 2016, wet storage decreased 33% from the prior year. Shellfish Plant combined production was down 2% from 2015. It would appear Master Digger and wholesale dealer activity shifted from wet storage to depuration. Fees per rack remained at $6 for both depuration and wet storage.

Shellfish Purification Plant and Laboratory

Laboratory Activities: The Shellfish Purification Plant's laboratory analyzed 564 shellfish samples from 106 runs for fecal coliform in compliance with Federal and state depuration standards. To validate the seawater used in the depuration process, tank and raw seawaters were examined for dissolved oxygen and temperature daily and for turbidity, salinity, and pH monthly. In addition, 426 UV light effluent water samples, 159 raw seawater samples, and 12 tap water samples were bacteriologically tested for the more stringent drinking water standard of total coliform.

An additional 601 shellfish samples were tested for the presence of Male Specific Coliphage (MSC). MSC is a virus of E. coli Famp, and its presence has been correlated with the presence of Norovirus and other human viral pathogens found in shellfish and shellfish waters. A validation study for MSC was completed in 2016. The laboratory partnered with the New Hampshire Department of Environmental Services analyzing for MSC in shellfish, environmental waters, and a wastewater treatment plant assessment study. The lab also analyzed samples for MSC from Wellfleet during the norovirus outbreak and closure.

The laboratory assisted in the assessment of *Vibrio parahaemolyticus (Vibrio)*, analyzing samples for resubmergence and tidal study projects in Duxbury and Katama. Samples where run for the t*lh* gene of *Vibrio* as well as *tdh* and *trh* using the AB7500 FAST PCR system. Eighty-eight oyster samples were analyzed by MPN, with 908 boil preps for t*lh* gene by PCR, and 256 boil preps for *tdh/trh* genes.

The laboratory participated in and passed two proficiency evaluations: USFDA for shellfish meats, depuration waters, and Vibrio; and Northeast Laboratory Evaluation Officers and Managers (NELEOM) for classification waters. The lab supervisor also attended the Association of Food Protection workshop in St. Louis, MO in July on Norovirus testing and the annual NELEOM meeting in Boothbay Harbor, ME in September.

Education and Outreach: Numerous scheduled tours were provided throughout the year for school groups and the general public as well as impromptu tours. The plant hosted an event in December where the completion of 24 energy efficiency projects at state facilities, including the plant, were announced. State officials, local legislators, and the Mayor of Newburyport attended, touring the facility afterwards to learn of the plant's history, public health standards, national water quality standards, and the impact the facility has on the local shellfish industry. Support and outreach to the educational community also continued by supplying seawater to local educators for classroom saltwater cultures, displays, and aquaria.

Facility Maintenance: The Plant was inspected on a monthly basis by *Mass*DPH. General improvements and extensive maintenance continued and accelerated throughout the year. Most notably, the oil fired furnace was replaced with a high efficiency propane furnace and five electric hyper-efficient split units for both A/C and heating down to 30°F were installed, as part of a suite of energy efficiency projects at state facilities. In addition to reducing energy use and costs, the $88,735 investment in the Plant for heating and cooling equipment will reduce time and resources spent on maintenance and improve the facility's ability to control temperature, eliminating temperature spikes that had adversely affected the performance of temperature-sensitive lab equipment previously.

Shellfish Restoration and Mitigation in Buzzards Bay

Since 2014, South Coast Shellfish Section staff in New Bedford has been involved in two major shellfish restoration and mitigation activities in Buzzards Bay. Shellfish restoration refers to enhancing or augmenting shellfish stocks that have waned or been lost due to a myriad of possible factors, some of which include overfishing, disease, natural predation, poor recruitment and natural changes in habitat features. Shellfish mitigation, on the other hand, refers to replacement of shellfish that have been permanently lost due to direct human actions, including shoreline alteration projects, dredging activities and placement of pipe lines and electric cables.

New Bedford Marine Commerce Terminal Quahog Mitigation: The New Bedford Marine Commerce Terminal (NBMCT) located at the South Terminal in New Bedford was created to develop a multi-purpose marine terminal capable of supporting offshore renewable energy facilities, international shipping, and other industries within New Bedford. It is estimated that approximately 9.8 million shellfish were lost as a result of the filing and dredging activities involved with the project. In fulfillment of an agreement between the Massachusetts Clean Energy Technology Center (CEC) and *MarineFisheries* to fulfill certain requirements of the Final Mitigation Plan for the NBMCT, the Division has implemented a program to plant 2.5 quahog seed for every one quahog impacted by the project, for a total of 24.5 million seed quahogs to be planted within New Bedford waters over the next 10 years.

Planting activities target shallow sub-tidal areas in New Bedford municipal waters, in Approved and Conditionally Approved areas only. Each year, seeding takes place in a portion of one of 10 separate subareas (Figure 11). The planted area is then shut down to shellfishing for a maximum of three years in order to allow the seed to grow to a sufficient size to spawn and reach legal harvest size. The annual objective of the seeding program is to plant 2 million juvenile quahogs (in the 20–25mm size range).

In preparation for the 2016 planting season, the Shellfish Program collaborated with the Division's Habitat Program to identify sites within the Clark's Cove areas with optimal quahog habitat: sand and sand/mud mixtures. Using sidescan sonar, Habitat Program staff provided a map of the seafloor by substrate type. Divers were then deployed to verify ground conditions for selection of a 10-acre planting site within Area 3 (Figure 12). These efforts were not undertaken prior to site selection for the first year of planting in 2015, which led to the planting of 582,500 seed quahogs within Area 6 of Outer New Bedford Harbor in suboptimal habitat: hard or rocky bottom and areas with dense vegetation. These types of substrates make it difficult for planted seed quahogs to quickly burrow into the bottom sediment, making them more vulnerable to predation.

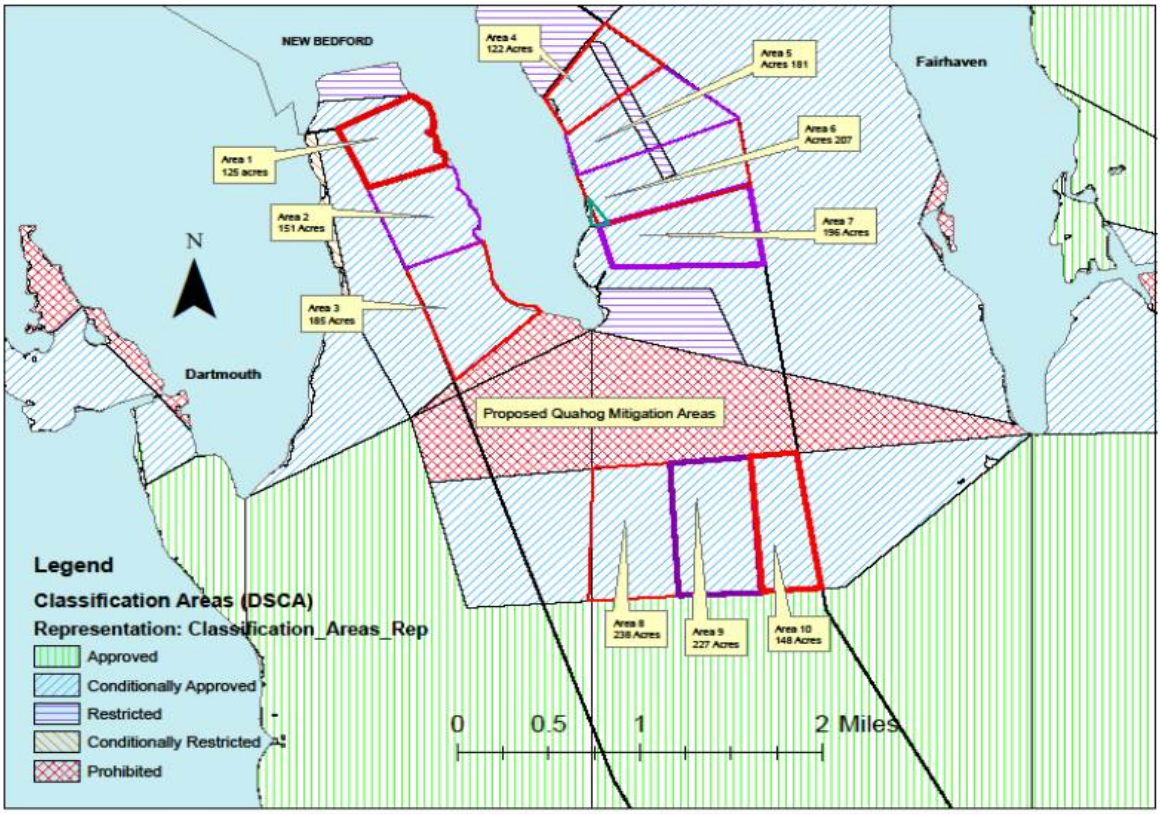


Figure 11. Ten proposed quahog mitigation areas within New Bedford waters. Shellfish Classification Areas are included.

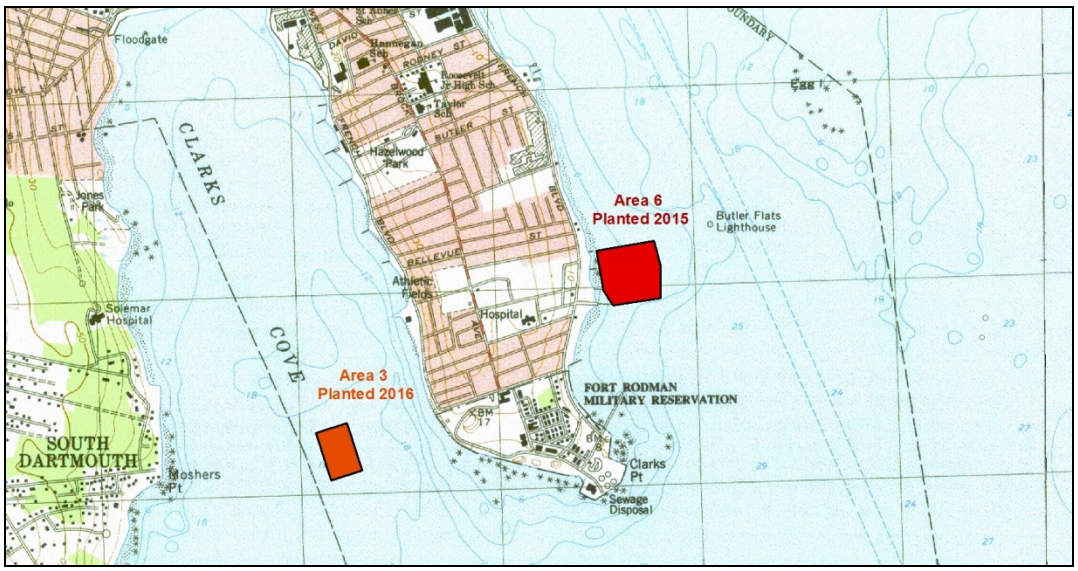


Figure 12. Areas planted with quahogs within Area 6 in 2015 and Area 3 in 2016.

During the summer and fall of 2016, Division staff planted a total of 1,855,500 seed quahogs over 8.4 acres within Area 3 (Table 8). Most of the quahogs were purchased from two commercial hatcheries—the Aquacultural Research Corporation (ARC) in Dennis, MA and Bill Avery's Quality Bay Clams in Galloway, NJ—although 174,000 were produced at the Division's Hughes Hatchery in Oak Bluffs, MA. On four separate occasions, Seawatch International Ltd. kindly transported quahogs from the NJ hatchery to New Bedford within their refrigerated trucks free of charge. This resulted in tremendous savings of resources and labor.

Table 8. Summary of 2016 quahog planting activities.

Planting Date	Planting Area	# Planted	Size Range (mm)	Area Planted (Acres)	Target Density (per ft^2)	Hatchery Source
6/24/16	3A	180,000	15–28	0.9	5	Avery's
7/8/16	3B	160,000	12–34	0.7	5	ARC
7/15/16	3C	295,000	11–32	1.4	5	Avery's
7/22/16	3D	265,000	20–33	1.2	5	ARC
7/29/16	3E	249,000	13–33	1.0	5	ARC
7/29/16	So. Exper. Plot	16,000	14–25	0.07	5	ARC
8/17/16	3F	156,500	14–39	0.7	5	Avery's
10/21/16	3G	300,000	12–26	1.5	5	ARC
10/29/16	3H	60,000	21–27	0.5	5	Avery's
11/28/16	3I	126,000	5–14	0.2	11.7	Hughes
11/28/16	No. Exper. Plot	48,000	5–14	0.07	15	Hughes

Planting activity included placement of quahogs in two experimental plots for future monitoring of quahog growth and survival (Table 8). In July, divers planted 16,000 quahogs with an average size of 19 mm within the southern portion of the mitigation site and in November, divers planted 48,000 quahogs with an average size of 10 mm within the northern portion. Depending on documented growth and survival rates, the Division may expand the quahog mitigation program by including smaller hatchery reared quahogs from Hughes Hatchery in future years. All mitigation sites are sampled annually by divers in order to monitor growth and survival of the planted quahogs.

With the knowledge and experience gained during 2015–2016, the Shellfish Program's mitigation team plans on planting 2 million seed quahogs within Area 1 in Clarks Cove during the 2017 season. The team will continue monitoring growth and survival of the quahogs within all of the planting sites. By the end of the 2017 season, the team will have sufficient data to accurately assess quahog survival rates and to assess the overall success of the quahog mitigation strategy to date.

B-120 Buzzards Bay Shellfish Restoration Project: In April of 2003 the grounding of the B-120 oil barge, owned and operated by the Bouchard Transportation Company, resulted in an estimated 98,000-gallon oil spill in Buzzards Bay. Federal and state Trustee representatives were tasked, through the Natural Resource Damage Assessment process, with managing and supporting restoration of natural resource and resource use injuries. Restoration planning was completed in 2014 and injuries to shellfish resources and the recreational shellfishery were among those addressed. In partnership with nine Buzzards Bay communities, *MarineFisheries* was selected by the Trustees to implement specified restoration strategies.

MarineFisheries designed a five-year program to restore shellfish resources and benefit public recreational shellfishing, including four activities: (1) contaminated quahog transplants; (2) quahog upwellers and seed plantings; (3) single oyster purchases and out-planting; and (4) working collaboratively with The Nature

Conservancy (TNC) by providing monitoring services for TNC-conducted oyster and bay scallop restoration work. *MarineFisheries* is working collaboratively with the Trustees on all aspects of these projects and is providing technical oversight on all TNC B-120 shellfish restoration work via participation on a Technical Advisory Committee.

- Contaminated Quahog Transplants: This project involves the relocation of quahog broodstock harvested from bacterially contaminated waters in the Taunton River to designated transplant sites within the municipal waters of Westport, Dartmouth, New Bedford, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, and Gosnold. The five years of transplant activity began on a limited scale in 2015, with four towns receiving a total of 2,500 bushels of quahogs. In 2016, transplants occurred in all nine participating communities, with a total of 6,645 bushels of quahogs transplanted (Table 9). Division Shellfish Program staff assisted shellfish officials in each town with mapping the transplant sites and conducting pre- and post-relay assessments of the quahog population. The sites will remain closed to recreational fishing for one to three years.

Table 9. Summary of B-120 Buzzards Bay quahog relay activities.

Town	# Bushels Relayed	Estimated # Quahogs	Size Range (mm)	Site Name	Acres Planted
Bourne	800	149,871	64–110	Tahanto Flats	4.0
Dartmouth	884	169,905	61–110	Apponagansett Bay	1.0
Fairhaven	800	145,920	59–110	West Island North, Jack's Cove	3.0
Gosnold	70	14,840	68–102	Nashawena	0.3
Marion	800	190,720	50–103	Planting Island Cove	1.5
Mattapoisett	806	137,342	62–111	Brandt Island Cove	2.7
New Bedford	800	169,920	60–104	Dudley St. Clark's Cove	1.0
Wareham	884	151,164	41–110	Sunset Cove	2.0
Westport	801	136,341	66–110	The Let, East Branch - Westport R.	8.0
TOTAL	**6,645**	**1,266,023**	**41–111**		**23.5**

- Quahog Upwellers and Seed Releases: Under this project, Wareham, Dartmouth, and Fairhaven will grow small quahog seed using upwellers for subsequent out-planting. Beginning in 2017 and for three years, each town will receive 3–5mm hatchery-reared quahogs for intermediate grow out in municipally-managed upwellers (i.e., moored, floating flow through nursery systems). Once they have reached field-plant size (>20mm), the quahogs will be planted at one site per town per year (for a total of nine sites). Division Shellfish Program staff will work collaboratively with municipal shellfish officials in each town to select appropriate seeding sites and conduct pre- and post- seeding assessments of the quahog population. During 2016, materials were purchased and the upwellers constructed (Figure 13).

Figure 13. A newly constructed upweller.

- Single Oyster Purchases and Out-planting: Under this project, Bourne, Marion, and Wareham will purchase field plant sized oysters (≥ 20 mm) for direct seeding in municipal public shellfish beds and/or smaller oyster seed for grow out in upwellers followed by out-planting. Municipal shellfish officials will work collaboratively with Shellfish Program staff to determine the size and quantity of oyster seed best suited to meet town needs depending on the availability of upweller space and oyster habitat and pool their resources to acquire oyster seed at the best available price. Beginning in 2017 and for two years, each town will plant oysters in one site, amounting to a total of six planted sites within Buzzards Bay. Shellfish Program staff will work collaboratively with municipal shellfish officials to monitor oyster growth, survival, and density.
- TNC Oyster and Bay Scallop Restoration: The Nature Conservancy is implementing three oyster placement projects under a four-year plan. Through 2016, one oyster project had occurred in Fairhaven (Nasketucket Bay), and a second was scheduled to occur in Wareham (Onset Harbor) in 2017. TNC will also be using bay scallop spawner cages in an attempt to restore a spawning bay scallop population inside Squeteague Harbor in Bourne. The Shellfish Program is playing a lead role in these projects by advising on implementation techniques, site selection, monitoring protocols, and performance measures. The Shellfish Program is also providing regulatory oversight for the project in conjunction with other state and local regulatory processes.

Environmental Protection Activities

Shellfish Program personnel respond to pollution events in coastal waters in order to assess damage to shellfish populations and to determine the need for public health closures. Types of events include sewage discharges, boat sinkings, petrochemical spills, and other discharges of hazardous chemicals. Several pollution-related events in 2016 are detailed below.

- On February 9, a filtration failure at the Scituate Waste Water Treatment Plant led to the release of 1.8 million gallons of untreated sewage into the North River (MB5). Areas classified as Approved or Conditionally Approved and in the “Open” status within the North River (MB5), South River (MB6), and adjacent coastal waters (MB4) were immediately closed to shellfishing. The bypass was fully closed on February 10, and plant operations were back to normal soon after. These areas were reopened to shellfishing 21 days later on March 2.
- On February 17, a pickup truck entered Jacks Cove in Fairhaven (BB18.1). The southeast corner of the bay was closed for two days.
- On March 2, a tow truck spilled 27 gallons of diesel oil near the Bridge Street bridge in Osterville. Crews managed to recover all but five gallons. West Bay (SC22) and North Bay (SC23) in Barnstable were closed to shellfishing for one day.
- On April 28, another malfunction at the Scituate Waste Water Treatment Plant occurred, resulting in the release of nearly 900,000 gallons of partially treated sewage effluent into the North River (MB5). Areas classified as Approved or Conditionally Approved and in the “Open” status within the North River (MB5), South River (MB6), and adjacent coastal waters (MB4) were immediately closed to shellfishing. These areas were reopened to shellfishing 12 days later on May 13.
- On June 23**,** Lake Tashmoo (V8) on Martha’s Vineyard was closed due to an oil sheen observed near the town landing. The source was unknown, but *Mass*DEP believed it could be from a house close to shore. A site inspection with the Town constable was conducted and no visible sheen was seen in the water or in the sediment. The area was reopened at sunrise on June 30.
- New Bedford Outer Harbor (BB15) was closed to shellfishing on two occasions due to diesel fuel leaking from fishing boats: November 19–22 and November 28–29.

The Shellfish Program also contributes to the review of proposed coastal alteration projects for impacts on water quality, shellfish resources, and habitat. Recommendations are provided through *MarineFisheries* environmental review process to the permitting agencies concerning the effects of proposed structures, filling, and discharge to marine waters. In 2016, staff biologists reviewed a combined 211 project proposals.

Aquaculture Project

The management of marine aquaculture is a major responsibility of *MarineFisheries*. Currently the vast majority of marine aquaculture in Massachusetts consists of municipally licensed molluscan shellfish aquaculture. *MarineFisheries* shellfish aquaculture responsibilities involve two major areas of concern: certifying the issuance of aquaculture licenses by municipalities, and the permitting of aquaculturists, towns and hatcheries to obtain, possess and sell sub-legal shellfish (seed) for transplant and grow-out to legal size.

Shellfish License Certification

Under state statute, *MarineFisheries* is required to certify that municipally issued aquaculture licenses and associated culture activities will cause no substantial adverse effects on the shellfish or other natural marine resources of the city or town where they are located.

Project staff review proposed aquaculture projects and survey sites to determine a project's potential to impact important or protected marine resources. Staff also review projects to evaluate potential conflicts with existing recreational and commercial fisheries and other public uses. If it is determined a project presents a risk to marine resources or may limit public access, the agency may deny certification or require the town to condition the license to minimize such impacts.

In 2016, Project staff certified 70 new shellfish aquaculture license sites and inspected just over 90 acres of tidelands (Table 10).

Table 10. New License Certifications in 2016.

Town	License Sites	Acres
Bourne	4*	3.6
Brewster	1	1
Chilmark	4	5.2
Duxbury	21*	2
Eastham	4	2.5
Edgartown	4	8
Falmouth	3	10
Marion	1	0.5
Mashpee	1	1
Plymouth	15	34.5
Provincetown	9	10
Truro	1	2
Wareham	1	7
Yarmouth	1	3
Total	**70**	**90.3**

* Includes upweller sites

Permitting

MarineFisheries issues permits for all marine aquaculture activities in the Commonwealth. Permits require holders to manage their culture activities in a manner that prevents the introduction of diseases, non-native species, and other pests or predators that could decimate natural populations and harm both aquaculture and wild commercial fisheries. Additionally, permits may be conditioned to ensure food safety standards are met.

In the case of shellfish, a propagation permit is issued annually to both private growers and municipalities. The permit allows the possession, transplant, and grow-out of seed shellfish from approved sources. In 2016, *MarineFisheries* issued shellfish propagation permits to 360 private aquaculture license site holders (Table 11) and 24 municipalities (for public propagation activities) operating shellfish aquaculture projects in 30 coastal municipalities throughout the Commonwealth.

In 2016, *MarineFisheries* also issued the first three commercial kelp aquaculture permits in the state. The permits authorize kelp aquaculture on existing licensed shellfish aquaculture sites and the sale of kelp to

wholesale seafood dealers for distribution. *MarineFisheries* staff began and will continue working closely with partner agencies, the aquaculture industry, and researchers to foster the sustainable development of this new aquaculture sector in Massachusetts.

Table 11. 2016 Private Shellfish Propagation Permits and Acreage Under Cultivation, by Municipality.

Municipality	# Growers	Total Acres	Species Grown
Aquinnah	1	1.6	Quahog
Barnstable	54	139.0	Oyster, Quahog, Soft Shell Clam, Surf Clam
Bourne	4	5.0	Oyster
Brewster	10	9.5	Oyster, Quahog
Chatham	2	7.0	Oyster, Quahog, Soft Shell Clam, Razor Clam
Chilmark	7	23.0	Oyster, Blue Mussel, Sugar Kelp
Dartmouth	1	0.5	Oyster
Dennis	28	32.0	Oyster
Duxbury	28	77.5	Oyster, Quahog, Surf Clam
Eastham	17	22.5	Oyster, Quahog
Edgartown	13	17.0	Oyster
Fairhaven	2	46.0	Oyster, Quahog
Falmouth	10	43.0	Oyster, Quahog
Gosnold	1	32.0	Oyster
Ipswich	2	2.0	Soft Shell Clam
Kingston	3	8.5	Oyster
Marion	3	2.5	Oyster
Mashpee	4	18.0	Oyster, Quahog
Mattapoisett	2	109.0	Oyster, Bay Scallop
Nantucket	8	73.0	Oyster, Quahog
Oak Bluffs	1	2.0	Oyster, Sugar Kelp
Orleans	18	23.3	Oyster, Quahog, Blue Mussel, Surf Clam
Plymouth	26	84.6	Oyster, Quahog, Surf Clam, Bay Scallop
Provincetown	13	24.5	Oyster, Quahog, Soft Shell Clam, Razor Clam
Rowley	3	8.0	Oyster, Soft Shell Clam, Razor Clam
Truro	6	20.0	Oyster
Wareham	4	87.7	Oyster, Quahog
Wellfleet	81	261.0	Oyster, Quahog, Soft Shell Clam, Surf Clam, Razor Clam, Blood Arc
Westport	6	55.0	Oyster, Quahog
Yarmouth	2	24.0	Oyster, Quahog
Grand Total	**360**	**1258.7**	

Aquaculture Landings

Aquaculture landings, as derived from SAFIS dealer reports, are presented in Table 12. Confidentiality of an individual or corporation's data is protected by only displaying summarized values and quantities that could not be used to identify data attributed to a single permitted entity. Units for quantity are converted for reporting purposes using standardized conversion factors developed by the Fisheries Statistics Program. Value is calculated from the unit prices reported by dealers with the average unit price used to fill in missing data.

Table 12. 2016 Aquaculture Landings and Value.

American Oyster		
Town or Region	Pieces	Reported Value
Barnstable	6,412,096	$3,656,989
Brewster	361,330	$207,731
Chilmark	74,865	$46,197
Dennis	2,365,022	$1,361,091
Duxbury	10,107,280	$5,708,971
Eastham	441,480	$254,913
Edgartown	3,081,966	$1,785,712
Fairhaven	285,725	$175,071
Falmouth	410,504	$260,116
Kingston	255,720	$142,094
Marion	69,055	$36,002
Nantucket	378,771	$249,684
Orleans	1,136,550	$663,299
Plymouth	1,383,617	$745,698
Provincetown	67,761	$39,010
Wareham	1,478,255	$846,396
Wellfleet	7,760,428	$4,253,771
Yarmouth	368,051	$206,747
Other Areas	1,812,883	$1,072,191
Total	**38,251,358**	**$21,711,683**

Quahog		
Town or Region	Pieces	Reported Value
Wellfleet	4,775,057	$1,128,432
Barnstable	251,114	$61,397
Eastham/Orleans	224,516	$53,856
Other Areas	303,954	$119,121
Total	**5,554,641**	**$1,362,806**

All Other Aquaculture Species	$111,582
Total Aquaculture Landings Value	**$23,186,070**

John T. Hughes Hatchery & Research Station

Infrastructure investments in *MarineFisheries*' John T. Hughes Hatchery and Research Station continue to pay off in the form of enhanced public shellfish beds through its partnership with the Martha's Vineyard Shellfish Group (MVSG). The MVSG, a consortium of the Shellfish Departments of the six towns of Martha's Vineyard, continues to use portions of this Division-owned facility to spawn and culture shellfish for eventual transplant to harvestable shellfish beds throughout the waters of Martha's Vineyard. Access to the hatchery greatly expanded MVSG's hatchery and nursery capacity. This activity supports several of the Division's strategic goals, including improving fisheries sustainability, supporting the Commonwealth's commercial and recreational fisheries, and providing technical support to Martha's Vineyard Town Shellfish Departments.

In 2016, MVSG continued to expand capacity at the station to culture algae for feeding young bivalves throughout the hatchery by installing four 200L kalwall tubes. Staff expanded the capacity to rear larval shellfish by adding a third conical tank in the new greenhouse (Figure 14). Additionally, a deep tank in the new greenhouse was converted to recirculate heated water for growing post-set quahogs in the new greenhouse. Culture activities in the main building and old greenhouse continue to include nursery grow-out of quahog and bay scallop juveniles in downwellers utilizing fresh seawater from Lagoon Pond and aeration for its many tanks, silos, and tables.

Figure 14. The third larval tank in the new greenhouse (MVSG photo).

MVSG also continues to diversify activities at Hughes Hatchery by expanding their remote setting of spat-on-oyster shells and culturing of blue mussels. These activities are intended to support expanded efforts by Martha's Vineyard communities to utilize cultured shellfish to improve water quality and marine habitats in compromised nearshore waters that are plagued by eutrophic conditions caused primarily by excess nutrients.

Shellfish production at Hughes Hatchery continued to increase in 2016 (Table 13). Oyster and scallop larvae were produced; phytoplankton tanks provided additional food for setting quahogs, scallops, and spat-on- oyster shells; quahog and scallop larvae were set in re-circulated and flow-through systems; and blue mussel seed was cultured. In early December, 174,000 seed quahogs reared at Hughes Hatchery were planted in New Bedford waters as part of the New Bedford Marine Commerce Terminal Shellfish Mitigation Project.

Table 13. Estimated 2016 shellfish production at the Hughes Hatchery.

Shellfish	Number
Quahog Seed	13 million
Oysters (including spat-on shell & larval releases)	129 million
Bay Scallop Seed	20 million
Blue Mussel Eyed Larvae	1 million
Blue Mussel Seed	unknown

The culture of sugar kelp *(Saccharina latissima)* in New England waters is emerging. The agency has received a growing number of inquiries from potential and active aquaculturists about kelp culture in state waters. Shellfish growers see kelp culture as a way of diversifying their crop and allowing the production and sale of a second product in the winter and early-spring when demand for shellfish is low. In tandem with this growing industry interest, MVSG continued to expand capacity at Hughes Hatchery to provide young kelp plants to interested aquaculturists. After three years of trials with several species of macro algae and various methods of culture, MVSG was recently able to obtain very promising results with the spool and

long line culture of sugar kelp (Figure 15). Since 2012, the Shellfish Group has developed the capacity to successfully release and settle kelp spores on spools of nylon twine, and culture the young kelp sporophytes in an aquarium system at Hughes Hatchery. They are planning on expanding their production in 2017 to provide young kelp plants to interested oyster farmers on Martha's Vineyard.

Figure 15. Spools of kelp laden string are deployed on long lines in Oak Bluffs (MVSG photos).

Vibrio Management

A major component of the Shellfish Program's public health protection responsibilities is the implementation of control measures intended to limit the human health risks associated with the exposure of *Vibrio parahaemolyticus* bacteria (*Vibrio*) from the consumption of raw oysters. Exposure to *Vibrio* can cause severe gastrointestinal illness and in rare cases can be lethal. As a result, the USFDA requires NSSP member states with a history of *Vibrio* illness to monitor conditions in oyster harvest areas, implement *Vibrio* control measures, and respond in the event of a *Vibrio* illness outbreak associated with shellfish consumption. *MarineFisheries* is also responsible for the closure of harvest areas following the notification of a *Vibrio* outbreak from *Mass*DPH.

The Vibrio Control Season in Massachusetts runs from May to October, when the risk of *Vibrio* infection is highest. During this period, commercial oyster harvesters are required to ice oysters to prevent the post-harvest growth of *Vibrio;* tag containers of oysters with the time of harvest and time of icing; shade oysters during harvest and transportation; and maintain a harvest logbook. Additionally, certain aquaculture activities related to the culling and processing of oysters are subject to *Vibrio* related restrictions. *MarineFisheries,* in cooperation with local Shellfish Constables and the Massachusetts Office of Law Enforcement, work with harvesters and growers to educate and verify compliance with the *Vibrio* Control Plan through routine compliance monitoring and training workshops.

MarineFisheries and *Mass*DPH continually evaluate the effectiveness of *Vibrio* controls and work with industry and other stakeholders to make improvements and incorporate state-specific data where possible. New research efforts initiated in 2015 continued in 2016. These efforts aim to fine-tune existing *Vibrio* controls, explore additional illness reduction options, and where possible reduce the growing

regulatory burden *Vibrio* has placed on the Massachusetts oyster industry. Ongoing monitoring included environmental data collection and oyster tissue sampling for *Vibrio* levels.

Despite the substantial efforts made in Massachusetts to curb *Vibrio* illness, certain harvest areas have continued to experience elevated levels of *Vibrio* cases, specifically Duxbury, Plymouth and Kingston Bays and Katama Bay on Martha's Vineyard. As a result of the continued occurrence of illness during the 2015 season, additional requirements were put in place prior to the 2016 season. These changes primarily focused on meeting illness reduction goals in the growing areas that continue to show an annual occurrence of *Vibrio* illness. *MarineFisheries* also implemented a pilot program in cooperation with the Town of Edgartown and aquaculturists on Martha's Vineyard to evaluate the efficacy of transplanting oysters from Katama Bay to Vineyard Sound prior to harvest. This program showed promising results with an over 80% reduction in *Vibrio* illnesses reported from Katama Bay in 2016 as compared to 2015.

Table 14. *Vibrio* cases related to the consumption of MA-harvested shellfish.

Year	# of Cases
2011	2
2012	9
2013	33
2014	11
2015	28
2016	10

Vibrio illnesses linked to Massachusetts harvested shellfish reduced approximately 65% in 2016 (Table 14) and Massachusetts experienced no growing area closures or recalls during the 2016 season. As a result, *MarineFisheries* did not propose any changes to the *Vibrio* regulations for the 2017 *Vibrio* season. *MarineFisheries* also planned to continue its research efforts to further fine tune *Vibrio* controls and where possible reduce the regulatory burden associated with *Vibrio*.

Other Activities

Technical Assistance: In Massachusetts, cities and towns manage the shellfisheries in all waters within their boundaries not closed by *MarineFisheries* for public health reasons. This includes all shellfisheries with the exception of commercial harvest of surf clams and ocean quahogs which remain under state control. The Shellfish Program assists municipalities on a wide variety of shellfisheries management issues providing technical and regulatory information as well as recommendations on numerous subjects to local shellfish managers. Assistance includes: shellfish propagation; predator control; survey methods; management openings and closures; habitat improvement; shellfish management plans; aquaculture development and regulation; water quality; public health and sanitation; and permitting. Shellfish staff provided technical assistance to municipal managers and boards, state and federal agencies, academia and non-governmental research and management organizations, and individuals.

Professional Organizations: Program staff participated in many professional organizations such as the ISSC, Northeast Shellfish Sanitation Association, Massachusetts Shellfish Officers Association, and New England Estuarine Research Society. In 2016, Program staff participated in numerous ISSC committees throughout the year, and attended the USFDA Shellfish Growing Area Training Course in Richmond, VA during March 8-10.

Neoplasia Monitoring: Staff continued sampling softshell clams as part of a long-term study with a West Chester University researcher to track the prevalence and extent of incidence of hemic neoplasia in these shellfish throughout Massachusetts coastal waters. Neoplasia has been implicated in clam die-offs in Cape Cod, Boston Harbor, and the North Shore as well as other regions of the east coast.

Hydrography Study: From August 23 through September 1, program biologists participated in a USFDA hydrographic dye study of the Lynn Waste Water Treatment Plant in Broad Sound and the Pines and Saugus Rivers.

Habitat Program

Personnel

Dr. Kathryn Ford, Program Leader
Jillian Carr, Assistant Marine Fisheries Biologist
Tay Evans, Marine Fisheries Biologist
Eileen Feeney, Marine Fisheries Biologist
Dr. John Logan, Marine Fisheries Biologist
Katelyn Ostrikis, Assistant Marine Fisheries Biologist
Christian Petitpas, Assistant Marine Fisheries Biologist
Mark Rousseau, Marine Fisheries Biologist
Steve Voss, Marine Fisheries Biologist
Pooja Potti, Contract Assistant

Overview

The goal of the Habitat Program is to protect and enhance marine fisheries resources. Strategies include: 1) reviewing coastal alteration projects and providing science-based guidance and policies that address potential impacts of coastal alteration activities to fisheries resources and habitats of the Commonwealth; 2) initiating and performing fisheries habitat research and applied studies; 3) developing and overseeing *MarineFisheries'* climate change program; and 4) supporting ocean planning in the Northeast.

Technical Review Project

The Technical Review team provides input to the Massachusetts environmental permitting process through review and comment to permitting agencies on a project's potential impact to marine fisheries resources and habitats. This group is also responsible for recommending mitigation, tracking mitigation projects, and reviewing state and federal policy documents. The process of Technical Review includes tracking coastal and marine construction projects, soliciting specific resource information from *MarineFisheries* biologists, conducting literature reviews, attending site visits, writing project comment letters, reviewing options for compensatory mitigation, and participating in interagency meetings. The Technical Reviewers also create programmatic approaches to resource recommendations, provide access to coastal resource information, and support research specific to review needs.

Technical Review

In 2016, staff reviewed 598 projects in 97 municipalities (Figure 16). Of these projects, 421 were new projects. Docks, piers, and floats represented 44% of the project types (Figure 16). Five full-time staff members dedicated up to 75% of their time to technical review; a part-time SMAST-MFI graduate student in an internship also played a vital role in maintaining records and assisting with the preparation of our comment letters in New Bedford.

Major projects reviewed in 2016 included: Army Corps navigational improvements in Boston, Long Island bridge demolition, Conley Terminal dredging, Wynn Casino development, Rockport Meadow Brook and Mill Pond Restoration (Ecological Restoration Limited Project), Boston East Designated Port Area, Muddy River dredging, Pier 4 development, Gloucester Harbor remediation dredging, Charlestown Marina, Hull's Crescent Beach Seawall, Admiral's Hill Marina Chelsea, Lewis Lake tidegate, Massport Logan 4R-2 pier

replacement addressing docks over eelgrass in several municipalities, and Army Corps ordinance removal in Martha's Vineyard coastal waters. Shoreline protection remained a very high priority issue.

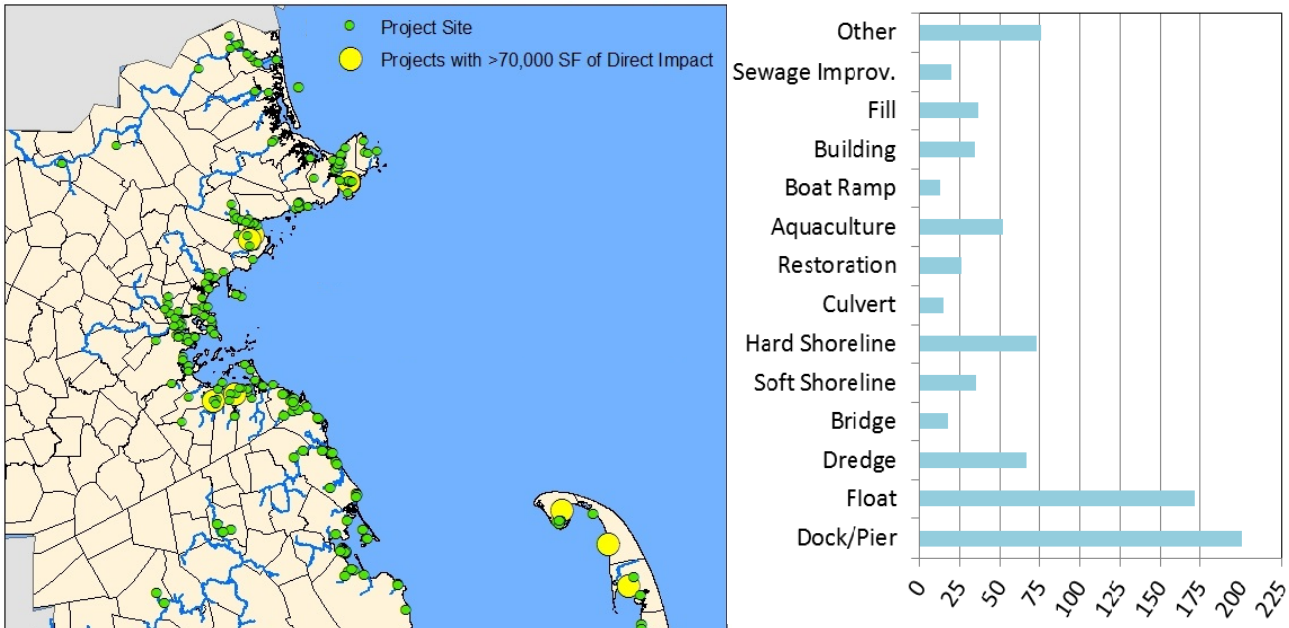


Figure 16. Coastal alteration projects reviewed by Program staff in 2016 by location (left) and type (right). Note: a single project can include multiple project types).

The Technical Review team realized several benefits from its 2013 overhaul of the Project's data management system, which has resulted in more consistent logging and tracking of projects. The new system was used to determine that docks and piers are the most common project types; the team thus developed a standardized approach for these reviews to improve efficiency. The team also used the database to conduct spatial analyses of the construction projects for a presentation at a conference of the American Fisheries Society Southern New England Chapter. Understanding the spatial distribution of our projects has been an advantage to reviewing new projects and assessing cumulative impacts. Also, we can target technical assistance to those municipalities with the greatest need.

Several other major activities follow. The team participated in the review and editing of permit guidance such as the Army Corps General Permit, which went through an amendment process in 2016. Staff also represented *MarineFisheries* on several steering committees and technical advisory groups, such as the Mass Bay Management Committee, the Buzzards Bay National Estuary Program, the Boston Harbor Habitat Coalition, and as reviewers of proposals for *Mass*CZM's Green Infrastructure and Coastal Resilience Grant programs.

In Lieu Fee Program

The In Lieu Fee (ILF) Program is the mechanism by which the Army Corps of Engineers can mitigate for unavoidable impacts on natural resources from the construction activities they regulate. From 2009–2014, *MarineFisheries* was the sponsor for the first ILF program in Massachusetts, the Coastal ILF Program. The Coastal ILF Program addressed authorized impacts of less than one acre in extent to coastal aquatic resources. Under the Coastal ILF Program, 27 construction projects impacting 18,980 square feet of aquatic habitat contributed nearly $230,000. Following a competitive selection process, two *Phragmites* removal projects were funded at Rough Meadows, Rowley and Great Marsh, Newbury and two stream connectivity projects were funded at Off Billington Street Dam, Plymouth and Draka Dam, Taunton.

In 2016, project staff monitored these ILF-funded projects as required under the Coastal ILF Program (Figure 17). At the Rough Meadows site, *Phragmites* cover had been reduced by approximately 92% overall. In the Upper Great Marsh, *Phragmites* stands were removed in both high and low salt marsh areas and regrowth of salt marsh grass (*Spartina* sp.) was documented. Efforts are ongoing at Town Brook to restore connectivity between the Billington Sea and the ocean. In 2015, the Plymco dam, upstream of the Off Billington Street dam, was removed and in 2016 revegetation of the streambank occurred. Planning is currently underway for removal of the Holmes dam downstream from Off Billington Street. Permitting and design is expected to be completed for the Draka Dam fishway project in 2017, with installation targeted to occur by September 2017. Monitoring for the three completed projects will continue through 2019. For the Draka Dam project, monitoring will continue for five years from the date of installation of the fishway.

Figure 17. ILF restoration monitoring. Left: Off Billington Street impoundment upstream of old dam, 2012 photo. Dam was removed in 2013. Right: Restored stream after three full growing seasons, 2016 photo. Over $122,000 in ILF funds were used for vegetating the embankment created when impoundment upstream of dam was removed.

In 2014, the program was expanded to include unavoidable resource impacts statewide under both the Corps General Permit and Individual Permits. In 2016, *Mass*DFG selected the first project to receive funding under the new *Mass*DFG sponsored ILF program. The selection process included review and approval by the Army Corps and the multi-agency ILF steering committee. The selected project is a *MarineFisheries*-led eelgrass restoration project, which will transplant 0.25 acres of eelgrass at Middle Ground in Salem Sound and 0.25 acres at Governors Island Flats in Boston Harbor. *MarineFisheries* is uniquely qualified to conduct this restoration because of its active and successful eelgrass restoration project.

Fisheries Habitat Research Project

The Fisheries Habitat Research Project conducts research, monitoring, and restoration relevant to the mapping, identification, and quality of marine fisheries habitats. Research projects in 2016 included habitat characterization; eelgrass monitoring, restoration, conservation, and mapping; artificial reef siting, construction, and monitoring; and dock impact assessment on salt marsh. Project staff continued to serve on a variety of habitat-related committees, including the ASMFC Habitat and Artificial Reef Committees, the Atlantic Coastal Fish Habitat Partnership, the NEFMC Habitat Plan Development Team, the NROC Habitat Classification Working Group, the NERACOOS Benthic Working Group, and the NEERS Executive Committee. In 2016, staff also participated in the first meeting of the NEFMC Essential Fish Habitat Working Group to discuss the development of EFH maps and assess the efficacy of the existing development process. Staff also reviewed proposals for NOAA and MIT SeaGrant Programs.

Habitat Characterization

The Habitat Research team conducts research focused on seafloor mapping. Using single-beam sonar, sidescan sonar, and video equipment, the team maps eelgrass beds and shallow coastal areas not covered by other seafloor mapping studies in each year. In 2016, we mapped eelgrass in Sandwich, Duxbury, and Salem in partnership with MassBays to assess temporal trends in eelgrass spatial distribution in those areas. In Duxbury, we documented a loss of close to 1,000 acres of eelgrass between 2012 and 2014 (Figure 18) and found that the loss is coincident with increases in chlorophyll *a* likely driven by eutrophication and warming. Shading from phytoplankton blooms could be a factor in the eelgrass loss. A similar study was initiated in Salem Sound with funding secured by MassBays Estuary Program. Initial results suggest that the existing aerial mapping of eelgrass in Salem Sound is not as reliable as the aerial mapping done in Duxbury, and that historical trends and current extent of eelgrass in Salem Sound may be underestimated.

In order to expand on our capabilities to map nearshore environments, staff began exploring how to use drones to collect imagery. Efforts included connecting with other researchers using drones, drafting a drone standard operating procedure for *MarineFisheries*, experimenting with personally-owned drones, and considering data processing/management challenges.

For the past two years, we have had a partnership with MassBays, EPA, and UMass Boston exploring the carbon storage and ocean acidification buffering value of seagrass ecosystems under the EPA's Climate Ready Estuaries Program. The work has resulted in the first estimates of eelgrass' role in the coastal carbon cycle in Massachusetts. The reliance of the carbon estimates on adequate mapping was highlighted. The ability of eelgrass to migrate shoreward as sea level rises remains a concern.

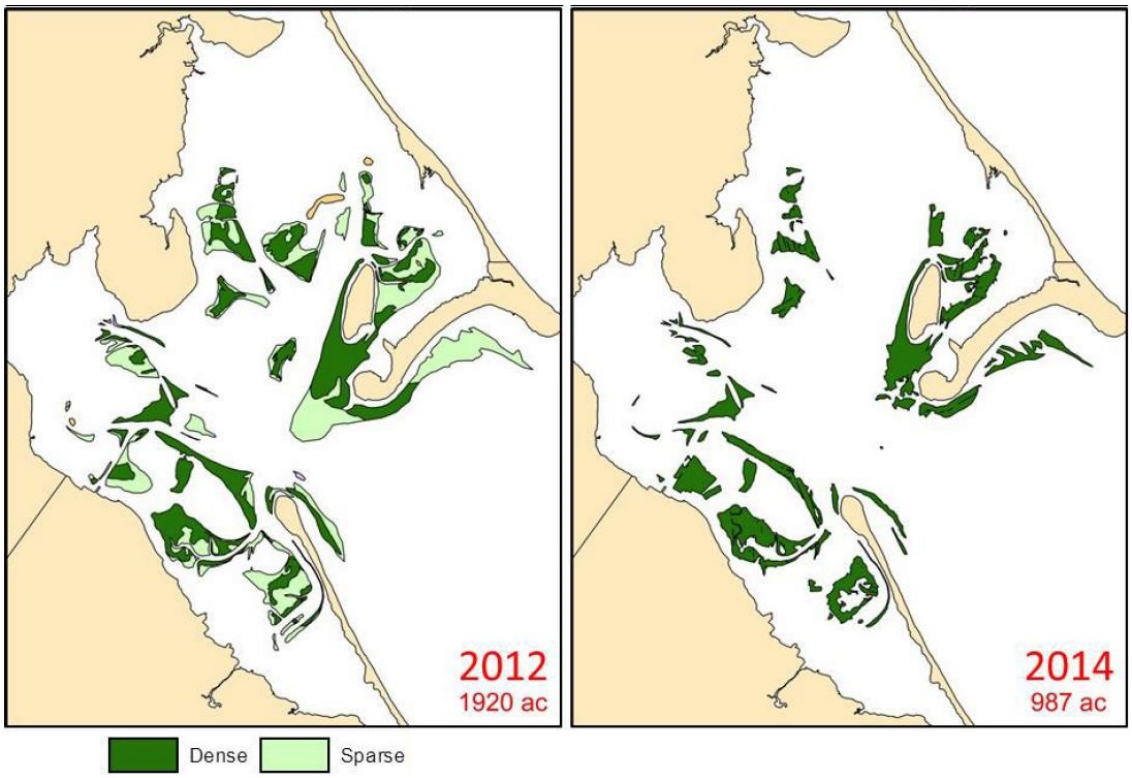


Figure 18. Eelgrass distribution trend in Duxbury-Kingston-Plymouth Bays.

The Habitat Program partnered with Conservation Engineering on two studies this year. First, we used sidescan sonar to conduct a controlled study designed to quantify the abundance of debris lobster pots in the Gulf of Maine. Second, we used sidescan sonar to measure door spread and head height on an experimental otter trawl. These studies are more thoroughly described under *Conservation Engineering Project* (page 18). We also contributed data and review to the NOAA Environmental Sensitivity Index (ESI) mapping project which identifies resources at risk when there is an oil spill.

For the past several years, there have been ongoing concerns over the controversy arising from impact of hydraulic clamming in the Herring Cove region of the Provincetown Coast and the town's enforcing local regulations under the state Wetlands Protection Act to restrict the activity. The Habitat Program continued to participate in conversations and meetings regarding the potential for impact from this gear type.

Eelgrass

Eelgrass is a critical marine fisheries habitat and has been the center of many studies and restoration efforts at *MarineFisheries* for over a decade (Figure 19). The eelgrass team focuses on research, monitoring, and restoration of eelgrass in Massachusetts.

In 2016, the eelgrass team completed its tenth year of monitoring a site in Salem Sound as part of the international SeagrassNet monitoring program. This program tracks short- and long-term trends in eelgrass distribution and health globally. The site is also monitored for invasive species as part of a partnership with the Marine Invader Monitoring and Information Collaborative. Staff also collaborated with other SeagrassNet stations in the northeast for the preparation of a regional synthesis.

From 2012–2015, the Division transplanted eelgrass to several sites in Boston Harbor and Salem Sound as part of mitigation for Hubline pipeline impacts to an eelgrass bed in Beverly. In 2016, the sites were revisited

to continue to track restoration success. This monitoring confirmed that three of the six sites—Middleground, Woodbury Point, and Governor's Island Flats—continue to grow and expand, and both Middleground and Governor's Island Flats have met the restoration success criteria.

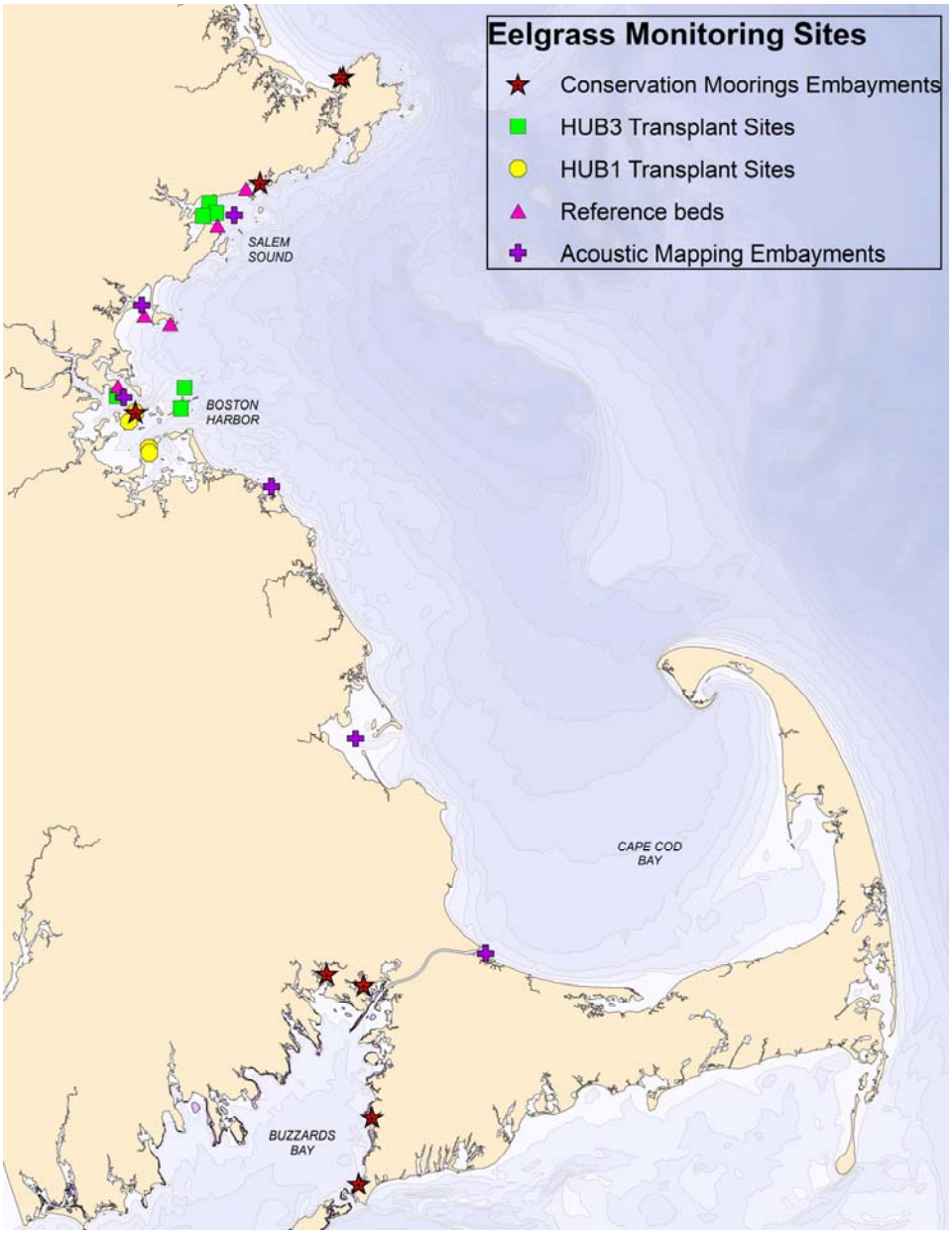


Figure 19. Eelgrass monitoring sites in Massachusetts waters.

Since 2010 we have been studying the effectiveness of "conservation mooring" systems designed to minimize impact of moorings in eelgrass beds. Using flexible rode technology, these mooring systems should reduce scarring associated with the chain of traditional moorings. At sites in Gloucester, Boston, Manchester, Wareham, and Falmouth, we have measured variable success with these systems. Proper installation is the key to effectiveness. In 2016, we met with several harbormaster groups to present a summary of our findings along with our guidelines and recommendations with respect to conservation moorings.

The Habitat Program gave several talks and presentations related to the importance of eelgrass and methods to protect and restore eelgrass. In 2016, talks were given to the Zosterapalooza meeting at EPA in March, the Massachusetts Shellfish Officer's Association annual meeting in August, the New England Estuarine Research Society conference in October, and the Boston Harbor Habitat Coalition meeting in December.

Artificial Reefs

In March 2016, sixteen hundred cubic yards of concrete rubble was deployed into the waters of Nantucket Sound, creating the first artificial reef deployed by *MarineFisheries* in a decade (Figure 20). Concurrent with creating the reef, the Division enacted a regulation prohibiting certain activities, including all commercial fishing, within an additional 100 meters from the site in all directions. This regulation establishes the Harwich artificial reef site as the first and only site in Massachusetts dedicated exclusively to recreational saltwater fishing. The efforts of Mark Rousseau, the Habitat staff member who oversaw this project, were recognized with a *Mass*DFG Outstanding Performance Award. Collaboration with the Cape Cod Charter Boat Association to site additional near shore artificial reefs in the southern portion of Cape Cod Bay began in December.

With the addition of the Harwich Reef, there are now five state-permitted artificial reef locations in Massachusetts. Sites are visited annually to document the presence of finfish, invertebrates, and invasive species and service temperature monitors and acoustic receivers.

Habitat Program staff participated in an organizational steering committee and attended the National Artificial Reef Workshop held by NOAA Fisheries during June in Alexandria, VA.
This year we continued our project exploring how to beneficially reuse dredged rock material coming from the Army Corps' Boston Harbor Deepening Project. This project, funded by the National Fish and Wildlife Foundation's Hurricane Sandy Coastal Resiliency Competitive Grants Program, identified two sites where nearshore artificial reefs could be sited for the purpose of shoreline protection. Conceptual reef designs were drafted and pre-permitting studies were conducted.

Figure 20. Barge deploying material on the new Harwich artificial reef site.

Salt Marsh

Across the Massachusetts coastline, more than 2,500 docks and piers are constructed over salt marsh. These structures can reduce salt marsh ecosystem services through shading-induced declines in marsh stem density and biomass. In 2016, Program staff completed lab work and data analyses and submitted manuscripts on two field studies evaluating the impacts of docks on marsh vegetation and abiotic conditions: a three-year controlled experiment assessing the impact of dock height (Figure 21), and a review of two years' worth of data collected from private docks of different designs. Both studies provide support for height-based design best management practices for future dock construction in salt marsh habitats.

Figure 21. Experimental dock array in Marshfield, MA. The three dock height levels are visible in the foreground with low (2 foot), intermediate (4 foot), and high (six foot) docks included in each treatment. Docks were maintained over the marsh for three consecutive growing seasons (2013–2015).

Tuna Habitat Connectivity Study

Based on the individual expertise of one of the Habitat Program staff, a NOAA-funded project was initiated to quantify the connectivity between bluefin tuna (*Thunnus thynnus*) spawning grounds in the Gulf of Mexico and feeding grounds throughout the North Atlantic and Mediterranean Sea. The project combines three chemical tracer techniques with otolith oxygen isotope ratios being used to assign natal origin and muscle carbon and nitrogen stable isotope values as well as organochlorine contaminant ratios used to assign previous feeding locations. These data will allow managers to better understand the connectivity between western Atlantic spawning grounds in the Gulf of Mexico and seasonal feeding grounds, including waters off New England where bluefin tuna are targeted by a variety of fisheries. This project is a collaboration between *MarineFisheries* and researchers from the University of South Alabama, Old Dominion University, the University of Southern Mississippi, Texas A&M University, the University of Massachusetts, and the NOAA Southeast Fisheries Science Center.This study will fund a four-month seasonal position in 2017 to assist with sample preparation as well assist with other Habitat Project activities.

Climate Change Project

Climate change is an area of active research and policy focus in New England. *MarineFisheries* initiated its Climate Change Project in 2010 with a primary focus on harnessing existing research efforts and ensuring that data relevant to climate change (in particular temperature) are being collected in a standardized way and made accessible to internal and external research entities. In 2013, all DMF temperature datasets were inventoried and the data assembled into an Access database, compiling over 7.2 million temperature records from 26 coastal stations. The database has continued to grow steadily, and now inventories 30 stations with continuous temperature readings plus more than 30 estuarine and riverine sites where data are collected seasonally, typically March to October. On average, approximately 200,000 temperature records state-wide are collected annually by *MarineFisheries*. In 2016, we recognized that a directed effort is required to update the database and we initiated a project with Mass IT to develop a new data platform and migrate existing data from Access into an Oracle database. Habitat staff used the database in 2016 to assess the impact of temperature trends on eelgrass within the Duxbury-Kingston-Plymouth embayment system.

We continued participation on several climate change-related committees, including the Gulf of Maine Climate Network's Sentinel Monitoring Project and the EOEEA's Climate Change Adaptation subcommittee. Many other Division staff are involved with climate change related activities as well, primarily focusing on changes associated with temperature, sea level rise, and acidification.

Offshore Wind & Ocean Planning

MarineFisheries participates on the Massachusetts Renewable Energy Task Force and the Joint RI-MA Renewable Energy Task Force, as well as the Habitat and Fisheries Workgroups for the Mass Wind Energy Area. Three meetings of these groups were held in 2016. Offshore MW and Baystate Wind, the lease holders, conducted geotechnical surveys in the fall of 2016. Two meetings were held to discuss cable access routes from the offshore areas to landfall in Massachusetts or Rhode Island.

Massachusetts state ocean planning activities included participation at two meetings of the ocean advisory commission and science advisory council to stay apprised of activities relating to the Massachusetts ocean plan and potential amendments. The main areas of focus related to the state plan were: 1) cable access for offshore wind farms, 2) sand mining, and 3) aquaculture. These advisory bodies meet quarterly. There were two major actions in the region related to regional ocean planning in 2016. The Regional Ocean Plan was certified by the National Ocean Council and the Northeast Canyons and Seamounts Marine National Monument was created. The Northeast Regional Planning Body held several workshops and conference calls, and Habitat staff reviewed two drafts of the plan and worked toward consensus on its language. Habitat staff participated on the Ecosystem Based Management Working Group, which included two meetings and several phone calls this year. Habitat staff participated in two meetings relating to the designation of the monument, which is the first national monument in the Atlantic U.S. Information pertaining to monuments and ocean planning was presented at the Massachusetts Shellfish Officer's Association Meeting in March 2016.

FISHERIES BIOLOGY SECTION

Dr. Michael Armstrong, Section Leader

Fish Biology Program

Personnel

Dr. Gary Nelson, Program Manager
Micah Dean, Senior Marine Fisheries Biologist
William Hoffman, Senior Marine Fisheries Biologist
Scott Elzey, Marine Fisheries Biologist
Nicholas Buchan, Marine Fisheries Biologist
Brad Schondelmeier, Assistant Marine Fisheries Biologist
Kimberly Trull, Assistant Marine Fisheries Biologist
Nicole Ward, Assistant Marine Fisheries Biologist
Elise Koob, Ageing Technician
Collin Farrell, Ageing Technician

Overview

The objectives of the Fish Biology Program are to collect, process, and analyze biological data on recreationally- and commercially-important fishes needed for effective, science-based management of Massachusetts' fishery resources. Biological data collected from harvested and released fish include age structures (i.e., scales, otoliths, and vertebrae), length frequencies, maturity stages, and bycatch levels. All data are used in stock assessments to determine the status of those resources. In addition, information on catch and effort of recreational anglers are collected via volunteer surveys. Special research projects are also conducted to address specific management needs.

Age and Growth Project

In 2016, staff aged hard-part structures from many species important to the recreational and commercial fisheries. Table 15 shows the number of samples processed. Several species projects in which the Age and Growth Project was involved in 2016 are highlighted below.

River Herring: Sampling of river herring bycatch from the Atlantic herring fishery continued in 2016 (n=1,247). Otoliths and genetic samples were collected to aid in a project to better understand the composition of the bycatch. Alewife were also collected from the Division's resource assessment trawl survey in the spring of 2016 to better understand size distributions of age 1 and 2 fish. Length distributions of these alewife change slightly year to year so this sampling will continue in order to help track year class strength.

Measurements of annual growth were taken from archived river herring otoliths (n=2,388). These samples were collected from six different rivers over a three year period. The measurements will be analyzed to help understand growth differences between river systems and between years.

Atlantic Halibut: In 2016, staff aged 95 Atlantic halibut otoliths that had been archived by the Northeast Fisheries Science Center in Woods Hole (Figure 22). Age and maturity data were presented in a poster entitled "A preliminary re-evaluation of Atlantic halibut life history in the northwestern Atlantic Ocean" at the Flatfish biology conference in December. This was a joint effort with staff at NMFS.

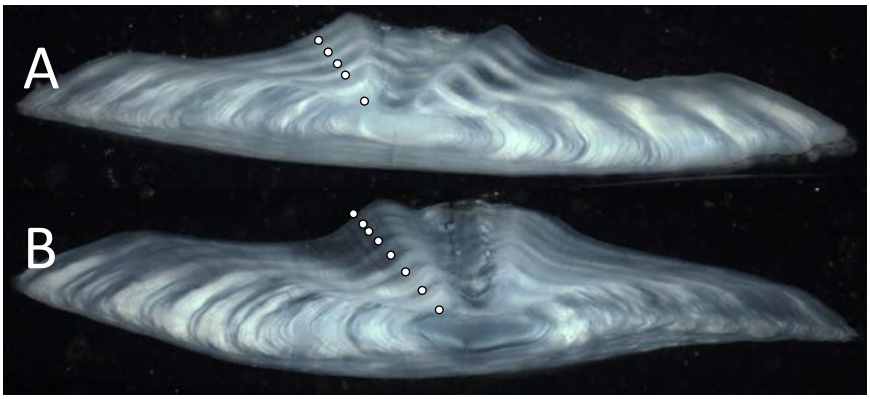


Figure 22. (A) An otolith from a 5-year old halibut captured in the fall. Opaque growth can be seen past the last translucent zone. (B) An otolith from an 8-year old halibut captured in the spring. The translucent zone can be seen starting to form at the edge.

Atlantic Cod: Otoliths were removed from juvenile Atlantic cod (n=101) captured during the *MarineFisheries* Resource Assessment Trawl Survey. Counts of daily growth rings were made to determine hatch date. The processing of these data was ongoing at year's end.

Ventless Trap Samples: Age determination for black sea bass and tautog collected through the Invertebrate Fisheries Project's Ventless Lobster Trap Survey continued in 2016. The ventless survey has been a valuable resource for collecting ageing structures from species that are undersampled in the bottom trawl survey.

Table 15. Samples processed for age in 2016; all samples were collected in 2016.

Species	Structure	Process	Number
American shad	Otoliths and scales	Otoliths aged, scales checked for repeat spawning	397
Atlantic cod	Otoliths	Daily ring counts	101
Atlantic Halibut	Otoliths	Sectioned, aged	95
Black sea bass	Otoliths and scales	Cleaned, mounted, aged	1,132
Bluefish	Otoliths	Baked, sectioned, aged	112
Fluke	Scales	Cleaned, pressed	72
Rainbow smelt	Scales	Cleaned, mounted, aged	1,000
River herring	Otoliths and scales	Cleaned, mounted, aged	6,433
Scup	Scales	Cleaned, pressed	78
Striped bass	Otoliths	Extracted, sectioned, aged	180
Striped bass	Scales	Cleaned, pressed	2,385
Tautog	Otoliths and opercula	Cleaned, sectioned, aged	408
Winter flounder	Otoliths	Sectioned, aged	914

Other Activities: Within the lab, regular maintenance and expansion of reference collections were performed.

Age and Growth staff participated in the High School Marine Science Symposium held by Massachusetts Marine Educators at Salem State College and Northeastern University. Staff also participated in the Division's outreach fishing clinic at Salem Willows for a local group of YMCA summer camp participants.

Staff trained researchers from the University of New Hampshire, Rutgers University and the U. S. Fish and Wildlife Service in Connecticut to age winter flounder, black sea bass, and river herring, respectively.

Staff participated in the continued joint effort by ASMFC and Gulf States Marine Fisheries Commission to construct an age determination manual. The first in a series of three meetings to finalize the document was held in November in Panama City, Florida.

Two grants with the Age and Growth Lab as a collaborator were awarded by NMFS' Saltonstall-Kennedy Grant Program to Elizabeth Fairchild at the University of New Hampshire and to Christopher McGuire at The Nature Conservancy. One of the grants involves ageing wolffish and the other ageing Atlantic halibut. Sampling will start in the spring of 2017.

Age and Growth Lab staff published a peer-reviewed paper assessing ageing structures of tautog collected by non-lethal sampling methods:

Elzey, Scott P., and Kimberly J. Trull, 2016. Identification of a nonlethal method for aging tautog (Tautoga onitis), Fish. Bull. 114:377–385.

Fisheries Dependent Sampling Project

The Fisheries Dependent Sampling (FDS) Project is responsible for the at-sea and shore-side sampling of landings and assessment of fishery performance from the commercial fisheries that occur in and adjacent to Massachusetts territorial waters. The Project also conducts other fish biology research studies and provides support to other projects and senior staff.

Commercial Fisheries Sampling

Project staff collected data and biological samples from commercial fisheries to document and characterize fishery performance, support stock assessments and research, and address specific management questions. These data also strengthened *MarineFisheries*' participation on, and contributions to, the regional fishery management councils and the ASMFC.

Port sampling of commercial catch, summarized in Table 16, was conducted in collaboration with Recreational Fisheries Project staff. Due to limited staffing and an increase in requested support, the sampling of several fisheries was reduced or eliminated for 2016. These fisheries were primarily based out of the southern portion of the state and included the longfin squid, spiny dogfish, summer flounder, whelk, menhaden, black sea bass, and horseshoe crab fisheries. Samplers based out of the Gloucester field station were able to collect the required high-priority south shore striped bass samples at a Boston fish processing facility.

The northern shrimp fishery remained closed to harvest in 2016 due to historic low levels of abundance. A sentinel experimental fishery was conducted in 2016; however no Massachusetts-based vessels were awarded research quota, and thus no commercial samples were collected or analyzed.

Table 16. Number of port sampling events, or trips, made to intercept commercial vessels or seafood dealers where information was collected in 2016.

Species	Intercepts	Number individuals	Number age
Spiny dogfish	4	200	0
Menhaden	3	30	30
Striped Bass	28	703	703

At-sea sampling activities by Project staff are summarized in Table 17. Planning and implementation of the Industry-Based Survey (IBS) for Gulf of Maine Atlantic Cod (page 69) became the dominant activity for Project staff in 2016. Transition of one full-time staff member to coordinate the Cod IBS left a sampling vacancy that was not filled until September. During certain months of the year, Cod IBS requirements dominated the duties of two to three Project staff members. Field support and data management for grant-funded acoustic telemetry studies (pages 68, 72) were consistent with past years and ranked second by sea days. For the experimental whiting fishery in Ipswich Bay and Cape Cod Bay (pages 18, 110), project staff designed the sampling protocols; trained nine contracted sea samplers; conducted four sea sampling trips; edited, audited, and entered all 31 completed trips into relational databases; and continued to conduct analysis and support at year's end. Multiple sea days were also conducted aboard R/V *Michael Craven* and R/V *Alosa* in support of other *MarineFisheries* projects or external collaborations. These efforts included: collecting biological samples for UMass-Boston/New England Aquarium; Gloucester Marine Genomics Institute; hauling gear for NOAA Acoustic Research for Atlantic Cod; and assisting Massachusetts Environmental Police on abandoned lobster gear removal.

Table 17. Summary of at-sea sampling efforts by Project staff in 2016.

Sea Days (#)	Project
95	Cod IBS
25	Acoustic telemetry – Striped Bass
22	Acoustic telemetry – Cusk
13	Coastal lobster
9	Resource assessment
4	Experimental Whiting Fishery
19	Vessel Support for external projects

Atlantic Herring Fishery Portside Sampling and River Herring Bycatch Avoidance

Project staff continued portside sampling of the Atlantic herring and mackerel mid-water trawl (MWT) and bottom-trawl fisheries for the ninth year, and administered the River Herring Bycatch Avoidance programs in collaboration with industry and SMAST. Funding for sampling and bycatch avoidance was provided through the NOAA-issued Atlantic Herring Research Set-Aside (RSA) and an ASMFC grant. In 2016, with the aid of contracted biologists, staff sampled 77 trips portside, and incorporated data from an additional 32 trips sampled by other programs—most often the NMFS Northeast Fisheries Observer Program. From landings in MA ports, 64 MWT trips totaling 10,880 metric tons of herring or mackerel were sampled. From bottom-trawl landings in RI ports, 13 trips totaling 217 metric tons were sampled. Combined, this sampling represents over 37% of coast-wide landings by MWT or bottom trawl vessels participating in the Atlantic herring and mackerel fishery. From these sampled landings, over 9,000 Atlantic herring and mackerel lengths were collected. Over 1,800 alewife and blueback herring lengths were taken and over 1,500 individual specimens were collected and frozen for further analysis.

The goal of the bycatch avoidance program is to reduce the incidental catch of river herring (alewife and blueback herring) and American shad in the pelagic MWT fishery and Rhode Island-based small-mesh bottom trawl (RI SMBT) fishery. Under the bycatch avoidance program, portside sampling data are aggregated and bycatch rates reported back to the industry, allowing vessels to make more informed decisions about where to fish in order to reduce river herring and shad bycatch. Due in part to the success of this program, portside sampling is also being considered as a viable fishery monitoring tool under the Omnibus Industry-Funded Monitoring Amendment (IFM) being developed jointly by the New England Fisheries Management Council (NEFMC), the Mid-Atlantic Fisheries Management Council (MAFMC) and NOAA-GARFO. Project staff have aided greatly in the development of alternatives for this amendment.

Project staff conducted extensive outreach with industry, fisheries managers, and stakeholders during 2016. Informational documents were published through the *MarineFisheries* website and social media, the SMAST bycatch avoidance website, and Massachusetts Lobstermen's Association publications. A text message notification system was developed to inform commercial fixed-gear fishermen about ongoing RSA fishing activity. In order to further the understanding of project goals and achievements, and assist in development of management measures, project staff presented at a NOAA/NEFMC/MAFMC Herring IFM PDT meeting, as well as two NOAA Fisheries Observer Program High-Volume Fisheries trainings. Staff also travelled to Kansas City, MO to present results from the Bycatch Avoidance Program at the annual American Fisheries Society meeting. The talk, "The Influence of a Cooperatively Developed Portside Sampling and Bycatch Communication Program on Fisheries Management Policies", was well received as part of a collaborative research symposium.

Project staff's collaboration with external agencies continues to broaden the scope of research and utility of river bycatch data. Collaboration with NOAA Cooperative Research's Study Fleet program helps implement tow-level electronic Vessel Trip Reports via onboard laptops. This system allows for real-time data collection which aids *MarineFisheries*, NOAA, and fishermen alike. Project staff continued to use portside sampling to collect biological samples in order to leverage future research opportunities.

Operating under the 2016–2018 Herring Research Set-Aside, *MarineFisheries* and SMAST have 2,136 metric tons of RSA herring quota to allocate for harvest, annually. In late 2016, 873 metric tons of Gulf of Maine (Area 1A) RSA quota were caught, generating over $68,000 in funding. This collaborative program has produced over $175,000 in industry funding over the past three years and will sustain the portside sampling and River Herring Bycatch Avoidance program through 2018. In addition, the program has begun evaluating (for possible integration) a *MarineFisheries* pelagic species distribution model. *MarineFisheries* and SMAST also finalized a comprehensive River Herring Bycatch Avoidance program evaluation, and submitted it for peer review. This study compares MWT fishery data (catch, bycatch rates, effort, etc.) from the four years preceding the Bycatch Avoidance Program (2007–2010) with the first four years of high-level portside sampling and bycatch avoidance work (2011–2014).

In order to inform the timing of the Massachusetts/New Hampshire (MA/NH) Spawning Area closure, staff sampled the commercial landings from Herring Management Area 1A to develop the required gonad somatic index (GSI). Utilizing a new spawning projection model created by Division staff, fewer sampled trips would be needed to project a closure. Data were loaded to an ACCSP server daily, and spawning closure projections were updated daily. In 2016, staff sampled four trips from August 2–28. Sampling of Gulf of Maine herring landings following the 4-week spawning closure indicated that the majority of spawning activities had been completed and no re-closure was necessary. Staff also obtained two GSI samples on landings from Georges Bank. While there are currently no regulations that address harvest of spawning herring on Georges Bank, collection of spawning data is a continued priority.

Special Fisheries Research Projects

Program staff greatly expanded their involvement with groundfish and other species research in 2016 by collaborating with multiple university, non-profit, state, and federal organizations.

Atlantic Cod Spawning Activity

Our team of collaborators from *MarineFisheries*, The Nature Conservancy, SMAST, NEFSC, and the Stellwagen Bank National Marine Sanctuary were awarded a Saltonstall-Kennedy grant from NOAA Fisheries in 2014 to describe the distribution of winter spawning cod in Massachusetts Bay. Relatively little is known about the spawning time and location for this group of fish and our work will be instrumental in providing the necessary information to design appropriate conservation measures. This project has relied on a combination of acoustic telemetry and passive acoustic recording to remotely observe the movements and behavior of spawning cod in their natural environment.

This third and final year of field work represented the most important for data collection because all telemetry detections came from fish tagged in previous seasons and are therefore most representative of natural spawning behavior. While no additional spawning cod were tagged in this season, a total of 317 fish tagged over the previous two years were still at-liberty and had sufficient battery life to be detected through the 2015/16 winter spawning season. An array of 56 acoustic receivers encompassing a 350 km^2 portion of Massachusetts Bay was maintained from September through March. In addition, multiple autonomous underwater vehicles (AUV) were deployed and programmed to make five complete surveys of Massachusetts Bay between November and January, providing detections of our acoustically tagged fish over an even wider area. Each AUV was also equipped with a passive acoustic monitoring device to record the spawning vocalizations produced by male cod. Six additional passive acoustic monitoring devices were deployed at fixed stations to further augment our ability to describe the distribution of cod spawning activity.

Groundfish Discard Mortality Studies

Atlantic Cod: Program biologists continued their collaboration with the New England Aquarium, SMAST, and the University of New England to provide a more accurate estimate of the post-release mortality of recreationally caught cod. This project, grant funded by NOAA Fisheries' Bycatch Reduction Engineering Program, used acoustic telemetry to monitor the long-term survival of discarded cod caught via hook-and-line. A total of 136 fish were affixed with depth-sensing transmitters and released into a dense array of 31 acoustic receivers, allowing for the determination of mortality from their horizontal and vertical movements. Environmental and fishery variables collected for each fish (e.g., fight time, handling time, injury score, water temperature, etc.) allowed us to determine which factors most influence post-release survival. Results of this study were used in the 2015 stock assessment update for GOM cod and are expected to contribute to future assessments. In addition, the novel analytical methods developed under the project will likely steer the direction of future discard mortality studies. During 2016, a second peer-reviewed paper was published:

Capizzano, C.W., Mandelman, J.W., Hoffman, W.S., Dean, M.J., Zemeckis, D.R., Benoit, H.P., Kneebobe, J., Jones, E. Stettner, M., Buchan, N., Langan, J., and Silukowski, J.A., 2016. Estimating and mitigating the discard mortality of Atlantic cod (Gadus morhua) in the Gulf of Maine recreational rod-and-reel fishery. ICES Journal of Marine Science. 73: 2342-2355.

As a follow up to the study described above, our team of collaborators received a NOAA Saltonstall-Kennedy grant to estimate the discard mortality of cod captured in the lobster trap fishery. The project follows a

similar methodology to our study of the recreational fishery and completed its first year of fieldwork in 2016.

Atlantic Haddock: Building on our success at utilizing acoustic telemetry to estimate the discard mortality of Atlantic cod, the same collaborative team received two separate NOAA grants to evaluate the recreational discard mortality of haddock in the GOM. These combined funds allowed us to tag 156 haddock with acoustic transmitters in 2015 and record observations on an additional 2,422 haddock that will be used to model the influence of release condition on discard mortality. An array of 32 receivers was maintained at the study site (central Jeffrey's ledge) to monitor the fate of tagged haddock. Data analysis began in 2016. Staff expect to produce a robust estimate of haddock discard mortality for use in future stock assessments.

Cusk: Nearly all cusk caught by the recreational fishery exhibit severe barotrauma symptoms and are unable to re-submerge to their natural benthic habitat. Staff and other grant collaborators designed a study to evaluate release devices as a tool to return cusk to the seafloor allowing them to recompress their gas bladders (Figure 23). Acoustic telemetry was used to monitor the behavior and fate of fish post-release, revealing an unprecedented view of cusk movements. A 43 acoustic receiver array was built and maintained between June and October. Eighteen tagging trips were completed by staff and grant collaborators and a total of 447 cusk were tagged. All were released using a release device and a subset of 76 fish was tagged with acoustic transmitters. With the field work completed, analysis of data was underway at year's end. It is anticipated the analysis will be completed in 2017 and results submitted for publication in a peer-reviewed journal.

Figure 23. *MarineFisheries* biologist Matt Ayer tagging a captured cusk (photo courtesy of Steve DeNeef).

Larval Cod Transport

With funding from MIT SeaGrant, Program biologists partnered with WHOI and SMAST on a project to combine the information we have obtained on the spatial distribution of cod at various life stages with environmental variables and a hydrodynamic model to construct a full life history model of cod movements in the GOM. To provide empirical observations for comparison with model outputs for the transport of pelagic cod eggs and larvae, we partnered with local school groups to build and deploy drogued drifters equipped with GPS tracking devices that continuously relay their position via ARGOS satellite.

A related project that used hydrodynamic modeling to predict larval transport success and connectivity between GOM cod spawning groups led to a paper that was published in ICES Journal of Marine Science:

Churchill, J. H., Kritzer, J. P., Dean, M. J., Grabowski, J. H., and Sherwood, G. D. 2016. Patterns of larval-stage connectivity of Atlantic cod (Gadus morhua) within the Gulf of Maine in relation to current structure and a proposed fisheries closure. ICES Journal of Marine Science. 74: 20-30.

Fishery Selectivity

Many fish species undergo seasonal migrations between breeding grounds and feeding areas (e.g., striped bass, bluefin tuna, Atlantic menhaden). Often, not all members of the population participate in these

migratory loops: juveniles may occupy "nursery" habitat prior to joining the adult migrations; younger adults may not migrate as far or at the same time as older adults. When fishing occurs more intensively over a portion of this migratory range, the size selectivity of the fishery can differ dramatically from what is typically associated with the fishing gear. In 2016, staff co-published a paper (see below) on research that used a simulation model to explore how the shape of the selectivity curve can be influenced by a suite of fishery (gear, season, area) and biological (age, season, area of migration) processes. Using Atlantic menhaden as a case study, the authors demonstrate that despite a "flat-topped" selectivity curve associated with purse seine fishing gear, the selectivity of the fishery is actually "dome-shaped" due to the spatial and seasonal patterns of the population and the fishery.

O'Boyle, R., Dean, M. J., and Legault, C. 2016. The influence of seasonal migrations on fishery selectivity. ICES Journal of Marine Science. 73: 1774-1787.

Industry-Based Survey for Gulf of Maine Cod

In 2015, *MarineFisheries* committed to conducting an industry-based trawl survey (IBS) for GOM cod to better understand the population's dynamics and improve our ability to assess and manage the stock (Figure 24). The survey was initiated in response to recent stock assessments that have found the stock to be overfished and subject to declining biomass despite repeated management actions to achieve rebuilding, and to address fishermen's concerns that the assessments do not reflect the true abundance of the stock. Sampling will occur in a portion of the GOM, west of 69.5 degrees longitude, which encompasses 97% of the cod biomass and 93% of the commercial cod landings the portion of the GOM. Every element of the survey design has been optimized for cod and specifically addresses key areas of uncertainty in the stock assessment and management plan.

Figure 24. Catch from one station of the Industry-based Survey.

Logistical planning, training, and pre-survey preparation were a major undertaking during the first half of 2016. In January, *MarineFisheries* posted a Request for Response for a commercial fishing vessel to be used as a survey platform. After evaluating bids, the F/V Miss Emily, a Scituate-based 55' stern trawler, that is owned and operated by Kevin Norton, was selected. In addition, an onboard electronic data collection system, known as Fisheries Scientific Computer System (FSCS), was designed and built with contributions and support from the NOAA Northeast Fisheries Science Center.

To cover the two peaks in cod spawning activity, monthly sampling was conducted in April, May, June, July, October, November, and December of 2016. The target number of tows per month was fifty. Program staff completed 69 days of survey work and 283 representative stations, resulting in an overall completion rate of 81%. In December, a vessel breakdown and inclement weather lead to a lower completion rate of 62% (Table 18).

Sixty-seven different fish and invertebrates were observed during the survey's 2016 sampling efforts. The survey caught 6243.95 kg of cod with a catch per unit effort (CPUE) of 46.28 kg/hr. Market sized cod (40cm–60cm) were the most prevalent, while there was a notable absence of younger fish (<40cm) and large adults (>80cm). The most abundant species caught was haddock (39567.91 kg) with a CPUE of 293.28 kg/hr. In total, 71082.95 kg of groundfish were caught with a CPUE of 526.88 kg per hour (Table 19).

While the survey has been designed to study cod and it is the priority species, all organisms caught were weighed and all groundfish, river herring, and lobsters were measured. Biological data collected from cod included: length, sex, maturity, genetics, and age structures (Table 20). Data and specimen requests were also collected for numerous government agencies, scientific organizations, and universities.

Table 18. Tow completion rate by Month.

Month	Rate (%)
April	82
May	88
June	94
July	84
October	78
November	78
December	62

Table 20. Biological data collected from Atlantic cod.

Data element	Quantity
Lengths	2089
Sex & maturity	1454
Otoliths	634
Dorsal fin clips	429
Caudal fins	267

Table 19. Total catch weights and CPUE of groundfish species.

Species	Kilograms	CPUE (kg/hr)
haddock	39567.91	293.28
Acadian redfish	11918.31	88.34
Atlantic cod	6243.95	46.28
American plaice	5220.51	38.69
winter flounder	2305.93	17.09
yellowtail flounder	2047.36	15.18
white hake	1875.53	13.90
pollock	850.31	6.30
witch flounder	790.11	5.87
Atlantic wolffish	130.97	0.97
Atlantic halibut	74.01	0.55
windowpane	58.05	0.43

Year one of the survey will be completed in January 2017. Beginning in April 2017, year two of the survey will begin, and if funds allow, continue for a full second year.

In addition to standard survey operations, *MarineFisheries* began a complementary study to estimate the efficiency of the cod IBS trawl. Funding for the study was received through a NEFMC grant and administered by the Gulf of Maine Research Institute. In particular, this study will quantify the escapement of groundfish species under the sweep of the trawl which will be used to increase the accuracy of swept area biomass estimates from the cod IBS. This important work will be continued into 2017, when schedule and relative fish abundance allows.

Geolocation of Groundfish from Archival Data Storage Tags

This project was funded by a NOAA Saltonstall-Kennedy grant in 2015 and is a collaboration between scientists at *MarineFisheries*, SMAST, Northeastern University, and the Gulf of Maine Research Institute. Its goal is to produce geolocation methods for reconstructing the movements of tagged fish in the GOM from the depth and temperature record provided by data storage tags (DSTs). This approach has been used elsewhere in the world to describe the natural movements and habitat associations of fish species; however, the unique tidal and temperature characteristics of the GOM prevent the direct application of existing

methods and present a unique modeling challenge. Work continued in 2016 to utilize existing datasets on Atlantic cod, yellowtail flounder, and monkfish in the development of an optimal geolocation methodology that can be shared with the broader GOM research community to greatly augment the utility and information provided by DST studies.

Alewife Life History Modeling

As part of a collaborative grant with researchers from University of Massachusetts Amherst, Southwest Fisheries Science Center of NOAA Fisheries, University of California at Santa Cruz, and The Nature Conservancy to study impacts of bycatch on river herring production, staff developed an empirical-based alewife (*Alosa pseudoharengus*) life history model that includes all life stages (Figure 25) and allows movement of individuals between ocean and freshwater systems. Immigration to and emigration from the freshwater system is regulated by water temperature and rainfall. The model will be used to simulate impact of different levels of offshore bycatch on the resilience of an alewife population with different levels of young production. A manuscript to be submitted to a peer-reviewed journal was planned for 2017.

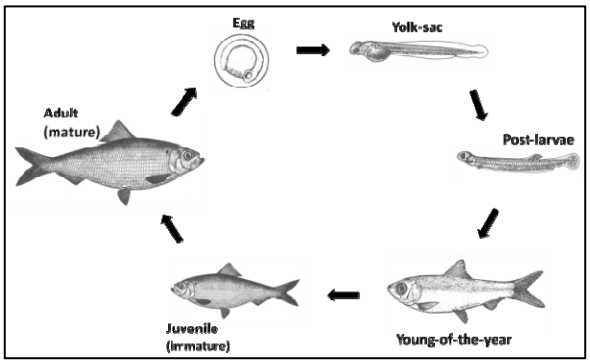


Figure 25. Life stages of alewife.

Bias in Catch-Curve Analysis of Age Data from Fisheries-Independent Surveys

Staff conducted this special project to assess the bias of estimators of total mortality when applied to fisheries research data. Catch curve analysis is often used in fisheries stock assessment to estimate total instantaneous mortality (Z) from a single sample of age composition data taken from fish populations. In cases where catch age compositions are not available from commercial resources, researchers often use age data collected from fisheries-independent surveys. The most common estimators of total mortality and standard error used in catch curve analysis have underlying assumptions that are violated when applied to fisheries data because fish are collected in groups (cluster sampling), not individually. Through a simulation of the sampling process, it was determined that the Chapman-Robson and Poisson generalized linear model methods produce the least biased estimates of total mortality but the standard errors of all methods are usually under-estimated (Figure 26). A manuscript to be submitted to a peer-reviewed journal was planned for 2017.

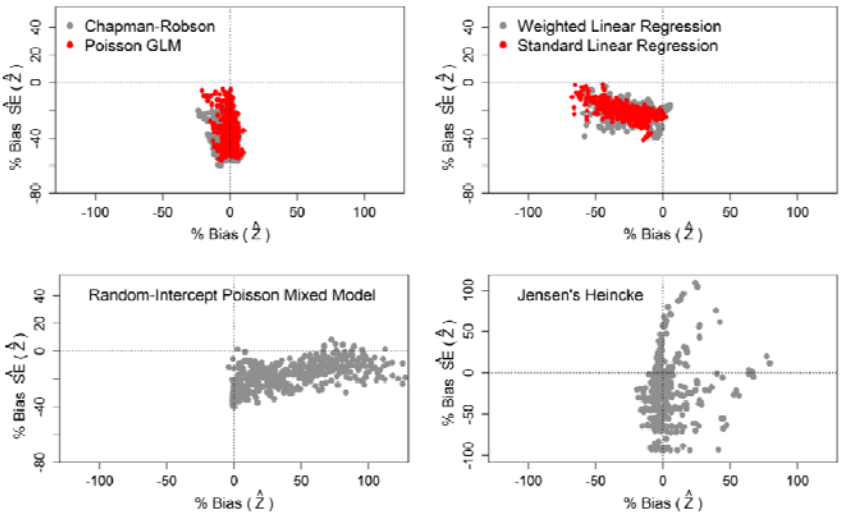


Figure 26. Comparison of bias in total mortality (Z) and estimates of standard error (SE(Z)) from six commonly-used methods over a range of sampling scenarios.

Striped Bass Research Project

Massachusetts is home to the one of the largest striped bass fisheries in the country. High population abundance of striped bass, the diversity of the Commonwealth's nearshore habitat, and many sources of food for striped bass are major factors contributing to the success of this fishery. Without a doubt, striped bass are the backbone of the Massachusetts recreational industry and provide enjoyment to hundreds of thousands of recreational anglers each year. Accordingly, this important resource is given a high level of attention by conducting many special investigations and monitoring programs designed to support the regional management process.

Survival Tagging Study

MarineFisheries has participated in the Striped Bass Cooperative State-Federal Coast-wide Tagging Study since 1991. The study's primary objective has been to develop an integrated database of tag releases and recoveries that will provide current information related to striped bass mortality and migration rates. During 2016, Striped Bass Research Project staff conducted 15 trips aboard contracted vessels, tagging a total of 712 striped bass. Annual post-release survival of striped bass (28 inches and greater) tagged in Massachusetts waters has been relatively stable over the last decade, averaging 74%.

Market Sampling

Monitoring of the age, size, and sex composition of the commercial harvest of striped bass is indispensable for identifying effective management and for substantiating estimates of mortality derived from fishery-independent sources. The objective of this project is to generate a time series database of biological characteristics of Massachusetts's commercial striped bass landings. During 2016, Striped Bass Research Project staff conducted 28 market sampling trips, collecting length, weight, and age structures (scales) from 703 commercially-caught fish.

Acoustic Tagging Study

In 2016, *MarineFisheries* continued an acoustic telemetry study of striped bass in Massachusetts waters. This study is a collaboration between staff in the Fish Biology Program and Diadromous Fisheries Project and examines how mortality is influenced by their selection of habitat and migratory route to and from Massachusetts waters. The study design combines analysis of acoustically tagged fish with genetically derived population composition estimates of summering aggregations. *MarineFisheries* biologists are also collaborating with researchers from University of Massachusetts Amherst, University of Montana, and University of New Brunswick St. John to develop genetic tools and analyze collected data. The creation of a

Figure 27. A tagged striped bass, ready for release. An acoustic transmitter has been inserted in the gut cavity of the fish; the red external tag notifies anglers that they have caught a tagged fish and provides directions for contacting *MarineFisheries*.

genetic population baseline for striped bass will allow *MarineFisheries* to establish spawning-population-specific mortality rates for striped bass harvested by Massachusetts anglers. Since 2015, a total of 1,523 genetic samples have been collected from striped bass caught in state waters.

During 2016, 78 additional striped bass were released with implanted acoustic transmitters in three distinct areas: Boston Harbor, east side of Cape Cod, and waters of Buzzards Bay and Vineyard Sound (Figure 27). To monitor the movements of tagged striped bass, acoustic receivers were deployed between Nahant and Hull in Boston Harbor, off Provincetown and Monomoy on Cape Cod, and between East Chop and Falmouth as well as Gay Head and the Gooseberry Islands in Vineyard Sound and Buzzards Bay. Acoustic monitoring will continue through at least 2018.

Volunteer Recreational Angler Data Collection Program

Implemented in 2002, the objective of the Sportfish Angler Data Collection Team (SADCT) program is to generate a time series database of biological characteristics of Massachusetts' striped bass recreational catch. During 2016, 58 participating anglers collected over 1,700 paired length/age samples from striped bass. The size composition of striped bass reported by participating anglers and fishing mode (shore versus boat fishing) is shown in Figure 28.

In 2013, the SADCT program was expanded to include black sea bass, scup, and fluke. In 2016, SADCT anglers collected 218 samples from black sea bass, 72 samples from fluke, and 78 samples from scup.

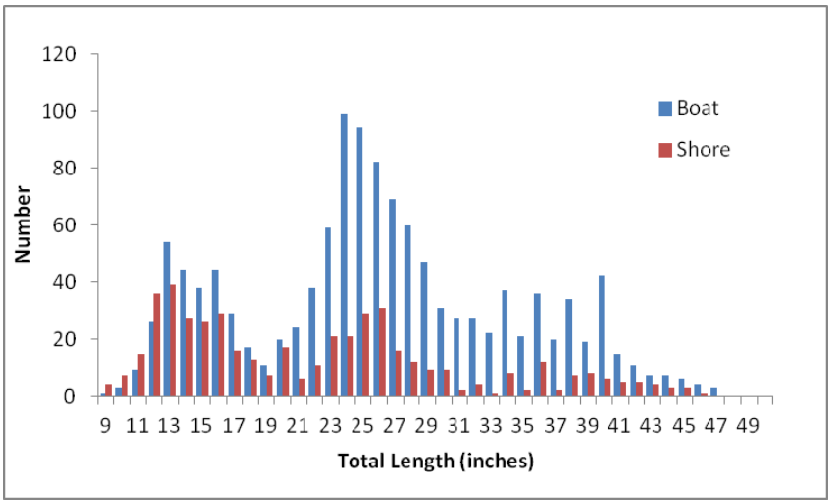


Figure 28. Size composition of striped bass collected by SADCT anglers in 2016.

The striped bass carcass collection program also continued in 2016 and obtained 153 otolith samples from volunteer anglers.

Striped Bass Stock Assessment

As the developer of the ASMFC striped bass stock assessment model, Dr. Gary Nelson conducted the updated striped bass stock assessment in 2016. The results found that the stock was not overfished and overfishing was not occurring.

Other Activities

Sportfisheries Technical Assistance

Fish Biology Program staff provide technical expertise to other governmental organizations, private groups, and individuals with concerns about marine fisheries and serve on technical and advisory committees to support management efforts of important marine species. In 2016, Dr. Gary Nelson served as the Massachusetts representative to the ASMFC's striped bass tagging, technical, and stock assessment sub-committees. Micah Dean served on the ASMFC menhaden technical committee and multispecies committee and the New England Fisheries Management Council's Atlantic Herring plan development team. William Hoffman served on the ACCSP bycatch and biological sampling priorities committees. Scott Elzey served on the ASMFC age and growth QA/QC manual committee. Many presentations were given by staff to other governmental organizations and private groups.

Assessment and Survey Program

Personnel

Robert Glenn, Program Manager

Resource Assessment Project
Matthew Camisa, Senior Marine Fisheries Biologist, Project Leader
Vincent Manfredi, Marine Fisheries Biologist
Mark Szymanski, Marine Fisheries Biologist

Invertebrate Fisheries Project
Dr. Tracy Pugh, Senior Marine Fisheries Biologist, Project Leader
Derek Perry, Marine Fisheries Biologist
Kelly Whitmore, Marine Fisheries Biologist
Steve Wilcox, Marine Fisheries Biologist
Mike Trainor, Assistant Marine Fisheries Biologist
Elizabeth Morrissey, Seasonal Fisheries Technician

Protected Species Project
Erin Burke, Protected Species Specialist

Stock Assessment and Management Support Project
Dr. Mike Bednarski, Senior Marine Fisheries Biologist/Stock Assessment Specialist (through September)
Dr. Greg Decelles, Senior Marine Fisheries Biologist/Stock Assessment Specialist
Brendan Reilly, Seasonal Fisheries Technician

Overview

The Assessment and Survey Program includes four projects.

The **Resource Assessment Project** monitors the distribution, relative abundance, and size composition of marine fish and invertebrates in Massachusetts waters by conducting annual surveys utilizing consistent protocols. These include spring and fall statewide trawl surveys and a seine survey in certain south-facing Cape Cod estuaries. Survey data are used in assessments of numerous regional fish stocks, inform fishery management decisions, and contribute to evaluation of coastal alteration projects.

The **Invertebrate Fisheries Project** focuses on research and monitoring of commercially important marine invertebrates including American lobster, horseshoe crab, whelk, Jonah crab, and northern shrimp. Fishery-dependent and -independent surveys, as well as applied research projects, are conducted to characterize the populations of, and the fisheries for, these valuable species and to inform their management. Additional tasks include research grant writing and administration, and participation in ASMFC technical meetings.

The **Protected Species Project** is involved in various activities related to the conservation and management of protected species in Massachusetts waters. This covers all efforts of the Large Whale Conservation Program, including oversight of the right whale surveillance program, acoustic monitoring of right whales, and large whale disentanglement. Project staff oversees and participates in work on other protected species, such as harbor porpoise and sea turtles. Issues include sea turtle disentanglement, federal Take Reduction Teams, grant management, and potential risk of entanglement in subtidal aquaculture gear.

The **Stock Assessment and Management Support Project** provides dedicated staff to the task of contributing technical and analytical skills in support of regional stock assessments and management decisions in two areas: 1) key recreational species, including fluke, scup, black sea bass, tautog, and bluefish; and 2) groundfish. The recreational fisheries Marine Fisheries Biologist position is funded by saltwater fishing permit revenues through the Marine Recreational Fisheries Development Fund.

Resource Assessment Project

2016 Trawl Survey

The 39th annual spring and fall surveys were accomplished aboard the NEFSC research vessel, the *Gloria Michelle*. The spring survey completed 98 stations from May 9–26, while the fall survey completed 89 stations from September 7–23 (Figure 29).

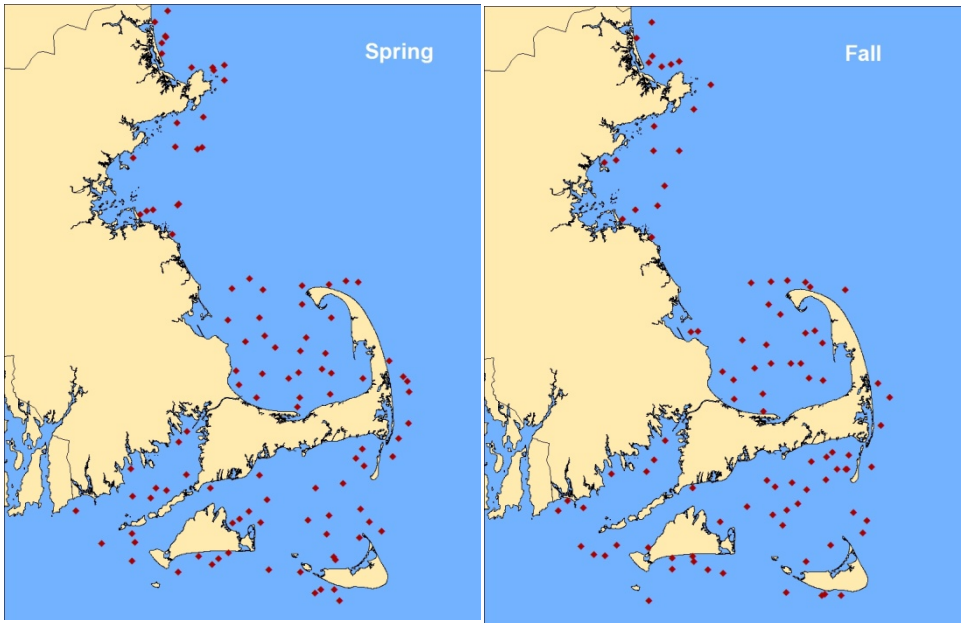


Figure 29. 2016 spring and fall trawl survey station locations.

The 2016 trawl surveys provided weights, counts, and measurements for 100 different species of fish and invertebrates. To aid cooperative fisheries assessments, survey crew collected over 3,000 age structures and sex and maturity observations from cod, haddock, summer flounder, yellowtail flounder, winter flounder, windowpane flounder, black sea bass, scup, weakfish, tautog, American lobster, and Jonah crab. Additional collections supported studies on the spatial structure of cod and river herring populations, size at maturity for female Jonah crab, contaminant monitoring in little skate, climate change, and the Ocean Genome Project.

Survey data provided by project personnel in 2016 were included in annual compliance reports for various ASMFC-managed species; supported regional assessment efforts for witch flounder, American lobster, winter flounder, summer flounder, scup, and black sea bass; and aided research efforts by outside institutions related to ocean planning, effects of temperature on fish distribution, and NOAA environmental sensitivity index maps. Project personnel also served on the following committees of the ASMFC's Northeast Area Monitoring and Assessment Program: Operations, Data Management, and Trawl Technical.

2016 Seine Survey

The 41st Nantucket Sound Estuarine Winter Flounder Young-of-Year (YOY) Seine Survey was completed between June 15 and July 1, 2016. The objective of this survey is to index winter flounder YOY abundance for the Southern New England stock; however, we count all commercially and recreationally-important finfish and invertebrates, and record presence/absence for all other species.

The 2016 stratified mean index fell below the time series median for the fourteenth time since 2001, indicating long-term decline of the southern New England winter flounder stock. Forty-one species occurred in 2016 seine survey hauls.

Invertebrate Fisheries Project

American Lobster Research and Monitoring

Commercial Lobster Trap Sampling: *MarineFisheries* has worked cooperatively with Massachusetts commercial lobster trap fishermen to sample their catch since 1981. In 2016, the 36th year of operation, a total of 72 trips were conducted by staff members of the Invertebrate Fisheries Project and the Fisheries Dependent Sampling Project, during which 45,610 lobsters were sampled from 15,213 trap hauls. This effort also includes shell disease monitoring, which tracks the prevalence of shell disease symptoms on lobsters in Massachusetts coastal waters. In 2016, a total of 6,679 lobsters were sampled for shell disease. All commercial trap sampling program data are provided annually to the ASMFC and ACCSP.

We incorporated a bycatch sampling protocol into our commercial lobster trap sampling program in 2015 to better characterize the incidental catch of several commercially important finfish species in lobster gear. For each sampled species (e.g., black sea bass, tautog, scup, cod, haddock, various flounders), we collect size and disposition information (including presence/absence of barotrauma wounds). At year's end, development of a database was underway.

Ventless Lobster Trap Survey: The 2016 Ventless Trap Survey took place from June through September with eight contracted vessels. This is a cooperative effort between *MarineFisheries* and the lobster fishing industry to monitor and forecast the abundance of lobster (and bycatch species). In the northern survey area (Cape Cod Bay to the NH border), a total of 19,911 lobsters were sampled from 2,851 trap hauls. In the southern survey area (Buzzards Bay, south of the Elizabeth Islands, and portions of Rhode Island Sound), a total of 8,173 lobsters were sampled from 1,966 trap hauls. The data from the Ventless Trap Survey are used to generate indices of lobster relative abundance and to monitor various other population characteristics. The ASMFC Lobster Technical Committee continually monitors the results of the various states' Ventless Trap Surveys as indicators of stock status in both the GOM/GB and SNE stocks.

While we have always monitored bycatch in terms of species ID and numbers caught, additional biological sampling of bycatch species was added to the survey's protocols in 2015. Along with size and sex (for crabs) in all survey areas, we also collect sex information and age structures for black sea bass and tautog captured in the southern survey area. These sampling efforts increase the available data on the sizes of commercially important crab and finfish species including black sea bass, tautog, Jonah and rock crabs, and whelk.

Annual Early-Benthic-Phase Lobster Suction Sampling: Project staff completed the 22nd year of this sampling program in 2016. The program is conducted to track year class strength of newly settled post-larval American lobsters and to delineate coastal habitat important to the settlement of these juveniles. A total of 23 coastal sites were surveyed in 2016 spanning Buzzards Bay, Cape Cod Bay, and Massachusetts Bay. Project staff conducted the SCUBA-based survey over 12 field days from mid-August to mid-October (Figure 30). Mean densities of YOY lobsters were below time series means in all survey regions, with no YOY found along the South Shore, in Cape Cod Bay, or in Vineyard Sound (Table 21). Data from this program contribute annually to the American Lobster Settlement Index, an international research collaborative that tracks changes in recruitment of American lobsters.

Figure 30. *MarineFisheries* divers D. Perry, S. Wilcox, and K. Whitmore preparing to suction sample sites in outer Boston Harbor.

Table 21. Comparison of YOY lobster densities in 2015 and time series means by region.

Region (# yrs surveyed)	2016 YOY Mean (#/m^2)	Time Series Mean (#/m^2)
Cape Ann (7)	0.42	0.45
Salem Sound (21)	0.11	0.65
Boston (20)	0.06	0.15
South Shore (5)	0	0.04
Cape Cod Bay (22)	0	0.29
Buzzards Bay (22)	0.03	0.08
Vineyard Sound (7)	0	0.01

Applied Research: *MarineFisheries* received a NOAA Saltonstall-Kennedy grant for a project titled "*Can climate change induce reproductive failure in American lobster? Case study of a collapsed stock*" (T. Pugh, PI). This is a collaborative project involving researchers from University of New Hampshire, Wells National Estuarine Research Reserve, and Department of Fisheries and Oceans Canada. The goal of the research is to examine potential sub-lethal impacts of stress to reproductive output in SNE lobsters and determine if shell disease can be used as an indicator of reproductive problems in all lobster stocks. The work will look at various aspects of lobster reproduction, including potential and realized fecundity, female mating activity, whether disease status affects the quality or quantity of sperm produced by males and received by females, and the impacts of disease on mating behavior. Field and laboratory work started in the fall of 2016, and work will continue through 2018.

Staff members were also involved in a second Saltonstall-Kennedy grant funded project, entitled "*Modeling the Impact of Climate Change on Larval Connectivity and Recruitment of the American Lobster off of Southern New England.*" This collaborative project, led by researchers at WHOI and also including SMAST and NEFSC partners, will examine how early-stage lobster recruitment is impacted by warming ocean waters.

Work was completed towards updating maturity information for lobsters, focusing in 2016 on offshore populations for which data are lacking. Staff obtained female lobsters from the NEFSC spring and fall bottom trawl surveys, from two offshore regions: eastern George's Bank and the southern portion of NMFS Statistical Area 537. Staff started processing these samples in summer of 2016 with help from Roger Williams University student M. Foote, who is using the work as part of a senior research project for 2017. Data from this project will help to fill gaps in maturity information for the offshore components of the GOM/GB and the SNE lobster stocks.

Assessment and Management Support: Robert Glenn served as chairperson for the ASMFC American Lobster Technical Committee through June of 2016. In July, he stepped down from the committee and was replaced by staff member Dr. Tracy Pugh. During 2016, ASMFC lobster management support consisted of conducting analyses to describe and project stock conditions and to examine results of potential management measures on the Southern New England lobster stock.

Presentations and publications: Dr. Pugh co-authored two manuscripts on lobster reproduction expected to be published in peer-reviewed journals in 2017. She also gave presentations on various aspects of lobster biology, research, and the fishery at the following venues: the University of New Hampshire student chapter of the American Fisheries Society, the 2016 Canadian/U.S. Lobstermen's Town Meeting, and the MA Shellfish Officer's Association 2016 training.

Other Activities: Invertebrate Fisheries Project staff members attended the 2016 Massachusetts Lobstermen's Association Annual Weekend, which serves to improve relations with industry members and provides an opportunity to engage them on the various research and monitoring programs we conduct.

Staff participated in a comprehensive review and analysis of a Swedish proposal to the European Union (EU) to list American lobster as an invasive species, which would have resulted in a ban on live imports. This review of available data on life history characteristics, environmental requirements and suitability of EU waters, the potential for hybridization with the native European lobster, and potential for ecological impacts was a multi-state effort, led by NOAA Fisheries, and the results were compiled into a comprehensive report delivered by NOAA to the EU Director General (DG Environment) and to US Congressional leaders.

Horseshoe Crab Monitoring

Commercial Fishery Sampling: Monitoring of the commercial bait and biomedical harvests continued in accordance with the interstate FMP. Prosomal width measurements were obtained from 3,118 crabs during sampling from a local biomedical facility. The size distribution of bait and biomedical crabs has been fairly consistent since sampling began in 2008.

Figure 31. A juvenile horseshoe crab molting.

Fisheries Independent Surveys: Annual volunteer-based spawning beach surveys continued at 15 beaches along the South Coast, Cape Cod, and the islands (Figure 31). *MarineFisheries* staff conducted 30 surveys at Swift's Beach in Wareham and analyzed data from all 15 survey beaches. The survey results were inconsistent across the state, with results from some areas at or near all-time highs, while others were below normal. The peak of observed spawning activity took place in late May and early June.

Assessment and Management Support: Derek Perry participated as a member of the ASMFC Horseshoe Crab Technical Committee. He also hosted a Horseshoe Crab Science Committee meeting and presented the results of the 2015 spawning beach survey and resource assessment trawl survey and gave an overview of horseshoe crab management.

Jonah Crab Research

Commercial Fishery Monitoring: Traditionally considered bycatch of the American lobster fishery, Jonah crab (*Cancer borealis*) is now a targeted species and its fishery is one of the top ten most valuable in the state. In 2016, 10.6 million pounds of Jonah crabs were landed in Massachusetts with a value of $8.1 million. Over 60% of all Jonah crabs commercially harvested in the United States are landed in Massachusetts.

Invertebrate Project staff conduct port sampling programs to monitor the sex ratio and size distribution of crabs harvested. Sampled crabs come from both inshore and offshore waters, and from vessels that fish in multiple NMFS Statistical Areas. Our biologists measured and sexed 9,449 Jonah crabs in 2016. The sampled catch was comprised almost entirely of males (>99.9%) and most crabs (97%) were larger than 4.75" carapace width. The average size of crabs sampled was 5.5"; the largest crab sampled was 6.9".

Applied Research: Staff continued to work on two Jonah crab studies in 2016. *MarineFisheries* and the Atlantic Offshore Lobstermen's Association (AOLA) received funding from a NOAA Saltonstall-Kennedy Grant awarded to the Commercial Fisheries Research Foundation (CFRF) to conduct a Jonah crab maturity study. The study will determine male and female gonadal and morphometric maturity in five regions (inshore Gulf

of Maine, offshore Gulf of Maine, Georges Bank, inshore Southern New England, and offshore Southern New England). This work will be completed in 2017.

In another partnership with AOLA, *MarineFisheries* received financial assistance from ASMFC to conduct a tagging study. Through years end, 4,305 Jonah crabs have been tagged in an effort to determine movement patterns, stock boundaries, and collect growth information. An additional 15,000 crabs will be tagged in the Gulf of Maine, Georges Bank, and Southern New England in 2017.

Staff conducted the first phase of a tag loss and mortality study in tanks at the UMASS Marine Station at Hodgkins Cove in Gloucester. One hundred crabs were tagged using the t-bar and zip tag techniques (Figure 32), and kept in the tanks for two months in the fall of 2016. At the completion of the study, tag loss rates and damage to the shell related to the t-bar tag were documented. Further work on tag loss and mortality will be completed in 2017, specifically to examine the impact of molting on t-bar tag retention.

Figure 32. A Jonah crab with two types of tags (an orange zip tag on the left, and a green t-bar tag on the right) being used to track movement and growth.

Assessment and Management Support: Program Leader Glenn served on the ASMFC Jonah Crab Plan Development Team. In 2016, the PDT worked on crafting Addendum I and Addendum II to the Interstate FMP. These addenda focused on setting harvest limits for bycatch and the claw-only fishery, respectively. Derek Perry was named as the chairperson of the ASMFC Jonah Crab Technical Committee in 2016.

Presentations: Derek Perry gave a presentation to the Massachusetts Shellfish Officers Association on the biology and fisheries of Massachusetts crabs and whelk.

Whelk Research

Commercial Fishery Sampling: Staff conducted multiple commercial sampling trips aboard commercial vessels fishing conch pots for channeled whelk in 2016, measuring over 7,000 whelk. Fishery-dependent sampling trips have been conducted opportunistically in Nantucket Sound and Buzzards Bay since 2003. Over this timeframe, there has been a ⅜-inch decrease in the average size of channeled whelk observed. Despite minimum legal size increases that occurred in 2014 and 2015, the average size has decreased and there are fewer whelk above the size at which females reach maturity than in previous years.

Applied Research: Staff collected and processed knobbed whelk captured during the fall trawl survey to further examine size-at-maturity. Samples were taken to the lab for external measurement and then dissected to determine maturity status. Maturity information was used to help monitor the populations and provide management advice for the whelk fisheries. Understanding reproductive biology is important to assuring there is adequate spawning stock to replenish the population and allow for sustainable harvest.

Fisheries Management Support and Informational Meetings: Staff generated an updated whelk fisheries status report for the MFAC. This report presented concerns regarding size at maturity, life history, catch and effort trends, fisheries independent trends, and proper use of the standardized gauge. This information was then conveyed to industry through several scoping meetings.

Presentations: S. Wilcox gave a presentation to the Massachusetts Shellfish Officers Association on the biology, fishery, and management of whelk in Massachusetts.

Northern Shrimp Research and Monitoring

Northern Shrimp Assessment Survey: In July and August, *MarineFisheries* staff participated on several one-week legs of the 33rd annual northern shrimp assessment survey conducted throughout the Gulf of Maine aboard the NOAA Ship R/V *Gloria Michelle* (Figure 33). For the fifth consecutive year, the survey indicated an exceptionally low abundance of shrimp that will be available to the fishery in the upcoming fishing season, and low recruitment of the newest year class. The ASMFC Technical Committee recommended a 2016/2017 harvest moratorium based on the 2016 survey and assessment results, and noted that recently-observed unfavorable water temperatures may contribute further to poor recruitment.

Figure 33. Northern shrimp being sampled during the 2016 assessment survey.

Assessment and Management Support: K. Whitmore was chairperson of the ASMFC Northern Shrimp Technical Committee. She assisted in preparation of the annual ASMFC Northern Shrimp Stock Status Report and facilitated development and implementation of the 2016 cooperative winter research sampling program. Whitmore also participated on the ASMFC Northern Shrimp Plan Development Team, which worked to develop Draft Amendment 3 to the interstate FMP.

Great Marsh Green Crab Depletion Program

Figure 34. A green crab observed by *MarineFisheries* divers.

In the spring of 2016, *MarineFisheries* staff administered a program to remove green crabs (*Carcinus maenas,* Figure 34) from the Great Marsh, a large stretch of salt marsh located along the Commonwealth's north shore. Green crabs are known predators of soft shell clams and other shellfish, and this removal program was developed to address local concerns that fisheries resources were being threatened due to recent expansions of the green crab population. In large numbers, green crabs can also degrade habitats including eelgrass beds and salt marsh due to extensive burrowing activity. To reduce green crab numbers, north shore municipalities were offered reimbursement for the removal of green crabs from estuaries and nearshore shallow waters. The Towns of Ipswich, Essex, and Newbury, and the City of Gloucester participated in the depletion program, where fishermen trapped a total of 103,600 pounds of green crabs. Ninety-seven percent of the green crabs collected through this program were sold to seafood dealers (primarily as bait), and the remaining 3% were composted.

Kelly Whitmore was invited to attend the 2016 Regional Green Crab Meeting in Ipswich in October, to discuss the Division's green crab trapping program and to participate in discussions on recent research initiatives, municipal control programs, and development of markets for green crabs.

Protected Species Project

Cape Cod Bay Right Whale Surveillance Program

In 2016, *MarineFisheries* partnered with the Provincetown Center for Coastal Studies (PCCS) and NOAA Fisheries to carry out the 18th year of the Cape Cod Bay Right Whale Surveillance Program. The program conducts aerial surveillance and habitat monitoring of right whales in the Cape Cod Bay portion of Right Whale Critical Habitat.

The trend of high abundance of right whales in Cape Cod Bay continued in 2016. At least 35% (n=182) of the known right whale population was documented in Cape Cod Bay and adjacent waters (Figure 35). The proportion of the population visiting CCB in 2016 was higher than 2015 but lower than other recent years (e.g., 65% in 2011). The departure of right whales from the Bay was slightly earlier in 2016 than recent seasons; however, a group of mother/calf pairs aggregated in the western portion of the Bay until late April.

After departing the Bay, one of these calves was struck and killed by a ship in the shipping lanes east of Cape Cod. The high abundance of right whales visiting Cape Cod Bay in 2016, along with the unfortunate ship strike event, further demonstrate the importance of protecting right whales and how critical Massachusetts waters are to the North Atlantic population.

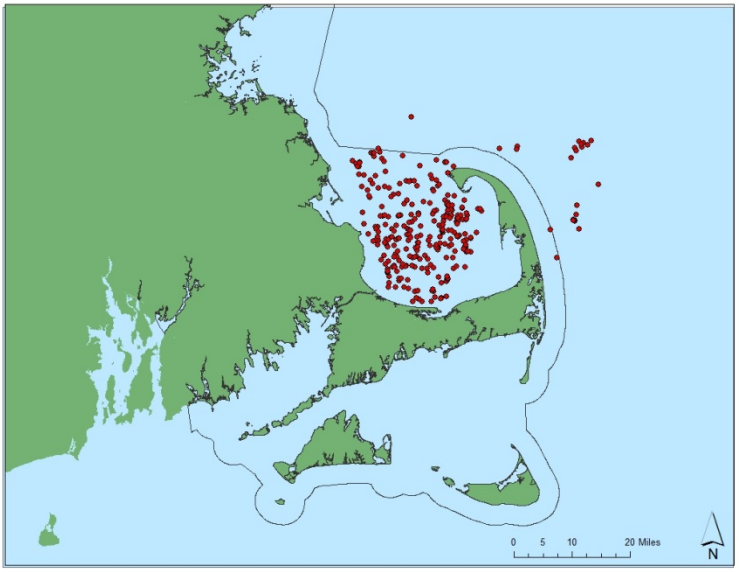


Figure 35. Map of 2016 right whale aerial sightings (PCCS data).

Project Staff administered the grant from NMFS that supports aerial surveillance and habitat monitoring and assisted in coordination of large whale conservation activities. The Division issued advisories to mariners about the presence of high risk right whale aggregations.

Leatherback Sea Turtle Tagging

MarineFisheries and Woods Hole Oceanographic Institution began collaborating on a study intended to mitigate entanglement in fixed gear fisheries. The goal is to collect fine-scale data on turtle behavior in gear-dense areas in order to understand how turtles maneuver around gear and how they become entangled. In 2016, we tagged four leatherback sea turtles in Nantucket Sound with a REMUS-100 AUV and conducted concurrent habitat-sampling with a second REMUS-100 AUV. Tagging will continue in 2017.

Large Whale and Sea Turtle Disentanglement

MarineFisheries and PCCS cooperatively administer the large whale and sea turtle disentanglement efforts around Massachusetts through grants from NMFS and the Massachusetts Environmental Trust. Project Staff assisted in disentanglement efforts, gear analysis, and performed all grant management activities.

Of the 45 whale entanglement cases documented in 2016 along the United States and Canadian coasts, 26 of those were observed off the coast of Massachusetts: one right whale, twenty humpback whales, four fin whales, and one sei whale. The right whale, ten humpback whales, and two fin whales were disentangled. The remaining cases were either not in a life-threatening condition or were not in a position to be resolved due to time of day and distance from responders.

In 2016, there were 21 confirmed leatherback sea turtle entanglement cases, slightly higher than the average of 15 but lower than the record highs in 2012 and 2013 (37 and 51, respectively). Of these 21 cases, 14 were disentangled, either through the efforts of the Disentanglement Network or through ad-hoc disentanglement by boaters.

Other Activities

Erin Burke participated as a member of the Massachusetts Habitat Working Group. This body assists EEOEA, the federal Bureau of Ocean Energy Management, and the Massachusetts Clean Energy Center with analysis of natural resource data as it relates to potential impacts in the Massachusetts Wind Energy Area (WEA). State and federal governments are assessing the area south of Martha's Vineyard and Nantucket for future offshore wind energy development. Burke advised the Habitat Working Group on monitoring whales, marine turtles, and other potential protected species in the WEA.

E. Burke provided guidance to DMF shellfish personnel and municipal and federal shellfish authorities on the potential impacts of subtidal aquaculture projects to protected species. Entanglement in ropes is a major cause of injury and mortality for endangered large whales and sea turtles. The potential for subtidal aquaculture gear to increase entanglement risk should be carefully considered when developing and licensing these projects, especially if they fall within the boundaries of Right Whale Critical Habitat.

Stock Assessment and Management Support Project

Recreational Fish Assessment and Management Support

Michael Bednarski was an active member of the ASMFC technical committees for black sea bass, summer flounder, scup, tautog, bluefish, weakfish, and Atlantic sturgeon. He also participated on the MAFMC bluefish, scup, summer flounder, and black sea bass monitoring committees. Mike provided technical and analytical support to several ASMFC stock assessment subcommittees in 2016, including weakfish, black sea bass, and Atlantic sturgeon. The weakfish and black sea bass stock assessments were completed in 2016 and the Atlantic sturgeon assessment is expected in 2017.

In 2016, M*arineFisheries* received a NOAA Saltonstall-Kennedy grant for the project titled "*Feasibility of a hook and line survey to assess tautog (Tautoga onitis) in southern Massachusetts*" (R. Glenn and M. Bednarski, Co-PI). This survey employs a stratified random design using depth and substrate type as strata. The first fall season of the survey was completed in October and November in which 27 and 28 stations were sampled, respectively. Preliminary data indicate that tautog are fairly abundant on rocky bottom in Buzzards Bay and the stock still has a fair portion of large mature fish. *MarineFisheries* hopes this pilot effort will shed light on effective methods to monitor structure dwelling fish and provide additional information on the status of the tautog stock for the next ASMFC tautog stock assessment.

Groundfish Assessment and Management Support

Greg DeCelles served on the NEFMC Groundfish Plan Development Team, providing analysis for assessment and management support. He participated in the NEFSC stock assessments for monkfish in the spring of 2016 and witch flounder in the fall of 2016. He also participated in the Transboundary Resource Assessment Committee stock assessments for Eastern Georges Bank cod and haddock, and yellowtail flounder in the summer of 2016.

DeCelles collaborated with researchers from SMAST to continue the development of a video trawl system which uses a high definition camera and LED lights mounted in an otter trawl to count and identify fish that pass through the net. By relying on the camera to record the fish, the net can be towed with the end open, so that the fish are not retained, reducing the mortality associated with the survey and increasing the spatial coverage of the sampling. A manuscript associated with this project was submitted to the journal Transactions of the American Fisheries Society and was expected to publish in 2017.

Figure 36. *MarineFisheries* biologists G. DeCelles and D. Martins interview a New Bedford fisherman to learn about cod spawning grounds on Georges Bank and Nantucket Shoals.

DeCelles also worked with scientists at *MarineFisheries* and SMAST to collect fishermen's ecological knowledge to better understand the spatial and temporal distribution of cod spawning grounds on Georges Bank and Nantucket Shoals. They interviewed 40 fishermen from New York to Nova Scotia who had experience fishing for cod on Georges Bank, and compiled their responses to produce detailed maps of cod spawning grounds there (Figure 36). They also analyzed the available data from scientific surveys and observer programs, and combined these data with the fishermen's observations to generate a more holistic understanding of cod spawning activity on Georges Bank. This study can be used to guide future research efforts, help understand cod population structure, and inform the stock assessment. A manuscript on the research was prepared and expected to be published in the ICES Journal of Marine Science in early 2017.

DeCelles also collaborated with 13 scientists from a number of national and international agencies to write a manuscript on reproductive resilience. The manuscript details a variety of methods to evaluate stock-recruitment relationships in fish populations, and was published in 2016.

Lowerre-Barbieri, S., DeCelles, G., Pepin, P., Catalan, I.A., Muhling, B., Erisman, B., et al. 2016. Reproductive resilience: a paradigm shift in understanding spawner-recruit systems in exploited marine fish. Fish and Fisheries, doi: 10.1111/faf.12180.

Vincent Manfredi served as a member of the ASMFC Winter Flounder Technical Committee. During 2016 he also compiled data to create analytical graphics of Massachusetts groundfish landings data before, during, and after a federal prohibition on landings for the Southern New England stock unit.

Recreational and Diadromous Fisheries Program

Personnel

Dr. Gregory Skomal, Program Manager

Recreational Fisheries Project
Dr. Gregory Skomal, Senior Marine Fisheries Biologist, Project Leader
John Boardman, Marine Fisheries Biologist
Matt Ayer, Marine Fisheries Biologist
Ross Kessler, Public Access Coordinator
David Martins, MRIP Coordinator

Large Pelagics Research Project
Dr. Gregory Skomal, Senior Marine Fisheries Biologist, Project Leader
John Chisholm, Marine Fisheries Biologist

Diadromous Fisheries Project
Brad Chase, Senior Marine Fisheries Biologist, Project Leader
John Sheppard, Marine Fisheries Biologist
Dr. Sarah Turner, Marine Fisheries Biologist
Ben Gahagan, Marine Fisheries Biologist
Edward Clark, Carpenter

Overview

The Recreational and Diadromous Fisheries Program includes three Projects.

The **Recreational Fisheries Project** works to preserve, enhance, and promote the marine recreational fisheries of the Commonwealth. Goals are to conserve key recreational species through science-based management; support the recreational fishing community, including local recreational fishing businesses; and educate the Commonwealth's citizens of the features and benefits of local recreational fisheries resources. Project personnel measure abundance, length frequency, and age classes of key finfish populations for input to stock assessments and to design and analyze management options; assess habitat and prey needs of key species; measure harvest and release of key species; promote and enhance recreational fishing access through the purchase and maintenance of access sites; and disseminate information on all aspects of recreational species and fisheries to the public.

The **Large Pelagics Research Project** has been conducting research since 1987 to enhance our understanding of the ecology, life history, and relative abundance of sharks, tunas, and billfish off the coast of Massachusetts, where extensive recreational fisheries for these species occur. In addition to this research, the Project's goals are to foster cooperative research; to participate in the state, regional, and federal management process; and to provide public education and technical information on the biology, management, and utilization of highly migratory species.

The **Diadromous Fisheries Project** is comprised of two major initiatives: fish passage and restoration, and fish biology and management. The former is coordinated among *MarineFisheries* staff, state and federal agencies, municipalities, and private groups to facilitate, design, and execute restoration projects with the goal of enhancing diadromous fish populations and habitats. In addition, technical assistance and monitoring are provided as needed for individual restoration projects and coastal watersheds. The latter is responsible

for the management, investigations, and assessment of over 10 species of diadromous fish stocks in Massachusetts. Species such as river herring (alewife and blueback herring), rainbow smelt, white perch, tomcod, American eel, and American shad are evaluated for run counts, indices of population abundance, size and age composition, local harvests, and restoration potential. Information generated by this project is necessary for the sustainable management of diadromous fish populations as required by state and federal law.

Recreational Fisheries Project

MRIP Sampling Project

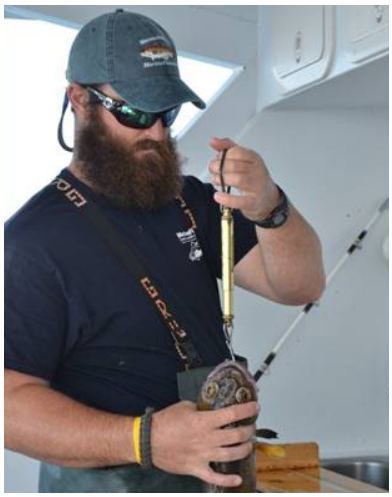


Figure 37. Biologist Matt Ayer measures catch on a headboat.

Since 1983, recreational fisheries catch and effort data have been collected along the Atlantic Coast through NOAA Fisheries' Marine Recreational Information Program (MRIP). *MarineFisheries* has managed the at-sea head boat survey segment for Massachusetts waters since 2003, and assumed the shore-side sampling of charter vessels, shore anglers, and private/rental vessel anglers in 2013. The benefits of doing so include the ability to increase sample sizes and the precision of catch estimates.

In 2016, *MarineFisheries* continued its coordination of MRIP surveys—training 20 seasonal field interviewers, scheduling trips, logging data, maintaining equipment, attending data review meetings, and maintaining regular communication with ACCSP regarding survey performance and sampling. (The ACCSP administers the program for NOAA Fisheries.)

During 2016, 59 headboat sea sampling trips were completed for a total of 1,298 angler intercepts (Figure 37). For shore-side sampling, our MRIP field interviewers completed 1,167 assignments for a total of 3,116 angler intercepts: 1,880 from private vessels, 501 from charter vessels, and 735 from shore anglers.

Recreational Fishing Derby

Project staff administered *MarineFisheries'* Saltwater Fishing Derby. The derby, formally known as the Governor's Cup and hosted by the Division of Tourism, was moved to *MarineFisheries* in 1983. New changes were drafted in 2016 for implementation in 2017. These included the lowering of minimum weights for junior anglers and the expansion of the catch and release portion of the derby to include all species. Other activities in 2016 included creating, printing, and distributing rule pamphlets and entry forms. Project staff had regular communications with weigh stations, prepared press releases, distributed outreach materials, and tracked derby standings. Derby winners will be recognized with awards at the annual New England Boat Show in 2017.

Public Access

The Public Access Coordinator position is funded from the Marine Recreational Fisheries Development Fund. The Coordinator manages all *MarineFisheries* saltwater fishing access projects, working closely with the *Mass*DFG Office of Fishing and Boating Access (OFBA), NGOs, towns, and other state and federal agencies to identify, plan, and implement construction/renovation/improvement of new fishing piers and other

structures for fishing access. The Coordinator also serves as a liaison to the fishing public for all matters of saltwater fishing access including advocating for beach and shore access.

In 2016, Ross Kessler worked with the OFBA to refurbish the South Street fishing pier on Bass River in Yarmouth (Figure 38); fund an artificial reef for recreational fishing in Nantucket Sound; complete the planning, permitting, design, and engineering for a fishing pier on Boston Harbor's Deer Island. In addition, he collaborated with the Massachusetts Natural Heritage Program and many other organizations to write a Habitat Conservation Plan for alternate management options in piping plover habitat.

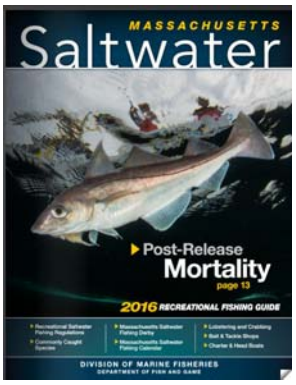
Figure 38. Anglers enjoy the refurbished fishing pier on Bass River in Yarmouth.

MarineFisheries completed another year of the small grants program providing $50,600 of recreational fishing permit money to assist local towns with small public access projects. This program allows for municipalities to apply for grants that fund projects promoting or supporting recreational fishing activities and access in their towns. In 2016, five projects were funded: a new fillet station at the state boat ramp in Plymouth, providing anglers with the ability to clean their catch and leave the fish remains for use by the local lobster fleet; a new light post at the state boat ramp in Green Harbor, Marshfield; a rebuilt float at Magnolia Pier, Gloucester, for which grant money was used to purchase the materials, while the plans were provided by a local engineering firm and the structure was built by local high school students; improvements to the scenic Atlantic Path in Rockport, which included pathway clearing; and new floats and a gangway at the state boat ramp on the Bass River in Dennis.

At the *MarineFisheries* Craven's Landing access site on Scorton Creek in Sandwich, periodic site monitoring and maintenance were required. A seasonal contractor was hired for site patrol and coordinated for weekly summer assignments. For the sixth consecutive year, a brief closure of Craven's Landing was necessary due to the presence of federally protected piping plovers. When present, staff worked closely with Mass Audubon to comply with USFWS regulations. Access is limited at Craven's Landing after the plover chicks are born and re-opened when young plovers are no longer in danger.

Kessler also worked with various entities to develop proposals for public access sites of interest. These included: USFWS, The Trustees of Reservations, Massachusetts Water Resource Authority, local municipalities, and multiple NGOs including Massachusetts Striped Bass Association, Mass Audubon, Barnstable County League of Sportsmen, Plymouth County League of Sportsmen, Cape Cod Charter Boat Association, Bay State Divers Council, Nantucket Anglers Club, Standish Sportsman's Club, Mass Sportsmen's Council, Falmouth Fishermen's Association, and Massachusetts Beach Buggy Association. In 2016, R. Kessler responded to numerous inquiries from user groups and private individuals regarding shore-side fishing sites, public access rights, and future access projects, and he represented the agency at multiple fishing and boating trade shows.

Outreach



Staff routinely answered public inquiries regarding recreational fisheries, attended meetings of the recreational fishing community, represented the agency at fishing and boating trade shows, and delivered presentations on fisheries management and research to organized groups such as local schools and fishing clubs.

The Massachusetts Saltwater Recreational Fishing Guide (Figure 39) was prepared and distributed at numerous trade shows, over 140 bait and tackle shops, similar locations along the coast, and to requesting anglers by mail and website downloads. In addition, an e-mail based newsletter—*The Broadcast*—was distributed electronically to permit holders.

Figure 39. The cover of the 2016 sport fishing guide.

Large Pelagics Research Project

Shark Research

MarineFisheries began shark research in 1987 to more fully elucidate the ecology, distribution, and relative abundance of sharks subjected to fisheries off the coast of Massachusetts. Staff conducts field research and opportunistically collects data from recreational and commercial fishermen's catch. Biological parameters including age, feeding ecology, movements, and reproductive status are examined through dissection and tagging of sharks. The goals are to foster cooperative shark research; participate in state, regional, and federal management processes; and provide public education and technical information on the biology, management, and utilization of sharks.

Movement and Habitat Studies: With external funding from private and federal grants, personnel continued in 2016 to collaborate with federal and academic researchers on the study of broad and fine-scale movements of numerous shark species (described below) using pop-up satellite tags (PSAT), real-time satellite tags (SPOT), acoustic transmitters, and conventional tags.

White Shark: Our efforts to study the movement ecology of white sharks off Massachusetts and the eastern US seaboard continued in 2016. An additional 23 white sharks were tagged, bringing the total to 102 individuals since 2009. These sharks were tagged with one or more of the following technologies: PSAT, SPOT, coded acoustic transmitters, autonomous underwater vehicle transponders, active acoustic transmitters, and NOAA Fisheries conventional tags. The tagged sharks ranged from roughly 7.5 to 18.5 feet in total length.

Work continued on a five-year study initiated in 2014 to quantify the regional population size and relative abundance of white sharks in Massachusetts waters. With funding and logistical support from local non-profits, the Atlantic White Shark Conservancy and the John J. and Edith L. Sacco Charitable Foundation, aerial and vessel surveys were conducted from mid-June through October off the eastern coast of Cape Cod. During 40 vessel surveys, a total of 572 white sharks comprising 147 individuals were sighted and cataloged in 2016; 40% were re-sighted from previous years. As was the case in 2015, the distribution of white sharks shifted throughout the season in 2016 (Figure 40).Throughout the summer and fall, 36 white sharks were detected by *MarineFisheries'* acoustic receivers. This quantitative study is being conducted by SMAST student Megan Winton as part of her PhD research.

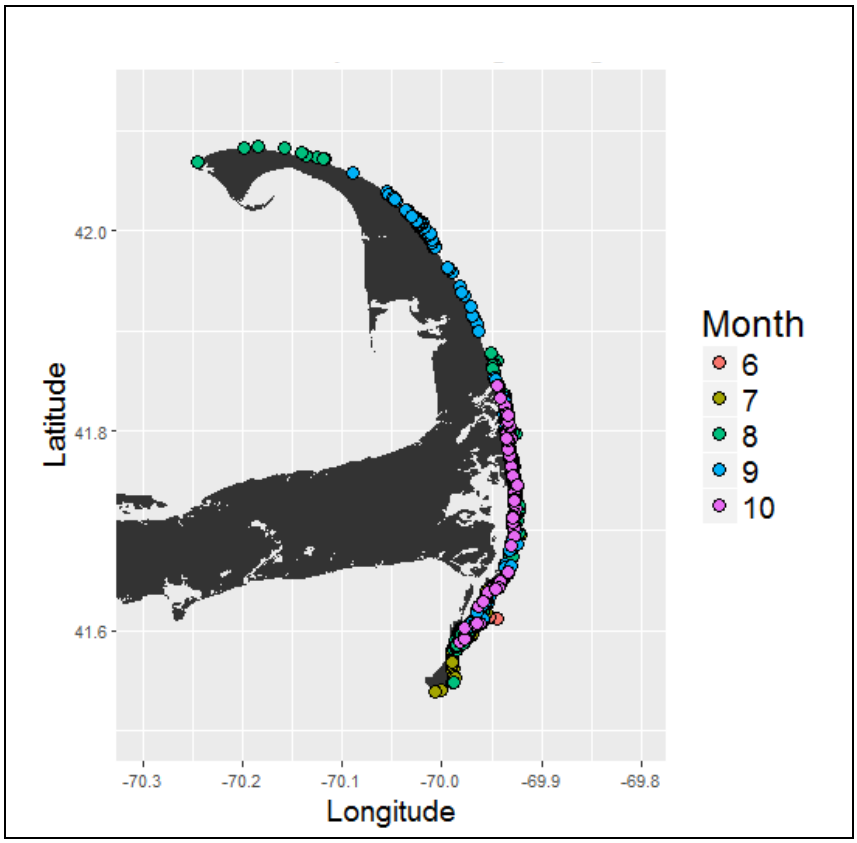


Figure 40. Monthly distribution of white sharks sighted off the coast of Cape Cod in 2016.

Shark Management: Staff participated in the development and/or amendment of state, interstate, federal, and international shark management plans. During 2016, Project Leader Skomal served on the following committees: ASMFC Coastal Sharks Technical Committee, ASMFC Coastal Sharks Plan Development Team, ASMFC Spiny Dogfish Technical Committee, ICCAT Advisory Committee Swordfish and Shark Working Group, and NOAA Fisheries Highly Migratory Species Advisory Panel.

Outreach and Media: To meet the public's constant and growing demand for information on sharks, especially white sharks, numerous presentations pertaining to sharks were delivered to the public. Technical information on sharks was also provided to several media outlets.

As adjunct faculty to SMAST, the UMass Biology Department, Woods Hole Oceanographic Institution, and the King Abdullah University for Science and Technology, Skomal co-advised and/or served on the committees of 10 graduate students; nine of which are investigating the relative abundance, life history, movements, and/or physiology of elasmobranch fishes.

Other Activities

Publications: The following peer-reviewed papers were published in 2016:

Whitney, N.M., C.F. White, A.C. Gleiss, G.D. Schwieterman, P. Anderson, R.E. Hueter, G.B. Skomal. 2016. A novel method for determining post-release mortality, behavior, and recovery period using acceleration data loggers. Fisheries Research 183 (2016) 210–221.

Haulsee, D.E., D.A. Fox, M.W. Breece, L. M. Brown, J. Kneebone, G. B. Skomal, and M. J. Oliver. 2016. Social network analysis reveals potential fission-fusion behavior in a shark. Scientific Report (6).

Cochran, J.E.M., R.S. Hardenstine, C.D. Braun, G.B. Skomal, S.R. Thorrold, K. Xu, M.G. Genton, and M.L. Berumen. 2016. Population structure of a whale shark Rhincodon typus aggregation in the Red Sea. Journal of Fish Biology (89)3:1570-1582.

Diadromous Fisheries Project

Diadromous fish migrate between fresh and marine waters to complete their life history. They are valued for the forage they provide to a wide range of fish and wildlife and were formerly important for traditional small-scale fisheries in coastal towns. *MarineFisheries* is not only responsible for the management of diadromous fish populations, but also the restoration, improvement, and maintenance of migratory pathways in Massachusetts.

Biological Assessments for River Herring

The alewife (*Alosa pseudoharengus*) is the most abundant and well-known anadromous fish in Massachusetts. Together with the closely related blueback herring (*Alosa aestivalis*), both species are known commonly as "river herring." River herring have had high cultural and economic importance historically, but present populations are well below former levels and harvest has been banned since 2006.

Management goals to restore river herring populations have warranted a ramping up of river herring monitoring in the last decade. In 2016, adult river herring monitoring continued with counts and/or biological sampling in 14 river systems (Table 22). A total of 3,786 alewives and 1,398 blueback herring were sampled from these coastal systems in 2016.

Table 22. River herring monitoring locations where biological samples and/or counts are collected.

River	Biological	Counts
Parker River, Newbury	Yes	Video
Essex River, Essex	No	Electronic
Mystic River, Medford	Yes	Visual (Volunteer)
Back River, Weymouth	Yes	Electronic
Herring Brook, Pembroke	No	Electronic
Town Brook, Plymouth	Yes	Electronic (Town)
Monument River, Bournedale	Yes	Electronic
Herring River, Harwich	Yes	Electronic
Acushnet River, Acushnet	Yes	Electronic
Nemasket River, Middleboro	Yes	Visual (Volunteer)
Merrimack River, Lawrence	Yes	Fish Lift
Agawam River, Wareham	No	Electronic
Wankinco River, Wareham	No	Electronic
Mattapoisett River, Mattapoisett	No	Electronic

MarineFisheries data collections indicate that river herring populations have experienced a truncation in age structure, with fewer older fish being collected; however, we have seen recent increases in herring size-at-age when compared to past years. In most rivers sampled, the age structure of alewives was composed mainly of age-5 fish; however, shifts to younger (age-3) fish in the Mystic and Parker Rivers were also observed.

In 2016, river herring counts varied from 4,930 fish in the Acushnet River to 561,538 in the Nemasket River. While electronic monitoring showed declines in some of the southern Massachusetts herring runs in 2016 (following a general four-year increasing trend), there was continued improvement north of Boston Harbor. For example, adult herring returns decreased in the Monument, Nemasket, Back, Mystic, and Mattapoisett Rivers, but increased in the Essex and Parker Rivers.

MarineFisheries funded and installed a new electronic counter in the Herring River, Harwich, and assisted in the installation of new electronic and video counting stations at Cedar Lake, Falmouth, and Herring Creek, Aquinnah, respectively. Project staff also provided technical assistance to local groups conducting volunteer visual counts at herring runs. In 2016, a total of 34 rivers in 26 towns were monitored in Massachusetts.

The passage of diadromous species is monitored during the spring/summer each year at the Essex Dam on the Merrimack River in Lawrence. In 2016, counts of American shad at this site decreased when compared to 2015. In addition, striped bass, sea lamprey, and river herring were also lifted above the Essex Dam. A substantial increase in the count of river herring was a result of stocking in previous years.

Propagation

MarineFisheries has the capacity to collect and transport live river herring to assist efforts to re-establish and enhance river herring runs. This work has gone on for decades and is presently guided by a Stocking Protocol Policy prepared in 2013. To assist ongoing fishway improvement projects, a total of 5,188 pre-spawning adult river herring were trapped and transported in 2016 via our stocking truck or lifted above a barrier into three coastal systems in the Commonwealth (Table 23): Three Mile River (Dighton), Billington Sea (Town Brook, Plymouth) and Pentucket Pond (Parker River, Georgetown). An additional 2,000 alewives were trapped from a Massachusetts donor system (Nemasket River, Middleborough) and released into two Rhode Island coastal systems—Ten Mile River, Turner Reservoir, East Providence and Kickemuit Reservoir, Warren—in a cooperative effort to improve these populations.

Table 23. Number of pre-spawning adult river herring trapped and transported in 2016.

Donor System	Recipient System	# of Adults
Nemasket River	Three Mile River	302
Town Brook	Billington Sea	3,900
Parker River	Pentucket Pond	481
Parker River	Main Street (Parker R.)	505
Nemasket River	Ten Mile River*	1,000
Nemasket River	Kickemuit Reservoir*	1,000

* Denotes out-of-basin transfer (between states)

In 2016, *MarineFisheries*, in conjunction with the USFWS Central New England Fisheries Resource Office, continued efforts to restore American shad to the Charles River watershed. Approximately 1.75 million young-of-year shad from the USFWS North Attleboro hatchery were hatched from Merrimack River broodstock and released above the Moody Street dam. A double oxytetracyclene mark was used on hatchery larvae to validate ageing methods and examine year-class specific mortality of shad in the Charles River.

Technical Assistance

Project staff provided technical assistance to local authorities, private organizations, and other agencies on topics related to diadromous fish resources. Numerous requests are received each year, especially during the spring, requiring a wide range of responses. Technical assistance associated with larger requests that require a sustained effort are as follows:

River Herring Habitat Assessment: River herring habitat assessments are conducted for two years during May–September to assess the suitability of habitats for restoration potential and to contribute to habitat and water quality remediation efforts. Assessments were concluded in 2016 at Mashpee-Wakeby Pond, Mashpee and Lake Noquochoke, Westport and were initiated at Lovells Pond, Barnstable, Fresh Pond, Plymouth, and Turners Reservoir, Dartmouth. Staff also assisted in the development of assessments at Shad Factory Pond, Rehoboth, Looks Pond and James Pond in West Tisbury, and in the Ipswich River watershed. After the field season, efforts focused on data processing and reporting for Whitman's Pond, Weymouth, and Lake Sabbatia, Taunton. The assessment report for the latter was completed and submitted to *MarineFisheries'* Technical Report series for review in 2016.

River Herring Sustainable Fisheries Plans: A state-prepared sustainable fishery plan must be approved by the ASMFC prior to the re-opening of any waters to the harvest of river herring. Massachusetts' river

herring runs have all been closed to harvest since 2006. At the request of the Middleborough-Lakeville Herring Fishery Commission, the process to prepare a Sustainable Fishery Plan for the Nemasket River began in 2014. After extensive review and technical assistance from project staff, a final plan was approved by the Shad and River Herring Management Board of ASMFC in October 2016.

Diadromous Fish Restoration Priority List/*Mass*DOT Diadromous Fish GIS Datalayer: Project staff maintain a diadromous fish restoration priority list to document the status of diadromous fish passageways and to prioritize restoration projects. The list focuses on passageways for river herring, but also considers other diadromous fish species and watershed connectivity. It contains about 450 fishways, impediments, and potential restoration sites, ranked by restoration potential within the four major coastal regions of Massachusetts: Buzzards Bay, Cape Cod, South Shore, and North Shore/Boston Harbor. In 2015, a GIS datalayer of the restoration priority list that supports transportation infrastructure planning was completed through a *MarineFisheries* and *Mass*DOT cooperative project. The datalayer has been used by both agencies for project planning and environmental review. Efforts began to update the GIS datalayer and priority list in 2016, and to coordinate with *Mass*DEP to integrate the priority list to their Wetlands Protection Act and Clean Water Act processes. The overall goal is to improve data quality and make the updated versions accessible to a wider audience.

River Herring Network: *MarineFisheries* provided technical and financial assistance to the River Herring Network. Staff member John Sheppard served on the Network's steering committee in 2016 and hosted the Network's 2016 annual meeting. Staff gave presentations on river herring in Massachusetts (Sarah Turner), the Nemasket River Sustainable Fishery Plan (Brad Chase), and stream channel maintenance in herring runs (Brad Chase).

Diadromous Fish Research Studies

In 2016, Diadromous Project biologists continued to study the movements of individual American shad with the purpose of informing managers about migration habits and potential challenges to shad restoration in the Charles River. Staff deployed an acoustic array of 11 receivers at various locations in the river to monitor shad movements. During late May and early June, 52 American shad were captured and tagged with acoustic transmitters (Figure 41). Subsequent monitoring showed that shad spent more time at the Watertown Dam and Charles River Locks than at other locations. When shad migrated downstream, transit from the Watertown dam area to the locks was rapid. A number of tagged shad were also detected in outer Boston Harbor or other acoustic arrays, including off Gloucester, on Jeffrey's Ledge, in the Bay of Fundy, and off Halifax, Nova Scotia. In 2017, a limited array will be deployed in the Charles River to monitor tagged fish returning to the river to spawn.

For the fourth consecutive year, Diadromous Fisheries Project biologists conducted a Passive Internal Transponder (PIT) tag study in the Parker River. To date, biologists have tagged more than 1,500 river herring below the Woolen Mill Dam (the first dam on the river) to measure passage efficiency following design changes and repairs to the ladder and downstream weirs. Following two years of physical changes to the site, biologists documented improved passage in 2015 and 2016 (Figure 42). Changes to entrance conditions and improved flow management in the ladder proved the most beneficial to passage. While passage at this dam has improved, overall rates remain low, indicating that further work at the dam is needed. The combination of undersized pools and the overly steep slope in the initial seven pools of the fishway were identified as impediments to passage that must be resolved. With tagging completed, the site will be monitored through 2018 to provide information on passage, repeat spawning, and mortality of river herring. *MarineFisheries* has also begun collaborating with engineers from the USFWS to design larger ladder modifications that will address the passage issues discovered through this tagging study.

Figure 41. *MarineFisheries* and USFWS biologists tagging American shad on the Charles River.

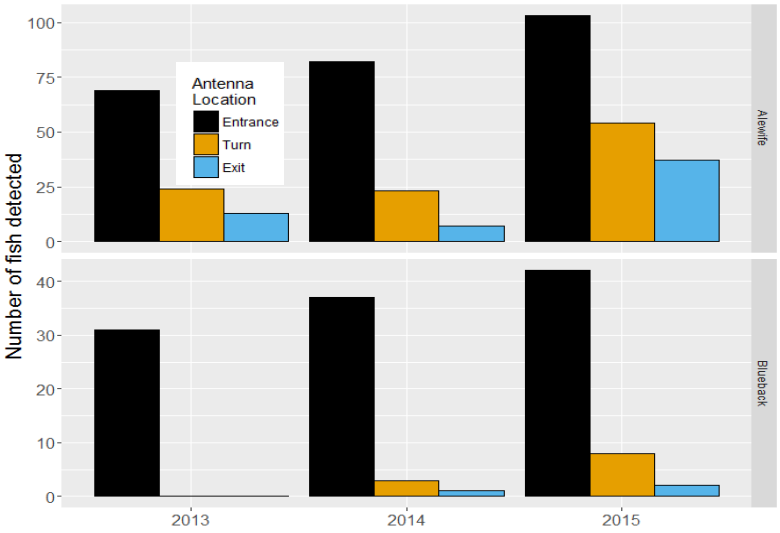


Figure 42. Passage rates of PIT-tagged alewife (top) and blueback herring (bottom) at the Central Street fishway on the Parker River from 2013–2015.

In the spring of 2016, Project staff initiated a pilot study to monitor the presence and abundance of American shad in the South River and Indianhead River (within the North and South River watershed). Monitoring was conducted in each river from the head of the tide to the first obstruction, using a combination of visual and stream electroshocking surveys to detect the presence of spawning adult shad. During 11 sampling trips in the South River and 12 sampling trips in the Indianhead River between April and June, 66 and 108 shad were captured, respectively, for size, age, and genetic sampling. Scale-based aging indicated shad ranged between 3 and 9 years of age with some individuals having spawned up to four times previously. Indices of abundance (catch-per-unit-effort and density estimates) were calculated for each river system. Given that the first year of monitoring documented the presence of American shad in these two rivers, *MarineFisheries* will continue monitoring to obtain long-term indices of population abundance.

Rainbow Smelt Population and Habitat Monitoring

Rainbow smelt population declines since the 1980s prompted *MarineFisheries* to initiate spawning run monitoring using in-stream fyke nets in 2004. The fyke net catches of smelt provide a relative index of population abundance and age-structure data. A NOAA Office of Protected Species grant supported the fyke net project for 2008–2012, including a full-time technician. Following the conclusion of the grant in 2012, field monitoring in 2013 was reduced from nine to six stations given the staff reduction. In 2014, the project committed to long-term monitoring at four fyke net stations: Parker River, Newbury; Fore River, Braintree; Jones River, Kingston; and Weweantic River, Wareham. Smelt catches in 2016 at two sites improved unexpectedly with larger than typical proportions of older smelt: the Fore River had the highest smelt catch per effort in the time series and the Jones River had the second highest catch per effort for that location. To date, over 35 species of fish have been caught in the fyke nets, including 10 diadromous species.

Following the spring field season, project effort shifts to field data entry in the project database and data processing and analysis. Project analysis continued for manuscripts on smelt population demographics and smelt spawning habitat characteristics in the study region of Maine, New Hampshire, and Massachusetts.

American Eel Young-of-the-Year Monitoring

All U.S. East Coast states conduct standardized monitoring of YOY American eels under mandatory ASMFC protocols. *MarineFisheries* has monitored the spring migration of YOY eels in the Jones River using a Sheldon trap since 2001 to contribute to a coastwide index of eel population relative abundance. YOY monitoring stations at the Acushnet River and Parker River were discontinued in 2015 due to a combination of site condition changes and data quality concerns following a multi-year data review. A new station at the Essex River was initiated in 2014. Eel catch at the Jones River trap declined in 2016 for the fourth straight year. The YOY catch per effort in 2016 was the second lowest recorded in the 16-year time series. Annual efforts continued to organize and improve the trap data files for inclusion in the ASMFC eel compliance report and the next coastwide eel stock assessment.

Project staff also monitors eel ramps installed in coastal rivers to provide eel passage over barriers. *MarineFisheries* first installed an eel ramp in the Saugus River in 2007 and has installed seven more since then. Most ramps are managed cooperatively with local groups and outfitted with a collection tank to evaluate the performance of the eel ramp and the potential to use the location as a monitoring station for census counts of YOY or age-1+ eels. The following locations have eel ramps with cooperative monitoring efforts ongoing: Saugus River, Saugus (2007); Cold Brook, Harwich (2008); Wankinco River, Wareham (2009); Pilgrim Lake, Orleans (2009); Mystic Lakes Dam, Medford (2010); Mill Brook, Rockport (2012); Morey's Street Dam, Taunton (2014); and Silver Springs Pond, Wellfleet (2014). Piped eel passes were installed at fishways in Falmouth and Yarmouth to improve eel passage. These eel passes are gravity flow systems with no collection tanks.

Fish Passage and Habitat Restoration Projects

Numerous projects to improve and maintain diadromous fish passage and habitat are conducted each year. In 2016, project staff devoted time to approximately 20 individual projects in various stages of development and implementation. The following list includes completed projects and larger ongoing projects of regional significance that require the most effort among all projects. Highlights in 2016 include the installation of fishways at three locations (Bourne Pond, Aberjona River, and Looks Pond) where fish passage was not previously provided over obstructions.

Bourne Pond, Falmouth. A request from the Town of Falmouth to reconstruct a pond outlet at Bog Pond in the Bourne Pond watershed set in motion a multi-year investigation on the suitability of Bourne Pond to support river herring and the feasibility of constructing and operation of a small fish ladder. Following a two-year habitat assessment in 2010–2011, fishway scoping designs prepared by the USFWS during 2012–2014, and additional design and permitting in 2015, construction occurred in 2016 on a new concrete weir and pool fishway at an impassible dam and the removal of a second downstream dam that blocked fish passage (Figure 43). To further add to the value of this cooperative project between the Town of Falmouth, the property owner, and *MarineFisheries*, rubble from the two dams was shipped to the Town of Harwich dump to stage for a future contribution to fish habitat at the fishing reef off Harwich.

Figure 43. New fishway at Bourne Pond, Falmouth.

Aberjona River, Winchester. Multiple years of efforts to provide fish passage at Center Falls Dam in Winchester culminated in the construction of an Alaskan steep-pass fishway in 2016 (Figure 44). The project was led by the dam owner and the Town of Winchester with funding from an upstream private mitigation site. *MarineFisheries* staff provided extensive technical assistance and review, as well as construction oversight. The project has also included consideration for providing fish passage to Horn Pond further upstream in the Aberjona River, which will likely occur in 2017. The fishway will be outfitted with a video monitoring station for counting river herring in 2017 or 2018.

Figure 44. Installation of a new steep-pass fishway at Center Falls Dam, Aberjona River, Winchester.

Looks Pond, West Tisbury. Preparations were made in 2015 to construct a fish ladder at the impassible Looks Pond Dam in West Tisbury. Stop log boards at a lower dam in the Tiasquam River were removed in 2015 and within days river herring were seen at the spillway of Looks Pond Dam. This observation launched the design and permitting of a wood weir and pool fishway. The *MarineFisheries* Fishway Crew designed the fishway with a custom aluminum bracket adjustable to changing pond outflow. The fishway was funded by the private property owner, and installed as a cooperative project with the Town of West Tisbury in 2016.

Long Pond, Harwich. The *MarineFisheries* Fishway Crew designed an innovative solution to a long-standing problem at Long Pond in Harwich, where sand movement obstructs the outlet fishway and substantial maintenance is needed to allow spring spawning migration of river herring and juvenile emigration. A floating aluminum chute was fabricated and attached to an adjustable bracket at the fishway exit. The underlying premise is that sand will move under the chute and not enter the fishway. This was a collaborative project with the Town of Harwich that will be watched closely in 2017 to see how this custom fishway adaptation functions.

Fore River Watershed. Efforts continued on the multi-site project to restore diadromous fish to the Fore River Watershed in the Boston Harbor region. This project ranks high among potential diadromous fish restoration projects in the region, given the opportunity to create a large river herring run to the 180-acre Great Pond Reservoir and strong local support. Working with the property owners, Town of Braintree, and Fore River Watershed Association*, MarineFisheries* has led this restoration project since 2008. A study on the removal of the Armstrong Dam was completed in 2016.This study was funded by USFWS, *MarineFisheries*, and the MassBays Program. Concurrently, the Town of Braintree led the design and permitted a rehabilitation project for the impassible Great Pond Reservoir Dam that includes a new steep-pass ladder, and the Project's staff worked with local partners to modify the channel to improve fish passage at the natural falls.

Three Mile River, Taunton. The project to construct a fishway at the impassable Draka Dam on the Three Mile River continued in 2016 after receiving all construction permits in 2014 with the exception of the DCR Office of Dam Safety (ODS). A Final Design Report was finalized in 2015 and the ODS permit was issued in 2016.The project engineer prepared bid documents for the fishway in 2016 but these were not approved in

time to meet the construction season. Efforts were underway to bid the project for construction during the summer of 2017.

Westport River, Westport. River herring in the East Branch of the Westport River are impeded from reaching the 165-acre Lake Noquochoke at two impassable dams. After two years of site investigation, a large-scale restoration effort in the Westport River began in 2014 and the USFWS produced conceptual designs for a fishway at the first dam, Forge Pond Dam, in 2015. In 2016, an MOU to establish fish passage at Forge Pond Dam was finalized between the dam owner and *MarineFisheries.* A project scope to begin site feasibility and further the fishway design was prepared by Project staff and presented at a meeting of stakeholders in November.

James Pond, West Tisbury. A channel maintenance plan was prepared in 2015 for James Pond to allow local officials to manage diadromous fish passage at this natural beach channel. Working with the Town of West Tisbury, this document included a project design for permitting an annual practice to keep the channel open for fish passage. The project design was submitted within a Notice of Intent to the West Tisbury Conservation Commission in 2016 to begin the permit review process.

High Street Dam, Bridgewater. After several years of preparatory communications with the High Street Dam owner and the Town River Herring Fishery Commission, a cooperative project was initiated in 2016 to investigate the removal of the dam to improve fish passage. *MarineFisheries* received a letter from the dam owner in March approving the plan to conduct a feasibility study for the removal of the High Street Dam. Working with project partners at The Nature Conservancy and *Mass*DER, a study scope was prepared and a public meeting was held in Bridgewater in November to introduce the project to the public.

Ipswich River, Ipswich. Efforts to improve fish passage at the Willowdale Dam on the Ipswich River were continued. Following meetings and an accepted MOU with the dam owner in 2015, Project staff convened a meeting of local stakeholders to plan for work and incorporate concerns of other parties. Final design, permitting, and construction were slated to occur in 2017.

Parker River, Newbury. A multi-year effort continued to make progress with fish passage improvements and river herring population restoration in the Parker River. Project staff worked with the dam owner and cooperative partners to advance a proposal for dam removal at the Larkin Mill Dam; however, no funds for removal were secured prior to year's end. Staff were actively involved with fishway management at the Woolen Dam and spent several days working on stream channel maintenance in the watershed.

Concord River, Billerica. *MarineFisheries* neared completion of a multi-agency collaboration to restore diadromous fish to the Concord River. Using available funds from the Nyanza Damage Assessment, staff bid out and contracted a feasibility study to examine restoration options at Middlesex Falls, Centennial Falls Dam, and Talbot Mills Dam. The first two sites provided some level of passage while the latter had none. Fish passage or dam removal at Talbot Mills would open up more than 35 main stem miles and 100 tributary miles of habitat. The feasibility study included a full archeological and historic report. Given the cultural and environmental significance, public comment was a large part of the feasibility study; two separate public meetings were held and written comments were also solicited. These comments were used to modify the initial drafts of the study report prior to finalization expected for early 2017.

Fishway Permitting and Operation and Maintenance Plans

An initiative was launched in 2011 to develop standardized fishway operation and maintenance (O&M) manuals for all new and recently constructed fishways. The general laws of Massachusetts (Chapter 130, Section 19) establish the authority of the Division's Director to prepare and require fishway O&M plans. The documentation of management practices for fishways is clearly needed for present operations and to guide

future state and local staff. One new O&M plan was drafted in 2016 for Wequaquet Lake in Barnstable and revisions were made on a working draft for Center Falls Dam at the Aberjona River in Winchester. Several site visits were made to fishways in relation to O&M working drafts and planning for future O&Ms.

MarineFisheries issues Fishway Construction Permits following the review of final engineering plans to construct, rebuild, or alter fishways. Fishway Construction Permits were prepared for projects at Center Falls Dam in Winchester, Bourne Pond in Falmouth, and for the Middle Pond fish ladder on the Marston Mills River, Barnstable (draft).

River Herring Stream Channel Maintenance

Project staff routinely fields requests to assist Towns to maintain passageways for river herring. The work can involve developing plans for removing debris jams and excessive plant growth in channels or responding quickly during the migration season to remove blockages that threaten sea-run fish survival. Field work on stream maintenance declined in 2016 due to staff limitations and competing tasks. One to two days were spent with 2–3 field crew working at the following sites: Island Creek in Duxbury, Jones River in Kingston, Acushnet River in Acushnet, and Sesuit Creek/Fresh River in Dennis. Three stream maintenance plans were completed in 2016, all in the South Shore region: Herring Brook in Pembroke, South River in Marshfield, and Island Creek in Duxbury. The plans receive approval from the town's Conservation Commissions to allow local management of the annual maintenance essential for sea run fish passage. A major effort was made in 2016 to prepare a Stream Maintenance Protocol for Diadromous Fish Passage to give guidance to both our field work and towns'. The protocol document was made available on the Division's website.

Other Activities

Technical Committee Participation: Staff actively participated on ASMFC committees and other professional organizations related to diadromous fish. ASMFC compliance reports were prepared in 2016 for American eel (B. Chase), river herring/American shad (J. Sheppard), and sturgeon (S. Turner). ASMFC committee work included the River Herring and American Shad Technical Committee (TC), American Eel TC, and Fish Passage Working Group (B. Chase); the Sturgeon TC (S. Turner); and River Herring Stock Assessment Sub-Committee (B. Gahagan). S. Turner served as the AFC Southern New England Chapter Secretary and President elect and on the NOAA River Herring Technical Expert Working Group (TEWG). B. Gahagan also served on the TEWG and on committees for the Connecticut and Merrimack rivers (Connecticut River Atlantic Salmon Commission TC; and Technical Committee for Anadromous Fishery Management of the Merrimack River Basin).

Education/Outreach: Project staff provided numerous presentations and technical assistance related to education and outreach. Staff also attended spring river herring festivals and events at the following locations: Nemasket River, Middleborough; Town Brook, Plymouth; Acushnet River, Acushnet; and Fore River, Braintree.

Publications, Reports, and Presentations:

Chase, B.C., E. Clark, and B Gahagan. 2016. American Eel Passage Improvements at Coastal Rivers in Massachusetts. Fish Passage 2016: International Conference on River Connectivity, University of Massachusetts, Amherst, MA, June 21, 2016.

Chase, B.C. 2016. Diadromous Fish Management in Massachusetts. University of Massachusetts, Amherst, MA, Seminar Series ECO 697, November 14, 2016.

Chase, B.C. 2016. The sea-run fish of Massachusetts. New England Aquarium, Boston , MA, Simons IMAX Theatre Lecture Series, December 1, 2016.

Stettiner, S.M., M. Staudinger, J. Sheppard, and A. Jordaan. 2016. Climate change induced shifts in the timing of migration of alewife (Alosa pseudoharengus) in Massachusetts natal streams. Fish Passage 2016: International Conference on River Connectivity. University of Massachusetts, Amherst, MA, June 21, 2016.

Sheppard, J.J., C. Denisevich, and M. Roux. 2016. Monitoring for American shad (Alosa sapidissima) in small Massachusetts coastal rivers. New England Estuarine Research Society Fall Meeting. Block Island, RI, October 22, 2016.

Llopiz, J., A. Jones, J. Sheppard, J. Suca, C. Rosinski, S. Cox, and J. Strock. 2016. Early life history of river herring from contrasting freshwater environments. River Herring Network Annual Meeting, New Bedford, MA, October 27, 2016.

Sheppard, J.J. 2016. Status and trends of river herring runs in Massachusetts. Eastham Public Library, Eastham, MA, March 23, 2016.

Sheppard, J.J. 2016. Biological monitoring and characterization of river herring populations in the Acushnet River, Massachusetts. NOAA-New Bedford Harbor Trustees Council 2016 summary report.

Marjadi, M., A. Jordaan, A. Roy, B. Gahagan, and A. Whiteley. 2016. Evaluating reproductive strategies in alewife (Alosa pseudoharengus) using pedigree reconstruction. Southern New England Chapter of the American Fisheries Society, Groton, CT, January 14,2016.

B. Gahagan, M. Bailey, and K. Cheung. 2016. Acoustic telemetry in American shad (Alosa sapidissima): Surgical implantation and subsequent movements in the Charles River and coastal waters. Southern New England Chapter of the American Fisheries Society, Groton, CT, January 14, 2016.

B. Gahagan and S. Elzey. 2016. Adaptive management of fish passage at a weir-pool fishway. Fish Passage 2016: International Conference on River Connectivity. University of Massachusetts, Amherst, MA, June 21, 2016.

B. Gahagan and S. Elzey. 2016. Adaptive management of fish passage at a weir-pool fishway. Atlantic International Chapter of the American Fisheries Society, Holderness, NH, September 12, 2016.

S. Turner. 2016. Drought impacts on Massachusetts coastal fish populations. Water Resources Commission meeting, Boston, MA, December 8, 2016.

ADMINISTRATION

Personnel

Kevin Creighton, Chief Fiscal Officer

Finance
Darlene Pari, Accounts Payable Coordinator
Eva Morales, Accountant III
Jeanne Hayes, Accounts Receivable Coordinator
Shannon Davis, Program Coordinator - Revenue

Boston Permit Office
Kerry Allard, Permitting Coordinator
Kerry Faugno, Permitting Receiving Teller
Sandra Downing, Permitting Receiving Teller

New Bedford Permit Office
Kim Trotto, Permitting and Administrative Support
Lynne Besse, Permitting and Administrative Support

Gloucester Permit Office
Rosemary Mitchell, Permitting and Administrative Support
Whitney Sargent, Permitting and Administrative Support

Grants Management
Stephanie Cunningham, Grants Management Leader
Cecil French, Clean Vessel Act and Boating Infrastructure Grant Leader
Maren Olson, Clean Vessel Act and Angler Education Coordinator

Outreach
Elaine Brewer, Information & Education Coordinator

Seafood Marketing
Wendy Mainardi, Marketing Coordinator

Scientific Diving
Vincent Malkoski, Diving Safety Officer and Capital Assets Coordinator for New Bedford Office

Capital Assets and Facilities Management
Brian Castonguay, Gloucester Office, Head of Facilities and Capital Assets

Overview

MarineFisheries Administration is responsible for the Division's fiscal functions, permitting, grants management, capital assets, diver training, outreach efforts, and seafood marketing. The program develops, analyzes, and manages the Division's financial planning and resource allocation activities including budget submissions to the Legislature. Analysts provide financial and performance analysis of Division programs and operations, and are responsible for the following: monitoring and forecasting revenue and expenditures; preparing the Division's annual budget recommendation and spending plans; working with Department, Legislative and Executive Branch budget staff; identifying and monitoring key budget and policy issues; and

analyzing and proposing policy and savings initiatives. The Program is responsible for permit issuance, collecting fees, and reconciling revenue. The Program also provides all fiscal oversight and reporting on grants, contracts, and mitigation projects. In addition, all capital assets are procured, inventoried, managed, and maintained. Outreach is conducted through the creation of educational media, event planning, and other activities. Seafood Marketing efforts support and promote Massachusetts seafood and the commercial industry. Capital Assets and Facilities Management is conducted with the intent to provide a healthy and productive working environment.

Budget

State-Appropriated Funds

The *MarineFisheries* general fund budget increased by 5.44% in Fiscal Year (FY) 2016. The FY2015 and FY2016 state appropriations are shown in Table 24.

Table 24. Fiscal Year 2015 and 2016 Appropriations (available funds for operations).

Title	Acct. Number	FY2015	FY2016	Change
General Fund Accounts				
General Operating	2330-0100	[1]$5,078,532	[2]$5,347,649	+5.30%
Sport Fish Program	2330-0120	$599,041	$638,635	+6.61%
General Fund Total		$5,677,573	$5,986,284	+5.44%
Retained Revenue Accounts				
Sport Fish Retained Revenue	2330-0121	$217,989	$217,898	0.00%
Depuration Retained Revenue	2330-0150	$45,768	$46,968	+2.62%
Lobster Permit Research Fee	2330-0199	$250,000	$250,000	0.00%
Special Fund Accounts				
Saltwater Sport Fish Licensing	2330-0300	$1,340,766	$1,305,519	-2.63%
Seafood Marketing	2330-0104	$250,000	$250,000	0.00%

[1] The final budget for FY2015, Chapter 165 of the Acts of 2014, was $6,037,213, and included the following earmarks: $450,000 to the SMAST; $133,000 for the Great Marsh Green Crab Trapping Program; $50,000 for the protection of the Herring Run in the town of Weymouth; $50,000 for the Fishing Academy, Inc.; and $100,000 for shellfish propagation in Barnstable, Dukes, and Nantucket counties. The final budget was reduced mid-way through the fiscal year by Governor Charles Baker through the 9c budget reduction process, which reduced the *MarineFisheries* operating budget by $175,681 and reduced earmarks by $288,000.

[2] The final budget for FY2016, Chapter 46 of the Acts of 2015, was $6,387,596, and included the following earmarks: $450,000 to SMAST; $83,400 for the Great Marsh Green Crab Trapping Program; $50,000 for the Fishing Academy, Inc.; and $175,000 for shellfish propagation in Barnstable, Dukes, and Nantucket counties. The final budget was reduced further for an Early Retirement Incentive Program (ERIP), in which four full time employees participated, resulting in a reduction of the *MarineFisheries* operating budget by $758,400.

While *MarineFisheries* realized an increase of 5.44% in appropriated funds for the operating budget, when factoring in the late year decrease in FY2015 resulting from a 9c[1] budget reduction, the overall increase in FY2016 was only 2.9%. The modest increase was approved to primarily cover increased annualized costs for payroll, and to fund an enhanced *Vibrio* monitoring program for shellfish. The increased costs were offset somewhat by an overall decrease in utilities resulting from a drastic reduction in fuel costs for the second year in a row. The Legislature slightly decreased the appropriation on the Saltwater Sport Fish Licensing account to more closely align with projected spending in that account. The Seafood Marketing Program,

[1] Section 9C of Chapter 29 of the Massachusetts General Laws requires the Governor to reduce spending if projected revenue is less than projected spending to bring the budget into balance.

funded by revenue collected from the issuance of commercial fisherman and seafood dealer permits, remained level funded. Table 25 provides the breakdown of overall costs by primary spending category for the *MarineFisheries* operating accounts.

Table 25. Fiscal Year 2016 Costs, State Appropriations (rounded to whole dollars).

Account Number	2330-0100	2330-0120	2330-0121	2330-0150	2330-0199
Salaries	$4,446,265	$628,291	$31,740	$41,745	$78,114
Employee Expenses	$25,091		$4,403		
Contracted Employees	$24,999		$105		$45,323
Contracts	$4,252		$97,748		
Facility Maintenance	$46,986		$18,870	$2,536	
Field & Lab Supplies	$70,835		$11,734	$285	$3,287
Fringe Costs	$73,775	$10,367	$524	$689	$17,829
Fuel	$45,794				
Utilities	$87,627				
Lease/Rent	$131,658				
Maintenance/Repair	$70,335		$11,349	$852	$186
Office & Administrative	$161,163		$15,064	$840	
Services/Equipment Lease	$2,336		$14,250		$34,489
Information/Technology			$5,372		$1,037
Outside Agencies	$109,302		$4,216		
Grants	$283,898				

Staffing

Staffing levels increased slightly between CY2015 and CY2016 (Table 26). New positions were added to the Grants Program, the Fisheries Policy and Management Program, the Fisheries Dependent Sampling Project, the Invertebrate Fisheries Project, and the Shellfish Program. There was a turnover of two long term employees at the Shellfish Purification Plant. One of the vacancies from the Shellfish Purification Plant and a CY2015 retirement was backfilled in 2016. Additionally, in CY2016 the *Mass*DFG's Human Resource department was consolidated into EOEEA. This consolidation shifted one employee off *MarineFisheries* payroll.

Table 26. Calendar Year 2015 and 2016 Authorized Personnel Levels.

Title	Acct. Number	CY2015	CY2016
MarineFisheries General Operating	2330-0100	61	61
Sport Fish Program	2330-0120	10	10
Saltwater Sport Fish Licensing	2330-0300	8	7
Federal Grants and Trust Account	2330-xxxx*	19	23
Total Employees in All Appropriations		**98**	**101**

*Multiple account numbers

Revenue

MarineFisheries collects fees primarily from permit issuance and from processing racks of soft-shelled clams at the Shellfish Purification Plant in Newburyport. A total of 28,636 permits and endorsements were issued for the categories of commercial fishing, seafood dealers, and special permit types, producing General Fund revenue of $2,155,905 in 2016. Overall, there was an increase in total number of permits issued by 1.7%. Total revenue for commercial permits saw a similar increase of 1.8%.

Revenue from the depuration of soft-shelled clams at the Shellfish Purification Plant in Newburyport has shown a steady decline over the past decade. To increase the plant's productivity, the Massachusetts legislature approved an expansion of services in the 2012 budget to include de-sanding of non-contaminated shellfish, a fee-for-service provided to seafood dealers seeking to improve product marketability. De-sanding operations began in March of 2013, and the plant realized a slight increase in processed racks of soft-shelled clams that year. This was the first increase in volume from one year to the next in more than 10 years. De-sanding accounted for more than 60% of the plant's production. Nonetheless, Plant production reached a historic low in 2014. It rebounded slightly in 2015, only to decline again in 2016. The plant processed 7,447 racks in 2016 resulting in General Fund revenues of $44,682, down 2% from 2015.

In addition to General Fund revenue, *MarineFisheries* generated $1,342,125 in revenue for the Marine Recreational Fisheries Development Fund from the issuance of 175,620 recreational saltwater fishing permits in 2016. Since inception in 2011, the total number of permits issued has increased each year, with steady growth of about 2.5% over the past four years. However, revenues declined by 2.6% (Table 24) due to the growing proportion of permits issued for free to anglers 60 and older.

Commercial Fisherman Permits

Anyone who lands and sells finfish, shellfish, lobsters, edible crabs, or other living marine resources in Massachusetts must have a *MarineFisheries* commercial fishing permit and must sell only to licensed Massachusetts dealers. All commercial permits, except Rod & Reel and Seasonal Lobster, may be endorsed for shellfish at no additional cost. See Table 27 for the number of commercial fisherman permits issued, by type, in 2016 and resulting revenue.

Table 27. 2016 Commercial Licensing and Revenue Statistics.

Permit Type (resident/ non-resident fee)	Permits Issued (#)		Revenue
	Resident	Non-Resident	
Coastal Lobster ($310/$570)	1,112	4	$347,000
Offshore Lobster ($310/$570)	303	94	$147,510
Seasonal Lobster ($80/$145)	90	1	$7,345
Boat 100'+ ($260/$520)	11	15	$10,660
Boat 60-99' ($195/$390)	75	148	$72,345
Boat 0-59' ($130/$260)	3,309	344	$519,610
Individual ($65/$130)	213	5	$14,495
Shellfish & Seaworm ($40/$80)	803	3	$32,360
Shellfish & Rod & Reel ($55/$130)	414		$22,770
Rod & Reel ($35/$100)	441	39	$19,335

Coastal Lobster Permit allows the taking, landing, and sale of lobsters and edible crabs (to a licensed dealer) harvested from within the coastal waters of the Commonwealth. There is a maximum pot limit per vessel that is based on Lobster Management Areas and individual allocations. The permit may be endorsed to take and sell shellfish and finfish at no additional cost. In the case of skin or scuba divers, only the licensee is covered.

Offshore Lobster Permit allows the landing and sale of lobsters and edible crabs (to a licensed dealer) taken outside of the coastal waters of the Commonwealth pursuant to appropriate federal permit(s). If the permit is endorsed for the use of pots to harvest lobster, there is a maximum pot limit per vessel that is based on Lobster Management Areas and individual allocations. The permit may be endorsed to take and sell shellfish and finfish at no additional cost.

Seasonal Lobster Permit is issued to full-time students only (verification required), and allows the licensee only to take and sell lobsters and edible crabs (to a licensed dealer) from June 15–September 15. A maximum of 25 pots may be used. Diving is not permitted; sale of fish and/or shellfish is not permitted.

Boat Permit allows the taking, landing, and sale of finfish (to a licensed dealer) and may be endorsed for shellfish. The permit covers everyone aboard the vessel. Price varies with vessel size (0–59', 60–99', and 100+'). No lobsters or edible crabs may be taken.

Individual Permit allows the holder only to take, land, and sell finfish (to a licensed dealer) and may be endorsed for shellfish. No lobster or edible crabs may be taken.

Shellfish Permit allows an individual to take, land, and sell (to a licensed dealer) shellfish and seaworms. A shellfish ID card from *MarineFisheries* and a town permit are also required.

(A Shellfish Transaction Card allows the named individual holding a commercial permit endorsed for shellfish and seaworms to sell shellfish and seaworms when used in conjunction with a Registry of Motor Vehicles identification card. In 2016, *MarineFisheries* issued 3,208 shellfish transaction cards; of which 208 were issued as employee shellfish transaction cards to 103 shellfish businesses.)

Rod & Reel Permit allows the holder only to catch and sell finfish (to a licensed dealer) caught by Rod & Reel only. No other gear types may be used.

Over the past decade, *MarineFisheries* has seen a steady decrease in commercial fisherman permit sales, with the exception of small boats, 0–59' in length. Generally, this change can be attributed to more restrictive regulations, especially limited entry rules for various fisheries that results in attrition of participants, and the increasing cost of operation within the fisheries. Figure 45 illustrates the 10-year trend in sales for four of *MarineFisheries'* frequently issued commercial permits: (1) Coastal Lobster Permit sales have steadily decreased 18% over the past 10 years; (2) Shellfish Permits have seen an overall decrease of 14% from 2007 to 2016, although sales fluctuated over the entire time period; (3) Rod & Reel Permit sales remained relatively constant from 2006 to 2013, but decreased 38% from 2013 to 2016; and (4) Boat Permits have seen the only rise in numbers over the past decade of all Commercial Fisherman Permits issued by *MarineFisheries*, with the largest spike (16%) occurring between 2013 and 2016.

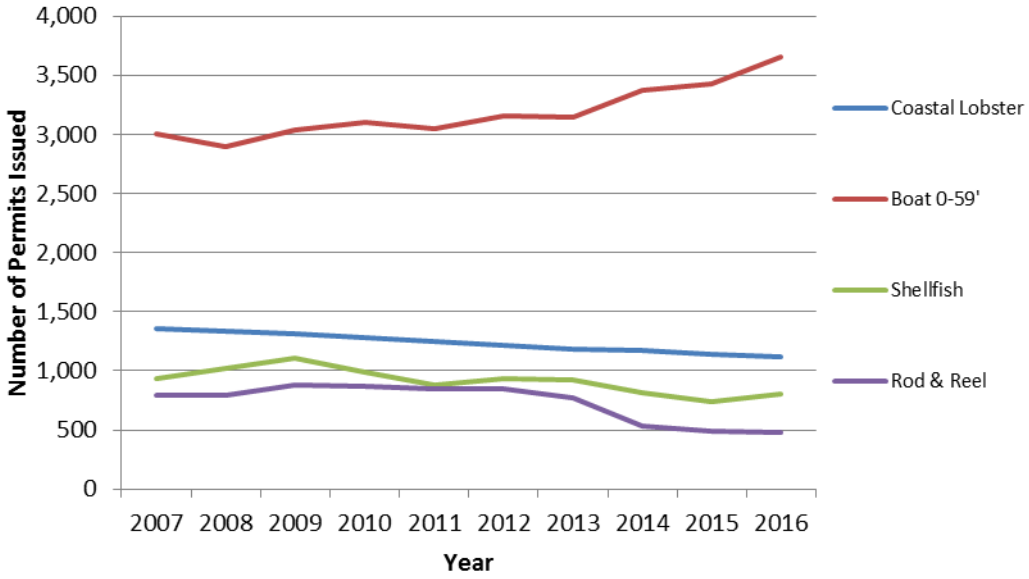


Figure 45. Trend of Commercial Permit Sales from 2007–2016.

Dealer Permits

Anyone engaged in the wholesale or retail trade of raw fish, shellfish, lobsters, or bait, whether frozen or fresh, must have a *MarineFisheries* Dealer Permit and may be subject to inspection from the Massachusetts Department of Public Health (*Mass*DPH). Shellfish dealers must abide by *Mass*DPH regulations for tagging and record keeping. Massachusetts seafood dealers who purchase seafood products, even if for bait purposes, directly from fishermen are considered primary buyers, and must be so endorsed on their dealer permits. See Table 28 for the number of dealer permits issued, by type, in 2016 and resulting revenue.

Table 28. 2016 Dealer Licensing and Revenue Statistics.

Permit Type (resident/non-resident fee)	Permits Issued (#)		Revenue
	Resident	Non-Resident	
Wholesale Dealer ($130/$260)	385	8	$52,130
Wholesale Truck ($130/$260)	96	130	$46,280
Wholesale Broker ($130/$260)	30	9	$6,240
Retail Dealer ($65/$130)	810	77	$62,660
Retail Truck ($65/$130)	39	3	$2,925
Retail Boat ($65/$130)	105		$6,825
Bait Dealer ($65/$130)	148	12	$11,180

Wholesale Seafood Dealer Permit allows the holder to acquire, handle, store, distribute, process, fillet, ship, or sell raw fish and/or shellfish, whether frozen or unfrozen, in bulk or for resale. It also allows retail sales from the same single, fixed location. An approved inspection from the Division of Food and Drugs is required. A copy of the inspection report must be submitted with the application to *MarineFisheries*. The name and address must be the same on the inspection report and permit. This permit may be endorsed for bait (excluding shellfish), with an inspection specifically stating, “Approved for retail and bait license”. A Hazard Analysis and Critical Control Points (HACCP) plan is required.

Wholesale Seafood Truck Dealer Permit allows the holder to acquire, handle, distribute, ship, or sell raw fish, whether frozen or unfrozen, in bulk or for resale from a truck only. It does not allow the holder to process raw fish, whether frozen or unfrozen, lobster, or shellfish. Nor does it allow the holder to purchase shellfish or shuck, re-label, or repack shellfish. An approved inspection from the Division of Food and Drugs is required. A copy of the inspection report must be submitted with the application to *MarineFisheries*.

Wholesale Seafood Broker Permit allows the holder to act as an agent who negotiates contracts of purchase and sale of seafood. The brokerage activities will not involve the actual handling, processing or reshipping of finfish, shellfish or other marine resources. A "broker only" waiver must be filed in lieu of a health inspection.

Retail Seafood Dealer Permit allows the holder to sell raw fish, whether frozen or unfrozen, shellfish, and lobsters at one retail location. The holder must purchase shellfish only from a holder of a wholesale dealer or wholesale truck permit, or from a certified out-of-state wholesale dealer. Shellfish CANNOT be purchased directly from a harvester. It does not allow the holder to shuck, relabel, or repack shellfish. An approved inspection from the Division of Food and Drugs must be submitted to *MarineFisheries*. The name and address must be the same on the inspection report and permit. This permit may be endorsed for bait (excluding shellfish). The inspection must specifically state "Approved for retail and bait license".

Retail Seafood Truck Dealer Permit allows the holder to sell fish or lobsters at retail from a mobile unit (does not include shellfish). It does not allow the holder to process, fillet, shuck, cook, etc. An inspection is required from a town or county Board of Health. A copy of the inspection must be submitted with the application. The name and address must be the same on the inspection report and permit. A Hawkers and Peddlers permit may also be required.

Retail Boat Seafood Dealer Permit allows the holder to sell whole fish and lobsters from his/her boat only (does not include shellfish). A commercial fisherman's permit is required in addition to this permit. A boat waiver must be filed in lieu of a health inspection.

Bait Dealer Permit allows the holder to take and sell marine bait. No inspection is required. Local regulations (i.e., on worms, eels) may apply.

Special Permits

Special permits are required for scientific collection, shellfish aquaculture, shellfish propagation, contaminated shellfish harvest, and for the non-commercial harvest of lobster. Regulated fisheries are issued as endorsements on commercial permits. See Table 29 for the number of special permits issued, by type, in 2016 and resulting revenue.

Table 29. 2016 Special Licensing and Revenue Statistics.

Permit Type (resident/non-resident fee)	Permits Issued (#)		Revenue
	Resident	Non-resident	
Non-Commercial Lobster ($55/$75)	6,713	126	$378,665
Regulated Fishery Endorsements ($30/$60)	11,203	738	$380,370
Master Digger ($250/$500)	8	1	$2,500
Subordinate Digger ($100/$200)	76		$7,600
Scientific Collection ($10/$20)	74	15	$1,040
"Other" Special Permits ($10/$20)	406		$4,060

Non-Commercial Lobster Permit is required to fish for or take lobsters and edible crabs for personal use. This authorizes the holder and members of the holders' immediate family, residing in the same residence, to fish for and take lobsters using 10 pots only. The immediate family is defined as the spouse, parents, children, grandparents, brothers, and sisters of the holder. This permit may be endorsed for diving by the permit holder only. Other family members may purchase additional permits for diving only.

Regulated Fishery Endorsement is required for commercial fishing in certain areas under certain conditions. Regulated fishery endorsement are required for dragging, gillnetting, and netting in inshore net areas, and for setting fish pots in waters under the jurisdiction of the Commonwealth. Regulated fishery endorsements are also required for the commercial harvest of northern shrimp, surf clams, ocean quahogs, sea herring, sea urchins, fluke, black sea bass, scup, striped bass, spiny dogfish, American eel, horseshoe crabs, groundfish, and menhaden.

Master Digger Permit is required for an individual who wants to harvest contaminated clams from areas classified as "restricted". Shellfish are depurated at the Shellfish Purification Plant in Newburyport in accordance with regulations and established procedures. In addition to this application form, applicants must also include a $1,000 surety bond, sign a master digger affidavit, have their vehicle inspected and approved by *Mass*DPH Division of Food and Drugs, must be at least 18 years of age, and may not possess an "open" area commercial shellfish license at the same time as a Master Digger Permit.

Subordinate Digger Permit is required for the harvest of contaminated clams from areas classified as "restricted". Shellfish are depurated at the Shellfish Purification Plant in Newburyport in accordance with regulations and established procedures. Subordinate diggers must work for a Master Digger, be at least 18 years of age, and may not possess an "open" area commercial shellfish license at the same time as a Subordinate Digger Permit.

Other Special Permits are required for specific activities in the marine environment, including; aquaculture, scientific collection, shellfish propagation, and shellfish relay.

Limited Entry Permit Transfer Program

Limited entry permits are those permits and permit endorsements that are restricted in distribution to renewals and are only transferable according to criteria established by regulation. Transfer criteria include two key components: the permit's activity and the transferee's experience. Limited entry permits include, but are not limited to, coastal lobster, fish pot (scup, conch, and black sea bass), gillnetting, surf clam, ocean quahog, mobile gear coastal access, fluke, horseshoe crab, groundfish, black sea bass, and menhaden.

Coastal Lobster Permits can be transferred by the holder along with lobster related business assets under the historical transfer criteria developed for the coastal lobster fishery. A permit must be actively fished prior to the transfer request, where "actively fished" means landing and selling at least 1,000 pounds of lobster or landing and selling lobster on at least 20 occasions, in a single year. The transferee must document that s/he has at least one year of full-time or equivalent part-time experience in the commercial lobster trap fishery or two years of full-time or equivalent part-time experience in other commercial fisheries.

Limited entry endorsements for fish pot-scup, fish pot-conch, fish pot-sea bass, ocean quahog, mobile gear coastal access, fluke, horseshoe crab, groundfish, quahog-dredge, menhaden, and black sea bass can be transferred by the holder provided they have been actively fished for four of the past five years. "Actively fished" means any landings, unless otherwise determined by the Director in a written policy. For fish pot endorsements, the transferee must document that s/he has at least one year of full-time or equivalent part-time experience in the commercial trap fishery or two years of full-time or equivalent part-time experience

in other commercial fisheries. For the other endorsements, the transferee must document that s/he has at least one year full-time or equivalent part-time experience in a commercial fishery.

Staff use a pre-application to allow permit holders to determine their eligibility to participate in a transfer. See Table 30 for a summary of transfers administered by *MarineFisheries* during the year.

Table 30. 2016 Transfer Statistics (permits with no transfers are not listed).

Permit/Endorsement Type	Permits Transferred (#)	
	Resident	Non-Resident
Coastal Lobster	31	0
Mobile Gear Coastal Access	4	4
Fish Pot	4	2
Fluke	5	5
Sea Bass	2	3
Groundfish	2	2
Surf Clam	3	2
Ocean Quahog	2	1
Quahog-Dredge	2	0
Horseshoe Crab	3	0

Recreational Fishing Permit

MarineFisheries began issuing recreational saltwater fishing permits in 2011 for the first year of the recreational saltwater fishing permit program. The program was created as a "user pays, user benefits" program, ensuring all fees collected from the sale of recreational saltwater fishing permits, including permits issued to the for-hire fleet, are deposited into the Marine Recreational Fisheries Development Fund. The agency's spending of these dedicated revenues is subject to the input from a five-member stakeholder panel established by the enabling statute. In addition to permit issuance, many individuals contributed to the program through direct donations to the agency to improve recreational fishing programs. The number of permitted fishermen showed significant growth in each of the first three years of the program as fishermen became aware of the permit requirement. Permit issuance has continued to rise at about 2.5 to 3% per year for the past four years, but revenue had leveled off in 2015 as a result of fewer for-hire permits, lower donations, and most of the permit growth being in the Age 60+ category (no fee). In 2016, permit issuance rose again about 3% from 2015 due to an increase in recreational saltwater fishing permits sales. See Table 31 for the number of permits issued, by type, in 2016 and resulting revenue.

Table 31. 2016 Recreational Saltwater Permitting and Revenue Statistics.

Permit Type (and resident/non-resident fee)	Number Permits issued		Revenue
	Resident	Non-Resident	
Recreational Saltwater ($10/$10)	108,618	15,517	$1,241,350
Recreational Saltwater Age 60+ ($0/$0)	44,804	5,857	$0
Charter Boat ($65/$130)	732	47	$53,690
Head Boat ($130/$260)	40	5	$6,500
Recreational Fund Donations			$40,585
Marine Recreational Fisheries Development Fund, Total Revenue:			$1,342,125

Recreational Saltwater Fishing Permit is required of all fishermen age 16 and over. Exceptions have been made for anglers fishing aboard legally permitted for-hire vessels, individuals that are disabled, and for those fishermen with a valid recreational saltwater fishing permit from another coastal state that has entered into a reciprocity agreement with Massachusetts. The fee for the permit has been set at $10 for fishermen between the ages of 16 and 59, inclusive. The permit is free for fishermen aged 60 and over.

Charter Boat Permit is required for a vessel that can carry up to six persons fishing as passengers from the for-hire vessel.

Head Boat Permit is required for a vessel that can carry seven or more persons fishing as passengers from the for-hire vessel.

Grants

In FY2015 and FY2016, *MarineFisheries* spent approximately $15.5 million and $14.5 million, respectively, on federal grants and mitigation projects operating out of the *MarineFisheries* Trust account. The increased spending from prior years (e.g., approximately $5.5 million in FY2013 and FY2014) can be mainly attributed to the federally funded Groundfish Disaster Economic Assistance Program (see below). The Federal Grant Awards and expenditures out of the *MarineFisheries* Trust are provided in Table 32.

Table 32. Fiscal Year 2015 and 2016 Expenditures.

Title of Federal Grant or Trust	Account Number	FY2015	FY2016
Clean Vessel Act	2330-9222	$1,300,000	$1,104,000
Fisheries Statistics	2330-9712	$120,000	$135,000
Boating Infrastructure	2330-9725	$190,000	$25,000
Interstate Fisheries	2330-9730	$290,000	$175,000
ACCSP	2330-9732	$20,000	$600
Turtle Disentanglement/Protected Species	2330-9739	$625,000	$587,000
Economic Relief	2330-9741	$10,150,000	$10,604,000
Fish Age & Growth	2330-9742	$160,000	$216,000
Sport Fish Coordination	2330-9743	$0	$75,000
Marine Fisheries Research Trust	2330-0101	$2,650,000	$1,600,000

The Revolving Loan Fund (RLF)

The Massachusetts Commercial Fisheries RLF Program, operating under a Memorandum of Agreement (MOA) between NOAA Fisheries and *MarineFisheries*, seeks to promote the effective implementation of catch-share programs in New England, while minimizing any potential adverse socio-economic impacts to fishing communities and small-scale fishing businesses that are sometimes attributed to catch-share programs. *MarineFisheries* contracted with two financial institutions to provide approved loan services to eligible applicants throughout the Commonwealth: (1) Tremont Credit Union, and (2) the Community Development Partnership.

MarineFisheries continued to operate the RLF in 2016 as a dynamic program that responds to individual fishing communities' abilities and ideas to preserve fishing opportunities for small-scale fishermen. Most recently the program was overhauled for the Cape Ann area to allow Gloucester-based sectors to administer funds for groundfish quota leasing. Gloucester fishermen were previously provided loan services through the Cape Ann Commercial Fishermen's Loan Fund. However, due to the lack of lending activity in the service area, the program was restructured with sector leasing anticipated to begin in early 2017.

During calendar year 2016, Tremont Credit Union and the Community Development Partnership together continued administration of six active loans totaling $223,542 in RLF funds. No new loans were issued or closed during the year; all fishermen remained compliant with their repayment terms. Additionally, lenders assisted borrowers with technical assistance and business planning.

Groundfish Disaster Economic Assistance Program

Previously, *MarineFisheries* was awarded $21,715,292 in federal grants stemming from a September 2012 disaster declaration in the Northeast multispecies (groundfish) fishery by the Acting Secretary of Commerce. The Commonwealth's Groundfish Disaster Economic Assistance Program is part of a greater consensus framework for the distribution of $32.8 million in federal disaster aid monies to the New England groundfish industry. In the consensus framework, the state fishery directors from Maine through New York, in partnership with NOAA Fisheries, apportioned funds between three themes (roughly $11 million each): one-third to be used for direct assistance, one-third to be split among the states and used at their discretion, and one-third to be used in developing a federally-funded buyout or industry-funded buyback.

Efforts to allocate disaster aid funds began in August 2014, when *MarineFisheries* distributed Bin 1 funds, totaling $6.3 million, to eligible federal limited access multispecies permit holders pre-qualified by NOAA Fisheries. During CY2015 *MarineFisheries* fully distributed Bin 2's $8.1 million in direct aid payments and had also implemented the third and final bin of funds, directing $6 million to federal limited access multispecies permit holders. By June 30, 2016, *MarineFisheries* completed direct aid payments in all three bins. See Table 33.

Remaining Bin 3 funds have been directed towards an Industry-Based Survey, expanding opportunities for small mesh fishing, and administrative support for developing an industry-funded buyback program.

Industry-Based Survey: In April 2016, *MarineFisheries* launched the Gulf of Maine (GOM) cod Industry-Based Survey. The goal of the survey is to provide an independent, scientifically-credible perspective on GOM cod stock status that is accepted by the scientific community and believable by fishermen, while addressing key uncertainties in groundfish management plans and stock assessments. *MarineFisheries* contracted with the Scituate based stern trawler, F/V Miss Emily, owned and operated by Kevin Norton. During the first year, the IBS project completed 7 monthly cruises in April, May, June, July, October, November, and December. Through collaboration with NEFSC, *MarineFisheries* installed a computerized system aboard the F/V Miss Emily that allows for the electronic collection and real-time audit of effort, catch, and biological data. Data processing was underway at year's end. Additional cod IBS operations were set to start up again on April 1, 2017.

Increased Fishing Opportunities: *MarineFisheries* set aside $50,000 in disaster aid funds to assist groundfishermen in their efforts to conduct experimental fishing outside the existing small-mesh whiting fishery season towards possible regulatory amendments. (See Conservation Engineering Project, page 18.)

Industry-funded Buyback Administration: The final component of the Bin 3 program allocated an additional non-discretionary $200,000 to support further developing an industry-funded buyback program. In April 2016, *MarineFisheries* hired a Groundfish Buyback Coordinator to facilitate industry input and design of a potential program. Policy and Management staff met with NOAA Greater Atlantic Regional Fisheries Office staff in June to re-initiate discussions of a buyback program. Subsequently, staff began organizing meetings with groundfish industry members to gauge continued support for a buyback program and design specific program elements, including program objectives, federal loan terms and repayment options, and scale and scope of a buyback program. The first of these meetings was held on September 8 in Chatham, MA. Additional meetings were expected to be scheduled in ports throughout the northeast in 2017.

Table 33. Disbursement of Disaster Aid Funds by Program.

Disaster Aid Program	# of Eligible Individuals	Flat Rate Payment Range	Total Amount Paid	Program Completion Date
Bin 1				
Permit Holders	201	$18,642–$32,500	$6,269,198	9/18/2015
Bin 2				
Permit Holders	142	$9,750–$32,500	$3,919,500	4/1/2016
Crew Members	525	$1,209–$10,080	$3,173,562	6/30/2016
Shoreside Businesses	30	$16,071–$26,786	$750,005	10/15/2015
Sectors	11	$18,300–$31,300	$315,650	5/7/2016
Bin 3				
Permit Holders	171	$35,520	$6,027,750	3/11/2016

The Clean Vessel Act Program

MarineFisheries administers the Clean Vessel Act (*Mass*CVA) Program to ensure that adequate, convenient pumpout facilities are provided to meet the needs of recreational boaters in Massachusetts coastal waters. This is achieved by monitoring the need for new or replacement coastal pumpout equipment and providing operation and maintenance funds to pumpout facilities offering free pumpout service to recreational boaters. Responsibilities include the identification of appropriate sites for needed pumpout equipment, providing technical assistance and information to boaters and others in need of *Mass*CVA information, and agency coordination with public and private parties.

In 2016, the 22nd year of our participation, *Mass*CVA continued to support Massachusetts' status as a No Discharge Zone (NDZ). With its hundreds of bays, coves, and inlets, it is challenging to provide adequate shore-side pumpout support along the Massachusetts coastline, especially with our short, intense New England boating season. Consequently, we have been a leader in the implementation of pumpout vessel use. Our matrix of pumpout vessels and shore-side pumpouts (Figure 46), along with dump stations, has created much wider boater access along the coast than twice the number of conventional shore-side facilities could have provided, and has been instrumental in Massachusetts' efforts to establish a statewide NDZ.

Figure 46. Shore-side pumpout stations can be stationary (left) or mobile (right). Along with pumpout boats and dump stations, they help meet the needs of the Commonwealth's recreational boaters.

Our capital reinvestment program has enabled *Mass*CVA to expand with minimal cost to new grant recipients that lack the capital for a full investment in new infrastructure. Through this program, when a grant recipient replaces an existing *Mass*CVA pumpout boat or fixed-location station, the replaced equipment can be provided to a new or existing applicant who can pay to have it refurbished at a fraction of the cost of new equipment. In 2016, our CVA-funded pumpout facilities included 44 private marinas, one non-profit organization, and 50 cities and towns.

Our pumpout facility site visits and recreational boater outreach efforts remain a critical component of the *Mass*CVA Program. This year the *Mass*CVA brochure was updated and improved to include a "how to" guide for pumpout shore-side station use. Staff continued to distribute over 8,000 pumpout location guides annually to the public at marinas and other boating or fishing-related outreach events. In 2016, *Mass*CVA completed its tenth consecutive year of exhibiting with our public and private partners at the New England Boat Show.

This year, staff took extra steps in reaching out to our pumpout facilities to assess programmatic needs and shortfalls. As a result, they were able to better anticipate equipment needs and address them sooner, rather than risk emergency needs. In response to pumpout program performance, recipients' awards have been adjusted to reflect recreational boater demand and programmatic needs, making better use of overall program funds for the Commonwealth. In 2016, there were a number of requests for replacement equipment, a sign that useful life is being achieved, yet program interest still remains strong. Table 34 summarizes this infrastructure for 2016. To date, the *Mass*CVA Program has kept over 8 million gallons of effluent from state coastal waters.

Total reimbursement for all new and replacement equipment reimbursed through the *Mass*CVA program in 2016 was $220,905. In addition, $592,011 was spent on operation and maintenance costs for 95 grant recipients during the 2016 calendar year to help their facilities operate successful pumpout programs. The operation and maintenance funds annually help support service for 64 pumpout boats, 77 fixed-location pumpout stations, and 11 mobile pumpout carts available to the recreational boating public along the Massachusetts coastline.

Table 34. New and Replacement CVA Infrastructure for 2016.

Recipient	Equipment
Bass River Marina	Replacement shore-side pumpout station
Boston Waterboat Marina	Replacement shore-side pumpout station
Bourne	Replacement shore-side pumpout station
Charles River Yacht Club	Replacement engine for pumpout boat
Charlestown Marina	Install new year-round shore-side pumpout stations
Cohasset	Replacement pumpout boat
Constitution Marina	Replacement pumps for shore-side pumpout station and pumpout boat
Harwich	Replacement pump and pumpout boat rehab
Haverhill	New shore-side station
Manchester Marine	New mobile pumpout cart
Perley's Marina	Replacement shed to house shore-side pumpout unit
Roht Marine	New mobile pumpout station

Boating Infrastructure Grant Program

The Massachusetts Boating Infrastructure Grant (*Mass*BIG) Program, begun in 2001, is a two-tiered federal grant program, directed through the USFWS and administered by *MarineFisheries*. The *Mass*BIG Program is funded by the Sport Fish Restoration Fund which in turn is funded by a small percentage of the Federal Gasoline Tax—an amount which represents fuel purchased by boaters across the nation. BIG is designed to provide grants to upgrade or install facilities for transient recreational boats 26 feet or more in length at public or partnered private facilities.

Proposed projects filed under Tier II can be much larger in scope than those in Tier I. Unlike Tier I, Tier II proposals are judged in a nationally competitive process based on a strict point system. Both grant tiers are reimbursement grants, meaning that payments are made upon the submission of invoices for work accomplished. Selected applicants provide at least a 25% match for Federal funds received. All payments are based on 75% reimbursement of invoices from work completed.

One Tier I grant was awarded and one was applied for by the *Mass* BIG program in 2016 (Table 35).

The Town of Nantucket's Transient Boater Navigational Project was awarded $45,056 to replace 15 nun buoys, 15 can buoys, 20 anchors, and 10 lights and the town worked with project staff towards completion of permitting and compliance. The Tier I grant will help transient boaters safely access the island from the federal navigation channel through Nantucket and Madaket Harbors.

Mattapoisett worked with the *Mass*BIG team to successfully submit a Tier I proposal for inclusion in the state's 2016 submission for federal funding. The 2016 federal awards will be announced in spring 2017. The town's Transient Boater Access Project proposes to construct a 100-foot long, 6-foot wide timber pier off the southeasterly end of Long Wharf in Mattapoisett Harbor, providing for five spaces for transient boats. A 10'x30' timber float and gangway would also be constructed and installed to provide enhanced pick up and drop off access for individuals wishing to access the wharf and town facilities.

The City of Lynn and *Mass*BIG staff worked with USFW to extend the Tier II Seaport Landing Marina Transient Dockage project to allow time for completion of the project within the grant period.

Table 35. Massachusetts BIG Project Summary for the past five years.

Year	Project	Award	% Complete
2009	Scituate Marine Center Transient Access (Scituate Harbor)	$90,000	100%
2011	Wessagusset Yacht Club Transient Dockage (Fore River, Weymouth)	$92,250	100%
2013	Wessagusset Yacht Club Transient Dockage Phase II & Phase III (Fore River, Weymouth)	$92,250	100%
	Seaport Landing Marina Transient Dockage (Lynn) *Extended in 2016*	$267,700	10%
2015	Solomon Jacobs Park Harbormaster Facility Project (Gloucester Harbor)	$263,930	10%
	Newburyport Visiting Transient Boater Project (Merrimack River) (Figure 47)	$448,059	95%
	Manchester by-the-Sea Transient Boater Infrastructure Improvement Project (Manchester Harbor)	$360,222	10%
2016	Nantucket Transient Boater Navigational Project (Nantucket and Madaket Harbors)	$45,056	10%
	Mattapoisett Transient Boater Access Project (Mattapoisett Harbor)	Tier I project applied for in 2016	

Figure 47. Newburyport's Visiting Transient Boater Project, which received a Tier II grant in 2015, neared completion in 2016. The project included construction of the visitor facility (complete with bathrooms, showers, laundry, and a reception area), access ramp, six additional transient moorings, and six additional dinghy dock spaces along the Merrimack River Riverwalk.

Outreach

MarineFisheries outreach efforts establish a connection with the Massachusetts saltwater fishing community and general public. Funds, including for the salary of an information and education coordinator, are from the Marine Recreational Fisheries Development Fund.

Figure 48. Children learning about flounder at a fishing clinic in Salem.

In 2016, a number of activities were completed. The program's coordinator, Elaine Brewer, co-edited two issues of *DMF News*, the *MarineFisheries* newsletter and took over as art director for the second issue.

The third "Let's Go Fishing!" youth fishing clinic was held in August in Yarmouth. Pre-registered youngsters between the ages of seven and 15 participated in a number of activities, including learning knots, casting practice, and dropping baited lines from the Yarmouth fishing pier. Other fishing clinics were held in Newburyport, Salem (Figure 48), Castle Island in Boston, and at the Cape Cod Canal Visitors Center.

Outreach was present at various trade shows throughout the year. Informational brochures on research and policy were distributed at the New England Boat Show in Boston, the Boston Sea Rovers Clinic in Danvers, and the Fishing and Outdoor Expo in Worcester, among others.

Communications with constituents through our social media platforms continued on: Facebook (user MaMarineFisheries), Twitter (handle @MassDMF), YouTube (channel MA MarineFisheries), and Flickr (user MA MarineFisheries). *MarineFisheries* uses these platforms to share information regarding policy and research as well as to cross promote with sister agencies within the Commonwealth.

At year's end, there were 65 videos posted by the agency on the *MarineFisheries* YouTube channel. The Outreach Project worked with *MarineFisheries* biologists to gather video from the field, then edited and produced each for YouTube viewing. Three videos contracted to be made and produced by Northern Light Motion Pictures, Inc. are included in the YouTube listings.

Brewer served as a co-webmaster for the *MarineFisheries* pages on Mass.gov. She also worked on preparing the website for migration to the new platform that the entire state will be moving to..

Since inception of *MarineFisheries* Outreach Project, Brewer has been the *MarineFisheries* representative to local and national educational groups including Massachusetts Marine Educators (MME), National Marine Educators Association (NMEA), and the New England Ocean Science Education Collaborative (NEOSEC). Within MME, she chaired the Marketing and Communication Committee (chair), participated on the North Shore High School Marine Science Symposium Committee, and served as Secretary on the Board of Directors. She chaired both the social media committee and the communications pod for NMEA, and took on the chair position for NEOSEC in July.

Seafood Marketing

Figure 49. *MarineFisheries* Seafood Marketing Program logo.

The Seafood Marketing Program was officially launched in August of 2016 at the 5th annual Boston Seafood Festival, which the program sponsored. The Boston Seafood Festival was chosen for the announcement because the event celebrates the commercial fishing heritage of Massachusetts while highlighting the significant infrastructure of the Boston Fish Pier. Also as part of the debut, the program sponsored Cambridge restaurateur Peter McCarthy's participation in the Great American Seafood Cook-Off in New Orleans. Chefs from 12 states participated in the competition, hosted by the Louisiana Seafood Promotion and Marketing Board, and Peter came in 3rd place.

The inaugural and second steering committee meetings were held at the Statehouse and in New Bedford, respectively. Legislators, agency heads, and industry members were enthusiastic about the Seafood Marketing Program's new educational logo and tagline "Fresh for Generations" that invokes a sense of historical pride while also being modern (Figure 49). Interestingly, the logo was created using the older Massachusetts Seafood logo from the 1970s. With this new logo, printed educational material—such as a new seafood availability calendar—was designed and distributed at various events (Boston Local Food Festival, the Big E, etc.) throughout the state in 2016.

The Seafood Marketing Program partnered with Massachusetts Farm to School to promote the consumption of local seafood in schools and other institutions. Massachusetts Farm to School is a statewide organization that strengthens the connections that communities have with fresh, healthy food and local food producers

by changing food purchasing and education practices at schools. This two-year partnership began in September 2016 and has three main action items: seafood as the Harvest of the Month in May, local seafood cooking demonstrations for institutional food service, and a seafood focus track at the Massachusetts Farm & Sea to Cafeteria Conference.

Additionally, a pilot grant program was launched in the fall of 2016. Over $100,000 was awarded to seven projects designed to increase awareness and demand for Massachusetts seafood products. These recipients are: Cape Cod Commercial Fishermen's Alliance of Chatham, Fishing Partnership Support Services Massachusetts of Burlington, Red's Best of Boston, City of Gloucester/Gloucester Fishermen's Wives Association of Gloucester, Green Crab R & D Group of Ipswich, New Bedford Harbor Development Commission of New Bedford, and Wellfleet SPAT of Wellfleet.

Scientific Diving

Scientific Diving is responsible for management of all scientific diving activities conducted by *MarineFisheries*. First organized in 1972, the program has evolved to meet the standards of the Occupational Safety and Health Administration's scientific diving exemption. This structure sets high standards for *MarineFisheries*' training and dive operations, affording *MarineFisheries* divers greater protection from accidental injury and helping to ensure the success of research performed by diving.

MarineFisheries' scientific divers conducted over 700 research dives to support on-going research and monitoring programs, including artificial reef site surveys, coast-wide benthic temperature monitoring; early-benthic-phase lobster suction surveys; eelgrass monitoring and restoration; shellfish abundance and habitat surveys; maintenance of acoustic telemetry receivers for numerous finfish species; PCB monitoring sample collection; and dive program training. 2016 highlights included surveys and post-deployment monitoring of the new artificial reef off Harwich (Figure 50) and the successful incorporation of two Department of Fisheries and Wildlife biologists into the Division's Diving Program.

Figure 50. *MarineFisheries* diver Mark Rousseau at the Harwich artificial reef.

Routine program management duties included diver training, equipment maintenance and repair, and maintenance of the air system.

Educational and outreach efforts to dive clubs, schools, and local dive shows continued. Highlights included a Division booth/table at the Boston Sea Rovers Show, World Oceans Day at the New England Aquarium, and the Beneath the Sea Show in New Jersey. *MarineFisheries* also hosted the 2016 Boston Sea Rovers Summer Intern and the 2016 North American Our-World Underwater Scholar during the summer field season.

Capital Assets and Facilities Management

Facilities

MarineFisheries maintains facilities at several coastal locations throughout the state. Headquarters are located in Boston, and the two primary field stations are located in Gloucester and New Bedford. Other facilities include the Shellfish Purification Plant in Newburyport, the Hughes Hatchery and Research Facility

in Vineyard Haven, a storage facility in New Bedford, and a subsidiary field office and storage facility in Sandwich.

In FY2016, *MarineFisheries* spent approximately $200,000 in facility planning, infrastructure maintenance, emergency repairs, and equipment throughout the Agency. This included several large repairs in the Gloucester Field station, routine maintenance at both the Hughes Hatchery and the Shellfish Purification Plant, and a continued effort to develop the South Coast Field Station.

The Annisquam River Marine Fisheries Field Station in Gloucester upgraded or replaced several mechanical systems throughout the facility as part of an overall plan to make the facility more energy efficient. In addition to upgrading the heating system, old windows were replaced with high efficiency windows in one wing of the main building. An asbestos abatement project was also completed in the main building, and 50 year old tile was removed and replaced with commercial carpet. A new surveillance/security system was installed, adding several cameras to the exterior of the building. The other major project completed in FY2016 was the renovation of the front office reception area; the new design is a major improvement for both the front office staff and the visiting public.

Development of *MarineFisherie*s South Coast storage and field support facility in New Bedford continued in 2016. New materials storage racks were installed for the Fishway Carpentry Shop and an ice machine was installed for general use. At Shawme-Crowell State Forest, the parking lot used for *MarineFisheries* vessel storage was regraded and hard-pack installed using $20,000 of Capital Funds. Plans also continued for the construction of a new storage building at Shawme. This structure will be shared by multiple projects and provide a central parking and storage area for *MarineFisheries'* projects on Cape Cod.

Construction of the new SMAST II facility accelerated in 2016 with numerous *MarineFisheries* staff participating in design and planning meetings. Completion is expected in fall 2017 with *MarineFisheries* staff moving in by the end of the calendar year. *MarineFisheries*' South Shore Shellfish personnel will be moving into renovated space on the SMAST campus in the SMAST I Building.

The South Coast Field Station received a new phone system and support computer, replacing a failing, 15-year old system. Considerable money and effort was also expended to address network problems and upgrade the network infrastructure. Both systems will be installed in the SMAST II building when the move is completed in 2017.

The SCUBA air compressor was overhauled in 2016 and a leaky fourth stage filter assembly replaced. The 12 high-pressure storage tanks were removed from the container and transported for a 5-year hydrostatic test. Following reinstallation, all equipment was once again fully functional. Maintenance and replacement of Division diving equipment in 2016 totaled $14,500.

Vehicles and Boats

MarineFisheries maintains a fleet of 40 vehicles and 16 boats. In 2016, roughly $80,000 was paid to the Office of Vehicle Management for lease vehicles, and an additional $46,000 was spent on maintenance and repair for all stock. Five new 4WD pick-up trucks, three 4WD SUVs, and a heavy duty cargo van were received in 2016, replacing extremely worn and sidelined vehicles. The *R/V Alosa*, *R/V Mya*, and two smaller vessels received upgraded electronics packages, one of the Maritime Skiffs was repowered, and safety equipment was replaced and upgraded on nearly all of the boats using $56,000 of Capital funds.