Department of Fish and Game

Massachusetts Division of Marine Fisheries 2018 Annual Report

Atlantic cod, post-release.
Photography by Steve de Neef.

Department of Fish and Game

Massachusetts Division of Marine Fisheries

2018 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 Ronald Amidon

Division of Marine Fisheries
Director David E. Pierce, Ph.D.

www.mass.gov/marinefisheries

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Introduction

The Massachusetts Division of Marine Fisheries (DMF or Division) of the Department of Fish and Game is the Commonwealth's marine fisheries management agency. DMF 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
BOEM	Bureau of Ocean Energy Management (Federal)
CCB	Cape Cod Bay
DMF	Division of Marine Fisheries (Massachusetts)
EOEEA	Executive Office of Energy and Environmental Affairs (Massachusetts)
EPA	Unites States Environmental Protection Agency
FMP	Fishery Management Plan
GIS	Geospatial Information System
GOM	Gulf of Maine
IBS	Industry-Based Survey
ILF	In-lieu Fee
ISSC	Interstate Shellfish Sanitation Conference
LCMA	Lobster Conservation Management Area
MassBays	Massachusetts Bays National Estuarine Program
*Mass*CZM	Massachusetts Office of Coastal Zone Management
*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
*Mass*Wildlife	Massachusetts Division of Fisheries and Wildlife
MAFMC	Mid-Atlantic Fishery Management Council
MFAC	Marine Fisheries Advisory Commission (Massachusetts)
MRIP	Marine Recreational Information Program
NEFMC	New England Fishery Management Council
NOAA	National Oceanic and Atmospheric Administration (and NOAA Fisheries)
NSSP	National Shellfish Sanitation Program
OCC	Outer Cape Cod
OLE	Office of Law Enforcement (Massachusetts)
PCCS	Provincetown Center for Coastal Studies
PSP	Paralytic Shellfish Poisoning
RHL	Recreational Harvest Limit
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-the-year

FISHERIES MANAGEMENT SECTION

Dr. David Pierce, Director, Section Leader

Fisheries Policy and Management Program

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Overview

DMF is responsible for managing the Commonwealth's saltwater 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 DMF proposes in order for them to be implemented.

Advisory Groups

Following below is a summary of 2018 proceedings by groups advising DMF 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 MFAC held nine business meetings during 2018. Regulatory revisions and fishery specifications that were approved by the Commission or became effective during 2018 are included in the summary of fisheries management actions beginning on page 9. Where possible, Commissioners also attended five DMF public hearings on proposed regulations, ten DMF scoping meetings on various management issues, and five Division-hosted ASMFC public hearings on interstate fishery management plans.

An MFAC Law Enforcement Subcommittee composed of several Commission members and Massachusetts environmental police officers also met in April to discuss various non-compliance issues within the recreational and commercial fishing sectors. A subsequent subcommittee meeting in September focused on proposals to address non-compliance issues in the for-hire recreational fishery. The MFAC also advocated for additional financial support for the Office of Law Enforcement (OLE) to increase coastal enforcement personnel numbers.

Changes to MFAC membership in 2018 included the appointment of Plymouth-based headboat owner/operator Captain Tim Brady to the seat vacated by Gus Sanfilippo in 2017 (Figure 1). The MFAC awarded commercial fisherman Arthur DeCosta the 2017 Belding Award for his lasting contributions to fisheries science and conservation.

Figure 1. MFAC Commissioners, from left to right: Louis Williams, Charles Quinn, Kalil Boghdan, Arthur Sawyer, Raymond Kane, Jr. (chair), Michael Pierdinock (vice-chair), Tim Brady, and William Doyle (clerk). Not pictured: Andrew Walsh.

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 May 2018 to review spending of the Fiscal Year (FY) 2018 fund appropriation and make recommendations for spending of the expected FY2019 fund appropriation of roughly $1.4 million. The approved spending plan included, but was not limited to: funding for a new Deer Island Fishing Pier in Boston Harbor; continuation of a Small Grants Program through which municipalities can compete for funds to finance public access improvement projects; 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.

Seafood Marketing Steering Committee

On August 13, 2014, "An Act Promoting Economic Growth Across the Commonwealth" established a Seafood Marketing Program within DMF. The legislation laid out initial objectives of the program, required the appointment of a 19-member steering committee to guide DMF in the administration of the marketing program, and designated funding of up to $250,000 per fiscal year from commercial harvester and dealer permit revenues. The steering committee, chaired by DMF, met once during the year. See Seafood Marketing (page 98) for more information.

Shellfish Advisory Panel

DMF 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 did not meet in 2018, but was expected to be reconvened in 2019.

Fisheries Management Actions

American Eel

Yellow Eel Commercial Quota Management: In June, DMF hosted an ASMFC public hearing on Draft Addendum V to the interstate FMP for eel. While no changes to Massachusetts' regulations were required under the addendum as approved in August, Addendum V removed the possibility of state-by-state yellow eel quota management being triggered, and also adjusted the commercial harvest cap that requires a management response.

Atlantic Herring

Inshore Gulf of Maine Management: DMF implemented the days out schedule for the directed herring fishery in Area 1A (inshore GOM) consistent with ASMFC Herring Management Board decisions. Permit conditions were issued to vessels declared into the directed fishery through DMF's opt-in process. For Trimester 2 (June–September, 72.8% of the area's quota), the schedule included a four day 480,000-pound/week limit from June 1–July 22 and a five day 640,000-pound/week limit from July 23–September 12, followed by a directed fishery closure for the rest of the trimester. The trimester started with an 80,000-pound weekly limit for carrier vessels, increased to 160,000 pounds on July 23. For Trimester 3 (October–December, 27.2% of the area's quota), the schedule included a five day fishery from October 1–November 15 and seven day fishery from November 16–December 31 (no daily or weekly limits or restrictions on carrier vessels). The Massachusetts/New Hampshire Spawning Area within Area 1A was closed to the directed fishery from October 26–November 22, based on the gonadal somatic index of maturing females sampled from commercial catches.

Atlantic Menhaden

Use of Carrier Vessels and Purse Seines in the Commercial Fishery: In February, DMF held a scoping meeting to discuss its management of the Commonwealth's commercial menhaden fishery and any potential improvements.

One objective of the scoping meeting was to address a renewed interest in the use of carrier vessels. DMF had developed the state's system of trip limits in part to discourage large-scale carrier vessel activity and preserve the available quota for the traditional inshore fishery. This included restricting carrier vessels from possessing or landing more than one trip limit per calendar day or trip. However, several longstanding operators of state waters seine vessels were interested to work with a carrier vessel, in a limited manner, to increase their efficiency. Accordingly, DMF developed new permit conditions for the fishery which allow, prior to 75% quota utilization, for two permitted harvester vessels to offload to a single carrier vessel. For the purposes of compliance monitoring, all vessels (harvester and carrier) were newly required to maintain a daily logbook. Additionally, fishing with purse seines for menhaden was prohibited on Saturdays, Sundays, Memorial Day, Independence Day, and Labor Day to deter user group conflict from becoming an issue should the Commonwealth's increased menhaden quota (up 65% in 2018) encourage additional fishing effort.

Bycatch Limit: Effective April 20, DMF amended its menhaden bycatch allowance to comply with a change to the interstate FMP. Amendment 3, approved by the ASMFC in 2017, clarified the bycatch allowance by limiting its use to defined lists of small-scale and non-directed gears, specifically excluding large purse seine vessels. Public comment was collected at two hearings in March.

Mystic River Fish Kill: In mid-July, a menhaden die-off occurred within the Mystic River along Everett and Somerville (Figure 2). Estimated to number in the tens of thousands of fish, DMF was called upon to assess the likely cause of the mortality event. These kills can and do happen throughout the menhaden's range along the Atlantic coast when large schools of fish enter tight embayments, often chased there by predators, and deplete the water's dissolved oxygen content and consequently suffocate. Long stretches of hot weather contribute to lowered oxygen levels. This natural event, while unpleasant, was another indication of high menhaden abundance re-establishing itself north of Cape Cod, and an additional reason why DMF supports the maintenance of a commercial menhaden fishery capable of taking its share of the coastwide quota.

Figure 2. 2018 menhaden fish kill along the Mystic River.

Bluefish

Bluefish Allocation Amendment: In July, DMF hosted an ASMFC/MAFMC public hearing on the scoping document for the next amendment to the joint interstate/federal FMP for bluefish. It has been dubbed the "allocation amendment" because the issues expected to take center stage include the commercial/recreational sharing formula and the commercial allocations to the states.

Fluke, Scup, and Black Sea Bass

Fluke (summer flounder), scup, and black sea bass are managed as part of a multispecies FMP; their management actions are thus grouped.

Fluke Commercial Issues Amendment: DMF hosted a MAFMC/ASMFC public hearing in September on a draft amendment to the joint federal/interstate FMP for fluke. The document focused on the commercial fishery's management, with the major topic being potential quota reallocation in light of the stock's northward shifting

distribution. Final action on the amendment was expected in December, but the management bodies' deliberations on this contentious issue spilled over into early 2019.

Fluke Commercial Wintertime Fishery: DMF discontinued its pilot program allowing interested fluke permit endorsement holders to land a weekly limit of fluke rather than the standard daily limit during the Period I (winter) fishery. The pilot program was first implemented in 2011 (via Letter of Authorization) at the request of offshore trawl vessel fishermen to assist the fleet in achieving its seasonal quota allocation, with the additional goal of reducing discards. While the program was initially viewed favorably, recent substantial quota reductions invalidated the rationale for the program. DMF announced the program's discontinuation in January, along with another decision of the Director to not allow, at this time, vessels to possess multiple state limits for fluke when transiting and landing in Massachusetts. Members of the offshore fleet had met with DMF in 2017 to make this request, arguing it would improve fishery efficiency. Agency concerns included enforcement challenges, quota monitoring complications, and implications for Period I quota utilization.

Fluke Recreational Management: DMF held a scoping meeting in March on how best to utilize a 17% harvest liberalization, as allowed under the ASMFC's regional management approach for recreational fluke in which MA is its own region. The result was a one fish increase to the possession limit (from 4 fish to 5 fish) and an addition of 15 days to the open season (from 125 days to 140 days). The specific opening and closing dates were changed from May 22–September 23 to May 23–October 9, thereby encapsulating both the Memorial Day and Columbus Day weekends. These rules were effective April 30 by emergency action, with a public hearing held in June.

DMF also hosted an ASMFC public hearing in October on two addenda addressing future years' management. As approved in December, Addendum XXXII established a new annual specifications approach for regionally setting recreational measures beginning in 2019, while Addendum XXXI will implement in 2020 provisions for state-only permitted recreational and commercial harvesters to transit federal waters in Block Island Sound with legal catch, and the ability for the recreational fishery to be managed with a slot limit.

Black Sea Bass Commercial Fishing Days: DMF replaced Wednesday with Thursday as an open commercial fishing day during the summer-time directed fishing season for black sea bass. This made the three open fishing days Sundays, Tuesdays, and Thursdays for the season beginning July 9. This action was taken to provide non-consecutive open fishing days in order to spread the supply of fish out over the week. Public comment was collected at two hearings in March, with a rule-change effective April 20.

Black Sea Bass Bycatch Allowance for Trawlers during the Squid Fishery: DMF adopted an allowance for trawlers to retain and land a 50-pound bycatch limit of black sea bass during the April 23–June 9 inshore small mesh squid fishery. Prior to this rule change, the retention of black sea bass during this period was prohibited. Harvest under the bycatch limit counts towards the quota and is capped at 50,000 pounds. After the end of the inshore squid fishery or once the 50,000-pound cap is reached, the retention of black sea bass by trawlers is prohibited until the directed summer-time fishery opens. This small allowance responds to DMF's objective to reduce unnecessary discarding where practicable. Public comment was collected at two hearings in March, with a rule-change effective April 20. During the 2018 squid season, trawlers landed just over 3,000 pounds of black sea bass under the bycatch allowance.

Black Sea Bass Recreational Management: DMF hosted an ASMFC public hearing on Draft Addendum XXX in January. When approved by ASMFC in February, Addendum XXX established regional (MA–NY, NJ, DE–NC) allocations of the recreational harvest limit (RHL) based on a combination of prior years' resource distribution and fishery harvest. The states within each region were then to agree upon measures to restrict regional harvest to their allocation, subject to guidelines meant to reduce regulatory disparity between the states in a region. Thus, while our region faced a 12% harvest reduction for 2018, MA would be allowed to liberalize by over 4%. DMF held a scoping meeting in March to collect input on various season and possession limit combinations. In April, DMF announced its plan to add four open days to the season (May 19–September 1), while maintaining the prior year's size and possession limits (15" and 5 fish).

Concurrently, the Northern Region states developed an appeal to Addendum XXX requesting reconsideration of the timeframe of exploitable biomass estimates used to allocate the RHL. At the insistence of southern states, stock distribution data as old as 2006 had been incorporated into the regional allocations—despite resource dynamics having changed markedly in just the last few years (Figure 3). ASMFC leadership agreed with portions of our appeal and ultimately the Management Board settled upon an alternative approach to 2018 management that also factored in projected resource availability in order to provide the Northern Region with a 4% liberalization while the southern states maintained their planned increases. DMF was able to implement regulations with a projected 15% liberalization. Compared to 2017, these regulations added 15 days to the season while maintaining the third Saturday in May opening date (May 19–September 12, 15" minimum size, and 5-fish limit). The new season was implemented by emergency action effective May 4, followed by a public hearing in June.

Figure 3. Anglers in Massachusetts are experiencing a boom in black sea bass availability thanks to favorable stock conditions and a northward shift in resource distribution.

The revisions to Addendum XXX rendered it useful for only one year, prompting ASMFC to develop a new addendum for future year(s) management. Consequently, DMF hosted an October public hearing on Draft Addendum XXXII, along with Draft Addendum XXXI which had been previously initiated in tandem with a MAFMC framework action. As approved in December, Addendum XXXII established a new annual specifications approach to regionally set black sea bass recreational measures subject to prescribed guidelines (e.g., for equitable access). Beginning in 2020, Addendum XXXI will allow for: federal waters regulations to be lifted when appropriate state measures have been implemented, state-only permitted recreational and commercial harvesters to transit federal waters in Block Island Sound with legal catch, and the recreational fishery to be managed with a slot limit.

Early in 2018, DMF also commented on NOAA Fisheries' proposed rule to open up February to recreational black sea bass harvest for interested states. Our concerns included inequitable benefits along the coast (none in MA), data inadequacies, lack of full accountability for state harvest, and interference with the ASMFC's Addendum XXX process for setting measures. While the opening was implemented, DMF's stance on these issues would help prevent further relaxation of the accountability measures for participating states in 2019.

Scup Commercial Incidental Trip Limits: To comply with the interstate and federal plan, DMF enacted seasonal incidental limits of scup for trawlers using nets with mesh that measures less than 5" diamond. Such trawls were limited to retaining just 200 pounds of scup during May–September and 1,000 pounds of scup during October–April. DMF had overlooked this compliance measure when making earlier changes to its scup commercial trip limit which allowed the inshore small mesh squid fishery to land above these limits. DMF implemented the requirement effective April 20 after taking comment at two public hearings in March, but also subsequently worked with Rhode Island to submit a request to the MAFMC to consider a higher incidental limit during the springtime in recognition of the two states' inshore small mesh squid fishery. While the long-standing requirement was implemented to reduce discarding of sub-legal sized fish when the stock was overfished, MA and RI proposed that it was now creating an unnecessary discarding problem for a healthy resource. In August 2018, the MAFMC and ASMFC reviewed the request and increased the incidental trip limit to 2,000 pounds during April 15–June 15, which DMF expected to implement in time for the 2019 inshore squid fishery.

Scup Commercial Seasons: DMF removed the month of October from its summertime fishery subject to state management. This action stemmed from a MAFMC and ASMFC decision to move October to the federally-managed Winter II period to encourage better utilization of the quota given the higher trip limits in place during the winter fishery. The shares of the coastwide quota allocated to each period remained unchanged. Public comment was collected at two hearings in March, with a rule-change effective April 20.

Scup Commercial Trip Limits: Two Director's declarations set the 2018 Winter II and 2019 Winter I trip limits at 28,500 pounds and 50,000 pounds, respectively, to compliment the federal measures. Public comment was collected prior to each declaration.

Scup Recreational Management: DMF held a scoping hearing in March on its intended measures for the scup recreational fishery. Under the ASMFC plan, the Northern Region of MA–NY strives for compatible regulations to achieve its harvest target, which increased 34% in 2018. Given already liberal season and bag limits, the Northern Region prioritized a reduction in the minimum size to 9", matching the federal waters size limit. The season and possession limits remained status quo: May 1–December 31 at 30-fish per person, with an additional 15 fish allowance for anglers aboard for-hire vessels during May and June. The new size limit was implemented effective April 30 by emergency action, with a public hearing later held in June.

DMF also submitted a request to the MAFMC and ASMFC in 2018 to have the scup monitoring committee review the concept of creating a "bait tolerance" for recreationally harvested scup whereby a portion of the allowed limit could be below the minimum size (e.g., 5 fish as small as 6") for use as live bait. DMF further developed and analyzed the proposal based on comments. While numerous arguments could be made to support the proposal, DMF ultimately decided by year's end to not further pursue the proposal for 2019 implementation given concerns about compliance, enforcement, monitoring, precedence, and ecosystem considerations.

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 federal multispecies FMP. *MarineFisheries* also includes monkfish in its definition of multispecies groundfish. These species' management actions are thus grouped.

Gulf of Maine Cod Recreational Management: In February, DMF accepted public comment on how to address the NEFMC's recommendation on 2018 Gulf of Maine (GOM) cod recreational limits. DMF could either implement a year-round prohibition on GOM cod possession for all anglers with GOM haddock rules remaining status quo, or continue an allowance for 1 cod for private anglers and face additional constraints on GOM haddock including a 2-fish reduction in the for-hire possession limit (from 12 fish to 10 fish) and a May closure for private anglers. DMF had first adopted a 1-cod limit for private anglers in the state-waters portion of the GOM in 2015, after the catch of GOM cod by all recreational anglers was prohibited in federal waters. DMF did not support the federal year-round closure for private anglers. We concluded zero possession was unprecedented and represented a difficult-to-defend policy, as it prohibited private citizens from accessing a public resource while continuing to allow a commercial fishery to access the same resource. However, faced with the Council's ultimatum, DMF prohibited the retention and landings of GOM cod by all anglers effective May 1. This decision turned on consideration of access to an abundant haddock resource with additional concern about the 1-fish allowance encouraging false reporting if cod is primarily caught in federal waters. The new rules for GOM cod were implemented by emergency action April 30 with a public hearing occurring in June.

Georges Bank Cod Recreational Management: Effective May 1, the recreational minimum size for recreationally harvested cod in the Southern New England Management Area was increased from 22" to 23" to complement federal waters rules. The bag limit remained at 10 fish with a year-round season. The rule-change was implemented by emergency action, with a public hearing occurring in June.

Shellfish

2018 Vibrio Control Plan for Oysters: DMF held four industry outreach meetings in April to provide information on the 2018 Vibrio Control Plan for Oysters. 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 *Vibrio parahaemolyticus* related to the consumption of raw oysters. The plans are crafted by DMF and the Massachusetts Department of Public Health (*Mass*DPH) and establish time-to-temperature, labeling, and reporting standards for the commercial harvest of wild and aquaculture-raised oysters to safeguard public health. No regulatory changes were required for 2018. See Vibrio Management (page 45) for more information.

Sea Scallop Requested Pilot Program: With limited exceptions, all waters under the jurisdiction of the Commonwealth north of Boston are closed to mobile gear fishing year-round. During January, DMF accepted public comment on allowing sea scallop dredging within a small area off Nahant during February and March in exemption of this closure. The proposal resulted from a public request to establish a pilot program for a seasonally- and spatially-limited exempted fishery. Based on a review of the extensive public comment received, the vast majority of which was in opposition, and expected research requirements, the Director decided in late January not to establish the pilot program.

Surf Clam and Ocean Quahog Dredge Seasonal Closure in Southwestern Cape Cod Bay: DMF adopted a new closure on surf clam and ocean quahog dredge fishing in a nearshore area adjacent to Ellisville and the east end of the Cape Cod Canal (Figure 4). The annual closure applies May 15–October 15 and was implemented to alleviate gear conflict between dredge fishermen and lobster trap fishermen and to protect egg-bearing and new-shell lobsters that seasonally utilize the area. A similar closure was implemented on a temporary and emergency basis in August 2017 for about two months per the request of local lobstermen. Public comment was collected at two public hearings in March. The regulation change took effect April 20.

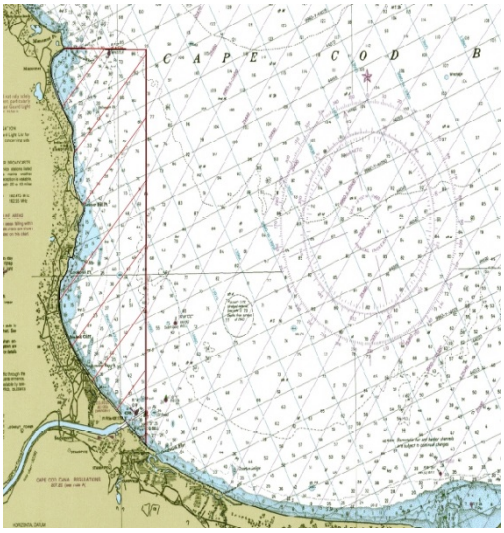

Figure 4. New seasonal closure area for surf clam and ocean quahog dredges, May 15–October 15.

Use of Bleach in Soft Shell Clam and Razor Clam Fisheries: Effective April 20, DMF clarified that it is unlawful to use bleach to harvest razor and soft shell clams. This reinforced state laws that prohibit the discharge of contaminants into marine waters. Chemical solutions have historically been used in the harvest of these clams. Most commonly, concentrated salt solutions are sprayed into clam holes forcing the animals to the surface and making harvest more efficient. This is not perceived to be problematic as it constitutes spraying a small amount of salt water into a marine environment. However, during cold winter months, some harvesters had been known to replace the brine solution with a bleach solution because the brine solution tends to crystalize at low temperatures. Bleach can kill off important micro-organisms, is harmful to fish and plant species, and can have a substantial negative impact on wetland ecosystems. Public comment was collected at two hearings in March.

Surf Clam Dredge Bar Spacing: Public comment was collected at two hearings in March on a proposal to establish a 2” minimum bar spacing requirements for surf clam dredges to reduce the potential harvest of sub-legal sized surf clams. The proposal was suggested by members of the Division’s Shellfish Advisory Panel. Action on the proposal was postponed in March to further assess the impact on small vessel operators who participate in multiple shellfish dredge fisheries.

Surf Clam Dredge Fishery Management: In January, DMF held a meeting with surf clam dredge fishery participants, federal fishery managers, law enforcement, public health officials, and other stakeholders to discuss challenges with

the fishery's management. Issues included: differences in the state and federal management systems (e.g., reporting requirements, conservation measures); state fishery issues (e.g., habitat protection, fishing area demarcations, gear conflicts); public health management issues (e.g., time-to-temperature standards); industry proposals (e.g., night fishing exemptions, increased access to available resource); and use of vessel monitoring technology to address spatial management issues (e.g., requiring a tracking system). From this meeting, DMF developed a list of deliverables including various rule-making proposals, research needs, and state-federal coordination. Action on these deliverables during the rest of 2018 focused on investigating the feasibility of implementing a vessel tracking system to assist in areal management and possibly enable several industry requests and address gear conflicts, mapping eel grass beds, and collaborating with federal partners on reporting requirements. Further action towards improving the state's management of this fishery was expected in 2019.

Striped Bass

Summer Holiday Closures in the Commercial Fishery: DMF adopted July 3, July 4, and Labor Day as additional closed fishing days in the commercial striped bass fishery. The open days otherwise remained Mondays and Thursdays during the open season beginning June 23. With the quota extending well beyond summer, the new rule did impact the 2018 fishery, closing Labor Day to commercial harvest; July 3 and 4 did not fall on a Monday or Thursday in 2018. Public comment was collected at two hearings in March, and the final rule took effect April 20.

In-season Adjustment to Commercial Fishing Days: By early September, quota monitoring data for the commercial striped bass fishery were projecting that a quota closure would not occur until at least October, with the potential for typical fall weather to reduce the fishery's ability to utilize the available quota prior to the fish's seasonal emigration. Effective September 14, the Director declared Tuesdays (in addition to Mondays and Thursdays) open to commercial fishing to enhance quota utilization.

Importation of Non-conforming Striped Bass: Effective October 29, DMF implemented an emergency regulation that eliminated the requirement for all wild caught commercial striped bass imported into Massachusetts to comply with the state's 34" minimum size while our commercial fishery is open. This action addressed the problem of our 2018 fishery remaining open unusually late, thus restricting non-conforming imports. In other years, striped bass imports from several mid-Atlantic states with a smaller minimum size limit than MA have been typical during the fall and early winter. With this emergency regulation in place, properly tagged, non-conforming striped bass could be imported into Massachusetts until the start of the 2019 commercial fishery. In addition, DMF planned to propose this change as a final rule in 2019, given that a mandatory coastwide striped bass tagging program has minimized its need as an enforcement tool.

Other Fisheries Management Issues

Increased Marine Fishery Fines and Penalties: Effective November 7, new non-criminal, criminal, and civil fines and penalties for violating marine fishery laws and regulations took effect. The modernized penalties schedule was enacted by the Legislature and signed by the Governor to address outdated and insignificant fines that were, for too long, considered the "cost of doing business" for poachers of marine fish and shellfish resources. This outcome began with an initiative launched by DMF in 2016 to overhaul the relevant state laws in response to longstanding and urgent demands from fishermen and Environmental Police to provide adequate deterrents to poaching. The fine schedule for non-criminal tickets was doubled (to $100/$200/$400 depending on the violation), with an additional $10 fine per illegally harvest fish authorized (except for bivalve shellfish). The criminal penalty schedule was greatly simplified, so that nearly all criminal violations result in a $400–$10,000 fine and up to 2.5-year jail sentence, while maintaining longstanding and effective criminal fines specific to lobsters, eels, and shellfish. Lastly, the law establishes the authority for the Commonwealth to assess a civil penalty of up to $10,000 through prosecution by the Attorney General's office on behalf of DMF or OLE.

Right Whale Protection: An aerial survey on April 22 observed more than 100 endangered North Atlantic right whales, about 25% of the known population, within Cape Cod Bay. Effective April 25, DMF implemented two emergency regulations designed to reduce these vulnerable aggregations' risk of vessel collision and gear entanglement, both leading causes of right whale injury and mortality. First, the existing February 1–April 30 Large Whale Trap Gear Closure was extended through May 15 for a portion of Cape Cod Bay (waters south of 42° 08ˈN latitude and west of 70° 10ˈ W longitude). Second, a 10-knot speed limit was implemented in those same waters of Cape Cod Bay through May 15 for vessels less than 65' overall length (a federal 10-knot speed limit already applied to vessels greater than 65'). Emergency and enforcement vessels were exempt, as well as vessels operating within Plymouth Bay shoreward of Gurnet Point, and Barnstable and Wellfleet Harbors. Public input was sought on the speed limit at two meetings in March, which affected the final version of the emergency rule.

Quota Transfers: Massachusetts received transfers of commercial quota after granting safe harbor to vessels bound for other states but experiencing either a medical or mechanical issue: in February, 5,450 pounds of fluke and 45 pounds of black sea bass from North Carolina; and in November, 3,169 pounds of fluke from Maryland. In August, Massachusetts agreed to transfer 100,000 pounds of Summer Period commercial scup quota to Connecticut. The transfer did not impact the length of our scup fishery.

Mobile Gear Closures: In 2017, DMF launched an initiative to modernize the Commonwealth's mobile gear closure regulations by translating outdated spatial references (i.e., to the "Line of 1881") into GPS coordinates, as requested by industry, the MFAC, and law enforcement. Following initial scoping in 2017 and an extensive review of the existing closure rules, DMF held two public hearings in October on proposals to update the nomenclature for the closures, clarify certain rules pertaining to the closures, and accept comment on possible revisions to the closures. In December, the MFAC approved the Director's recommendations to: switch to GPS coordinates for the closure boundaries; amend the western boundary of Cape Cod Bay Area 4 by moving it about ¼ mile shoreward, to align with historical effort; open the month of April to mobile gear fishing for sea scallops within the South Shore Area 3 (Hull to Plymouth), to provide new access; codify that the night fishing prohibition extends to sea herring purse seiners, as has been mandated by permit condition; clarify that the use of net strengtheners in allowed in the squid fishery and mirror federal rules regarding use of this gear modification; allow chafing gear on the bottom of the cod end in all trawl fisheries conducted in MA state waters, consist with federal regulations; correct permitting rules related to the open access nature of Coastal Access Purse Seine Permit Endorsements and Inshore Net Permit Endorsements; and consolidate all mobile gear fishing rules in one section. These rules were expected to be implemented by early spring 2019.

Commercial Kelp Longline Culture: Interest in kelp culture continued to grow in 2018. DMF received three new applications to commercially culture sugar kelp (*Saccharina latissimi*) including two in Nantucket Sound (off Chatham and Harwich) and one in Buzzards Bay (off Naushon Island). Given that the proposed projects include seasonal deployment of grow systems that incorporate submerged equipment with the potential to impact other user groups, DMF held a public hearing on each application (two hearings total in June and September) to evaluate stakeholder concerns and determine if modifications to location, gear marking, gear design or other features of the projects were warranted. Permits were issued for all three projects subject to some revision.

Free Saltwater Fishing Days: The Director declared June 16 and 17 as the 2018 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.

Spiny Dogfish Trip Limit: Consistent with ASMFC action, DMF declared a 6,000-pound possession and landing limit for the 2018/2019 commercial spiny dogfish fishery, effective May 1, 2018.

Tautog

Recreational Management: Effective April 20, DMF amended the Massachusetts recreational tautog regulations to better align with Rhode Island rules (also changed), per a new regional approach in the interstate management plan. Amendment 1 to the plan, approved by the ASMFC in October 2017, instituted a fundamental change in tautog management from a coastwide to regional basis due to differences in biology and fishery characteristics. Based on our regional stock assessment, the MA–RI region was not required to take harvest reductions, and instead focused on regionalizing recreational measures. The 2018 rules replaced the 3-fish per angler year-round possession limit with variable limits on a seasonal basis: 3 fish during April 1–May 31, 1 fish during June 1–July 31, 3 fish during August 1–October 14, and 5 fish during October 15–December 31 (size limit unchanged at 16" minimum). Additionally, harvest aboard private vessels was capped at 10 fish (year-round), regardless of the number of anglers aboard. Public comment was collected at two public hearings in March.

Adjudicatory Proceedings

Under state law, DMF may sanction commercial and recreational fishing permits for violations of the state's marine fishery laws and regulations subject to a due process adjudicatory proceeding. These adjudicatory proceedings are held before a magistrate. They may be initiated by the agency, the Environmental Police, or municipal officials authorized to enforce the marine fishery laws of the Commonwealth.

In 2018, DMF initiated 17 adjudicatory proceedings based upon incident reports for the following violations: sub-legal sized whelk; angler non-compliance on for-hire head boats; possession of egg bearing and scrubbed lobsters; possession of v-notched and mutilated v-notched lobsters; removal of shellfish from areas closed to commercial shellfish fishing; contaminated shellfish and the sanitary harvest of shellfish; non-conforming surf clam bycatch; over the limit striped bass, black sea bass, and tautog; undersized striped bass, black sea bass, and tautog; and failure to remove lobster trap gear from the Large Whale Seasonal Closure Area.

Eight adjudicatory proceedings were concluded in 2018. This included final decisions in five of the 17 matters initiated in 2018; the remaining twelve matters continued into 2019. The final decisions in these five proceedings produced: two three-year recreational fishing permit suspensions for violations of recreational striped bass fishing regulations; a revocation a commercial fishing permits for violations of black sea bass fishing regulations; one set of permit conditions to enhance angler compliance on a head boat; and one set of permit conditions to enhance compliance with lobster management regulations. Three matters from prior years were also concluded in 2018. The final decisions in these proceedings produced: two revocations of commercial shellfish permits for violations of the state's contaminated shellfish and sanitary harvest of shellfish regulations; and one three-year permit suspension of an individual's recreational and commercial fishing permits for striped bass violations.

Other Activities

Committee Work and Leadership Positions

During 2018, staff represented Massachusetts at five NEFMC and four ASMFC meetings, plus three additional Board-specific meetings of the ASMFC. Staff chaired the ASMFC management boards for winter flounder, tautog, striped bass, and menhaden, and served on numerous Council and Commission boards, committees, and teams throughout the year. Staff co-chaired the Massachusetts Marine Fisheries Institute (MFI), served as MFI Policy Director, and was member to the MFI Executive Committee. Staff also served as the state's representative to the Stellwagen Bank Advisory Council.

Marine Fisheries Institute

The Massachusetts Marine Fisheries Institute (MFI) is a cooperative venture between DMF and the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST). Founded in 2002, 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.

The MFI secured $450,000 in earmarked state funds in the Division's appropriation for collaborative research that applies innovative technology to assess the biomass of groundfish in the region. Specifically, the funds supported continued development and application of the open cod-end video trawl survey system to estimate stock size for cod, teaching and advising on stock assessment methods, and continuation of the MFI Advisory Council efforts.

In 2017, the MFI received its first external, competitive research grant through NOAA Fisheries' Bycatch Reduction Engineering Program. During 2018, DMF and SMAST researchers continued efforts on the two-year project, "Developing and testing a pelagic species distribution model to forecast river herring bycatch hotspots." The grant for $116,789 supports evaluation of the impact of fisheries-dependent data on river herring, Atlantic herring, and Atlantic mackerel habitat forecasts and compares predicted bycatch hotspots to observed river herring bycatch to determine utility in predicting bycatch. The project completed data collection from mid-water trawl vessels and has started analysis of forecasting models to predict bycatch hotspots.

DMF and SMAST researchers completed the 2017 Scallop Research Set-Aside funded project "Factors Influencing Scallop Landings per Unit Effort (LPUE)," which was reviewed through the Northeast Regional Stock Assessment Workshop (SAW 65) in June. The grant for $270,199 supported efforts to work with members of the scallop fishing industry to identify the primary factors that influence fishing behavior, including landings prices, season, and fishing area. The factors were modeled to predict future fishing behavior and reduce management uncertainty associated with the Days-At-Sea fishery management system.

DMF and SMAST researchers also continued and expanded collaborative research projects including the river herring/shad bycatch avoidance program for the Atlantic herring fishery, use of fishery-dependent effort data in stock assessment, lobster larvae settlement habitat, and white shark population modeling.

The MFI Advisory Council met in November to review the status of regional science related to Gulf of Maine cod, advance the survey efforts of DMF's Industry-Based Survey for Cod and SMAST's open cod-end video trawl survey, and receive updates on new and ongoing MFI research projects. The Advisory Council also reviewed DMF and SMAST efforts on review of offshore wind development projects.

The MFI released a technical report with results from the 2017 regional workshop, "Accountability Measures for Northeast Fisheries: A Workshop to Examine Best Practices", including participation from the Chairman and Executive Director of the NEFMC, staff from the MAFMC, NOAA Fisheries Greater Atlantic Regional Fisheries Office, Northeast Fisheries Science Center, and several environmental and academic institutions. The technical report included recommendations for best practices for bycatch management and alternatives to the current management system.

The MFI submitted its 2018 Annual Report in July, highlighting collaborative research on conservation engineering, fisheries surveys, benthic habitat characterization, and groundfish, scallop, lobster and pelagic fisheries research.

Coordination of NEFMC Nominations

DMF 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. Dr. John Quinn of Dartmouth was re-appointed by the Secretary of Commerce to a third term as the Massachusetts obligatory member.

Publications

Advisories: DMF released 99 electronic Marine Fisheries Advisories to subscribers of our listserv on various rule changes, public hearings, quota closures, and other important information.

DMF News: DMF published its newsletter twice in 2018 (Figure 5). These editions of "DMF News" were mailed to subscribers and made available through the Division's website.

Annual Report: DMF published its 2017 Annual Report.

Figure 5. The covers of the two 2018 editions of the DMF News.

Permitting and Fisheries Statistics Program

Personnel

Story Reed, Program Manager
Anna Webb, Fisheries Statistics Project Leader & Harvester Reporting Coordination
Kerry Allard, Permitting Project Coordinator
Kim Lundy, Dealer Reporting Coordination & Quota Monitoring
Erich Druskat, Fisheries Data Analyst
Mary Ann Fletcher, Fisheries Data Entry
Rosemary Mitchell, Permitting & Support for Fisheries Reporting
Whitney Sargent, Permitting & Support for Fisheries Reporting
Kerry Faugno, Permitting Receiving Teller
Sandra Downing, Permitting Receiving Teller
Kim Trotto, Permitting Receiving Teller
Lynne Besse, Permitting Receiving Teller
Leah Derleth, Permitting & Support for Fisheries Reporting (January–March)
George Davis, Permitting & Support for Fisheries Reporting (March–December)
Thomas Hoopes, Contractor

Overview

The **Permitting Project** is responsible for the issuance of commercial fishing, seafood dealer, recreational fishing, scientific, and other types of Division-issued permits; overseeing and approving the transfer of limited entry fishing permits and endorsements; issuing trap and fish tags; and issuing Letters of Authorization as needed. The project follows applicable laws, regulations, and policies relative to these activities. Project staff fulfill public data requests for non-confidential permit data and provide support to administrative staff as needed. Project staff also interact with the public on a routine basis to answer questions on permitting and regulations.

The **Fisheries Statistics Project** 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 DMF and to fulfill requests made from outside the agency. Project personnel also participate in the planning and development of the Atlantic Coastal Cooperative Statistics Program (ACCSP) and provide support to administrative staff for policy and permitting. In addition, Project 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.

Permitting Project

Commercial Fisherman Permits

Anyone who lands and sells finfish, shellfish, lobsters, edible crabs, or other living marine resources in Massachusetts must have a DMF commercial fishing permit and must sell only to licensed Massachusetts dealers. DMF issued a total of 7,843 commercial fisherman permits in 2018 (Table 1). Over the past decade, DMF has seen a steady decrease in commercial fisherman permit sales, with the exception of small boats, 0–59' in length (Figure 6). Generally, this change can be attributed to more restrictive regulations and the increasing cost of operation within the fisheries.

Table 1. 2018 commercial fisherman permit issuance.

Permit Type	Permits Issued (#)	
	Residents	Non-residents
Coastal Lobster	1,075	6
Offshore Lobster	297	95
Seasonal Lobster	99	1
Boat 99+'	14	15
Boat 60-99'	71	189
Boat 0-59'	3,513	369
Individual	202	2
Shellfish and Seaworm	878	1
Shellfish and Rod & Reel	421	0
Rod & Reel	555	40
Total	**7,125**	**718**

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 99+'). 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 DMF 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 2018, DMF issued 3,347 shellfish transaction cards; of which, 280 were issued as employee shellfish transaction cards to 128 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.

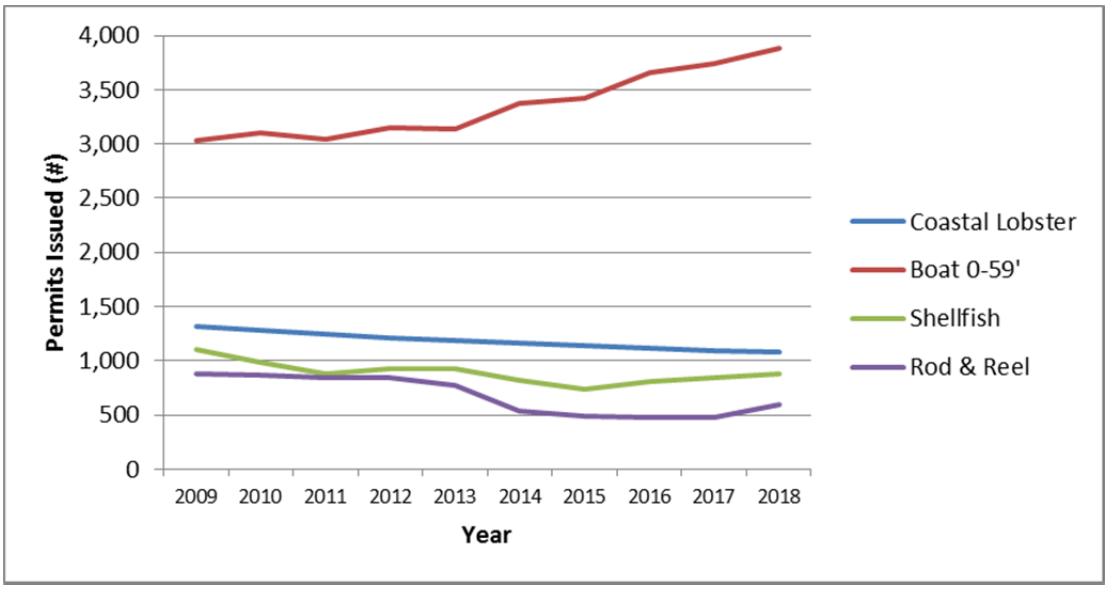

Figure 6. Trend in sales of four frequently issued commercial fisherman permits, 2009–2018.

Dealer Permits

Anyone engaged in the wholesale or retail trade of raw fish, shellfish, lobsters, or bait, whether frozen or fresh, must have a DMF 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. DMF issued a total of 1,864 seafood dealer permits in 2018 (Table 2).

Table 2. 2018 dealer permit issuance.

Permit Type	Permits Issued (#)	
	Resident	Non-resident
Wholesale Dealer	390	7
Wholesale Truck	84	129
Wholesale Broker	27	13
Retail Dealer	841	87
Retail Truck	31	3
Retail Boat	96	1
Bait Dealer	146	9
Total	**1,615**	**249**

Wholesale Seafood Dealer Permit allows the holder to acquire, handle, store, distribute, process, fillet, ship, or sell raw fish and 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 must be submitted with the application to DMF. 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 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 must be submitted with the application to DMF.

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. 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 DMF. 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 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, etc.) may apply.

Special Permits

Special Permits are required for certain activities in the marine environment, as described below. DMF issued a total of 21,254 special permits in 2018 (Table 3). Of the Special Permits issued, the Non-commercial Lobster Permit has had the largest percent decline in sales over the past 10 years (40%).

Table 3. 2018 special permit issuance.

Permit Type	Permits Issued (#)	
	Resident	Non-resident
Non-commercial Lobster	6,310	116
Regulated Fishery Endorsements	13,350	931
Master Digger	2	1
Subordinate Digger	25	0
Scientific Collection	63	17
"Other" Special Permits	438	1
Total	**20,188**	**1,066**

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 holder's 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 certain commercial fishing activities in addition to a commercial fisherman permit. Regulated Fishery Endorsements are required for dragging, gillnetting, netting in inshore net areas, and 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, dogfish, American eel, horseshoe crabs, groundfish, tautog, and menhaden. In 2018, DMF combined the Surf Clam and Ocean Quahog endorsements into a single Surf Clam/Ocean Quahog Dredge endorsement because of the similarities between the two fisheries.

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 the application form, applicants must 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 activities including aquaculture, scientific collection, shellfish propagation, and shellfish relay.

Recreational Saltwater Fishing Permits

DMF began issuing recreational saltwater fishing permits in 2011 in response to state legislation. DMF issued a total of 188,109 recreational saltwater fishing permits in 2018 (Table 4). Issuance rose 1.8% for the year, which when compared to the 2–5% increases seen in prior years, was the lowest rate of increase since the program began. Most of this increase is attributed to permits issued free of charge (age 60+ angler permits).

Table 4. 2018 recreational saltwater fishing permit issuance.

Permit Type	Permits Issued (#)	
	Resident	Non-resident
Recreational Saltwater, Age 16–59	113,498	17,583
Recreational Saltwater, Age 60+	49,637	6,537
Charter Boat	762	43
Head Boat	43	6
Total	**163,940**	**24,169**

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 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.

Limited Entry Permit Transfer Program

State regulations prohibit the transfer, loan, lease, exchange, barter or sale of any permit without DMF permission. Limited entry permits (commercial permits and endorsements that are restricted in distribution to renewals) are 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.

The transfer process begins with pre-application forms through which the permit holder and potential transfer recipient can determine their eligibility to participate in a transfer. Pre-approval is followed by the completion of a transfer packet, and final approval. See Table 5 for a summary of transfers administered by DMF during the year.

Table 5. 2018 limited entry permit transfer statistics.

Permit/Endorsement Type	Permits Transferred (#)	
	Resident	Non-resident
Coastal Lobster	32	0
Mobile Gear Coastal Access	5	2
Fish Pot	6	0
Fluke	7	3
Black Sea Bass	4	2
Groundfish	1	1
Surf Clam/ Ocean Quahog	1	0
Quahog Dredge	1	1
Horseshoe Crab	2	1

Fisheries Statistics Project

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 DMF 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 2018, 1,864 businesses obtained a Massachusetts seafood dealer permit. Of those, 464 (or 25%) 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 464 dealers, 230 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 234 dealers were categorized as "state-reporting."

Even though many of the primary buyers in 2018 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, 159,849 dealer reports were entered into the SAFIS database, an increase of approximately 2,500 reports compared to 2017. Federal-reporting dealers electronically submitted 75% of these transactions. Of the remaining transactions submitted by state-reporting dealers, one-third was entered electronically by dealers, and the rest were submitted on paper-based forms.

Total landings (in whole pounds), as reported through the SAFIS database or other federal reporting programs, amounted to 734 million pounds, valued at $647 million (ex-vessel). The five most valuable species were sea scallop, lobster, Eastern oyster, Atlantic surf clam, and Jonah crab totaling $520 million, or 80% of the total value. Offshore shellfish (sea scallop, Atlantic surf clam, and ocean quahog) made up 62% 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 37 million pounds, valued at $110 million, or 17% of the total value landed. Cumulative finfish landings, including both pelagic and benthic species, made up 14% of the total value with groundfish species amounting to 9% of the total value. Landed species with an individual gross value over $2 million are shown in Table 6; in aggregate, these species accounted for approximately 98% of the total value of all species landed.

Table 6. 2018 MA-landed species with value greater than $2 million*. Source: ACCSP Data Warehouse, 4/22/19.

Species	Landings (whole pounds)	Value
Sea scallop	336,345,572	$373,801,862
American lobster	17,495,554	$87,944,957
Eastern oyster	8,685,949	$28,384,509
Atlantic surf clam	89,561,319	$17,326,307
Jonah crab	13,307,457	$12,476,913
Haddock	13,488,321	$12,305,318
Monkfish	14,045,205	$8,461,636
Soft shell clam	3,649,032	$6,170,491
Bluefin tuna	917,292	$5,165,781
Northern quahog	5,985,493	$5,095,479
Winter flounder	1,687,586	$5,081,833
Atlantic herring	26,648,887	$4,996,985
Acadian redfish	9,738,099	$4,924,162
Channeled whelk	1,347,496	$4,380,553
Silver hake (whiting)	4,448,888	$4,379,598
Atlantic cod	1,890,752	$4,168,880
American plaice (dab)	1,913,264	$4,112,817
Pollock	5,775,452	$4,063,176
Striped bass	753,731	$3,871,151
White hake	3,720,810	$3,483,188
Winter skate	11,831,333	$3,398,949
Atlantic razor clam	732,913	$3,291,855
Loligo squid	1,608,540	$2,817,942
Witch flounder (gray sole)	1,184,719	$2,247,600
Summer flounder (fluke)	427,167	$2,013,460

*Ocean quahog, deep-sea red crab, and hagfishes are also in this list, but the data are confidential.

Species managed by quota in Massachusetts were monitored using the dealer reported landings in the SAFIS database. Automated analyses ran on a nightly basis and the results were displayed on both the DMF internet website (Figure 7) and the Statistics Project intranet website. On a weekly basis during the open season, staff

reviewed compliance and estimated projections 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
2018 Landings and Quota Information
as of Feb 28, 2019 - 07:15 A.M.

Species	2018 MA Landings	2018 Quota	Quota Type	Percent Landed
Black Sea Bass	480,793	457,645	MA	105.1%
Bluefish	195,378	486,539	MA	40.2%
Dogfish	7,676,370	22,153,577	CW	to NMFS
Fluke	427,167	413,361	MA	103.3%
Horseshoe Crab*	145,837	165,000	MA	88.4%
Menhaden	5,714,256	6,065,015	MA	94.2%
Scup *(Winter I)*	567,959	10,820,000	CW	to NMFS
Scup *(Summer)*	736,543	1,916,280	MA	38.4%
Scup *(Winter II)*	178,643	9,766,677	CW	to NMFS
Striped Bass	753,731	847,585	MA	88.9%
Tautog	61,055	62,945	MA	97.0%

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 7. Example of quota monitoring data available on DMF's 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 NMFS (e.g., Vessel Trip Report or VTR), were exempt from reporting to DMF for those activities occurring on their federally-permitted vessel as were those vessels commercially fishing solely for bluefin tuna who were already required to report landings to the NMFS Highly Migratory Species (HMS) Division. All other individuals were required to report to DMF.

Standardized trip-level reporting 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 online using the SAFIS eTRIPS application, a web-based program developed jointly by ACCSP staff and program partners, or the eTRIPS mobile application. 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 NMFS, was the SAFIS database. Data were easily downloaded from the SAFIS database and used for compliance and fisheries analyses.

In 2018, DMF issued 7,843 commercial harvester permits, of which 18% were for federal reporting vessels, and the remaining 6,453 commercial permits were designated as "state-reporting." Thirty-five percent of the permit holders reported electronically using the SAFIS eTRIPS application, a 1% increase in electronic reporting participation since 2017. This left 47% of all harvesters submitting paper reports to DMF. Of the 108,381 commercial trips that were entered in the SAFIS database to date for 2018, approximately 30% were entered by commercial permit holders

using the SAFIS eTRIPS applications, with the remaining trips entered by DMF staff. Project staff are in the process of finalizing these data at the time of publication, so the values are subject to change.

Data Analysis and Dissemination

Project staff provided a wide variety of data and technical support during 2018. Significant time was dedicated to ensuring correct harvester reporting methods and compliance during the permit renewal period. Compliance metrics were maintained for harvester and dealer reporting, and work was distributed to continue to accommodate more real time data entry. A bottleneck was identified for loading entered data into the SAFIS system; work will be redistributed in 2019 to address this issue. Additionally, significant time was spent working through landings validations efforts with ACCSP for a variety of species. A number of projects are highlighted below.

Horseshoe Crab Landings Validation Exercise: Project staff completed an in-depth audit of all horseshoe crab landings data from 2005–2017. Specific data elements reviewed included product disposition (bait versus biomedical), unit of measure, permitting, and more. ACCSP, the DMF horseshoe crab biologist, and project staff worked together to resolve discrepancies and finalize the landings time series to be used in the upcoming horseshoe crab stock assessment. This process was highly detailed and extensive to ensure the best available landings were available for the assessment process.

Groundfish In-season Landings Analysis: Efforts were made by project staff to better track groundfish landings to prevent over harvest of the state-waters, stock-specific, sub-components available to Massachusetts. Because these sub-components are spatially explicit, a mix of harvester and dealer data elements must be used to approximate Gulf of Maine landings of the various groundfish species, specifically Atlantic cod and winter flounder. Harvest regions were gathered from historical harvester reports and were applied to the current dealer reported landings by those harvesters to produce total landings by month, species, and stocks. These totals were updated periodically from May–December and compared to the sub-component targets. Ultimately, these summaries were used as justification for management decisions regarding opening a previously established closure for April 2019.

Analysis of Shellfisheries in Falmouth: Falmouth Marine & Environmental Services in conjunction with the Falmouth Water Quality Management Committee was investigating impacts of shellfish harvest on nitrogen removal and requested commercial harvest data for supporting analyses. The request sought annual landings data of shellfish harvested from all designated shellfish growing areas in Falmouth town waters. Extensive correspondence was required in order to maximize the amount of data provided to the town while adhering to confidentiality rules. The resulting dataset painted a detailed picture of Falmouth's shellfisheries.

Striped Bass Tagging Program: 2018 was the fifth year of a commercial fishery tagging program mandated by ASMFC. Program staff estimated the 2018 tag requirements for individual dealers and distributed tags prior to the season and throughout as needed. At the end of the season, unused tags and an 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 (Table 7).

Table 7. 2018 striped bass tagging statistics (as of April 2019)**.**

# of Dealers Receiving Tags	# of Tags Purchased	# of Tags Distributed	# of Tags Returned	# of Tags Used	# of Tags Missing
92	80,000	53,100	14,882	37,777	441

ACCSP Participation and Planning

DMF staff continued to participate on all partner-based committees within ACCSP. Staff were member to the Operations, Information Systems (chair), and Commercial Technical committees. 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. ACCSP's SAFIS redesign project continued in 2018, specifically focusing on the development and release of an updated eTRIPS mobile application that would allow submission of federal VTRs from both the Northeast and Southeast while also initiating the development of a trip management system to help provide a link between disparate data collection systems. Neither of these projects have a direct impact on Massachusetts harvesters and dealers yet, but required significant input from project staff to ensure all applications meet Massachusetts reporting requirements. This effort is expected to continue at or above the current commitment beyond 2018.

In March, the MAFMC mandated electronic reporting for federal for-hire vessels participating in mid-Atlantic managed fisheries. ACCSP's eTRIPS mobile application became one of the primary tools used by this fleet to electronically submit VTRs, further increasing the application's visibility in the industry. Project staff began preparing to launch the application in Massachusetts for 2019. This required extensive testing of the application and discussion with ACCSP and the developers regarding implementation of partner specific requirements.

Swipe Card Pilot Project: The SAFIS eDR/mobile application was launched into production in Massachusetts (and Maine) in August 2016. The free application runs on Windows, iOS, and Android platforms and utilizes a harvester's shellfish transaction card to consummate a point-of-sale transaction between the harvester and dealer. This technology promotes 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. DMF had four dealers using the application in 2018, and by the end of the year, several others were queued for setup. Discussions between state and federal partners of ACCSP to codify the requirements necessary to expand the use of the product to federal dealers were still in progress at the end of 2018. Pending successful implementation for federal dealers, this (or similar) technology could potentially be expanded to other fisheries in Massachusetts in the future.

Local IT Management

Information systems/technology is primarily conducted through the Executive Office of Energy and Environmental Affairs' Information Technology Group (EOEEA-IT). During 2018, Project staff provided assistance to EOEEA-IT on local information systems issues when needed and worked on several specific tasks outlined below.

Website Maintenance: The Quota Monitoring webpage is one of the agencies top visited pages on the DMF website. Quota information is also displayed on a Statistics Project intranet site, along with reporting compliance and both harvester and dealer reporting information. Maintaining the automated process that updates the data displayed on both sites and accommodating changing requirements was an ongoing task.

Oracle Database / Application Development & Maintenance: DMF continued to use three production databases and associated applications during 2018: Commercial Permits and Statistics; Lobster Sampling; Shellfish Sampling & Area Management. The Time Tracking for Federal Grants was no longer supported in 2018. Minor updates were made to the Commercial Permits and Statistics application during the year, and further development and testing occurred 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 2018 for the 2019 permit year. However, in late 2018, EOEEA-IT initiated a project to redesign the current Oracle system and associated applications, and finalization of the aquaculture forms was put on hold. This larger project will be a major focus of both the Permitting and Statistics projects in coming years.

Gloucester Facility Server Retirement: In the fall of 2018, the Executive Office of Technology Services and Security Services notified staff that both servers residing in Gloucester were to be retired and began work to migrate all data to Boston based servers. One of the two servers was officially retired in 2018, and during this transition, project staff worked extensively on updating the DMF shared folder structure and access. This ultimately resulted in a folder structure that more closely aligns with current projects operating at the Gloucester facility.

SHELLFISH AND HABITAT SECTION

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Shellfish Sanitation and Management Program

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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 U.S. Public Health Service, and is administered

today by the United States Food and Drug Administration (USFDA) and the Interstate Shellfish Sanitation Conference (ISSC), a federal/state cooperative. Massachusetts is a voting member of ISSC.

Shellfisheries management is accomplished by direct DMF 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. DMF 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. Indirectly, DMF 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 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 2018, staff biologists completed 310 annual reports, 45 triennial evaluations, and 30 sanitary surveys (Table 8). Thirty-one conditional area management plans were re-evaluated. A total of 9,962 water samples were collected and analyzed for fecal coliform bacteria from 297 shellfish growing areas in 65 cities and towns of the Commonwealth. All samples were tested at one of the Division's shellfish laboratories using the mTEC method.

USFDA evaluates Massachusetts annually for compliance with the NSSP. Shellfish growing area files are reviewed with regards to NSSP standards for minimum sampling frequency, completion of required reports, conditional area management plan updates, and conformity with appropriate water quality criteria requirements. The USFDA's 2018 Program Element Evaluation Report determined that there are programmatic deficiencies. DMF will submit a corrective action plan based on the report's recommendations to strengthen the program.

Table 8. Summary of 2018 shellfish growing area report and sampling activity.

	North Section	South Section	Total
Annual Reports	33	277	310
Triennial Evaluations	9	36	45
Sanitary Surveys	5	25	30
Management Plans/MOUs Reviewed	20	11	31
Total Water Samples	3,108	6,854	9,962
Classification Station Water Samples	2,678	6,478	9,156
Pollution Source Water Samples	280	286	566
Ad-hoc Water Samples	150	90	240
Shellfish Growing Areas Sampled	20	277	297
Classification Sub-Areas sampled	103	577	680
Cities/Towns Sampled	21	44	65

Classification and Status: The Shellfish Program uses two methods to control harvesting access to shellfish growing areas. Classification is assigned according to the NSSP's five definitions: Approved, Conditionally Approved, Restricted, Conditionally Restricted, and Prohibited (defined below; Figure 8). If water quality within a growing area trends towards permanent improvement or impairment, its Classification is upgraded or downgraded depending on the particular circumstances. The Status of a growing area (Open/Closed) is separate and distinct from its Classification. If water quality within a growing area suddenly demonstrates degradation from emergency or unexpected conditions, the growing area can be temporarily closed until water quality improves and the source of contamination no longer exists. All Classifications except Prohibited may be in the Open status or placed in the Closed status for cause.

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 DMF 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 DMF permit.

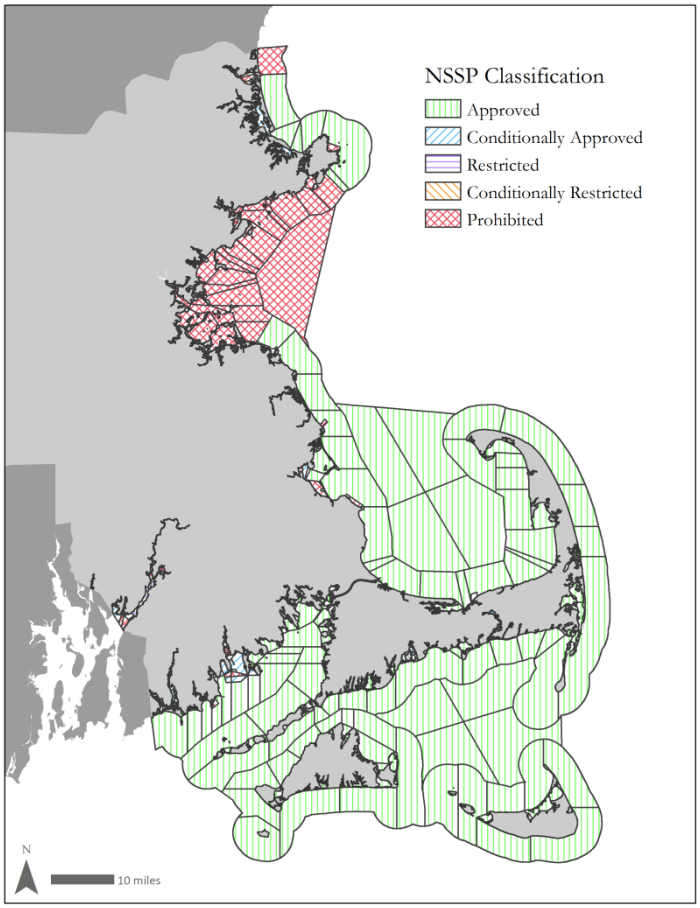

Figure 8. 2018 NSSP classification map of MA waters.

In 2018, a total of 1,738,504 acres were assigned a Classification (Table 9). Overall, Approved and Conditionally Approved acreage decreased while Restricted and Prohibited acreage increased.

Major reclassifications included:

- In March, a 136-acre portion of Nantucket Harbor West (NT2.3) was downgraded from Conditionally Approved to Prohibited due to water quality data that did not meet NSSP standards. The area had been in the Closed status since January 2015.
- In May, a 120-acre portion of Provincetown Inner Harbor (CCB4.1) was upgraded from Prohibited to Restricted and given the designation CCB4.6. There was a public health concern over potential poaching of a large population of legal-sized oysters in the area east of MacMillan Pier, where there is also a popular bathing beach. The reclassification allowed the town to move the oysters via the Contaminated Relay Program and harvest the resource following the required depuration period.

- In July, a 4.3-acre portion of Lagoon Pond (V11.0) in Tisbury and a 12-acre portion of Tisbury Great Pond (V31.0) in West Tisbury and Chilmark were downgraded from Approved to Conditionally Approved due to seasonally impaired water quality (likely due to waterfowl). The new sub-areas were given the designations of V11.7 and V31.5, respectively, and are seasonally Closed during July 1–August 31.
- In July, the Cape Cod Canal (BB45.0) was downgraded from Approved to Prohibited. This 750-acre area contains very small quantities of shellfish and supports only a minor recreational fishery for blue mussels. Given the low abundance of shellfish resources within the canal, the Shellfish Program cannot justify allocating the resources necessary to maintain an Approved classification.
- In November, a 155-acre portion of Phinney's Harbor (BB46.2) in Bourne was downgraded from Approved to Conditionally Approved for the same reason as the Cape Cod Canal's reclassification.
- In December, a 3.5-acre portion of the Wareham River (BB36.1) was downgraded from Conditionally Approved to Prohibited. This area is fed by a large marsh system containing an abundance of wildlife.
- In December, a 21-acre portion of Cohasset Harbor (MB10.5) was downgraded from Approved to Prohibited due to poor water quality at routine classification stations. This sub-area had been in the Closed status the last two years.

Major temporary Status changes in 2018 included the following:

- In February, a 72-acre portion of the West Branch of the Westport River (BB3.38) was changed from Open to Closed, probably due to waterfowl.
- In August, a 2.1-acre portion of Buttermilk Bay in Wareham (BB44.16) was changed from Open to Closed, probably due to waterfowl.
- In August, a 113-acre portion of Phinney's Harbor in Bourne (BB46.3) was changed from Open to Closed due to elevated fecal coliform levels believed to be attributable to an increased bird population that was attracted to a high number of young-of-the-year menhaden in the region.
- In September, high counts in portions of the Conditionally Approved area of Jones River in Gloucester (N9.8) extended the seasonal Closed period through the end of the calendar year.
- In December, a 7.5-acre portion of Buttermilk Bay in Bourne (BB44.15) was changed from Closed to Open due to the improvement of water quality in the area.
- In December, a 7.5-acre portion of the Back River in Bourne (BB47.4) was changed from Open to Closed due to elevated fecal coliform levels.

Table 9. Change in Massachusetts shellfish growing area classification, 2017 to 2018.

Area Classification	Acreage		
	2017	2018	Change
Approved	1,476,262	1,475,668	-594
Conditionally Approved	25,091	24,656	-435
Restricted	3,225	3,261	36
Conditionally Restricted	4,377	4,377	0
Prohibited	229,543	230,542	999
Total	1,738,498	1,738,504	6*

* Difference due to salt pond previously unmapped included in 2018 totals.

Notification: A legal notice is required 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 2018, staff generated 422 legal notices which were distributed for sanitary reclassification, rainfall closures and re-openings, paralytic shellfish poisoning events, Vibrio closures, oil spills, and more typical emergency closures (e.g., extreme rainfall, flooding, sewage discharge).

Pollution Discharge and Contaminant Assessment

Figure 9. Image of effluent and Rhodamine dye boiling to the surface from the end of the Plymouth Waste Water Treatment Plant outfall pipe in Plymouth Harbor. Photo courtesy of Brewster EMS.

Program biologists comment and make recommendations regarding United States Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) Permits. In 2018, six permits required review. Direct consultation with EPA and the Massachusetts Department of Environmental Protection (*Mass*DEP) was provided to address shellfish staff concerns before issuance of final NPDES permits.

In June 2018, scientists from USFDA, together with staff from DMF's Shellfish Program, EPA, and the shellfish departments in the Towns of Plymouth, Kingston and Duxbury, conducted a hydrographic dye study of the Plymouth Waste Water Treatment Plant effluent (Figure 9). The purpose of this study was to determine if effluent from the plant's outfall into the three-bay system (Plymouth, Kingston and Duxbury) has an impact on nearby shellfish. USFDA will produce a report with dispersion maps which will ultimately help ensure the safety of shellfish harvested from the area for human consumption.

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. Staff collects shellfish from 13 primary stations weekly from March through October. Samples are analyzed at the DMF 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.

A total of 345 shellfish samples were processed for PSP during 2018, including 343 blue mussels (the indicator species), 1 quohog, and 1 American oyster. Six blue mussels were analyzed from the Salem State University mussel farm in federal waters.

Toxicity and closures occurred in the Nauset system only (Figure 10). Closure of the Nauset system is a nearly annual event, whereas closures elsewhere occur more sporadically. The Nauset system closure (1,540 acres) was enacted on April 4 and lifted on June 15 (72 days). There were no reported illnesses due to PSP from Massachusetts shellfish in 2018 as typical.

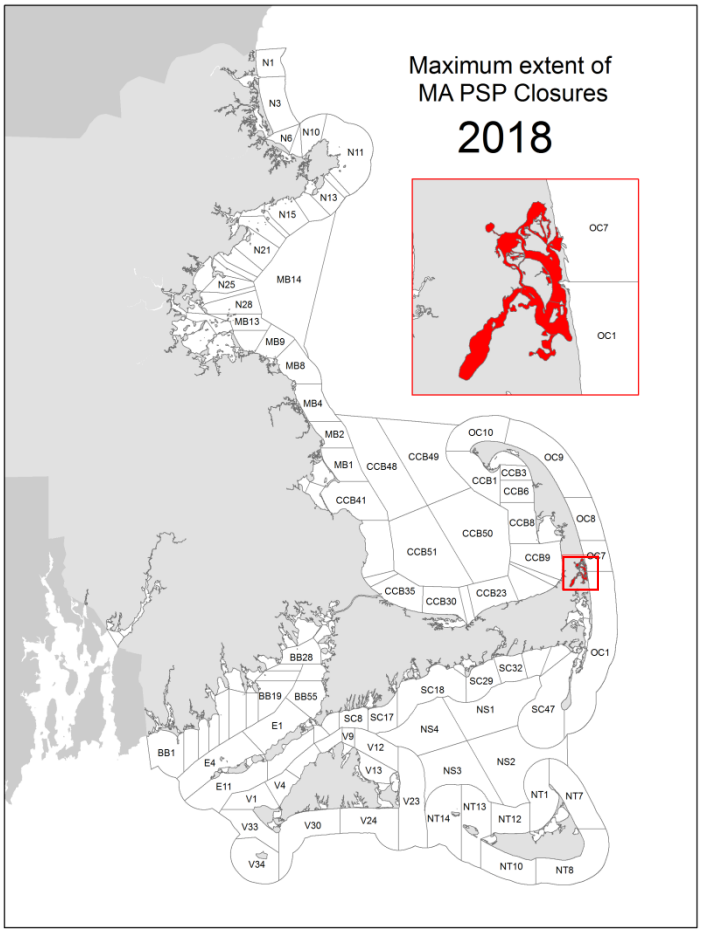

Figure 10. PSP shellfish area closures in 2018.

Phytoplankton Monitoring: Phytoplankton monitoring occurred year round on the North Shore, with 176 samples collected from the four primary regional stations in Newburyport, Ipswich, Essex, and Gloucester. Throughout 2018, there were no significant numbers of any harmful algal bloom species on the North Shore. The dinoflagellate *Karenia mikimotoi* was found again in Massachusetts waters in 2018 from the end of July until the end of September.

On the South Shore, the necessary equipment and supplies were purchased to begin a quantitative phytoplankton monitoring program similar to that taking place on the North Shore. Unfortunately, its launch was postponed until January 2019 due to the mid-season relocation of the South Shore field facility. To bridge the gap during 2018, South Shore personnel were able to utilize facilities and equipment at SMAST. Samples were collected and analyzed to monitor phytoplankton blooms in the Nauset system and to respond to multiple reports of discolored water from municipalities. In the majority of cases, the dinoflagellate *Cochlodinium* was identified as the source. 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. Although blooms of this species do not pose a direct threat to human health, they are known for causing fish kills around the world and can be a problem for both wild and farm raised shellfish as long-term blooms can affect larval development and lead to anoxic conditions. There was also a regional phytoplankton bloom of *Phaeocystis* in the spring of 2018. Like *Cochlodinium*, *Phaeocystis* does not pose a human health risk, but is associated with harmful impacts to shellfish and finfish. As usual, DMF also kept frequent contact with external groups quantitatively monitoring for potentially harmful phytoplankton.

Shellfisheries Management Project

Contaminated Shellfish Resources

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

Commercial Bait Harvest: Dredge boat permits were issued for the contaminated surf clam bait fishery off Nantasket Beach in Hull; however, because fewer than three vessels participated in this small fishery, landings cannot be reported.

Contaminated Relay: DMF permits municipalities to relocate (between and within communities) bacterially contaminated shellfish to Approved and Conditionally Approved waters for natural purification and propagation. Quahogs are the most frequently transplanted species followed by oysters. All activities are conducted under strict NSSP guidelines and are heavily supervised by state and local enforcement authorities. No shellfish can be harvested until bacterial testing of the meats has been completed on each lot. After transplant, the Division requires that shellfish remain in the water through at least one spawning season: if relocated by June 15, contaminated shellfish must remain at the transplant site until at least September 15; if relocated after June 15, they must remain until September 15 of the following year.

For 2018, disease monitoring was conducted on shellfish collected from donor sites in the Taunton River (quahogs) and Little Pond in the Town of Falmouth (oysters). Two 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 two boats moved a total of 8,167 bushels of quahogs to 12 coastal communities (Table 10). An additional 6,375 bushels of quahogs were delivered to nine Buzzard Bay towns as part of the B-120 Shellfish Restoration Program (see page 38). Provincetown and Falmouth each transplanted oysters from within their town waters (Table 11).

Table 10. 2018 contaminated quahog relays.

Harvest Site	Transplant Site	Area	Bushels	Last Day Planted
Taunton R.	Truro, Pamet Harbor	CCB7.1	300	Apr 20
Taunton R.	Yarmouth, Lewis Pond	SC31.20	845	Jun 14
Taunton R.	Oak Bluffs, Sengekontacket Pond	V16.22, .26, .29, .4	448	May 14
Taunton R.	Bass River Center	SC34.23	162	Jun 15
Taunton R.	Eastham, Town Cove, Salt Pond & River	OC4.23, 5.20, 6.23	350	Apr 26
Taunton R.	Provincetown, Inner Harbor	CCB4.20	201	May 11
Taunton R.	Westport, East and West Branches	BB3.27, 4.21, 4.24	3,233	Aug 17
Taunton R.	Wareham, Broad Cove	BB42.26	500	Jun 5
Taunton R.	Swansea, Coles River	MHB4.6, .27	1,000	May 10
Taunton R.	Sandwich, Sandwich Harbor	CCB37.0	400	May 31
Taunton R.	Fairhaven, West Island North	BB18.20, .4	526	Jun 13
Taunton R.	Wellfleet, Inner Harbor	CCB13.0	202	Jun 13

Table 11. 2018 contaminated oyster relays.

Harvest Site	Transplant Site	Area	Bushels	Last Day Planted
Provincetown, Inner Harbor	Provincetown, Inner Harbor	CCB4.21	100	June 14
Falmouth, Little Pond	Falmouth, Green Pond	SC12.20	162	Nov 5

Depuration: DMF 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. Oversight of this process is a sizeable and critical activity for DMF.

Clams are harvested from Conditionally Restricted areas in Boston Harbor, the Pines River in Revere and Saugus, the Merrimack River in Newburyport and Salisbury, and Maine 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 (Figure 11) who pay a depuration fee ($6 per rack). The purified clams are then sold into commerce.

Actual volumes of shellfish undergoing depuration at the plant cannot be reported due to confidentiality rules. During 2018, the plant received shellfish on 80 days, up from 62 days in 2017. As a result, the number of racks received for depuration increased 218% over 2017. The main reason for the increase in 2018 was the change from a three-day-a-week depuration harvest schedule (Monday–Wednesday) to a five-day-a-week schedule (Monday–Friday), allowing diggers an additional 31 days of harvest in 2018.

Figure 11. Walk-in cooler with purified soft shell clams awaiting pickup at the Shellfish Purification Plant in July.

However, 91% of the depuration harvest was from Maine, resulting in a 40% decline in the number of Massachusetts racks landed for depuration. Reasons for this decline in 2018 include: the loss of a conditionally restricted shellfish growing area to harvest due to a leak in a sewer plant outfall pipe; a sharp reduction in the number of clams in Boston Harbor due to neoplasia (disease); and an unusually high number of rainfall closures/sewer bypass events on the Merrimack River.

All lots met release criteria with no product recalls. Two Master Diggers delivered clams to the Purification Plant in 2018 down from three the previous year; the issuance of Subordinate Digger permits also declined from 37 to 25. In February, 2018 our seasonal laborer left, but the purification plant was able to maintain a depuration harvest schedule of five days/week for the remainder of the year.

Wet Storage

2018 marked the sixth year that the 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 as well as traceability standards.

In 2018, wet storage decreased 52% from the prior year. Combined with depuration, Shellfish Plant production was up 95% from 2017. Fees per rack remained at $6.

Shellfish Purification Plant and Laboratory

The Shellfish Purification Plant's laboratory analyzed 236 shellfish samples from 77 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, 372 effluent water samples, 153 raw seawater samples, and 9 tap water samples were bacteriologically tested for the more stringent drinking water standard of total coliform.

In addition, 344 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. The laboratory continued its partnership with the New Hampshire Department of Environmental Services analyzing for MSC in shellfish, environmental waters, and wastewater treatment plant influent and effluent. The laboratory is also investigating storage effects of varying environments on MSC sample counts.

The laboratory participated in *Vibrio parahaemolyticus (Vibrio)* assessments, analyzing samples for the resubmergence and tidal study project in Katama, Martha's Vineyard. Thirty seven oyster samples were analyzed by MPN-qPCR for total and pathogenic *Vibrio.*

Staff successfully participated in the USFDA Shellfish and Water Proficiency Test. The Plant was inspected on a monthly basis by *Mass*DPH, and was reviewed by the USFDA in October.

Staff attended the Northeast Shellfish Sanitation Association Annual Meeting, and participated in several monthly ISSC Laboratory Committee conference calls. Numerous scheduled tours of the lab were provided throughout the year for school groups and the general public as well as impromptu tours. Support and outreach to the educational community also continued by supplying seawater to local educators for classroom saltwater cultures, displays, and aquaria.

Shellfish Restoration and Mitigation in Buzzards Bay

Since 2014, Shellfish Program staff in New Bedford have 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, such as overfishing, poor recruitment, disease, natural predation, 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 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 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 Center and DMF to fulfill certain requirements of the Final Mitigation Plan for the terminal, the Division developed a program to plant 2.5 quahog seed for every one quahog impacted, for a total of 24.5 million seed quahogs to be planted within New Bedford waters over 10 years. Planting would target shallow sub-tidal areas in Approved and Conditionally Approved areas only, such that after a maximum of three years (to allow the seed to grow, spawn, and reach legal size), the areas could be opened to harvest.

Planting activities began in 2015. The plan calls for one of 10 subareas around the South End peninsula to be selected for seeding each year, with an annual objective of planting 2 million juvenile quahogs in the 20–25mm size range. Sites with optimal quahog habitat within each subarea were identified for planting each year. Between 2015 and 2017, Division staff planted a total of 3,242,760 seed quahogs over 16.6 acres within three subareas, including two experimental plots used to monitor quahog growth and survival. Quahogs were broadcast seeded from one of the Division's 21-foot vessels along predetermined transects to facilitate broadcast seeding the quahogs at target densities varying between 2.5 and 5 quahogs/ft^2.

No seed quahogs were planted in 2018 because the two main objectives of the program were not being met. First, annual planting numbers were well below target because of difficulty obtaining field plant sized quahogs from commercial shellfish hatcheries due to increased demand by commercial aquaculturists and municipal shellfish propagation programs. Second, the annual survival rates of planted quahogs was proving insufficient to reach the 40% target at year 3–5 at which time the quahogs are expected to reach harvestable size and begin spawning.

During 2018, DMF focused on monitoring quahog survival and growth within the experiment plots. In addition, the mitigation team began to explore the possibility of changing the basic approach of the mitigation project from planting seed quahogs to transplanting bacteriologically contaminated adult quahogs from the Mount Hope Bay/Taunton River complex. Progress was made in securing commitment from two commercial dredge boat owners to provide contaminated quahogs for the project beginning in spring 2019.

Buzzards Bay 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, DMF was selected by the Trustees to implement specified restoration strategies.

As a result, DMF is overseeing a five-year program to restore shellfish resources and benefit public recreational shellfishing through the three activities below. DMF works collaboratively with the Trustees on all aspects of these projects and also provides technical oversight to The Nature Conservancy on its B-120 shellfish restoration work via participation on a Technical Advisory Committee.

- Contaminated Quahog Relays: 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 Bourne, Dartmouth, Fairhaven, Gosnold, Marion, Mattapoisett, New Bedford, Wareham, and Westport. Shellfish Program staff assist shellfish officials in each town with mapping relay sites and conducting pre- and post-relay assessments of the quahog population and surrounding habitat. Planted sites remain closed to recreational fishing for one to three years. In 2018, relays were successfully completed in all nine towns, with a total of 6,375 bushels of quahogs transplanted into the specified Buzzards Bay sites.
- Quahog Upwellers and Seed Planting: Under this project, Wareham, Dartmouth, and Fairhaven are using municipally-managed upwellers purchased with B-120 funds to grow small quahog seed (3–5mm) for subsequent out-planting once they reach at least 20mm. The goal is to plant seed quahogs in one restoration site per town in each of three years. Shellfish Program staff 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. Due to a poor growth year for quahog seed at the New Jersey hatchery and time constraints for adequate field grow-out, quahog seed was not purchased in 2018. Post-planting surveys were conducted of all 2017 sites planted with upweller-reared quahogs. Quahog seed purchasing was planned to resume in 2019.
- Single Oyster Purchases and Out-planting: This oyster planting project involving Bourne, Marion, and Wareham is intended to create and maintain a sustainable oyster resource at six sites within Buzzards Bay. 2018 marked the second year in which each town ordered small oyster seed for upweller grow-out and larger seed to be placed directly into floating bags and cages (Figure 12). In 2018, over 2.1 million oysters were purchased by the three communities. Following the grow-out season, 1.24 million of these oysters were out-planted in designated, pre-surveyed sites in the three towns, which will be closed to shellfishing for a minimum of one year. Shellfish Program staff worked collaboratively with the towns to conduct post-planting surveys to assess growth and survival of oysters planted in 2017; these monitoring efforts were planned to continue into 2019.

Figure 12. Small oyster seed in Bourne's upweller—a moored, floating, flow-through nursery system (left), and larger oysters in floating bags in Winsor Cove (right).

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, torrential rainfall, petrochemical spills, and other discharges of hazardous chemicals. Seven pollution-related events in 2018 are detailed below.

- As a result of hurricane force winds, storm surge, and coastal flooding caused by Winter Storm Grayson, the entire Massachusetts coastline was closed to shellfishing on January 4. Three days later, the closure was lifted in all growing areas except NT1–6 and NT12, which remained closed due to a sewer line failure.
- During Winter Storm Grayson, Nantucket Town officials were notified of a catastrophic sewer line break along the downtown waterfront on January 4. Due to the resulting 2 million gallon discharge of untreated sewage, over 4,400 acres of shellfish growing area in Nantucket and Polpis Harbors (NT2–6) and 34,000 acres of adjacent shellfish growing area in Nantucket Sound (NT1 & NT12) were closed to shellfishing. Primary bypass repairs were completed on January 8; however, sewage continued to discharge into the harbor at a lesser rate due to back flows. Total estimated discharge into the harbor was then revised to 3 million gallons. There was also concern about secondary sewage discharge once the flow stopped because of pockets of sewage under the roadway and in basements. Once noified that all secondary sources of sewage were pumped out and sanitized, DMF implemented a 21-day shellfish closure. Nantucket and Polpis Harbors were closed for a total of 72 days (re-opened on March 17) and adjacent shellfish growing areas in Nantucket Sound were closed for 64 days (re-opened on March 9).
- On January 22, 242 acres of shellfish growing area in Great Harbor (SC2.0) in Falmouth were closed to shellfishing due to oil spilled from a tug boat that coated portions of the shoreline. The closure was lifted on September 5.
- The entire MA coastline was closed to shellfishing on March 1 due to hurricane strength winds, storm surge, and coastal flooding resulting from a winter storm. Most growing areas were re-opened within 7–9 days. Certain growing areas in Sandwich, Marshfield, Scituate, and Nantucket remained closed for longer periods due to a multitude of problems associated with coastal flooding and damage to sewage system infrastructures. The Sandwich areas (CCB35–CCB37) remained closed for 28 days; the Marshfield and Scituate areas (MB2–MB8) for 35 days; and the Nantucket areas (NT2–6) for 16 days.
- On March 9, 613 acres of shellfish growing area in Tisbury Great Pond (V31) were closed to shellfishing after shellfish constables from Chilmark and West Tisbury conveyed concerns over the extraordinarily high water level and associated basement and back yard flooding. Pollution source samples were collected on March 12 and the area was reopened March 19.
- On July 13, a portion of Cotuit Bay in Barnstable (SC21.4) was closed to shellfishing for eight days because vandals toppled over a portable restroom at a nearby boat launch, spilling raw sewage into the bay.
- During summer 2019, there were two major rain events on the Cape and Islands requiring regional closures of shellfish growing areas. On August 5, growing areas in Eastham, Orleans, Provincetown, Wellfleet and Truro (CCB1–37, E1–E14, OC1–OC10, SC1–SC64, and NS1–NS4) were closed for three days due to intense rainfall. On October 11, most growing areas around Cape Cod (CCB1–37, E1–E14, OC1–OC10, SC1–SC64, and NS1–NS4) were closed for two days as the result of a greater than 4 inch rainfall event. This same October 11 rain event resulted in the closure of all growing areas around Martha's Vineyard (V1–V36) and Nantucket (NT1–NT14) for four days.

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 to DMF's Habitat Program Technical Review Project. In 2018, staff biologists reviewed a combined 112 project proposals.

Aquaculture and Propagation Project

The management of marine aquaculture and shellfish propagation activities is a major responsibility of DMF. This includes managing the introduction, culture, and harvest of all marine species in the Commonwealth. Currently the vast majority of marine aquaculture in Massachusetts consists of municipally licensed molluscan shellfish aquaculture. DMF's duties 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, DMF 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 that 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 2018, Project staff certified 14 new shellfish aquaculture license sites and inspected 15 acres of tidelands (Table 12).

Table 12. New License Certifications in 2018.

Town	License Sites	Acres
Barnstable	1	Float
Dartmouth	1	0.5
Eastham	2	1
Falmouth	1	Upweller
Fairhaven	3	6
Marion	1	0.5
Provincetown	3	3
Westport	1	1
Yarmouth	1	3
Total	**14**	**15**

Permitting

DMF issues permits for all marine aquaculture activities in the Commonwealth. Permits require holders to manage their culture activities in a manner that prevents impacts to the environment and other user groups and 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 conducting shellfish planting activities. The permit allows the possession, transplant, and grow-out of seed shellfish from approved sources. In 2018, DMF issued shellfish propagation permits to 391 private aquaculture license site holders (Table 13) and 25 municipalities (for public propagation activities) operating shellfish aquaculture projects in over 30 coastal municipalities throughout the Commonwealth.

In 2018, DMF also issued commercial aquaculture permits for the culture of sugar kelp and horseshoe crabs (solely for the purpose of wild population enhancement). Division staff worked closely with partner agencies, the aquaculture industry, and researchers to foster the sustainable development of this new aquaculture sector in Massachusetts.

Table 13. 2018 private shellfish propagation permits and acreage under cultivation, by municipality.

Municipality	# Growers	Total Acres	Species Grown
Aquinnah	1	1.6	Quahog
Barnstable	49	156	Oyster, Quahog, Soft Shell Clam, Surf Clam
Bourne	7	9	Oyster, Quahog, Soft Shell Clam
Brewster	11	10.5	Oyster, Quahog
Chatham	2	7	Oyster, Quahog, Soft Shell Clam, Razor Clam, Sugar Kelp
Chilmark	9	23	Oyster, Blue Mussel, Sugar Kelp
Dartmouth	2	1	Oyster
Dennis	26	32	Oyster
Duxbury	28	77.5	Oyster, Quahog, Surf Clam
Eastham	25	27.6	Oyster, Quahog
Edgartown	13	17	Oyster
Essex	1	8.5	Oyster
Fairhaven	2	38	Oyster, Quahog
Falmouth	9	45	Oyster, Quahog
Gosnold	1	32	Oyster
Ipswich	2	2	Soft Shell Clam
Kingston	3	8.5	Oyster
Marion	4	2.5	Oyster, Quahog
Mashpee	4	18	Oyster, Quahog
Mattapoisett	2	7	Oyster, Bay Scallop
Nantucket	8	73	Oyster, Quahog
Oak Bluffs	2	2	Oyster, Sugar Kelp
Orleans	14	17.5	Oyster, Quahog, Blue Mussel, Surf Clam
Plymouth	30	81.5	Oyster, Quahog, Surf Clam, Bay Scallop
Provincetown	16	30	Oyster, Quahog, Soft Shell Clam, Razor Clam
Rowley	3	4	Oyster, Soft Shell Clam, Razor Clam
Truro	5	20	Oyster
Wareham	7	83	Oyster, Quahog
Wellfleet	93	261	Oyster, Quahog, Soft Shell, Surf Clam, Razor Clam, Blood Arc
Westport	5	80	Oyster, Quahog
Yarmouth	4	27	Oyster, Quahog
Grand Total	**391**	**1202.7**	

Aquaculture Landings

Aquaculture landings and value are presented in Table 14. 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 14. 2018 Aquaculture Landings and Value. (Source: SAFIS Dealer Reports on May 1, 2019 and staff edits.)

American Oyster		
Town or Region	Pieces	Reported Value
Barnstable	10,685,995	$5,970,081
Bourne/Falmouth	775,741	$441,710
Brewster	391,200	$223,380
Dennis	2,200,411	$1,248,374
Duxbury	12,038,250	$6,677,261
Eastham/ Orleans	1,839,710	$1,037,434
Edgartown	2,620,151	$1,629,713
Islands	720,399	$599,019
Kingston	308,440	$173,186
Marion	70,087	$33,296
Mashpee	182,400	$105,585
Outer Cape	789,094	$463,992
Plymouth	2,029,250	$1,072,383
South Coast	1,739,420	$934,544
Wareham	1,550,900	$896,489
Wellfleet	10,742,506	$5,756,181
Yarmouth	677,777	$370,350
Total	49,361,732	$27,632,978

Quahog		
Town or Region	Pieces	Reported Value
Barnstable	948,731	$252,810
Eastham/Orleans	50,913	$12,116
Other areas	66,432	$15,608
Wellfleet	2,704,270	$681,433
Total	3,770,347	$961,966

Total Aquaculture Landings Value	$28,594,944

John T. Hughes Hatchery & Research Station

The Martha's Vineyard Shellfish Group (MVSG), a consortium of the Shellfish Departments of the six towns of Martha's Vineyard, continued to use portions of the Division's John T. Hughes Hatchery and Research Station to spawn and culture shellfish for eventual transplant to harvestable shellfish beds throughout Martha's Vineyard. This activity supports several of the Division's strategic goals, including improving fisheries sustainability, supporting the state's commercial and recreational fisheries, and providing technical support to municipal shellfish departments.

In 2018, MVSG continued to repurpose the facility for bivalve culture by building new larval and algal culture systems to increase its functionality and efficiency (Figure 13). Culture activities in the main building and two greenhouses continue to include nursery grow-out of quahogs, bay scallops, and oysters in upweller silos, tanks, and tables utilizing fresh seawater from Lagoon Pond and aeration. In addition, bay scallop and oyster eggs and larvae were cultured and released to various salt ponds on the island. Various species of phytoplankton were continuously cultured and used to provide additional food for setting quahogs, scallops, and spat-on-oyster shells. Shellfish production at Hughes Hatchery relative to total production at the three facilities that MVSG uses is presented in Table 15.

Figure 13. Larval Tanks in the new greenhouse (2,000-L capacity). Photo courtesy of MVSG.

MVSG also continued to diversify activities at Hughes Hatchery by expanding their remote setting of spat-on-oyster shells. These oysters 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.

Table 15. 2018 Shellfish Production at Hughes Hatchery.

Shellfish Species by Developmental Stage	From Hughes Hatchery	Total MVGG Production	% From Hughes Hatchery
1-2mm Quahog Seed	9,078,000	17,170,000	52.9
Scallop Larvae Set	12,750,000	33,665,000	37.9
Oyster Larvae Set	7,800,000	15,413,000	50.61
Oyster Post-Sets	1,794,000	1,794,000	100

The Martha's Vineyard Fishermen's Preservation Trust also continued whelk aging research at Hughes Hatchery. Live whelks were tagged using a variety of methods and held to determine efficacy of the tags and to determine post-tagging survival.

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. DMF is also responsible for the closure of harvest areas following the notification of a *Vibrio* outbreak from *Mass*DPH.

No changes were made to the *Vibrio* regulations for 2018. 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. DMF*,* 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.

DMF 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. Ongoing monitoring included environmental data collection and oyster tissue sampling for *Vibrio* levels. Several research efforts continued in 2018 which aim to fine-tune existing *Vibrio* controls, explore additional illness reduction options, and where possible reduce the regulatory burden *Vibrio* has placed on the Massachusetts oyster industry. DMF completed the third year of a pilot program in cooperation with the Town of Edgartown and aquaculturists on Martha's Vineyard to transplant oysters from Katama Bay to Vineyard Sound prior to harvest to reduce the risk of illness; the program was expected to continue in 2019.

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. There was one precautionary growing area closure in the 2018 season associated with *Vibrio* illness. However, the number of cases linked to Massachusetts harvested shellfish continued to decrease in 2018 as compared to baseline years (Table 16). As a result, DMF did not propose any changes to the *Vibrio* regulations for the 2019 *Vibrio* season.

Table 16. Sole source *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
2017	14
2018	10

Other Activities

Technical Assistance: In Massachusetts, municipalities manage the shellfisheries within their boundaries not closed by DMF for public health reasons (with the exception of commercial harvest of surf clams and ocean quahogs which remain under state control). Staff assisted municipalities on a wide variety of shellfisheries management issues including: shellfish propagation; predator control; survey methods; 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: Staff participated in numerous professional organizations such as the ISSC, Northeast Shellfish Sanitation Association, Massachusetts Shellfish Officers Association, and New England Estuarine Research Society.

Habitat Program

Personnel

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Gloucester
Mark Rousseau, Marine Fisheries Biologist
Tay Evans, Marine Fisheries Biologist
Jillian Carr, Assistant Marine Fisheries Biologist
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Eileen Feeney, Marine Fisheries Biologist
Dr. John Logan, Marine Fisheries Biologist
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Pooja Potti, Contract Assistant

Overview

The goal of the Habitat Program is to protect and enhance marine fisheries resources. The Habitat Program includes two projects. The **Technical Review Project** reviews permits submitted to municipalities, the Commonwealth, and the federal government for construction projects occurring in waters with fisheries and habitats under DMF jurisdiction. The reviewers provide recommendations to avoid and minimize impacts to marine fisheries resources. In addition, staff participates on various working groups to provide technical analysis and policy input on a variety of topics including ocean planning and offshore wind development. The **Fisheries Habitat Research Project** conducts state- and grant-funded research related to marine fisheries habitats. Research varies year to year with studies focused on marshes, artificial reefs, eelgrass, and food webs.

Technical Review Project

Technical Review

In 2018, staff reviewed 598 projects in 86 municipalities (Figure 14). Of these, 410 were new projects. The project types were again dominated by docks, piers, and floats. Compared to previous years, more shoreline hardening projects were reviewed in 2018, with an apparent trend being an increase in large public seawall expansion and stabilization projects. Approximately 50% of all reviewed projects have the potential to directly impact habitat (n=307), including 143 projects in/near salt marsh and 47 in/near eelgrass. 2018 had an increase in proposals for new dock and pier projects located in or near eelgrass.

Some of the major projects reviewed this year included shoreline stabilization for municipalities such as Barnstable, Duxbury, Haverhill, Hull and Quincy; Vineyard Wind; dredging of marinas and yacht clubs such as Danversport Yacht Club, Outermost Harbor Marine in Chatham, and Neponset Wharf Marina in Boston; town dredging projects including the South River in Scituate and Marshfield, Hingham Harbor, and the Federal Navigational Channel in Plymouth Harbor; Town Neck Beach nourishment in Sandwich; Elm Street Dam Removal in Kingston; South Coast Rail Project; and Chatham Kelp LLC.

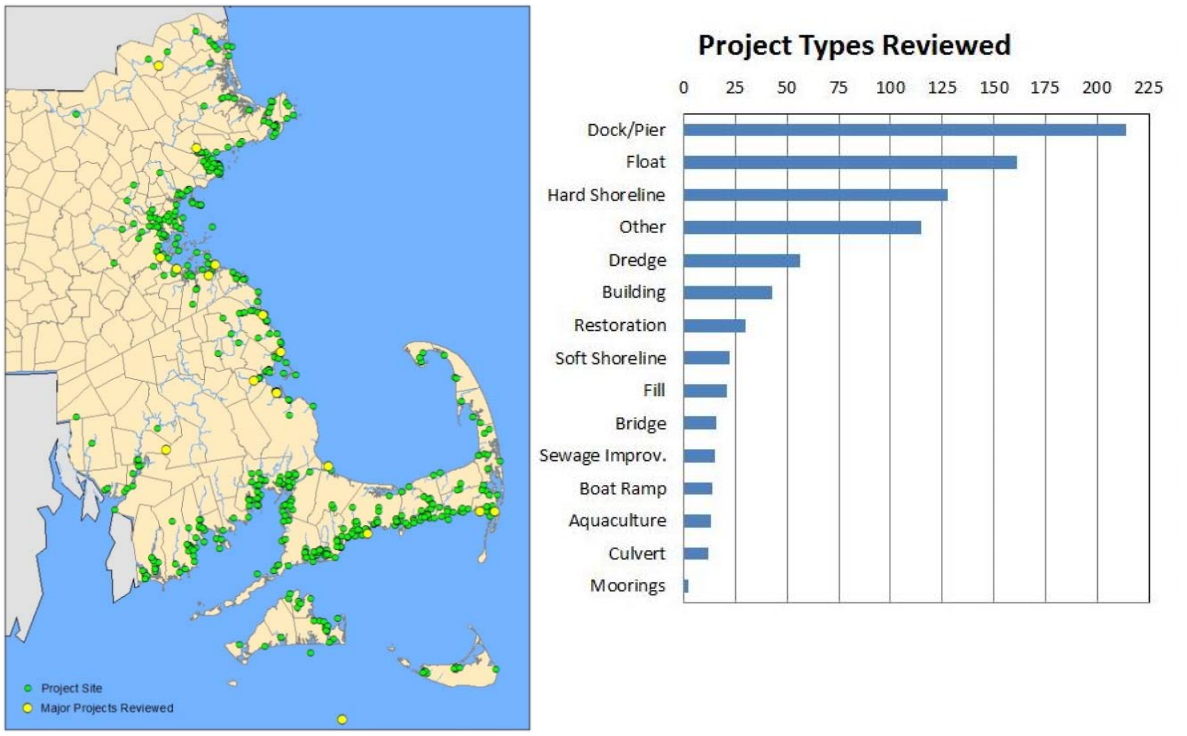

Figure 14. Coastal alteration projects reviewed by Program staff in 2018 by location (left) and type (right). Note that a single project can include multiple project types. "Other" includes cable work, borings, wetland management, invasive species removal, beach nourishment, pile replacement, boardwalks, marina reconfiguration, mosquito ditch maintenance, and road repairs.

It can be challenging to quantify how our oversight of coastal alteration permits lessens impacts to marine fisheries resources. DMF comment letters can result in project changes that avoid, minimize, or mitigate potential impacts. Examples include time-of-year recommendations that avoid impacts on critical life stages of marine fisheries resources, proposing soft shoreline solutions instead of rip rap or steel pile bulkhead to avoid habitat loss, the use of equipment to standardize infaunal samples at wind farms, and dock and pier design changes to minimize impacts to eelgrass and saltmarsh.

Efforts to improve efficiency and standardization of reviews continued. Staff neared completion of an extensive overhaul to the Technical Review Manual, which contains the Project's standard operating procedures. Expected in 2019 was a new guidance document with best management practices for the design of docks, piers, and floats. The development of new eelgrass mapping and monitoring protocols for consultants was also underway at year's end.

In Lieu Fee Program

The In Lieu Fee (ILF) Program is the mechanism by which the Army Corps of Engineers (Army Corps) can mitigate for unavoidable impacts on natural resources from the construction activities they regulate. From 2009–2014, DMF was the sponsor for the first ILF program in Massachusetts, the Coastal ILF Program, which addressed authorized impacts of less than one acre in extent to coastal aquatic resources. In 2014, a new Massachusetts-wide ILF program sponsored by *Mass*DFG was developed to include unavoidable resource impacts statewide under both the Army Corps General Permit and Individual Permit.

Coastal ILF Program: Under the Coastal ILF Program, 27 construction projects impacting 18,980 square feet (0.44 acres) of aquatic habitat contributed nearly $230,000 for compensatory mitigation. Following a competitive selection process, two *Phragmites* removal projects were funded at Rough Meadows, Rowley and Great Marsh,

Newbury and one stream connectivity project was funded at Off Billington Street Dam, Plymouth. Restoration work on all three projects was completed in 2013. Five years of required monitoring ended in 2017. The results are described in the 2017 Annual Report.

A fourth project, the installation of a fishway at Draka Dam, Taunton was partially funded through the Coastal ILF Program. In 2018, work was slated to start in late October but excessive river flows from September–December inhibited completion. All work remained under contract and was planned to resume in 2019 when weather allowed. Once completed, monitoring will continue for five years from the date of installation of the fishway.

***Mass*DFG ILF Program:** The first project funded under this program, a DMF-led eelgrass restoration project to transplant 0.5 acres of eelgrass in Salem Sound, was launched in 2017. Work continued in 2018, with the first of five years of required monitoring. See Eelgrass Monitoring and Restoration (page 52) for more details.

In 2018, *Mass*DFG initiated a selection process for identifying coastal restoration projects to submit to the Army Corps for funding approval. DMF developed a list of 15 potential restoration projects, of which seven were selected for the Department's final submission list. Two of our projects, a fishway installation in the Ipswich River at the Willowdale Dam and expansion of an artificial reef in Nantucket Sound off Yarmouth, were selected by the Army Corps in consultation with the Interagency Review Team (a multi-agency ILF steering committee) for full proposal development.

Staff contributed to the ILF Program's tracking of payments received and credits sold and the development of the Department's 2017 annual report on the program, which was submitted to the Army Corps and approved in August.

Offshore Wind

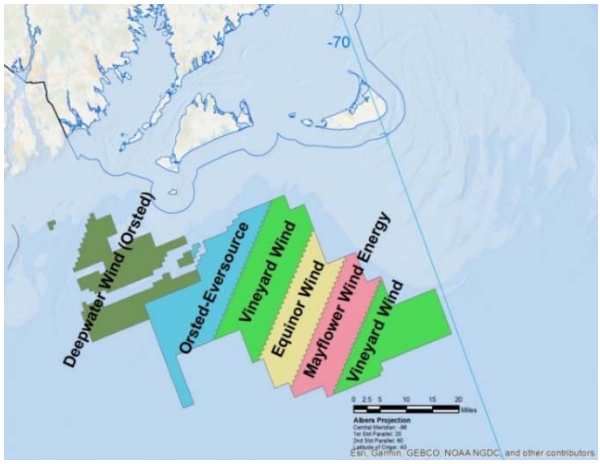

Figure 15. Offshore wind energy areas adjacent to Massachusetts.

For the past decade, planning has been underway for offshore wind. Two Wind Energy Areas (WEAs) are offshore of Massachusetts: the Massachusetts WEA and the Rhode Island-Massachusetts WEA (Figure 15).Federal oversight, including leasing of the WEAs, is provided by the Bureau of Ocean Energy Management (BOEM). In 2013, Deepwater Wind won an auction for the entire RI-MA WEA and in 2015 Orsted (originally DONG Energy) and Vineyard Wind (originally Offshore MW) won auctions for the western side of the MA WEA. In 2018, Equinor, Mayflower, and Vineyard Wind won the auction for lease areas on the eastern side of the MA WEA. Deepwater Wind (now part of Orsted), Orsted, and Vineyard Wind continued site assessment studies in 2018, and Vineyard Wind filed its Construction & Operations Plan and draft and final MA Environmental Impact Reports, and BOEM submitted a draft Environmental Impact Statement for the Vineyard Wind Project.

Project staff tracked these wind energy developments closely, including representing the Division and providing fishery and habitat impact analysis for BOEM's Joint RI-MA Renewable Energy Task Force (one meeting) and the Commonwealth's Offshore Wind Fisheries Working Group (five meetings). Staff also engaged with New York's Fisheries Technical Working Group, and attended NY's State of the Science on Wildlife and Offshore Wind Energy Development Workshop in November. Staff participated at an Offshore Wind Marine Mammal Workshop held in May. The Habitat Program authored a guideline document focused on regional fisheries research needs relevant to offshore wind.

Ocean Planning

The Northeast Ocean Plan, certified in December 2016, serves as a guide for agency decisions and practices that advance progress toward regional goals for the management of our public ocean resources. Implementation began in 2017. In 2018 the Northeast Regional Planning Body (NERPB) was officially disbanded and DMF lent support to establishing new processes for the Northeast Regional Ocean Council (NROC) to work on Plan implementation.

The Massachusetts Ocean Management Plan, as updated in 2015, serves as the Commonwealth's blueprint for the protection and sustainable use of state ocean waters. In 2018, staff participated in joint meetings of the Ocean Advisory Commission and Science Advisory Council to begin the Ocean Plan review process for 2019–2020. One of the goals of the Ocean Plan is to better coordinate on aquaculture activities. In collaboration with the Shellfish Program, Habitat Program staff assisted with procuring an ASMFC grant with UMass Boston to help support the development of the Massachusetts Aquaculture Permitting Plan (MAPP). This project involves multiple interagency meetings, coordination with the Massachusetts Shellfish Initiative, and following MEPA protocols for the environmental review of state actions. In 2018, staff prepared and submitted a request to the Secretary of EOEEA for a Special Review Procedure for the MAPP. The primary objective of the MAPP is to establish the permitting process for aquaculture projects in Massachusetts, identify project types that can receive standard conditions, and conduct an environmental assessment of the major aquaculture activities in Massachusetts.

Fisheries Habitat Research Project

Artificial Reefs

Massachusetts has five permitted artificial reefs in its waters. Staff performs surveys to identify new reef sites for permitting, conducts compliance and biological monitoring, and provides technical guidance to advance artificial reef development and uses in MA coastal waters.

Reef Monitoring: In 2018, all reef sites were monitored for community composition, biomass, invasive species presence, permit compliance, and temperature data. Acoustic receivers were utilized year-round to assess the patterns of tagged fish. Since deployment, transmittals from at least 327 unique fish have been received. While the large majority of fish documented through the acoustic receiver data have been striped bass, many other species have been observed. Other patterns are emerging. Thirty-eight individual fish visited multiple reef sites over this time. Additionally, 20 fish returned to the same reef site in multiple years. Work continued on the development of protocols to guide future reef monitoring efforts.

Material Storage and Procurement: Project staff secured a two-year lease with the Massachusetts Clean Energy Center for a one-acre artificial reef material staging area at the New Bedford Commerce Terminal. Pre-cast concrete reef units made by DMF were staged at the site (Figure 16). In addition, one thousand cubic yards of material from the South Coast Railway Redevelopment Project was secured from the Massachusetts Department of Transportation (*Mass*DOT). An effort to obtain surplus materials from *Mass*DOT maintenance depots was initiated and ongoing at year's end. Efforts were also continued to orchestrate future direct material deployments to reef sites from large coastal construction projects.

Figure 16. First set of reef materials staged for later use at the New Bedford storage site.

Cape Cod Bay Site Selection: In order to identify new locations to site future artificial reefs, four discrete areas covering over 12,000 acres of seafloor at depths between 25 and 70 feet were acoustically surveyed in lower Cape Cod Bay in 2017. In 2018, eight additional tracks covering an additional 1,250 acres were surveyed—four in Sandwich and four in Barnstable. Staff efforts then switched to photo groundtruthing of specific areas in order to select several 10-acre preferred and alternative locations for permitting. For this, the survey coverage area was divided into 250m^2 grids with 66 grid sites selected for further assessment using underwater cameras (Figure 17). The resulting 330 images (5 per grid) were georeferenced and classified by primary substrate composition. Photo groundtruthing data were essential for confirming the side-scan imagery and for selecting the sites with the most potential for reef building.

Sets of two experimental boxes and two control boxes were then chosen, one as the primary and one as an alternative site for permitting. SCUBA surveys were conducted from June to October (Figure 18). Final proposed reef sites were chosen utilizing a combination of the SCUBA survey, photo groundtruthing, and side-scan sonar data to select sites within each town that matched the ideal artificial reef site criteria.

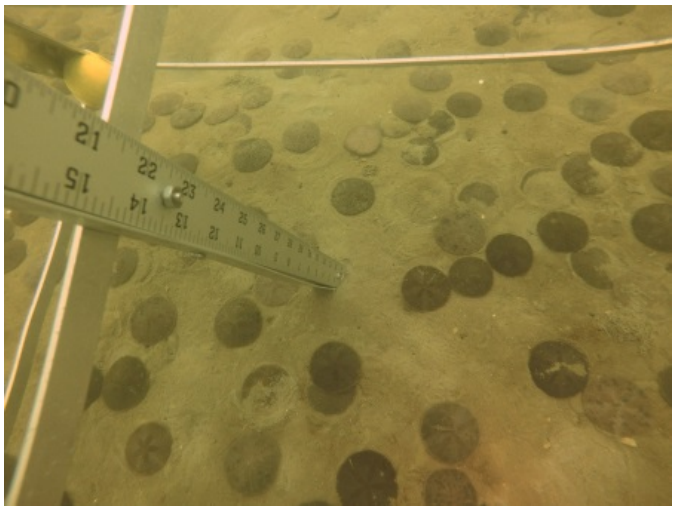

Figure 17. Photography used to groundtruth side-scan sonar data for identifying preferred and alternative reef sites for permitting. Here, abundant sand dollars are seen on sandy substrate.

Figure 18. DMF's Kate Frew collects species data along a dive transect in Cape Cod Bay.

Staff presented updates on the Division's artificial reef activities, with a focus on efforts to install a new Cape Cod Bay reef, to various groups, including: the Division's Marine Recreational Fisheries Development Panel, the Commonwealth's Ocean Advisory Commission and Science Advisory Council, the Cape Cod Charter Boat Association, and other Atlantic coast agencies. The work formed the basis of our intern's graduate school thesis, and was the subject of a poster prepared for the New England Estuarine Research Society's Fall 2018 Conference.

Boston Harbor Beneficial Use Reef: In partnership with Northeastern University, the City of Boston, the Massachusetts Office of Coastal Zone Management (*Mass*CZM), the Nature Conservancy, and the Army Corps, we continued our project exploring how to beneficially reuse dredged rock material coming from the Army Corps' Boston Harbor Deepening Project. One of the key conclusions of work completed in 2017 was that meaningful shoreline protection would require the construction of a nearshore berm that was too tall to be built using the Boston Harbor dredge material. Several meetings were convened to discuss moving the project into the permitting stages as a fish enhancement project without the shoreline protection advantages. A variety of factors limited DMF's ability to prepare and apply for permitting in 2018 and there was no interest or ability from other workgroup participants to take the lead on permitting. As a result, the project was tabled until further notice.

Climate Change

Climate change is an area of active research and policy development in New England. DMF's primary focus is 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 all research entities.

Temperature: Project staff compiles all marine and coastal continuous bottom temperature monitoring records collected by DMF. The database contains over 7 million records from 1986 to present, inventorying more than 30 seafloor stations and over 40 estuarine and riverine sites where bottom temperature data are collected seasonally, typically March to October. Approximately 200,000 temperature records statewide are collected annually. In 2018, DMF continued efforts to test a new SQL server platform for housing and archiving the database with a focus on improving database maintenance and enabling access to near real-time information. Staff met with MIT Sea Grant to discuss their interest in maintaining continuous access to the dataset. This effort was ongoing at year's end.

Climate Change Vulnerability: Beginning in 2017, Executive Branch agencies were required to complete a climate change vulnerability assessment in order to comply with *Executive Order No. 569 – Establishing an Integrated Climate Change Strategy for the Commonwealth*. This survey was designed to assist agencies in identifying key assets, functions, missions, services, and programs that may be affected by natural hazards, now and as they may exist in the future, and to assist in assessing the degree of exposure, sensitivity, and adaptive capacity to climate change. Program staff coordinated agency survey response efforts, incorporating input from all relevant staff and projects. A final report outlining the climate change vulnerabilities and risks specific to DMF assets and functions was completed in August 2018, for incorporation into a statewide adaptation plan released in September 2018.

Food Webs: Project staff has been researching the processes by which ocean warming and other physiological changes from climate change may alter food webs. Analysis performed in collaboration with other researchers in 2017 of tuna diet and stable isotope data in relation to environmental variables resulted in staff co-authoring a 2018 journal article finding that the expansion of warmer, less productive waters worldwide will impact the structure of marine food webs and the corresponding foraging habits of marine predators.

Two studies examining the interplay between eutrophication and contaminates transfer were also underway during the year. Analysis of seasonal microalgae blooms within New Bedford Harbor combined with stomach content and stable isotope tracer studies were used to suggest a linkage between elevated nutrient levels and possible contaminant transfer (polychlorinated biphenyls) via food webs within urban estuaries. Results from this study, conducted in collaboration with Northeastern University, the University of New Hampshire, and Roger Williams University (RWU), were prepared for publication in 2019. With partners from RWU, University of California Santa Cruz, and Dauphin Island Sea Lab and partial funding from Woods Hole Sea Grant, staff continued an examination of how eutrophication affects the bioavailability of mercury in coastal food webs within several Cape Cod estuaries.

Eelgrass Monitoring and Restoration

Eelgrass is a critical marine fisheries habitat. DMF focuses on research, monitoring, and restoration of eelgrass in Massachusetts.

Seagrass Monitoring: The eelgrass team completed its eleventh year of monitoring a site off of West Beach, Beverly in Salem Sound as part of the international SeagrassNet monitoring program. This program tracks short- and long-term trends in eelgrass meadow characteristics at 136 sites globally. Our Massachusetts site is also monitored for invasive species as part of a partnership with *Mass*CZM's Marine Invader Monitoring and Information Collaborative. In 2018, staff continued to collaborate with other SeagrassNet participants in the northeast and mid-Atlantic for the preparation of a regional synthesis which will be submitted for publication. For the second year in a row, we collaborated with scientists from Northeastern University to digitally scan high resolution images of collected eelgrass samples for quantitative analyzes of the presence of eelgrass wasting disease at our monitoring site.

Figure 19. DMF's Jill Carr collecting density and canopy height data during the peak growing season in July.

We also conducted our annual monitoring of four other reference beds in Marblehead, Boston, Broad Sound, and Nahant (Figure 19). These areas were established during 2013–2014 to track trends in natural beds compared to transplanted sites to determine restoration success. Acoustic mapping of restoration and reference beds was conducted in 2018 in order to determine the vegetated area and patchiness of restoration and reference meadows. Acoustic mapping is further described under Seafloor Mapping (page 54).

Hubline Eelgrass Restoration: The final grant report for the HubLine eelgrass restoration project was completed and submitted to *Mass*DEP in 2018. Planting and monitoring efforts for this project were successfully completed. Funded as mitigation for eelgrass impacts from the trenching of the Algonquin HubLine Natural Gas Pipeline in 2003, this restoration included eelgrass transplanting in Salem Sound and Boston Harbor. After extensive site-selection modeling and test-transplants, three sites were successfully planted. Five years after the initial transplanting, 2.4 acres of eelgrass were restored to Middle Ground and Woodbury Point in Salem Sound and Governors Island Flats in Boston Harbor. This degree of success is rare in New England since transplants are sensitive to many factors including winter storms, algal growth, crab bioturbation, boating and fishing activity, and poor sediment and water quality.

Salem Sound Eelgrass Restoration: The eelgrass team initiated a five-year ILF-funded project in 2017 to restore a half acre of eelgrass in Salem Sound to mitigate for construction impacts to coastal ecosystems. Eelgrass was transplanted to two adjacent sites at Middle Ground. The one-year post-planting monitoring was performed in July 2018. Due to a series of three consecutive Nor'easters in February and March, additional monitoring was conducted in April. The impacts of the storms were clearly evident at both sites and most severe at the easternmost site where six of 18 plots were gone and many others partially damaged. In May, we planted nearby and within the former site to equal the same acreage as was initially planted. One-month monitoring was completed in June, showing survival of 99% of the planting units. In the fall the plots were still growing and we sampled leaves for genetic diversity and wasting disease as part of our partnership with Northeastern University scientists.

Eelgrass Restoration Method Evaluation: Project staff launched a pilot study to compare the efficiency of planting eelgrass seed compared to adult plants as a restoration method. Staff collected reproductive shoots in the summer and kept them in the flow-through seawater tanks at UMass's Hodgkins Cove Lab (Figure 20). Once ripe, the seeds dropped out of the plant and divers planted them and adult plants at selected sites in Essex Bay, Plum Island Sound, and Salem Sound. Planting efforts were conducted in partnership with Boston University and Merrimack Valley Planning Commission staff. Monitoring was planned for summer of 2019 to assess the efficiency of the method.

Figure 20. DMF's Tay Evans sieving eelgrass seeds at UMass's Hodgkins Cove Lab (left) and a close up of eelgrass seeds on the sieve (above).

Duxbury-Kingston-Plymouth Bays Study: Eelgrass beds have experienced severe declines over several decades in the Duxbury-Kingston-Plymouth embayment, and there is a need and local interest in tracking these changes and preventing more loss. DMF previously investigated potential causes for eelgrass loss in the embayment in a

partnership with the Massachusetts Bays National Estuarine Program (MassBays) in 2014 and has conducted acoustic mapping surveys of the area since then. In 2018, with an EPA grant and in partnership with MassBays, DMF developed and tested a novel eelgrass monitoring protocol that could be implemented by trained citizen scientists with the goal of establishing rapid assessment standards that can be executed annually or biennially by volunteers. The pilot sampling effort, dubbed "Eelgrass Week," was conducted in August by 28 scientists including citizen volunteers, DMF, and MassBays staff aboard four boats. Over the course of six sea days, 250 stations were sampled for eelgrass presence and percent cover using underwater cameras mounted to standardized quadrat frames, in addition to depth and water clarity data (Figure 21). Of the 250 stations, 100 "indicator" stations within areas of highest eelgrass persistence were also sampled for plant height, width, disease, and epiphytic cover and subject to eelgrass shoot collection.

Figure 21. Deployment of the underwater camera frame used in Eelgrass Week (left); collection of eelgrass samples with the anchor method (right).

This effort provided a wealth of meaningful information about the presence and condition of eelgrass in the embayment, as well as a strong baseline dataset. The drop-frame photography system successfully provided seafloor and eelgrass imagery in a variety of conditions. Unfortunately, eelgrass has continued to die back in the area; only 32% of indicator stations contained eelgrass. Several discrete areas continued to support dense eelgrass beds. The cause of rapid eelgrass loss in the embayment remained unclear, though increased turbidity from loss of eelgrass could be acting as a negative feedback loop. A final report on the initiative was submitted to *Mass*Bays in December.

Conservation Moorings: Some mooring systems are termed "conservation moorings" because they use flexible rode technology to float the mooring rode, thereby eliminating chain drag and reducing scarring in eelgrass meadows. DMF has been studying these systems since 2010. In 2018, staff conducted the fourth year of post-installation monitoring of conservation moorings in Gloucester, Boston, Manchester, Wareham, and Falmouth under Massachusetts Port Authority (Massport) mitigation funding. We have reported variable success with these systems based on site conditions. Proper sizing, design, installation, and maintenance are critical to effectiveness. Our guidance document on the use of these systems was updated in 2018 and provided to harbormasters and mooring maintainers. Study results were shared at an Atlantic Coastal Fish Habitat Partnership meeting in November. An annual grant report was prepared and submitted to Massport.

Bay Scalloping Impacts to Eelgrass

As eelgrass declines statewide, efforts to protect it have growing importance. Bay scallops are found predominantly in eelgrass meadows and their wintertime fishery often targets vegetated areas. Regulations typically prohibit toothed dredges which could result in injury to underground eelgrass biomass. There is annecdotal evidence that bay scalloping does not impact eelgrass, but also reports of damaged meadows after the fishing season. Timing of the fishery outside of the growing season and the use of gear that is designed to avoid bottom scouring should limit associated habitat impacts; however, no studies exist to date in New England to evaluate any potential gear effects.To better understand eelgrass response to scallop dragging, DMF initiated two studies in 2018.

Assessment of Eelgrass Meadow After Dragging: The Westport River supported a large and prolonged bay scallop harvest in 2017 for the first time in decades, presenting a unique opportunity to characterize eelgrass meadows

during the growing season following a single season of scalloping. In summer 2018, DMF surveyed an eelgrass meadow that was the site of intensive scallop dragging as well as several nearby unfished beds that served as references for comparison. All beds were surveyed using drop camera and side scan sonar. Data analysis was planned for 2019.

Controlled Impact: To better understand potential impacts of scallop dragging on eelgrass meadows in a more controlled manner, DMF established an experimental scallop dragging site in an eelgrass meadow in Nasketucket Bay in Fairhaven in 2018. The site was selected due to minimal prior scalloping pressure but proximity to previously fished beds so that the site is generally representative of the environmental conditions where bay scalloping occurs. During the commercial and recreational bay scalloping season (November–December 2018), DMF performed both high and low intensity dragging using a pan dredge and surveyed both the fished sites as well as adjacent unfished reference sites using drop cameras and side scan sonar to assess any potential short-term impacts (Figure 22). Longer-term impacts were intended to be assessed through additional eelgrass surveys during the 2019 summer-time growing season. DMF also planned to repeat the experimental dragging with associated monitoring for two additional years. Information on the study was presented at three quarterly meetings of the Massachusetts Shellfish Officers Association.

Figure 22. DMF's Steve Voss and Vinny Manfredi sample a bay scallop dredge haul from the experimental site to assess eelgrass impacts.

Salt Marsh

Eutrophication poses a potential impact to Massachusetts salt marshes. Occupying the interface between uplands and coastal waters, salt marshes can be exposed to increased nitrogen inputs from both of these habitats. During 2018, DMF made use of over 200 reference samples collected across the state as part of a previous dock shading study to assess salt marsh response to eutrophication. Aboveground production data from the reference sites were compared to available nitrogen loading estimates from the Cape Cod Commission and water quality data from the Buzzards Bay Coalition and Provincetown Center for Coastal Studies. Results showed increased stem density and biomass in the high marsh for *Spartina patens*. In the low marsh, *S. alterniflora* stem biomass and height increased but overall stem density decreased, reflecting a shift towards characteristics more typical of the tall form of this species. Results from this analysis were presented at the New England Estuarine Research Society's Fall Meeting and published in 2018.

Seafloor Mapping

DMF's habitat characterization research primarily focuses on seafloor mapping. Using single-beam sonar, sidescan sonar, and video equipment, the team maps shallow coastal areas not covered by other seafloor mapping studies in each year.

Sidescan and Photo/Video Mapping: Staff mapped nearly 30 acres of eelgrass in Salem Sound, focusing on the restoration site at Middle Ground and the nearby reference beds at Peach's Point and Aquavitae off Marblehead. Nearly 60 acres of eelgrass was mapped in Gloucester Harbor at the beds off Niles Beach and Pavilion Beach. Overall we found more eelgrass than was previously mapped with aerial imagery, in part due to our ability to see deeper meadows and discriminate optically difficult areas (e.g., rocks, channels) from eelgrass areas using acoustics.

Efforts were underway to fine-tune the sensitivity of the equipment to determine the minimum eelgrass densities observable in the acoustic imagery.

Approximately 2 miles of supplemental acoustic mapping was conducted in lower Cape Cod Bay in support of the artificial reef program (page 50). Photo mapping was conducted to accompany the lower Cape Cod Bay study as well as for the Duxbury-Kingston-Plymouth eelgrass mapping project (page 52).

Through a partnership with MassBays, a novel approach to water quality monitoring and mapping was conducted in Duxbury-Kingston-Plymouth using an autonomous surface vehicle (ASV) developed and run by SeaTrac (Figure 23). The ASV was equipped with DMF sensors to continuously track turbidity, chlorophyll, dissolved oxygen, and temperature along transects that traversed roughly 25 miles of waterbody, including over eelgrass beds, shellfish flats, and channels. The survey was completed over three days to capture different tidal and weather conditions. Additional surveys were planned for 2019.

Figure 23. Autonomous surface vehicle used in Duxbury-Kingston-Plymouth Bay.

DMF also assisted EPA in the testing of satellite imagery combined with data about water column properties to map eelgrass in West Falmouth. In this effort, a hyperspectral sonde was towed to gather data about the interaction of light and water properties, and divers were deployed to collect groundtruthing information about the density and health of the eelgrass meadow being mapped. This effort will help determine if satellite imagery can be used as a reliable data source when trying to map eelgrass beds and estimate their density.

Impacts of Hydraulic Clam Dredging: For the past several years, there have been ongoing concerns over the impact of hydraulic clamming in eelgrass meadows particularly in the Herring Cove region of the Provincetown coast and the Ellisville region of the Plymouth coast. The Habitat Program continued to participate in the review of research related to this topic as well as meetings regarding the potential for impact from this gear type.

Ghost Gear Detection: Staff collaborated with the Conservation Engineering Project on the production of a presentation and manuscript regarding the use of side-scan sonar to survey for derelict lobster pots (page 67).

Other Activities

Technical Committees: Program 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 and Ocean Mapping Subcommittee, NEFMC/MAFMC Northeast Regional Habitat Assessment Team, MA Climate Change Vulnerability Assessment Team, the Massachusetts Bay Management Committee, the Buzzards Bay National Estuary Program, the Boston Harbor Habitat Coalition, the Gulf of Maine Climate Network's Sentinel Monitoring Project, the Marine Invader Monitoring and Information Collaborative, the Marine Dissolved Oxygen Technical Advisory Committee, and the NEERS Executive Committee.

Support Activities: Staff reviewed proposals for NOAA and MIT Sea Grant Programs, and performed peer review for the eight academic journals. Staff participated in running the New England Estuarine Research Society's Fall Meeting hosted at SMAST. Staff represented the agency at the Boston Boat Show, Women in Science and Engineering Fair, DMF fishing clinics, and the Topsfield Fair. Staff also participated on thesis committees for two Master's candidates at the University of Maine.

FISHERIES BIOLOGY SECTION

Dr. Michael Armstrong, Assistant Director, Section Leader

Fish Biology Program

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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. These activities are organized under four projects: **Age and Growth Project**, **Fisheries Dependent Sampling Project**, **Fisheries Research Project**, and **Striped Bass Project.**

Age and Growth Project

In 2018, staff aged hard-part structures from many species important to Massachusetts recreational and commercial fisheries. Table 17 shows the number of samples processed and aged. Several focus areas for 2018 are highlighted below.

River herring: River herring (n=2,135) were sampled from the Cod Industry-Based Survey (IBS). Otolith and genetic samples were removed from these fish to aid in future projects such as age validation (otoliths) and stock structure analysis (genetics).

Atlantic cod: Atlantic cod otoliths collected from the Cod IBS were processed. The age was determined and the first and second annuli were measured. This was an important part of a project to investigate the relative importance of winter- and spring-spawned Atlantic cod in the Gulf of Maine. Analyses of these data were performed and a manuscript was prepared.

Black sea bass: Work continued in 2018 on a project to validate the otolith ageing methodology for black sea bass. Annuli measurements for marginal increment analysis have been completed on 1,361 otoliths. Preliminary analyses show that one full increment occurs per year, confirming annual periodicity of growth bands. Additionally, a subset

of these otoliths were used for analyzing concentrations of trace elements and stable isotopes in otolith cores. All microchemistry samples have been processed and data collected; analysis was forthcoming.

Wolffish: Otoliths from 491 wolffish were collected and aged as part of a collaborative research project funded through the Saltonstall-Kennedy Grant Program. Ages determined from whole otoliths and ages determined from sectioned otoliths were compared. Sectioned otoliths yielded older ages, providing evidence that sectioning is the preferred otolith ageing method. Calculations on precision and bias were expected to be completed early in 2019.

Table 17. Samples processed for ageing in 2018.

Species	Structure	Process	Number
American shad	Otoliths and scales	Otoliths aged, scales checked for repeat spawning	488
Atlantic cod	Otoliths	Section and measure annuli	1188
Atlantic herring	Otoliths	Otoliths removed and imaged	390
Black sea bass	Otoliths and scales	Cleaned, mounted, aged	755
Bluefish	Otoliths	Baked, sectioned, aged	99
Fluke	Scales	Cleaned, pressed	33
River herring	Otoliths	Removed and archived	2,135
River herring	Otoliths and scales	Cleaned, mounted, aged	8,121
Scup	Scales	Cleaned, pressed	93
Striped bass	Otoliths	Sectioned, aged	185
Striped bass	Scales	Cleaned, pressed	2,000
Tautog	Otoliths and opercula	Cleaned, sectioned, aged	524
Whelk, channeled	Statoliths and opercula	Processed and aged	41
Whelk, knobbed	Statoliths and opercula	Processed and aged	186
Winter flounder	Otoliths	Sectioned, aged	943
Wolffish	Otoliths	Sectioned, aged	491

Other Activities: In 2018, staff continued cataloging and archiving all past and present samples. Archiving of samples through 2016 was completed. Protocols have been established so that all new samples will be properly archived.

Staff participated in an ASMFC-hosted ageing quality assurance and quality control meeting in March. During this meeting, representatives from state agencies along the east coast met and compared ages on a representative set of samples. This is an important step to ensure that all age data are as precise and accurate as possible. Staff also participated in the continued joint effort by the ASMFC and Gulf States Marine Fisheries Commission to construct an age determination manual. The document was expected to be finalized in early 2019.

The Age and Growth Lab continues to be a resource for others involved in fish ageing. Researchers from a variety of universities, several state agencies, and NOAA Fisheries consulted with staff on ageing of several fish species. Staff participated in the Marine Science Symposium for high school students in March, attending both the Salem State College and Northeastern University sessions.

Staff provided editorial support for a manuscript regarding the fecundity and spawning behavior of rainbow smelt. Staff also began planning and purchasing for wet lab upgrades that will allow for digital data collection. This data collection method will streamline sample processing and help to eliminate sources of potential error.

Fisheries Dependent Sampling Project

Commercial Fisheries Sampling

Project staff are responsible for the collection of 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 strengthen DMF's participation on, and contributions to, the regional fishery management councils and the ASMFC.

Shore-side Sampling: Port sampling of commercial catch was carried out for only the highest-priority species due to staffing constraints (Table 18). Sampling of the Atlantic herring fishery is integral to river herring bycatch avoidance and spawning protection closures. A trend to lighter more variable striped bass landings necessitated extra effort to obtain our market sampling targets. Northern shrimp samples represent those from a sentinel experimental fishery using research set-aside quota due to the ongoing harvest moratorium. Samples were collected from the commercial menhaden fishery per interstate requirements that help inform ASMFC coast-wide stock assessments.

Table 18. Number of port sampling events or trips made to intercept commercial vessels or seafood dealers where information was collected in 2018.

Species	Intercepts	Sample number	Number age samples
Atlantic herring (bycatch avoidance)	40	-	-
Atlantic herring (GSI)	10	1,210	-
Striped Bass	22	588	582
Menhaden	3	30	30
Northern Shrimp	2	-	-

At-sea Sampling: Project staff contributed extensively to numerous at-sea sampling activities. Conduct of the Industry-based Survey for Gulf of Maine Cod remained the dominant activity for project staff (109 sea days). The routine annual monitoring of the state's coastal lobster fishery was a major undertaking (33 sea days), with sampling occurring between May and November out of Rockport, Gloucester, Beverly, Quincy, and Boston. Staff provided field support and data management for grant-funded acoustic telemetry studies (28 sea days) enhancing the understanding of striped bass distribution and movement and American shad migration, and discard mortality studies (28 sea days) for cod and haddock . Vessel support (21 sea days) was provided for numerous other internal and external projects, including: biological sample collection for UMass-Boston/New England Aquarium, the Gloucester Marine Genomics Institute, and Maritime Gloucester; conduct of side-scan sonar work for the Cod IBS; training/assisting New England Aquarium staff on ROV deployments; assisting Massachusetts Environmental Police with lobster gear removal; and conduct of DMF's Resource Assessment Survey. Project staff contributed to the completion of reports for a cooperative research project evaluating possible revision to whiting special access areas for which at-sea sampling support was provided in prior years.

Atlantic Herring Fishery Portside Sampling and River Herring Bycatch Avoidance

Project staff completed an 11th year of portside sampling of the Atlantic herring and mackerel mid-water trawl (MWT) fishery in collaboration with industry and SMAST. In 2018, with the aid of contracted biologists, DMF sampled 40 trips and incorporated data from an additional 13 trips sampled by other programs, most often the NOAA Northeast Fisheries Observer Program (NEFOP). From landings in MA ports, 6,243 metric tons of herring or mackerel from 44 MWT trips were sampled. Over 5,500 lengths were collected on target species, and over 1,100 river herring and American shad bycatch lengths were recorded.

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 MWT fishery for Atlantic herring and mackerel. Under the bycatch avoidance program, portside sampling and sea sampling (NEFOP) data are aggregated and bycatch rates are communicated back to participating vessels, allowing them to make better-informed decisions about where to fish. Additionally, at the request of industry and the NEFMC, DMF and SMAST began summarizing bycatch levels of haddock and communicating them to vessels with the goal of reducing fishery interactions.

Operating under the final year of the 2016-2018 Herring Research Set-Aside, DMF and SMAST allocated 3,144 metric tons of RSA herring quota to eligible participating vessels. While two companies were able to harvest a portion of their RSA allocation in Herring Management Area 1A in May, favorable conditions for RSA harvest did not again arise (area quotas were not achieved) and less than 7% of RSA quota was harvested. However, funds remained for portside sampling due to industry's compensation for uncaught RSA quota in 2017.

In order to bolster NOAA monitoring of river herring/shad catch limits for the Atlantic herring fishery, DMF began uploading portside sampling data to NOAA's Greater Atlantic Regional Fisheries Office (GARFO) within a week of a trip being landed and sampled.

Project staff assisted with numerous federal and state fisheries management actions for Atlantic herring, mackerel, and river herring in 2018. Contributions were made to the NEFMC's River Herring and Shad White Paper, the MAFMC's Atlantic mackerel quota decision process, the ASMFC's Atlantic herring spawning monitoring, and the NEFMC's Research Set-Aside programmatic review. By assisting with the implementation of the NOAA Industry-Funded Monitoring Amendment, whereby Atlantic herring MWT vessels will fund a coverage increase to a target of 50%, a smooth transition to a federally-run portside sampling program was ensured. Project staff also assisted with drafting future NOAA portside sampling protocols, sampling logs, and sampling site safety guidelines.

Project staff conducted extensive outreach with industry, fisheries managers, and stakeholders during the year. DMF hosted NEFOP and GARFO staff for multiple portside samples and conducted tours of all sampling sites in MA ports. Talks and presentations were provided to the NEFMC's Research Steering Committee, a US/EU Pelagic Fisheries Workshop hosted by the MAFMC, and a Fisheries Innovation Fund Bycatch Reduction Webinar hosted by the National Fish and Wildlife Foundation. SMAST collaborators presented project work at the ICES Annual Conference in Germany and to the Marine Fisheries Institute Advisory Council. Finally, DMF collaborated with NEFOP and a herring industry member to create a poster and content for the International Fisheries Observer and Monitoring Conference in Spain.

Figure 24. DMF's Brad Schondelmeier mounts an oceanographic data logger onto the headrope sensor of a herring mid-water trawl net.

DMF collaboration with external agencies continued to broaden the scope of research and utility of fisheries sampling data. In addition to assisting with the implementation of the Industry-Funded Monitoring Amendment, multiple NEFMC fisheries monitoring and river herring conservation issues were directly informed by findings from past and ongoing work. Collaboration with NOAA Cooperative Research's Study Fleet program helped maintain tow-level electronic reporting via onboard laptops. This system allows for real-time data collection which aids DMF, NOAA and fishermen alike. A genetic stock identification of river herring caught as bycatch at sea, paired with bycatch expansions, progressed during the year with the goal of further describing the origin, scale, and relative impact of this bycatch.

Further, utilizing funding from a 2017 NOAA Bycatch Reduction Engineering Program grant, a group of DMF and SMAST staff are working to augment published habitat and pelagic species distribution models by integrating fisheries-dependent oceanographic data. To achieve this, data loggers were mounted on MWT nets in order to record environmental conditions during commercial hauls (Figure 24). In January 2018, six MWT vessels fishing for Atlantic herring and mackerel were outfitted with data loggers. By the end of April, temperature, depth and salinity had been collected from over 75 hauls on 38 trips. These data were formatted and paired with bycatch sampling data for future analysis as to their utility in bycatch modeling. If successful, these new species distribution models could have future potential for bycatch forecasting and proactive avoidance. These loggers were expected to be deployed for another winter fishing season in early 2019.

Finally, in order to inform the timing of the Massachusetts/New Hampshire Atlantic Herring Spawning Area closure, DMF sampled the gonad somatic index (GSI) of commercial landings from Herring Management Area 1A. Due to a lack of fishing effort and Massachusetts landings from the spawning area, DMF staff was able to sample just one trip prior to the closure on October 26. Ten GSI samples (100-fish each) collected by Maine Department of Marine Resources also informed the closure date. Staff sampled two trips following the four-week closure (through November 22), which confirmed that spawning had already occurred. In order to further describe spawning characteristics of Georges Bank and Nantucket Shoals herring, four GSI samples were conducted from Georges Bank landings and three from landings from east of Cape Cod. Catch of spawning herring from this area, also referred to as Nantucket Shoals, is relatively rare.

Fisheries Research Project

DMF greatly expanded its involvement with groundfish and other species research in 2018 by collaborating with multiple university, non-profit, state, and federal organizations.

Industry-Based Survey of Gulf of Maine Cod

Recent stock assessment updates for GOM cod have repeatedly found that the stock is overfished and that biomass continues to decline to unprecedented lows, despite repeated management actions to achieve rebuilding. At the same time, many fishermen have expressed concerns that the stock assessments do not reflect the true abundance of GOM cod. To better understand the population dynamics, improve our ability to assess and manage this stock, and address the issues that underlie industry disbelief in the scientific advice, DMF developed an industry-based trawl survey (IBS) in a portion of the GOM that encompasses 97% of the cod biomass and 93% of the commercial cod landings. The survey was launched in 2016.

The F/V Miss Emily, a Scituate-based 55’ stern trawler, owned and operated by Kevin Norton, continued to act as the survey vessel in 2018. Improvements were made to the vessel including reconfiguration of the net drum so that two survey nets can be carried simultaneously. This was a money and time saving alteration; in the event of a damaged net or mechanical failure, the captain can switch nets at sea rather than returning to port. The onboard electronic data collection system was further developed to operate in harsh environmental conditions, with the purchase of more rugged equipment and new data collection software.

Eight monthly cruises, that attempted 50 tows per cruise and covered the two peaks in cod spawning activity, were conducted in 2018: January, April, May, June, July, October, November, and December. DMF staff completed 76 days of survey work and 354 representative stations, resulting in an overall completion rate of 89% (Table 19).

The survey observed 66 different fish and invertebrate species. See Table 20 for total catch weights and catch per unit effort (CPUE) for groundfish species. Of the cod catch, market sized fish (15–24 inches) were the most prevalent, while there was a notable absence of younger fish (<15 inches) and large adults (>31 inches). Haddock was the most abundant species caught.

Although the survey has been designed to study cod and 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 21). Data and specimen requests were also collected for numerous government agencies, scientific organizations, and universities.

Table 19. Tow completion rate by month.

Month	Rate (%)
January	72
April	98
May	96
June	98
July	90
October	94
November	84
December	76

Table 21. Biological data collected from Atlantic cod.

Data element	Quantity
Lengths	1,575
Sex & maturity	1,306
Otoliths	1,166
Dorsal fin clips	677
Caudal fins	50

Table 20. Total catch weights and CPUE of groundfish species.

Species	Pounds	CPUE (lb/hr)
Haddock	112,528	667.07
Acadian redfish	47,443	281.24
Atlantic cod	9,856	58.43
American plaice	7,242	42.93
Yellowtail flounder	4,503	26.69
Winter flounder	4,251	25.2
White hake	3,132	18.57
Witch flounder	2,587	15.34
Pollock	2,368	14.04
Ocean pout	464	2.75
Atlantic wolffish	283	1.68
Atlantic halibut	161	0.95
Windowpane	149	0.88

An efficiency study of the survey's net was also conducted at the end of May (supplemental to the monthly surveys) to estimate the herding effect of the tow wires leading to the net. During this study, 47 tows were completed over a six-day period. This effort built off work in 2017 to estimate the amount of groundfish escaping under the sweep of the net. Collectively, these studies will increase the accuracy of the swept-area biomass estimates that will be produced at the end of the study.

Beginning in 2018 federal funding ran out and the survey was entirely funded through state funds and project income. For 2019, it was anticipated that there would be a funding short fall resulting in the termination of the field portion of the Cod IBS after the January 2019 cruise. This would mark the end of three complete years of survey work. Plans for 2019 included data compilation, continued analysis, and manuscript development. A paper describing the spatial and seasonal patterns of the mix of spring- and winter-spawning cod in the Gulf of Maine was prepared; publication in a peer-reviewed journal was anticipated in 2019.

Minimizing Recreational Discard Mortality

In collaboration with New England Aquarium, SMAST, Rutgers University, and industry partners, DMF was awarded a NOAA Bycatch Reduction Engineering Program grant in 2017 to gather comprehensive release condition data for recreationally caught cod and haddock, and estimate discard mortality as a function of release condition utilizing six terminal tackle configurations. This will allow us to determine which factors contribute to poor release condition and ultimately to poor survival, and provide more accurate fishery-wide estimates of discard mortality. Between April and October 2018, we conducted 32 scientific angling trips and recorded release condition (hook location, injury severity, barotrauma symptoms, etc.), along with various fishery and environmental variables (tackle

configuration, handling time, temperature, etc.) on nearly 7,000 fish (Figure 25). End results will include a set of best practice recommendations for the capture and handling of cod and haddock to promote survival.

Figure 25. Fieldwork conducted aboard the F/V Annie B during fall 2018. Photography by Steve de Neef.

Avoiding Cod in the Recreational Fishery

The overfished status of GOM cod has resulted in highly restrictive fishing regulations to reduce mortality, including a prohibition on recreational cod harvest in 2018. At the same time, GOM haddock has increased to record levels. Because these species often co-occur in the Gulf of Maine and can be caught by the same recreational gear, cod bycatch has recently constrained access to the abundant haddock resource. To address this management challenge, DMF initiated a project to translate species distribution and abundance data from the Division's Cod IBS into practical guidance for the recreational fishery to avoid cod while maintaining or increasing haddock catch.

Staff began the process of combining observations from the cod IBS with environmental variables (temperature, depth, and habitat) to produce monthly maps predicting the abundance of cod and haddock throughout the GOM. Extensive field testing will follow in 2019 to validate and further refine the map predictions. Then these monthly predictions will be converted into simple recreational fishery guidance maps that can be used to avoid high bycatch areas (Figure 26). These maps will be combined with best practice guidelines and widely disseminated to recreational fishermen in New England, allowing them to make more informed decisions about when and where to fish. Such voluntary bycatch avoidance programs have proven successful in other New England fisheries and offer a novel approach to bycatch mitigation that is independent of fishery regulations.

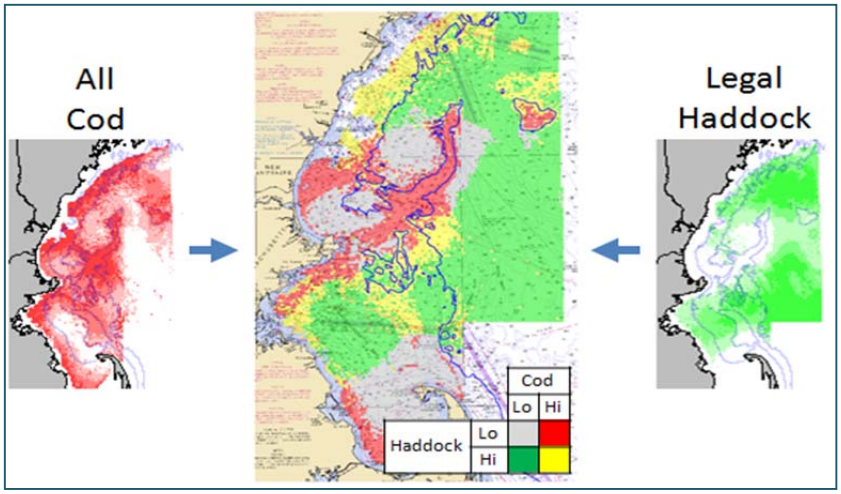

Figure 26. Overview of combing spatial model predictions to create fishery guidance maps.

Winter Spawning Cod in Massachusetts Bay

Project staff completed a research project to describe the distribution of winter spawning cod in Massachusetts Bay in collaboration with The Nature Conservancy, SMAST, Northeast Fisheries Science Center (NEFSC), and the Stellwagen Bank National Marine Sanctuary. Prior to this project, which received funding from the Saltonstall-Kennedy Grant Program in 2014, relatively little was known about the spawning time and location for this group of fish. Consequently, our work has been instrumental to the design of 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.

A total of 317 spawning cod were tagged and their movements monitored over three consecutive seasons via an array of 62 acoustic receivers encompassing a 350 km^2 area. In addition, multiple autonomous underwater vehicles (AUV) were deployed and programmed to make seven complete surveys over a wider 1000 km^2 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.

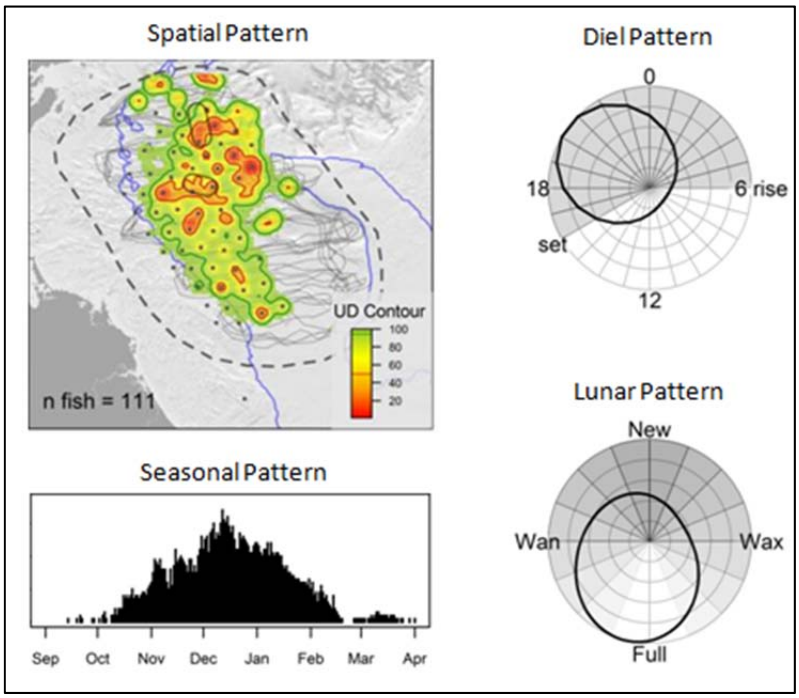

Figure 27. Patterns in cod spawning activity in winter in MA Bay.

We identified several consistent spatial and seasonal patterns to this cod spawning ground, with the center of activity located between the northern tip of Stellwagen Bank and the two deepwater liquid natural gas terminals (Figure 27). Spawning cod were present from October to February, but peak activity occurred in early-to-mid December. Interestingly, spawning activity was consistently highest at night and near full moons, causing the season to vary somewhat between years. A manuscript describing the findings was developed and submitted for publication in 2019.

Atlantic Cod Stock Structure

In February of 2018, a group of scientists from the US and Canada formed the Atlantic Cod Stock Structure Working Group, with the objective of determining the most appropriate representation of Atlantic cod stock structure for use in regional stock assessments. This group will follow a two-year process to broadly review all available scientific information and consider potential implications for fishery management. DMF scientists have played a key role in the group, including leading sub-groups on early life history and fishermen ecological knowledge.

Blueback Herring Life History Modeling

In collaboration Emerson College, DMF initiated a project to develop a spatially-explicit life history model for blueback herring in the Shawsheen River system. The goal of the project is to simulate the response of blueback herring to dam removal. The model will be empirically-based and include all life stages and allow dispersal of eggs, yolksac larvae, and young-of-the-year throughout the river system based on water flow.

Black Sea Bass Demographics and Migration

In 2017, staff initiated a study to improve general knowledge of a local black sea bass aggregation in Boston Harbor. Boston is on the northern extent of the range for this species and recent numbers have been high enough to support a small recreational fishery. A review of acoustic receiver data this year showed that, surprisingly, none of the 49 fish that were tagged with acoustic transmitters were detected migrating south through the Cape Cod Canal

in 2017 but were detected traveling in depths greater than 140 feet off the eastern side of the Cape. The tagged fish were detected leaving in mid-September and traveled as far south as northern New Jersey. Analysis of biological samples (age structures and DNA tissue) collected for demographic and genetic analyses was ongoing at year's end.

Striped Bass Project

Without a doubt, Atlantic striped bass are the backbone of the Massachusetts recreational fishing industry and provide enjoyment to hundreds of thousands of recreational anglers each year. The Commonwealth is also home to one of the largest commercial fisheries for striped bass in the country. 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

DMF has participated in the Striped Bass Cooperative State-Federal Coastwide 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 2018, Project staff conducted 10 trips aboard contracted vessels, tagging a total of 393 striped bass.

Volunteer Recreational Angler Data Collection Program

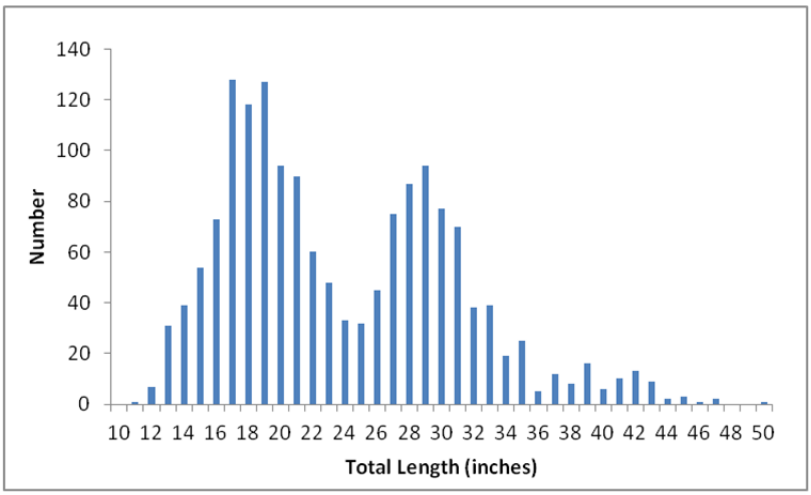

Figure 28. Size composition of striped bass collected by SADCT anglers in 2018.

The Sportfish Angler Data Collection Team (SADCT) program was implemented in 2002 to generate a time series database of biological characteristics of Massachusetts' striped bass recreational catch. During 2018, 50 participating anglers collected over 1,593 paired length/age samples from striped bass. The size composition of striped bass reported by participating anglers is shown in Figure 28. Participating anglers also collected 145 samples from black sea bass, 34 samples from fluke, and 94 samples from scup, species which the program was expanded to include in 2013. The striped bass carcass collection program also continued in 2018 and obtained 185 otolith samples from volunteer anglers.

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. Length, weight, and age (scales) are collected during market sampling trips, in accordance with ASMFC target sampling levels. Sample size for 2018 is provided in Table 18.

Acoustic Tagging Study

DMF continued an acoustic telemetry study of striped bass in Massachusetts waters which is examining how mortality is influenced by 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. DMF 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 genetic population baseline for striped bass will allow DMF to establish spawning-population-specific mortality rates for striped bass harvested by Massachusetts anglers. Since 2015, over 6,000 genetic samples have been collected from striped bass caught in state waters.

During 2018, 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 to monitor the movements of tagged striped bass. Acoustic monitoring was expected to continue through 2019. Initial analysis of tagged bass detections in Massachusetts and coastal waters during 2015–2017 illustrated that striped bass return to the same greater areas of the Massachusetts coast annually.

Striped Bass Stock Assessment

Staff spent considerable time in 2018 developing a new two-stock assessment model for Atlantic striped bass and preparing for the 2018 benchmark assessment peer review in November. The new model incorporated age-specific migration rates from Chesapeake Bay and tag-based estimates of stock composition and allowed stock-specific abundances and fishing mortality rates to be estimated. While not selected for immediate management use, recommendations from the peer review panel to improve the model, once incorporated, may make the two-stock assessment model the model of choice in the future.

Other

Publications: Staff authored a journal article providing a historical review of Massachusetts' commercial striped bass fishery regulations and co-authored a technical memorandum chronicling striped bass population restoration and conservation efforts in the Northwest Atlantic.

Other Activities

Assessment and Management Support: 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 2018, staff served on NOAA Fisheries' operational assessment review panel; ASMFC's Striped Bass Technical, Tagging, and Stock Assessment Committees, Menhaden Technical Committee, and Multispecies Committee; NEFMC's Atlantic Herring Plan Development Team; and ACCSP's Bycatch and Biological Sampling Priorities Committees. Many presentations were given by staff to other governmental organizations and private groups. Program staff also provided modeling expertise for the Division's 2018 stock assessment of channeled whelk in Nantucket Sound.

Assessment and Survey Program

Personnel

Robert Glenn, Program Manager

Conservation Engineering Project
Dr. Michael Pol, Senior Marine Fisheries Biologist, Project Leader
David Chosid, 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
Leah Derleth, Seasonal Fisheries Technician (June–December)
Elizabeth Morrissey, Seasonal Fisheries Technician (January–June)
Andrew Smith, Seasonal Fisheries Technician (June–October)

Protected Species Project
Erin Burke, Protected Species Specialist

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

Stock Assessment and Management Support Project
Dr. Greg DeCelles, Senior Marine Fisheries Biologist/Stock Assessment Specialist
Dr. Tiffany Cunningham, Senior Marine Fisheries Biologist/Stock Assessment Specialist
Brendan Reilly, Seasonal Fisheries Technician

Overview

The Assessment and Survey Program includes five projects.

The **Conservation Engineering Project** 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. The production of peer-reviewed publications and participation in national and international organizations is integral to CE's work.

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, plus 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 includes oversight of the right whale surveillance program, disentanglement efforts, participation on federal Take Reduction Teams, grant management, and other activities, such as evaluating the potential risk of entanglement in subtidal aquaculture gear.

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 **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.

Conservation Engineering Project

Revision of Existing Whiting Special Access Areas

Efforts on this ongoing project to evaluate possible alteration of existing whiting small-mesh exemption areas in response to changing fish distributions focused on data analysis, report writing, and presentation of results during 2018. During the two prior years, federal groundfish disaster aid was used to sample a total of 57 whiting trips in the two weeks prior to the opening of the established special access programs. In both years, unwanted bycatch of haddock caused catches to surpass a threshold of 5% bycatch, although observer data verified catches were similar to the existing fishery. Fishermen expressed continued interest in an ongoing early opening of the Small Mesh Area 1 exempted fishery.

An interim report was submitted to NOAA Fisheries as part of the experimental fishing permit process. A final report was prepared and presented to the NEFMC and its Research Steering Committee and Small-mesh Multispecies Committee. Additional analysis was incorporated into a manuscript submitted for publication in the DMF Technical Report Series (expected in 2019). Results were also presented at the summer meeting of the Southern New England Chapter of the American Fisheries Society. Work continued on analyzing 1997 data on the testing of the raised footrope trawl and a comparison to this recent performance in the experimental fishery.

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

Data analysis, report writing, and results dissemination were the foci of this Saltonstall-Kennedy Grant-funded cooperative research project to develop a trawl with a very low headline height to fish under cod for flatfish. Collaborators include the Gulf of Maine Research Institute, University of New Hampshire, SMAST, Memorial University of Newfoundland, and industry members. Following extensive modeling and testing of several net designs, the selected ultra-low-opening trawl with a headrope 10% longer than the footrope was tested in 2016 against a standard flatfish trawl and shown to reduce catch rates of Atlantic cod by 45% without impacting the rates of five other dominant commercial species, as well as reduce fuel consumption by over 6%. Economic modeling indicated the ultra-low-opening trawl can increase profitability by almost 60%, confirming its viability as an option to avoid cod while accessing quota of more abundant groundfish. These results were shared with all groundfish sector managers with an invitation to trial nets, and prepared into a final grant report to NOAA Fisheries. Staff co-authored a presentation given at the winter meeting of the Southern New England Chapter of the American Fisheries Society. A draft manuscript on knowledge needs of cod behavior in trawls was also begun.

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

A scientific manuscript was developed during 2018 on this National Fish and Wildlife Foundation funded project, the results of which demonstrate that reliable detection of derelict lobster pots using side-scan sonar requires

improvement of identification methods. Even with improvements, using sonar to accurately count pots may only be useful in simple seafloor types (e.g., flat, sandy). Submittal of the manuscript for publication was planned for early 2019. Results were presented at the annual conference of the Northeast Association of Fish and Wildlife Agencies.

Reducing Flatfish Bycatch in the Sea Scallop Fishery

With the submission of a final grant report to NOAA Fisheries in 2018, staff completed this Saltonstall-Kennedy Grant-funded cooperative research project (with the Provincetown Center for Coastal Studies and industry members) to evaluate a modification to a scallop dredge to reduce flatfish bycatch. The intent of the "tickle dredge" was to disturb flatfish that are on the bottom, causing them to swim away from the approaching scallop dredge and preventing their capture. Comparisons of 104 paired tows completed in 2016 and 2017 aboard a commercial scallop fishing vessel revealed no significant differences in catch between modified and standard dredges. Overall rates of bycatch were low. Both real-time and recorded underwater video were utilized to refine the size and arrangement of the tickler chains as well as optimal towing speed.

Redeveloping a Sustainable Redfish Trawl Fishery in the Gulf of Maine

Work on this ongoing effort in 2018 included continued development of a manuscript on redfish trawl fishery bycatch, selectivity, and escape timing in the Gulf of Maine. Staff also acted as a consultant to a Canadian effort to exploit deepwater redfish (a different species than Acadian redfish) in the Gulf of St. Lawrence.

Other Activities

Committee Work: Staff served on the ICES-FAO Working Group on Fishing Technology and Fish Behaviour, the NEFMC Research Steering Committee, the ASMFC Fishing Gear Technology Workgroup, and the NEFMC/MAFMC Northeast Trawl Advisory Panel. Staff co-chaired a joint workshop of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour and the Working Group on Fisheries Acoustics Science and Technology. Staff served as an editor on two academic journals. Staff continued contributing to the Massachusetts Wind Energy Fisheries Working Group, and New York Fisheries Technical Working Group.

Other Publications: Staff co-authored a 2018 journal article investigated the challenges of promoting widespread voluntary uptake of new or modified fishing gear.

Video Digitization: Staff have now digitized approximately 73% of the project's extensive collection of fishing gear video and related material (more than 1,400 recordings). Video hardware and software were also updated in 2018.

Invertebrate Fisheries Project

American Lobster Research and Monitoring

Commercial Lobster Trap Sampling: DMF has worked cooperatively with Massachusetts commercial lobster trap fishermen to sample their catch since 1981. In 2018, the 38th year of operation, a total of 69 trips were conducted by staff members of the Invertebrate Fisheries Project (37 trips) and the Fisheries Dependent Sampling Project (32 trips), during which 42,605 lobsters were sampled from 15,018 trap hauls. Data from the commercial trap sampling program are used to characterize the sex ratio and size distribution of the commercial catch, as well as to track conservation discards (including sublegal-sized lobsters, egg-bearing females, and v-notched females). This effort also includes shell disease monitoring, which tracks the prevalence of shell disease symptoms on lobsters in Massachusetts coastal waters, which is highest in Southern New England. In 2018, a total of 6,731 lobsters were sampled for shell disease. All commercial trap sampling program data are provided annually to the ASMFC and ACCSP.

Staff continued to conduct bycatch sampling during the commercial lobster trap sampling program 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), samplers collect size and disposition information (including presence/absence of barotrauma wounds).

Ventless Lobster Trap Survey: The 2018 Ventless Trap Survey took place from June through September with seven contracted vessels. Project staff completed a total of 56 sea days. This survey is a cooperative effort between DMF and the lobster fishing industry to monitor the abundance of lobster and several bycatch species, and is funded by commercial and recreational lobster permit fees. The data from the survey are used to generate indices of lobster relative abundance, monitor various population characteristics (such as sex ratio, abundance of egg-bearing females, and disease), and examine spatial patterns in abundance (Figure 29). 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. In 2018, a total of 15,823 lobsters were sampled from 2,832 trap hauls in the northern survey area (MA territorial waters from Cape Cod Bay to the NH border). In the southern survey area (MA territorial waters including Buzzards Bay and south of the Elizabeth Islands), a total of 3,381 lobsters were sampled from 1,068 trap hauls.

Additional biological sampling of bycatch species was continued in 2018, which increases the available data on commercially important crab and finfish species. In both survey areas, samplers collect length and sex for Cancer crabs (Jonah and rock crabs), and length information for various finfish species. Additionally, staff collected age structures for black sea bass and tautog captured in the southern survey area, which were analyzed by the Age and Growth Project in the Gloucester lab.

A detailed report summarizing and interpreting ten years of the Ventless Trap Survey (2006–2016) was prepared and submitted to internal review for publication in the DMF Technical Report Series.

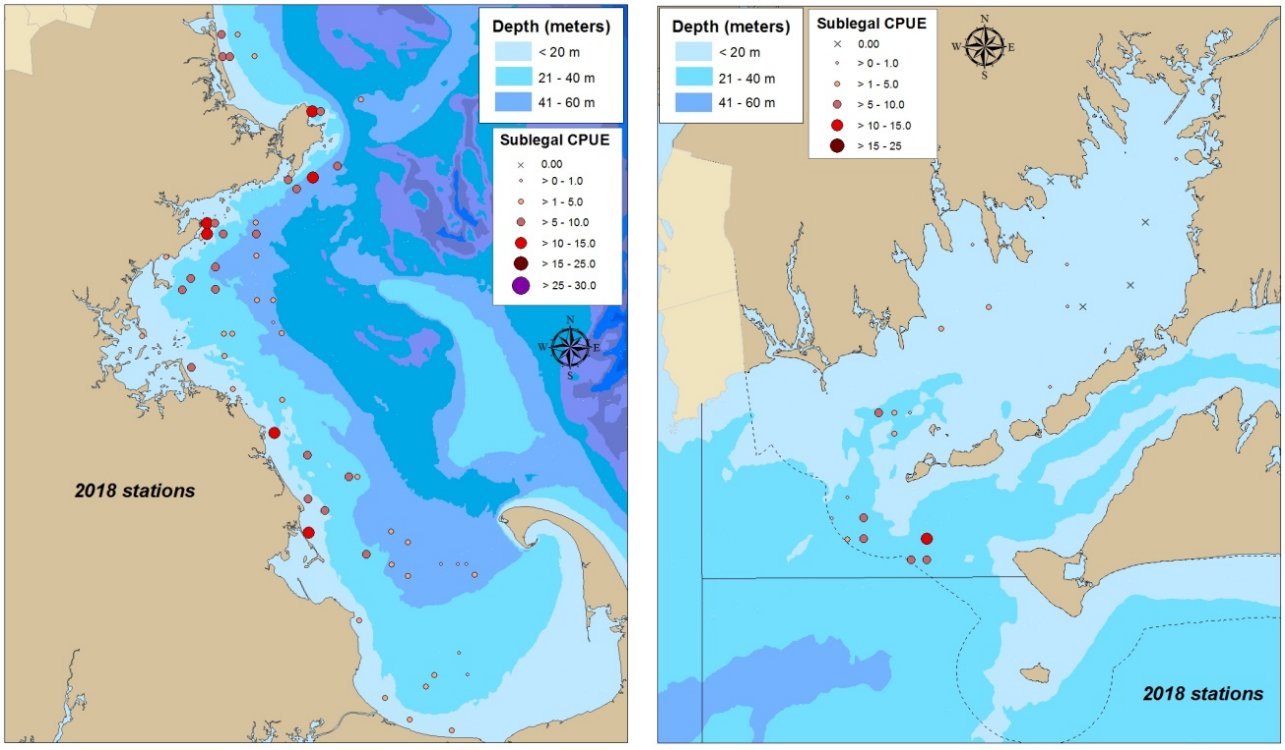

Figure 29. Average catch per trap haul (CPUE) of sublegal-sized lobsters at the 2018 ventless trap survey stations in the northern (left) and southern (right) survey areas.

Annual Early-Benthic-Phase Lobster Suction Sampling: Project staff completed the 24th year of this sampling program in 2018. 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 spanning Buzzards Bay, Cape Cod Bay, and Massachusetts Bay. Project staff conducted the SCUBA-based survey over 12 field days from August to October (Figure 30). Mean densities of YOY lobsters were below the time series mean in all regions of coastal Massachusetts (Table 22). 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. Sample of invertebrates enumerated by DMF biologists during lobster suction sampling in Salem Sound.

Table 22. Comparison of 2018 YOY lobster densities to time series means, by region.

Region (# years)	2018 YOY Mean (#/m^2)	Time Series Mean (#/m^2)
Cape Ann (9)	0.25	0.44
Salem Sound (23)	0.06	0.60
Boston (22)	0	0.14
South Shore (7)	0	0.05
Cape Cod Bay (24)	0	0.26
Buzzards Bay (24)	0	0.07
Vineyard Sound (9)	0	0.01

Applied Research: Work continued on a Saltonstall-Kennedy grant-funded research project 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. Working in collaboration with University of New Hampshire, Wells National Estuarine Research Reserve, and Department of Fisheries and Oceans Canada, staff applied for and received a one-year extension on the grant which enabled completion of a final field season in 2018, supplementing sample sizes for all aspects of the project. Data analyses were underway at year's end. Preliminary results were presented in a poster at the American Fisheries Society Annual Meeting.

Project staff continued to participate in another collaborative research project funded by the Saltonstall-Kennedy Grant program to examine how early-stage lobster recruitment is impacted by warming ocean waters. Staff provided data on lobster distribution shifts from commercial trap sampling datasets and the Ventless Trap Survey, and contributed biological advice to the modeling team from Woods Hole Oceanographic Institute and SMAST.

Staff continued work processing offshore samples of female lobsters to update existing size-at-maturity estimates. Staff also assisted Maine Department of Marine Resources research biologists with a new maturity research initiative in that state by providing training and analytical advice.

Research on spatial patterns in female lobster mating success was presented at the American Fisheries Society's Annual Meeting. Staff co-authored a manuscript on possible consequences of skewed sex ratios in American lobster populations accepted for publication in 2019.

Assessment and Management Support: Staff served on the ASMFC American Lobster Technical Committee (vice-chair) and Stock Assessment Subcommittee. Work focused on analyses to support management revisions initiated by the Board, as well as data contributions and analyses in preparation for the 2020 Benchmark Stock Assessment.

Project staff attended the 2018 Massachusetts Lobstermen's Association Annual Weekend, which allows staff to interact with industry members and engage with them on the various research and monitoring programs the Division conducts. A presentation was given to the Commercial Fisheries Research Foundation's Lobster and Jonah Crab Research Fleet, reviewing the many uses for lobster data collected by that program. Staff acted as a section editor and reviewer for an academic journal.

Horseshoe Crab Monitoring

Commercial Fishery Sampling: Monitoring of the commercial bait and biomedical harvests of horseshoe crab continued in accordance with the interstate FMP. Width measurements were obtained from 1,006 crabs from the bait fishery and 628 crabs from the biomedical fishery. The size distributions of male and female crabs from the fisheries have been relatively consistent over the entire time series (2008–2018).

Fisheries-Independent Surveys: Annual volunteer-based spawning beach surveys by DMF and other cooperating partners continued at 16 beaches along the South Coast, Cape Cod, and the islands. Surveys were conducted at high tide two days prior, the day of, and two days after the new and full moons from mid-April through the end of June. Staff conducted 30 surveys at Swift's Beach in Wareham. Survey results had been compiled and were under analysis at year's end. Preliminary results show that two survey locations in Nantucket Sound saw more crabs in 2018 than any other year in their respective time series.

Assessment and Management Support: Staff served on the ASMFC Horseshoe Crab Technical Committee, providing data and support for the 2018 Horseshoe Crab Benchmark Stock Assessment. Staff hosted a meeting for regional horseshoe crab biologists and enthusiasts and gave presentations on the status of horseshoe crabs in Massachusetts, and an update on the ongoing stock assessment.

Jonah Crab Research and Monitoring

Commercial Fishery Sampling: Monitoring of the commercial Jonah crab catch has been required by the FMP since 2015. Project biologists conducted 13 sea sampling trips and 16 port sampling trips to collect length frequency and sex ratio data from the commercial fishery in 2018. These trips sampled a total of 13,327 crabs from NMFS statistical areas 537, 562, 525, 526 and 514.

Applied Research: Project staff continued to work on a Jonah crab tagging study in 2018. Through funding provided by ASMFC and the Saltonstall-Kennedy Grant Program, DMF and industry partners tagged over 32,000 Jonah crabs with assistance from the Maine Department of Marine Resources and the New Hampshire Department of Fish & Game. Tagging effort ended in November of 2018, though the collection of recapture information continued. Median distance traveled by male crabs was 4.4 km, though one crab traveled over 400 km. Median distance traveled by female crabs was 0.8 km, with a maximum of 18 km. Two male crabs were at liberty for over 800 days, during which they did not molt. Crabs in offshore regions tended to move further than inshore crabs (Figure 31). No movement between inshore and offshore regions was observed. Results were provided for the American Fisheries Society's Annual Meeting.

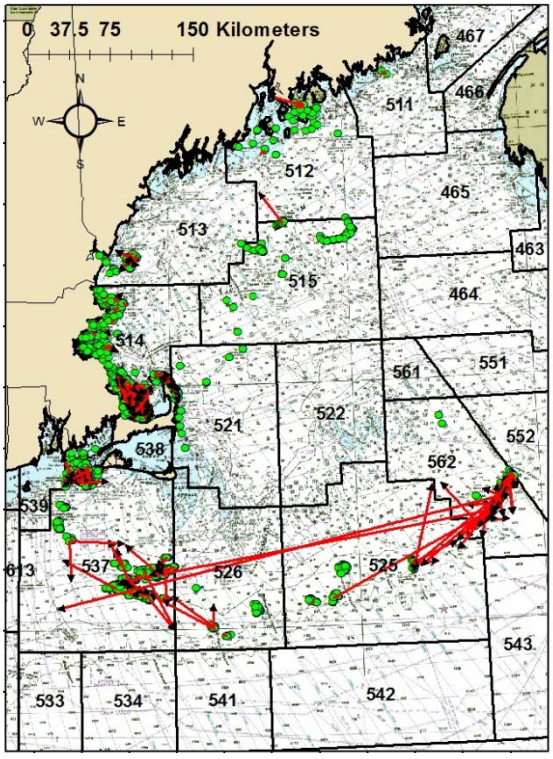

Figure 31. Location of released Jonah crabs (green circles) and location of recaptured tags (black arrows at end of red lines).

Assessment and Management Support: Staff served as chair of the ASMFC Jonah Crab Technical Committee, which focused on data collection for the next assessment, and as a member of the ASMFC Jonah Crab Plan Review Team, evaluating state compliance with FMP requirements.

Prior year research into Jonah crab size-at-maturity was the subject of a presentation given at the American Fisheries Society's Annual Meeting. Results of this study and the tagging work were also presented at the Massachusetts Lobstermen's Association Annual Trade Show and at a Jonah crab and lobster research symposium for the Commercial Fishermen's Research Foundation.

Whelk Research and Monitoring

Commercial Fishery Sampling: Staff conducted three commercial sampling trips aboard commercial vessels fishing conch pots for channeled whelk in 2018, measuring over 4,200 whelks. Fishery-dependent sampling trips have been conducted opportunistically in Nantucket Sound and Buzzards Bay since 2003. Over this timeframe, there has been a ¼ to ⅜ inch decrease in the average size of channeled whelk observed despite minimum legal size increases in 2014, 2015, and 2017, and there are fewer whelk above the size at which females reach maturity.

Applied Research: Staff collected and processed knobbed whelk captured during DMF's spring trawl survey to further examine size-at-maturity for this species. Over 60 whelk were measured and dissected to determine maturity status. Maturity information was used to help monitor the population and provide management advice.

Additionally staff met with industry members to answer questions and concerns on channeled whelk management and biology. One of the concerns was the potential that specific areas in Nantucket Sound existed where whelk grow at slower rates. Staff asked several industry members to provide a small number of samples they believed to be slow growers and an equal number of samples they believed to have normal growth rates. These samples were processed in the lab by project staff with the same protocol used in previous biological studies. The size and age of these samples were compared with baseline data collected from previous biological studies in Nantucket Sound. Results indicated that there were no differences in the size at which whelk were maturing based on the location within Nantucket Sound. While a few of the samples collected seemed to exhibit slower growth than baseline samples, it appeared to be related to previous shell damage and re-growth of the siphonal canal.

Stock Assessment: DMF conducted the first-ever stock assessment for channeled whelk in Massachusetts waters. A focus was placed on Nantucket Sound as it accounts for the majority of the state's channeled whelk landings. All of the life-history, fisheries, and survey data collected over previous years were used in this assessment. Multiple modeling approaches were used to determine that the stock is in poor condition with overfishing occurring. The continued practice of harvesting primarily immature whelk has been identified as a threat to the sustainability of the fishery. The stock assessment report was published in DMF's Technical Report Series.

Northern Shrimp Research and Monitoring

Northern Shrimp Assessment Survey: In July and August, staff participated on several one-week legs of the 35th annual northern shrimp assessment survey conducted throughout the Gulf of Maine aboard NOAA's R/V *Gloria Michelle*. For the seventh consecutive year, the survey indicated an exceptionally low abundance of shrimp expected to be available to the fishery in the upcoming fishing season and poor recruitment of the newest year class. The ASMFC Technical Committee recommended a 2019 harvest moratorium based on the survey and assessment results, noting that recently-observed water temperatures may contribute further to low recruitment.

Assessment and Management Support: Staff served on the ASMFC Northern Shrimp Stock Assessment Subcommittee to prepare the 2018 Northern Shrimp Benchmark Stock Assessment. The subcommittee's preferred statistical catch-at-length model was endorsed by the review panel and accepted for management use in October. Updates to the model inputs included spatio-temporal standardization of survey indices and incorporation of time and length-varying estimates of natural mortality.

Staff also served on the ASMFC Northern Shrimp Technical Committee, assisting in the preparation of the annual assessment report for the GOM stock and facilitating the development and implementation of a 2018 industry-cooperative winter research sampling program (with participation by the MA trawler F/V *Mystique Lady*). Staff processed shrimp samples from the cooperative winter research program (Figure 32) and provided biological and catch data to the Technical Committee.

Staff served on the ASMFC Northern Shrimp Plan Development Team as well, to formulate Addendum I to Amendment 3 to the Interstate FMP, approved in November, which provides the states with the authority to allocate any future state-specific quota between gear types in the event that the fishery reopens.

Figure 32. DMF's Kelly Whitmore staging and measuring Northern shrimp from the cooperative winter survey.

Green Crab

In 2018, DMF staff administered a program to remove European green crabs from the Great Marsh, a large stretch of salt marsh located along the North Shore of Massachusetts. This program was developed to address local concern that fisheries resources were being threatened due to recent expansions of the green crab population. Green crabs are known predators of soft shell clams and other shellfish. In large numbers they 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. In 2018, the Towns of Essex, Ipswich, and Newbury, and the City of Gloucester participated in the depletion program, where fishermen trapped nearly 211,000 pounds of green crabs. Around 82% of the green crabs collected through this program were sold to seafood dealers (primarily as bait), and the remaining 18% were composted locally.

Staff represented DMF at several meetings to address green crabs including an international *Green Crab Summit* held in June, where over 70 collaborators reviewed ongoing population monitoring, mitigation, and fishery, market, and culinary developments; a state-partners meeting in May to discuss salt marsh research initiatives; and a regional forum hosted by *Green Crab R&D* in November, where local and state officials, trappers, scientists, and activists discussed research efforts, catches, and advancements in green crab as a seafood product.

Other Activities

Technical Support: Invertebrate Project staff helped organize a symposium titled *American Lobster and Jonah Crabs: Assessing Biological and Fishery Impacts, and Stock Status in a Rapidly Changing Ecosystem* at the American Fisheries Society's Annual Meeting.

Staff served as a committee member on two graduate student committees and was appointed as adjunct faculty at University of Massachusetts Dartmouth SMAST.

Wind Energy Development: Staff contributed to DMF's review of regional offshore wind energy development plans, identifying concerns and providing comments on invertebrate fishery resources in and around project and lease areas, and contributing to the formulation of internal guidance documents on fisheries' research priorities relevant to offshore wind development near Massachusetts.

Protected Species Project

Cape Cod Bay Right Whale Surveillance Program

DMF partnered with the Provincetown Center for Coastal Studies (PCCS) and NOAA Fisheries to carry out the Cape Cod Bay Right Whale Surveillance Program. Started in 1998, the program conducts aerial surveillance and habitat monitoring of right whales in the Cape Cod Bay portion of Right Whale Critical Habitat.

Although the North Atlantic right whale population as a whole has been in decline since 2010, the proportion of the population that visits Cape Cod Bay has continued to be high. In 2018, at least 60% (n=246) of the known right whale population was documented in Cape Cod Bay and adjacent waters (Figure 33). Peak right whale abundance was two weeks later than normal, and the distribution of those late season whales was concentrated in the northwest portion of the CCB and up into Mass Bay and the North Shore, which is not consistent with previous spatial patterns of distribution.

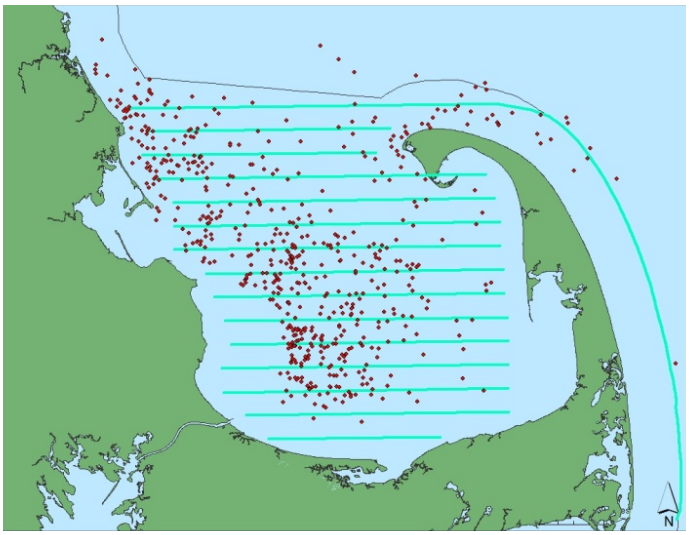

Figure 33. Map of PCCS 2018 right whale aerial sightings.

Right whale mortalities in 2018 returned to average levels compared to the high mortality seen in 2017. However, zero calves were born in 2018, highlighting the continued perilous state of the population. The high abundance of right whales visiting Cape Cod Bay demonstrates how critical Massachusetts waters are to the North Atlantic population and the importance of protecting them.

Project staff administered the grants from NOAA Fisheries and the Massachusetts Environmental Trust that support aerial surveillance and habitat monitoring and assisted in coordination of large whale conservation activities. In 2018, staff also assisted the Division in the development of a seasonal small vessel speed restriction in Cape Cod Bay to prevent potential injury and mortality to right whales caused by vessel collision.

Large Whale and Sea Turtle Disentanglement

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

Of the 53 whale entanglement cases documented in 2018 along the United States and Canadian coasts, 30 of those were observed off the coast of Massachusetts: three right whales, 24 humpback whales, and three minke whales. Four humpback whales were disentangled and one was partially disentangled. The remaining cases were either discovered as carcasses, not life-threatening or were not in a position to be resolved due to the time of day and distance from responders. Right and humpback whales are capable of carrying rope and other gear for long periods and distances. Location of sight of an entangled whale is not necessarily an indication of where the whale encountered the gear.

In 2018, there were 12 confirmed leatherback sea turtle entanglement cases, which is consistent with the past season averages. Ten of these cases were disentangled by network members. The remaining cases were either discovered as carcasses or could not be relocated by network members.

Other Activities

Wind Energy Development: Staff served on the Massachusetts Habitat Working Group on Offshore Wind Energy, working with EEOEA and BOEM on monitoring and protecting whales, sea turtles, and other protected species that inhabit the wind energy areas south of Martha's Vineyard and Nantucket. Staff was member to the steering committee for an Offshore Wind Marine Mammal Workshop held in May, and contributed to the development of a scientific framework to study the potential impact of wind energy development on marine mammals.

Ropeless Fishing Initiative: Staff also participated in various working groups and meetings related to the potential development and operation of ropeless fishing methods (i.e., gear set without vertical buoy lines) in the US and Canadian trap/pot fisheries. Entanglement in rope associated with fixed gear is the leading cause of injury and mortality for right whales. However there are a number of regulatory, logistical, technological, and financial challenges with this potential gear modification. DMF continued working closely with federal regulators, scientists, and fishermen to evaluate the risks and potential of ropeless systems.

Resource Assessment Project

2018 Trawl Survey

The 41st annual spring and fall surveys were accomplished aboard NOAA's R/V Gloria Michelle. The spring survey completed 105 stations from May 7–24; the fall survey completed 95 stations from September 4–23 (Figure 34).

The 2018 trawl surveys provided weights, counts, and measurements for 100 different species of fish and invertebrates. To aid cooperative fisheries assessments, survey crew collected over 2,325 age structures and sex and maturity observations from cod, haddock, summer flounder, yellowtail flounder, winter flounder, black sea bass, scup, tautog, lobster, and Jonah crab. Additional collections supported studies on the spatial structure of cod and river herring populations, size at maturity and distribution of Jonah crab, age and growth of tautog and black sea bass, longfin squid genetics, gray seal diets, sea turtle diets and the Ocean Genome Project.

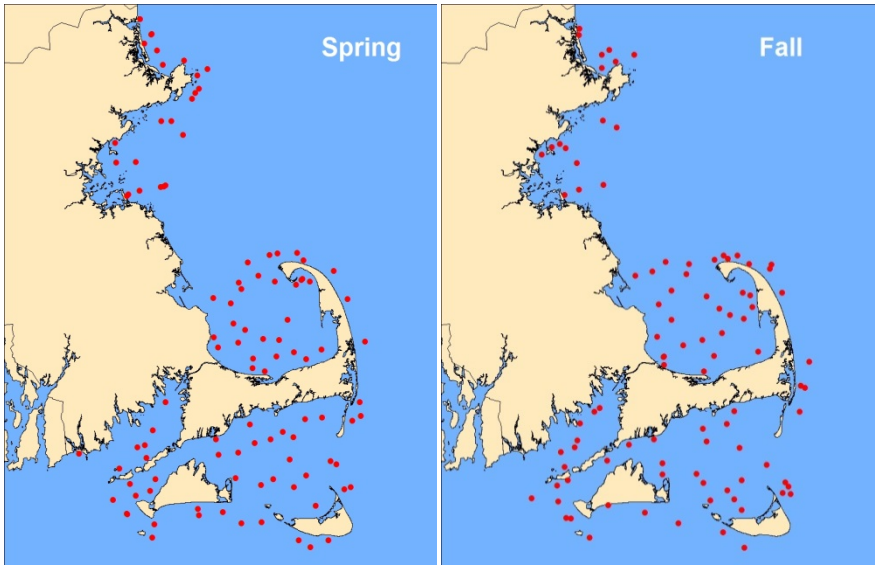

Figure 34. 2018 spring and fall trawl survey station locations.

Survey data provided by project personnel in 2018 were included in annual compliance reports for various ASMFC-managed species; supported regional management and assessment efforts for American lobster, yellowtail flounder, winter flounder, summer flounder, scup, tautog, and black sea bass; and aided research efforts by outside institutions related to climate change, changes in fish distribution and ocean planning. Project personnel also served on the following committees of the ASMFC's Northeast Area Monitoring and Assessment Program: Operations, Data Management, and Trawl Technical.

2018 Seine Survey

Figure 35. YOY winter flounder.

The 43rd Nantucket Sound Estuarine Winter Flounder Young-of-Year (YOY) Seine Survey was completed during June 21–July 3. This survey provides an index of abundance for YOY winter flounder in the Southern New England/Mid-Atlantic stock (Figure 35). Additionally, we count all commercially and recreationally-important finfish and invertebrates, and record presence/absence for all other species. Thirty-six species occurred in 2018 seine survey hauls. The 2018 stratified mean index for YOY winter flounder abundance fell to its lowest point since 2010. While three of the last eight years are above the time series median, the overall trend is one of decline for the Southern New England winter flounder stock since the survey's inception.

Groundfish Assessment and Management Support

Staff served as an active member on the NEFMC Groundfish Plan Development Team, providing analysis for assessment and management support during the development of Framework 58 and the continued drafting of Amendment 23. Staff participated in the Transboundary Resource Assessment Committee stock assessments for Eastern Georges Bank cod and haddock, and Georges Bank yellowtail flounder in the summer of 2018. Additional memberships included the NEFSC Atlantic Cod Stock Structure Working Group, the ASMFC Winter Flounder Technical Committee, and the NEFMC Monkfish Plan Development Team.

Staff collaborated with researchers from the Canadian Department of Fisheries and Oceans and he University of New Brunswick on a high-resolution genetic stock identification study for cod throughout the northwest Atlantic. Genetic samples from spawning and young-of-the-year cod from New England waters were collected for genetic analysis.

Staff was also active as an adjunct faculty member at the University of Massachusetts Dartmouth, co-teaching a class on field methods for fisheries research, and serving as a committee member for graduate students. Staff also helped organize and chair a symposium on fisheries-independent surveys at the AFS Annual Meeting.

Recreational Fish Assessment and Management Support

Staff served on the MAFMC monitoring committees for bluefish, scup, summer flounder, and black sea bass and the ASMFC technical committees for summer flounder, scup, black sea bass, tautog, bluefish, and weakfish, including the role of vice-chair for the Summer Flounder, Scup, and Black Sea Bass Technical Committee. In these roles, analysis of state and regional data was used to develop and recommend regulatory options for management use.

Staff was also appointed to the Stock Assessment Subcommittee for the 2018 Summer Flounder Benchmark Stock Assessment. The assessment passed peer-review with a sex-aggregated, age-structured model, similar to the model from previous assessments. The outcome from the assessment was favorable in that the stock is not overfished and overfishing is not occurring; however, recent recruitment remains below the long-term average.

A fishery-independent rod and reel survey for tautog was continued into its third year. Sampling was conducted throughout the month of October. Following additional years of data collection, staff will evaluate the trends in abundance from DMF's trawl survey to those from the rod and reel survey to assess whether the trawl survey index is adequate or if continuation of the complementary rod and reel survey is warranted to more effectively monitor trends in tautog abundance through time. Results from the initial pilot phase of this survey were published in 2018.

Research related to black sea bass in Massachusetts waters remained a high priority. In an effort to better characterize spawning behavior and habitat use during the spawning season, DMF conducted a pilot study using aerial surveys to map recreational fishing boat density in the spring when the black sea bass fishery is open. Boat

density was used as a proxy for fish density to begin identifying black sea bass spawning aggregations. Working with LightHawk, a nonprofit organization that donates flights for conservation objectives, staff made three flights across Buzzards Bay, Vineyard Sound, and Nantucket Sound. Once "hot spots" of fishing activity were identified from the plane, rod and reel sampling and MRIP data were used to support the assumption that the locations identified from the air were likely black sea bass spawning locations (Figure 36). Preliminary results from 2018 were encouraging and staff hoped to continue the aerial survey into 2019 and make progress towards characterizing the habitat in the spawning locations identified in 2018.

Figure 36. DMF's Brendan Reilly records data on recreational fishing boat density during a black sea bass spawning grounds aerial survey (left). DMF's Bob Glenn and Tiffany Cunningham display black sea bass caught during the rod and reel spawning ground sampling in the spring of 2018 (right).

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, Fishway Crew
James Rossignol, Fishway Crew

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 on 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, much of which is funded by recreational fishing permit sales; and disseminate information on all aspects of recreational species and fisheries to the public.

The **Large Pelagics Research Project** conducts research 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, federal, and international management processes; and to provide public education and technical information on the biology, management, and utilization of highly migratory species.

The **Diadromous Fisheries Project** works to improve fish passage and restoration, as well as investigate fish biology and contribute to fisheries management. Fish passage and restoration is accomplished through coordinated efforts of DMF 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. Technical assistance and monitoring are also provided as needed for individual restoration projects and coastal watersheds. The fish biology and management efforts cover 10 species of diadromous fish stocks in Massachusetts, such as river herring, rainbow

smelt, white perch, tomcod, American eel, and American shad. These species are monitored for run counts, indices of population abundance, size and age composition, harvest, and restoration potential. Information generated by this project is necessary for the sustainable management of diadromous fish populations as required by state and federal laws.

Recreational Fisheries Project

MRIP Sampling Project

Since 1983, recreational fisheries catch and effort data have been collected along the Atlantic Coast through NOAA Fisheries' Marine Recreational Information Program (MRIP). DMF 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 improve the precision of catch estimates.

In 2018, DMF 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. (ACCSP administers the program for NOAA Fisheries.) During 2018, 58 headboat sea sampling trips were completed for a total of 1,209 angler intercepts. For shore-side sampling, our MRIP field interviewers completed 1,197 assignments for a total of 4,356 angler intercepts: 3,189 from private vessels, 534 from charter vessels, and 633 from shore anglers.

DMF recognizes the social, economic, and cultural importance of recreational fishing to members of our Commonwealth. To that end, MRIP is vitally important to both fisheries scientists and managers who use the information to assess how catch levels affect fish population size and to develop measures for sustainable recreational fisheries.

Recreational Fishing Derby

Project staff administered the state's Saltwater Fishing Derby. Formally known as the Governor's Cup and hosted by the Division of Tourism, the derby was moved to DMF in 1983. Programmatic changes implemented in 2018 included: the creation of three new divisions of inshore, groundfish, and large pelagic; the establishment of three categories for men, women, and juniors in the catch and release portion; and the lowering of some of the minimum entry lengths for junior anglers.

There were more than 250 entries in the derby for 2018, including 60 winners with 5 Skillful Skippers and 2 Anglers of the Year. Two new state records were set for king mackerel and bigeye tuna. Other activities in 2018 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. 2018 Derby winners were recognized with awards at the annual New England Boat Show in February of 2019 (Figure 37).

Figure 37. Director Pierce and Commissioner Amidon recognizing Zak Potter for his 9-pound, 14-ounce king mackerel catch—a new state record entered during the 2018 Saltwater Fishing Derby.

Public Access

The Division's Public Access Coordinator manages all DMF saltwater fishing access projects, working closely with the *Mass*DFG Office of Fishing and Boating Access (OFBA), non-governmental organizations, towns, and other state and federal agencies to identify, plan, and implement construction/renovation/improvement of 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 2018, permitting, design, and engineering plans for a new fishing pier at Deer Island in Boston were completed. Construction was expected to begin in spring 2019. DMF also completed another year of the small grants program providing $50,000 to assist municipalities with projects that promote or support local recreational fishing activities and access. Four projects were approved for funding in 2018: the addition of lighting and security at the Gifford Street boat ramp in New Bedford; the addition of lighting at Lynn's Heritage State Park; the installation of timbers and hardware to replace worn planking at the Beverly fishing pier adjacent to the harbormaster's office; and the installation of kayak and canoe racks at Green Harbor and Peter Igo Park in Marshfield.

Figure 38. Maintenance at the Craven's Landings fishing access site in Sandwich.

Periodic site monitoring and maintenance were required at the DMF Craven's Landing access site on Scorton Creek in Sandwich (Figure 38). Seasonal contractors were hired for site patrol and coordinated for weekly summer assignments. For the first time in eight years, no closures of the property were necessary due to the presence of federally protected piping plovers. Every year, DMF staff works closely with Mass Audubon to comply with USFWS regulations. In most years, access is limited at Craven's Landing after plover chicks are born and re-opens when young plovers fledge or migrate out of a federally established buffer zone. Staff also participated in the Massachusetts Natural Heritage Program's continued implementation of a Habitat Conservation Plan for alternative management options in piping plover habitat, including serving on the Science Advisory Group's Predator Management team.

During 2018, staff worked with various entities to develop proposals for public access sites; responded to numerous inquiries from user groups and private individuals regarding shore-side fishing sites, public access rights, and future access projects; and 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, important recreational fishing news was distributed to recreational permit holders through an email alert referred to as *The Broadcast*.

Figure 39. The cover of the 2018 sport fishing guide.

Large Pelagics Research Project

Shark Research

DMF 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 are examined through the dissection and tagging of sharks. The goals are to foster cooperative shark research; participate in state, regional, federal, and international management processes; and provide public education and technical information on the biology, management, and utilization of sharks.

Movement and Habitat Studies: Our efforts to study the movement ecology of white sharks off Massachusetts and the eastern US seaboard continued with an additional 19 white sharks being tagged, bringing the total to 151 individuals since 2009. These sharks were tagged with one or more of the following technologies: pop-up satellite tags, real-time satellite tags, coded acoustic transmitters, active acoustic transmitters, and NOAA Fisheries conventional tags.

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, including the Atlantic White Shark Conservancy, aerial and vessel surveys were conducted from mid-June through October off the eastern coast of Cape Cod. Based on data collected to date, white sharks are distributed along the entire coastline of the Outer Cape (Figure 40).

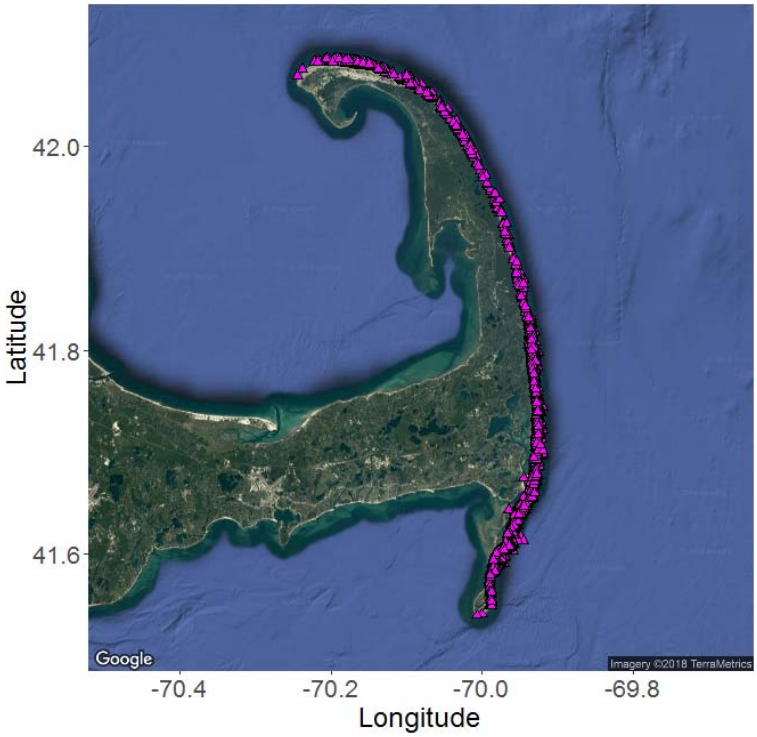

Figure 40. Distribution of white sharks along the Outer Cape, 2014–2018.

Shark Management: Staff participated in the development and/or amendment of state, interstate, federal, and international shark management plans. During 2018, staff served on the following committees: ASMFC Coastal Sharks Technical Committee and Plan Development Team; ASMFC Spiny Dogfish Technical Committee; ICCAT Advisory Committee Swordfish and Shark Working Group, and NMFS 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, and the Woods Hole Oceanographic Institution, staff co-advised and/or served on the committees of 11 graduate students; 10 of which are investigating the relative abundance, life history, movements, and/or physiology of elasmobranch fishes.

Publications: Staff co-authored eight articles published in scholarly journals in 2018. Topics included: abundance and demographics of coastal shark assemblage of Bimini, Bahamas; estimating basking shark movements in the western Atlantic; convergence of marine megafauna movement patterns in coastal and open oceans; diel movements of the blacktip shark in a Caribbean nursery; the use of shark vertebral band pairs to estimate age; the

influence of eddies on the movements of mature female white sharks in the Gulf Stream and Sargasso Sea; the use of accelerometer transmitters to study juvenile sand tiger activity patterns in a seasonal nursery; and future research directions for the study of white sharks.

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 wildlife and were formerly important for traditional small-scale fisheries in coastal towns. DMF is not only responsible for the management of diadromous fish populations in coastal rivers of Massachusetts, but also the restoration, improvement, and maintenance of their migratory pathways.

Biological Assessments for River Herring

The alewife (*Alosa pseudoharengus*) is the most abundant and well-known anadromous fish in Massachusetts. Along 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. As a result, management goals to restore river herring populations have warranted a ramping up of river herring monitoring over the last decade. DMF monitoring coverage includes at least one station targeting spawning run counts and biological data for each of the major coastal drainage areas. Additionally, DMF and local partners used electronic or video technologies to record spawning run counts at 12 other river systems in 2018 (Table 23).

In 2018, river herring counts ranged from 5,241 fish in the Mattapoisett River to 864,748 in the Herring River, Harwich. Census monitoring showed increases at most herring runs in 2018 (after a three-year decreasing trend). Substantial improvements in run counts occurred at a few locations with recent restoration activity: Mystic River, Medford; Herring Brook, Pembroke; and Pilgrim Lake, Orleans.

Project staff also provided technical assistance to local groups conducting volunteer visual counts at herring runs. In 2018, a total of 46 rivers in 34 towns were monitored in Massachusetts. Many of these local groups participate in the Massachusetts River Herring Network. Staff presented on river herring topics at the Network's annual meeting and aquatic invasive plant species workshop, including management updates, population status, and habitat concerns related to invasive plants.

Table 23. 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)
Aberjona River, Winchester	No	Video (Town)
Back River, Weymouth	Yes	Electronic
Herring Brook, Pembroke	No	Electronic
Town River, West Bridgewater	No	Electronic (Town)
Monument River, Bournedale	Yes	Electronic
Herring River, Harwich	Yes	Electronic
Acushnet River, Acushnet	No	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
Stony Brook, Brewster	No	Electronic
Sippican River, Rochester	No	Electronic
Cedar Lake, Falmouth	No	Electronic
Herring Creek, Aquinnah	No	Video

Propagation

DMF collects and transports live river herring to assist efforts to re-establish and enhance river herring runs, subject to the guidance of our Stocking Protocol Policy.

A total of 276 pre-spawning adult river herring were trapped and transported in 2018 via our stocking truck (Table 24). In cooperative efforts, an additional 11,250 river herring were collected from two Massachusetts donor systems and released into Rhode Island and New Hampshire rivers.

In 2018, DMF in conjunction with USFWS, continued efforts to restore American shad to the Charles River watershed. Approximately 300,000 young-of-year shad from the USFWS Nashua hatchery were hatched from Connecticut River broodstock and released above the Moody Street dam in Waltham.

Table 24. Number of pre-spawning adult river herring trapped and transported in 2018.

Donor System	Recipient System	Adults (#)
Parker River	Pentucket Pond, Parker River, Georgetown, MA	276
Nemasket River	Ten Mile River, Turner Reservoir, East Providence, RI	1,000
	Kickemuit Reservoir, Warren, RI	1,000
Merrimack River	Shawsheen River, Andover, MA	650
	Merrimack River, NH	1,200
	Piscataquog River, NH	1,650
	Suncook River, NH	3,000
	Pemigewasset River, NH	3,400

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 required a sustained effort in 2018 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. In 2018, assessments were concluded at Grassy Pond, Harwich and Kelly's Pond, Dennis. Technical assistance was provided to Biodiversity Works on Martha's Vineyard on their assessments of James Pond and Fresh Pond in West Tisbury. Efforts were underway in 2018 to update the project's quality assurance plan.

Diadromous Fish Restoration Priority List/*Mass*DOT Diadromous Fish GIS Datalayer: Staff provided updates and technical assistance related to a data file documenting the status of diadromous fish passageways and prioritizing restoration projects. The list focuses on passageways for river herring, but also considers other diadromous fish species and watershed connectivity. It contains 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. A GIS datalayer of the restoration priority list supports transportation infrastructure planning and environmental review activities conducted by *Mass*DOT and DMF.

Mystic River Video and Counting: Project staff provided technical assistance to help the Mystic River Watershed Association implement a web-based counting program that raised awareness about river herring passage and abundance, as well as helped assess the efficacy of an ongoing volunteer count. Staff installed and maintained the physical counting structure placed at Upper Mystic Lakes Dam. During the season, staff provided technical assistance with videography and system maintenance to ensure footage was of suitable quality.

Concord River Video and Counting: Project staff continued to provide technical assistance to help the Lowell Parks and Conservation Trust create a video count on the lower Concord River. Staff fabricated a new counting structure placed at Centennial Dam in North Billerica. During the season, staff provided technical assistance with videography and system maintenance to ensure footage was of suitable quality. This counter has confirmed that river herring ascend the ladder at Centennial Dam highlighting the need for restoration efforts at Talbot Mills Dam.

Diadromous Fish Research Studies

Alewife Tagging, Concord River: In 2018, project biologists continued to assess potential habitat use in the Concord River watershed by spawning river herring. DMF and the USFWS transported 90 alewife from the Essex Dam fish lift on the Merrimack River, implanted acoustic tags, and released them at several locations in the Sudbury-Assabet-Concord watershed. Acoustic receivers were placed throughout the watershed and lower Merrimack River to monitor tagged fish spawning activity and emigration.

American Shad Monitoring

Charles River Monitoring: In 2018, project staff worked with colleagues at USFWS to collect adult American shad from the Charles River to characterize the population and identify fish marked with oxytetracycline (OTC) in year-specific patterns. These marks will help validate otolith ageing for American shad and provide important information for coast-wide population assessments.

Merrimack River Monitoring: American shad are monitored in cooperation with *MassWildlife* each spring/summer at the Essex Dam fish lift on the Merrimack River in Lawrence, per ASMFC's Fishery Management Plan requirements. The count of American shad in 2018 decreased in comparison to 2017. Striped bass, river herring, and sea lamprey were also lifted above the Essex Dam in 2018.

American Shad Electrofishing Survey: In the spring of 2018, project staff completed the third season of a pilot study to monitor the presence and abundance of American shad in the South River and Indianhead River (Figure 41). Monitoring was conducted in each river from the head of tide to the first obstruction using a combination of visual and stream electroshocking surveys to detect the presence of spawning adult shad. During 18 sampling trips in the South River and 19 sampling trips in the Indianhead River between April and June, 56 and 181 shad were captured, respectively, for size, age, and genetic sampling. Scale-based aging indicated that these shad ranged from 3–9 years with some individuals having spawned up to four times previously. Catch-per-unit-effort indices of abundance were calculated for each river system. Monitoring was expected to continue in 2019 with the interest to develop biological and catch-per-unit-effort indices of population abundance.

Figure 41. DMF biologists release an American shad on the Indianhead River.

American Eel Young-of-the-Year Monitoring

All U.S. east coast states conduct standardized monitoring of YOY American eels under mandatory ASMFC protocols. DMF has monitored the spring migration of YOY eels in the Jones River (Kingston) using a Sheldon trap since 2001 and in the Essex River (Essex) with a fyke net since 2014 to contribute to a coast-wide index of eel population relative abundance. At 12,806 eels total and 285 eels per haul, catch at the Jones River trap improved in 2018 after a five-year trend with catches below the time-series median. The total catch of 28,708 eels in the Essex River was the highest recorded at that site.

Project staff also monitored eight eel ramps that are installed in coastal rivers to provide eel passage over barriers. 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 older eels. The eel ramp at the Wankinco River in Wareham had surprisingly high catches of glass eels in 2018. The total catch at the ramp was more than double the highest recorded for this site and was the highest recorded

for any Massachusetts eel ramp site in 12 years of monitoring. A new eel ramp was fabricated by DMF in 2018 for the Jenney Grist Mill Dam on Town Brook, Plymouth, as part of a cooperative project with the Town of Plymouth.

Rainbow Smelt Population and Habitat Monitoring

Figure 42. School of rainbow smelt next to Jones River fyke net, March 2018.

Rainbow smelt population declines since the 1980s prompted DMF to initiate spawning run monitoring using in-stream fyke nets in 2004. This monitoring continues as an annual data series to provide a relative index of abundance and size and age data. The project presently maintains four stations at the Parker River (Newbury), Fore River (Braintree), Jones River (Kingston), and Weweantic River (Wareham). Large smelt catches were made in the Fore River in 2018, greatly exceeding the previous top catches in the time-series. The Weweantic River also had improved catch numbers than in recent years. Smelt catches at the Parker River continue to trend near the lowest numbers of the time series, and the Jones River catch was below average (Figure 42).

Fish Passage and Habitat Restoration Projects

Numerous projects to improve and maintain diadromous fish passage, habitats, and populations are conducted each year. In 2018, project staff devoted time to approximately 30 individual projects in various stages of development and implementation. The following list includes completed projects and larger ongoing projects of regional significance. Efforts in 2018 focused on the large number of projects currently underway, preparations for the contracted fishway construction at the Draka Dam in Taunton, and the completion of the Pilgrim Lake outlet fishway in Orleans. Project highlights for 2018 include the documentation of river herring reaching river locations for the first time in many years due to restoration activities in the following systems: Mill River, Taunton; Bourne Pond, Falmouth; Grassy Pond, Harwich; and Forge Pond Dam, Kingston.

Pilgrim Lake, Orleans: The Pilgrim Lake outlet fishway was reconstructed by the DMF Fishway Crew in 2018 (Figure 43). This was done as a cooperative project with the Town of Orleans, in which the town provided funds for materials and essential labor and heavy machinery assistance. The construction occurred over three weeks in September and October. This site represents the final step in a long-term effort to rehabilitate the Pilgrim Lake herring run. Starting in 2011, degraded fishway components at three sites in the run were reconstructed; all excellent examples of efficient and low-cost fishway maintenance jobs by Town-Fishway Crew cooperation.

Figure 43. Construction of the Pilgrim Lake outlet fishway, Orleans.

Fore River Watershed: Efforts continued on a multi-site project to restore diadromous fish to the Fore River Watershed in the Boston Harbor region. The focus in 2018 was on the design of the Armstrong Dam removal project. The Mass*DFG* Division of Ecological Restoration was the project lead on the contracted 40% design plans for the dam removal, which was reviewed and finalized in 2018. Additionally, several meetings, dam site visits, and stream maintenance trips in Braintree were attended by project staff.

Mill River, Taunton: The removal of the Reed and Barton Dam on the Mill River in 2018 is an example of a large-scale, cooperative restoration project where multi-year technical assistance and field monitoring was provided by DMF. River herring and American eel monitoring continued to document responses in the abundance and migrations of diadromous fish to Mill River restoration actions. New in 2018 was the design, fabrication, and installation of a video counting system at Morey's Bridge Dam on the Mill River. The video system documented river herring entering Lake Sabbatia for the first time in over 200 years.

Town Brook, Plymouth: At the request of the Town of Plymouth, the DMF Fishway Crew designed and fabricated a custom pump-supplied eel ramp for the Jenney Grist Mill Dam on Town Brook (Figure 44). The eel ramp was installed at the dam in October to test the ramp and removed until deployment in the spring of 2019 to assist the glass eel migration.

Figure 44. Eel ramp installation at Jenney Grist Mill Dam, Plymouth.

Three Mile River, Taunton: The project to construct a fishway at the impassable Draka Dam on the Three Mile River continued in 2018, with a large effort of staff time to manage the construction bid process, contracting, and pre-construction preparations. The project was contracted and construction was planned for the fall, although high flows in the Three Mile River delayed construction until the summer of 2019.

Horn Pond, Woburn: Recent efforts by DMF and local partners resulted in river herring entering Horn Pond in the Mystic River Watershed for the first time in over a century in 2017. This work continued in 2018 as project staff worked with the Mystic River Watershed Association and Town of Woburn to manage flows and fish passage at the Scalley Dam. The modified spillway passed about 20,000 adult river herring, thereby granting spawning fish access to more than 100 acres of habitat. Research by UMass Amherst documented successful spawning and juvenile growth within Horn Pond. Planning began to create a nature like fishway or bypass reach to further improve passage at this site

Figure 45. James Pond beach prior to channel opening in March 2018.

Martha's Vineyard Projects: Two small-scale fishway projects and a long-term effort to provide fish passage at the James Pond barrier beach were completed on Martha's Vineyard. DMF staff drafted the project design and assisted the three-year process to develop and permit the Town of West Tisbury's plan to maintain a fish passage channel at James Pond, which was executed for the first time in March (Figure 45). In April, the Fishway Crew worked with the Town of Oak Bluffs and the Oak Bluffs Water District to replace the Denil baffles and remove sediment at the Lagoon Pond fishway, and with the Town of West Tisbury to install a new fishway entrance box at the Fresh Pond culvert.

Town River, Bridgewater: DMF is partner to cooperative efforts to improve fish passage in the Town River tributary to the Taunton River. Efforts in 2018 focused on advanced feasibility analyses and project design to remove the High Street Dam. DMF has also partnered with the Town of West Bridgewater to conduct a feasibility study for redesigning the fish ladder at the next dam upstream at War Memorial Park.

Jones River, Kingston: Staff continued to work on the long-term restoration project to restore access for diadromous fish to Silver Lake in the Jones River watershed. Stream maintenance work continued to improve fish passage downstream of the Forge Pond Dam. Technical assistance was provided to the cooperative project to remove the Elm Street Dam on the Jones River. A substantial effort through meetings, site visits, and correspondence was directed towards reaching an agreement with the City of Brockton on installing a fish ladder at the presently impassible Forge Pond Dam.

Herring Brook Park, Pembroke: DMF had a central role in the effort by the Town of Pembroke to improve fish passage at the scenic Herring Brook Park. The Fishway Crew surveyed the location and designed new instream weirs to assist passage over the rubble (Figure 46). A project narrative was drafted for the Town on this design and the project was presented at the Pembroke Conservation Commission in November. Construction of the channel and park improvements are expected to occur during the summer of 2019.

Figure 46. DMF's James Rossignol surveying the Herring Brook Park channel.

Triphammer Pond, Hingham. Working with the Town of Hingham, the DMF Fishway Crew rehabilitated the Triphammer Pond fishway in the summer of 2018. New fishway weir boards were installed, large rocks were removed from the fishway, control board slots and boards were added to the dam crest to reduce mortality of downstream migrating fish, and stream maintenance was conducted to the fragmented and overgrown stream channel downstream of the pond.

Ipswich River, Ipswich: Efforts to improve fish passage at the Willowdale Dam on the Ipswich River continued. Funding was secured through the DFG In Lieu Fee Program and designs for the new fishway and modifications to the old fishway for maximized eel passage were finalized. Construction was slated for the summer of 2020.

Fishway Permitting and Operation and Maintenance Plans

DMF issues Fishway Operation and Maintenance (O&M) Plans for all new and reconstructed fishways per the authority granted the Director under Chapter 130, Section 19 of Massachusetts General Laws. Three working draft O&M plans were revisited and revised in 2018: Snipatuit Pond fishway, Mattapoisett; Mattapoisett River Rt. 6 fishway, Mattapoisett; and Santuit Pond Dam, Mashpee. A new O&M plan was drafted and finalized for the Wequaquet Lake fishway, Barnstable.

DMF issues Fishway Construction Permits following the review of final engineering plans to construct, rebuild, or alter fishways. During 2018, four Fishway Construction Permits were prepared for projects at: Newfield Street Dam at Town Brook, Plymouth; Pilgrim Lake, Orleans; Draka Dam at Three Mile River, Taunton; and Baxter Mill Pond Dam, Yarmouth (draft).

River Herring Stream Channel Maintenance

Project staff routinely fields requests to assist Towns in maintaining 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. Our Stream Maintenance

Protocol for Diadromous Fish Passage provides coastwide guidance for these practices. Field work on stream maintenance in 2018 involved seven coastal river systems: Centerville River, Barnstable; Acushnet River, Acushnet; Jones River, Kingston; Island Creek, Duxbury; South River, Marshfield; Weir River, Hingham; and the Fore River, Braintree. The Jones River activity removed significant fallen tree jams and opened passage for river herring to the upstream Forge Pond Dam for the first time in many decades.

Other Activities

Technical Committee Participation: Staff actively participated on numerous committees related to diadromous fish including: the ASMFC technical committees for river herring, shad, American eel, and fish passage; the ASMFC stock-assessment subcommittees for river herring and American eel; the NMFS River Herring Technical Expert Working Group and River Herring Endangered Species Status Review Team; technical committees for the Connecticut River Atlantic Salmon Commission and Anadromous Fishery Management of the Merrimack River Basin. Staff also served as the president of the American Fisheries Society (AFS) Southern New England Chapter and registration coordinator for the AFS Annual Meeting. ASMFC compliance reports were prepared for American eel, river herring, American shad, and Atlantic sturgeon, as was an update to the MA American Shad Management Plan.

Education/Outreach: Project staff provided numerous presentations and technical assistance related to education, outreach, and constituency groups. Staff also attended spring river herring festivals and events at the following locations: Nemasket River, Middleborough; Town Brook, Plymouth; World Fish Migration Day at Herring River, Harwich, Mystic River, Medford, and Back River, Weymouth.

Additional Publications & Presentations: Staff authored a paper on the development of methods to monitor changes in yellow phase American eel populations in response to dam removal. Presentations were made at: the AFS Annual Meeting on foraging strategies of juvenile alewives, and the results of Mill River diadromous fish monitoring; the New England Estuarine Research Society Fall Meeting on the use of river herring spawning run counts for river herring management; the AFS Southern New England Chapter Winter Meeting on rainbow smelt reproductive life history; and the AFS Southern New England Chapter Summer Meeting on striped bass acoustic tagging.

ADMINISTRATION

Kevin Creighton, Chief Fiscal Operator, Section Leader

Personnel

Finance
Darlene Pari, Accounts Payable Coordinator
Eva Morales, Accountant III
Jeanne Hayes, Accounts Receivable Coordinator
Shannon Davis, Program Coordinator – Revenue
Samantha Andrews, Program Coordinator – Internal Control Officer

Administrative Support
Kim Trotto, Administrative Support
Lynne Besse, Administrative Support
Rosemary Mitchell, Administrative Support

Grants Management
Stephanie Cunningham, Federal Aid and Grants Coordinator
Cecil French, Project Leader – Clean Vessel Act and Boating Infrastructure Grant
Whitney Sargent, Project Coordinator – Clean Vessel Act
Maren Budrow, Assistant Federal Aid and Grants Coordinator
Melanie Griffin, Project Leader – Revolving Loan Fund & Groundfish Disaster Economic Assistance

Outreach
Christine Cassidy, Information & Education Coordinator
Kimberly Trull, Angler Education Coordinator

Seafood Marketing
Wendy Mainardi, Marketing Coordinator

Scientific Diving
Vincent Malkoski, Diving Safety Officer

Capital Assets and Facilities Management
Brian Castonguay, Gloucester Office, Head of Facilities and Capital Assets
Vincent Malkoski, New Bedford Office, Facilities and Capital Assets
Kevin Magowan, Shellfish Purification Plant, Facilities

Overview

DMF Administration is responsible for the Division's fiscal functions, grants management, capital assets, diver training, outreach efforts, and seafood marketing. Staff develops, analyzes, and manages the Division's financial planning and resource allocation activities including budget submission to the Legislature. The program is responsible for collecting fees and reconciling revenue. Staff also provide all fiscal oversight and reporting on grants, contracts, and mitigation projects. Facilities and capital assets are procured, inventoried, managed, and maintained with the intent to provide a healthy and productive working environment. 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.

Budget

Overall, state-appropriated funds increased 4.02% from Fiscal Year (FY) 2017 to FY2018 (Table 25). Appropriated funds for the operating budget increased 4.84%. The modest increase was approved to primarily cover increased annualized costs for payroll, and for boat costs associated with the completion of the third year of the cod IBS.

The Legislature has created three retained revenue accounts for DMF, whereby funds from a particular funding source may be retained by the Agency to expend for a particular purpose. The Sportfish Restoration account allows for the deposit of federal Wallop-Breaux reimbursements (a sportfish restoration program), which may then be spent on other Wallop-Breaux reimbursable projects. The Shellfish Purification Plant account allows for the deposit of funds collected for shellfish depuration and de-sanding at the Division's Newburyport facility, which may then be spent on the maintenance and operation of the plant. The Ventless Trap account allows for the deposit of funds generated from the sale of lobster permits, which are then used to fund research on commercially important invertebrate species in the Commonwealth. Funding from retained revenue accounts increased almost 10% in FY18.

Appropriations from special fund accounts decreased by less than one percent overall. The Legislature slightly decreased the appropriation on the Saltwater Sport Fish Licensing account to more closely align with projected spending in that account. This account is funded by recreational saltwater fishing permit sales and supports recreational fishery improvements. The Seafood Marketing Program, funded by revenue collected from the issuance of commercial fisherman and seafood dealer permits, remained level funded.

Table 26 provides the breakdown of costs by primary spending category for the DMF operating accounts.

Table 25. Fiscal Year 2017 and 2018 appropriations (available funds for operations).

Title	Acct. Number	FY2017	FY2018	Change
General Fund Accounts				
General Operating	2330-0100	[1]$5,526,817	[2]$5,791,632	+4.79%
Sportfish Program	2330-0120	$664,408	$699,079	+5.22%
General Fund Total		$6,191,225	$6,494,058	+4.84%
Retained Revenue Accounts				
Sportfish Retained Revenue	2330-0121	$217,989	$217,989	0.00%
Purification Retained Revenue	2330-0150	$50,524	$19,194	-61.81%
Ventless Trap Retained Revenue	2330-0199	$174,690	$250,000	43.11%
Retained Revenue Total		$442,842	$487,092	9.99%
Special Fund Accounts				
Saltwater Sport Fish Licensing	2330-0300	$1,320,159	$1,306,079	-1.07%
Seafood Marketing	2330-0104	$250,000	$250,000	0.00%
Special Fund Total		$1,570,159	$1,556,079	-0.90%
Appropriations Grand Total		**$8,204,226**	**$8,537,229**	**4.02%**

[1] The final budget for FY2017 in Chapter 133 of the Acts of 2016 was $6,298,094. DMF's general operating budget was affected by: 1) earmarks totaling $750,000 ($450,000 to SMAST; $50,000 for the Great Marsh Green Crab Trapping Program; $50,000 for the Fishing Academy, Inc.; $25,000 for Falmouth aeration; and $175,000 for shellfish propagation in Barnstable, Dukes, and Nantucket counties); 2) the Governor's 9c budget cuts and a debt payment totaling $55,148; and 3) $33,871 made available from a reserve draw account to cover employee buyout costs pertaining to the 2015 Early Retirement Incentive Program that carried into FY2017.

[2] The final budget for FY2018 in Chapter 47 of the Acts of 2017 was $6,511,649. DMF's general operating budget was affected by: 1) earmarks totaling $697,000 ($347,000 to SMAST; $50,000 for the Great Marsh Green Crab Trapping Program; $50,000 for the Fishing Academy, Inc.; $75,000 for Coastal Marsh Restoration; and $175,000 for shellfish propagation in Barnstable, Dukes, and Nantucket counties); 2) the Governor's reduction for debt payment totaling $57,888; and 3) $34,871 made available from a reserve draw account to cover employee buyout costs pertaining to the 2015 Early Retirement Incentive Program that carried into FY2018.

Table 26. FY2018 costs by account type and primary spending category (rounded to whole dollars).

	General Fund	Retained Revenue	Special Fund	Total
Salaries	$5,503,196	$140,783	$487,432	$6,131,411
Employee Expenses	$25,809	$11,605	$6,505	$43,919
Contracted Employees	$24,902	$44	$65,910	$90,856
Contracts	$5,230	$61,238	$280,594	$347,063
Facility Maintenance	$37,836	$1,606	$27,835	$67,277
Field & Lab Supplies	$68,839	$52,701	$22,340	$143,880
Fringe Costs	$92,609	$1,985	$7,800	$102,394
Fuel	$66,373	$6,084	$1,706	$74,163
Utilities	$73,340	$2	$108	$73,450
Lease/Rent	$120,502	$0	$0	$120,502
Maintenance/Repair	$68,274	$9,128	$2,661	$80,064
Office & Administrative	$167,699	$34,818	$17,646	$220,163
Services/Equipment Lease	$37,870	$148,395	$0	$186,265
Outside Agencies	$188,144	$2,064	$1,229	$191,437
Grants	$692,691	$12,876	$28,341	$733,908
Total	**$7,173,313**	**$483,328**	**$950,111**	**$8,606,751**

Staffing

Although there were several personnel changes and shifts within the spending accounts, the overall staffing level dropped by only one position between Calendar Year (CY) 2017 and CY2018 (Table 27).

Table 27. Calendar Year 2017 and 2018 Authorized Personnel Levels.

Title	Acct. Number	CY2017	CY2018
DMF General Operating	2330-0100	60	59
Sport Fish Program	2330-0120	10	10
Saltwater Sport Fish Licensing	2330-0300	7	8
Federal Grants and Trust Account	2330-xxxx*	24	23
Total Employees in All Appropriations		**101**	**100**

*Multiple account numbers

Revenue

General Fund Revenue

DMF collects fees primarily from permit issuance and processing racks of soft shell clams at the Shellfish Purification Plant. A total of 30,961 permits and endorsements were issued by the Permitting Project for the categories of commercial fishing, seafood dealers, and special permit types, producing General Fund revenue of $2,248,010 in 2018 (Table 28). Overall, there was an increase in total number of permits issued by approximately 8.4%, and total revenue for commercial permits increased by 4.18%.

The Shellfish Purification Plant processed 7,820 racks of soft shell clams in 2018, resulting in General Fund revenues of $46,920. This represents a 23% in revenue from 2017, which was due to increased de-sanding of product at the plant. Overall, there has been a declining trend in racks processed and resulting revenues since 2009.

Table 28. 2018 General Fund Permitting Revenue.

Permit Type		Permit Fee		Revenue
		Resident	Non-resident	
Commercial Fisherman	Coastal Lobster	$310	$570	$336,670
	Offshore Lobster	$310	$570	$146,220
	Seasonal Lobster	$80	$145	$8,065
	Boat 100'+	$260	$520	$11,440
	Boat 60-99'	$195	$310	$87,555
	Boat 0-59'	$130	$260	$552,630
	Individual	$65	$130	$13,390
	Shellfish & Seaworm	$40	$80	$35,200
	Shellfish & Rod & Reel	$55	$130	$23,155
	Rod & Reel	$35	$100	$23,425
Commercial Fisherman Permit Revenue Subtotal				**$1,237,750**
Seafood Dealer	Wholesale Dealer	$130	$260	$52,520
	Wholesale Truck	$130	$260	$44,460
	Wholesale Broker	$130	$260	$6,890
	Retail Dealer	$65	$130	$65,975
	Retail Truck	$65	$130	$2,405
	Retail Boat	$65	$130	$6,370
	Bait Dealer	$65	$130	$10,660
Seafood Dealer Permit Revenue Subtotal				**$189,280**
Special	Non-Commercial Lobster	$55	$75	$355,750
	Regulated Fishery Endorsements	$30	$60	$456,360
	Master Digger	$250	$500	$1,000
	Subordinate Digger	$100	$200	$2,500
	Scientific Collection	$10	$20	$970
	"Other" Special Permits	$10	$20	$4,400
Special Permit Revenue Subtotal				**$820,980**
Total				**$2,248,010**

Dedicated Fund Revenue

In addition to General Fund revenue, DMF generated $1,420,256 in revenue for the Marine Recreational Fisheries Development Fund in 2018 (Table 29). Revenue is primarily from the issuance of recreational saltwater fishing permits, but also includes direct donations to the fund. By law, all fees collected from the sale of recreational saltwater fishing permits, including permits issued to the for-hire fleet, are dedicated to the improvement of recreational saltwater fishing in Massachusetts. In 2018, the fund saw a slight increase in revenue of just over 1% over that of the previous year.

Table 29. 2018 Marine Recreational Fisheries Development Fund Revenue.

Permit Type	Permit Fee		Revenue
	Resident	Non-Resident	
Recreational Saltwater, Age 16–59	$10	$10	$1,310,810
Recreational Saltwater, Age 60+	$0	$0	$0
Charter Boat	$65	$130	$55,120
Head Boat	$130	$260	$7,150
Recreational Fund Donations			$47,176
		Total	**$1,420,256**

Grants

In FY2018, DMF spent approximately $3.9 million on federal grants and mitigation projects operating out of the DMF Trust Account, a decrease of about $1.6 million from FY2017 (Table 30). Much of the decrease can be attributed to changes in the Revolving Loan Fund (part of Economic Relief), and the lack of large infrastructure projects in the Clean Vessel Act and Boating Infrastructure Grant.

Table 30. Fiscal Year 2017 and 2018 Expenditures.

Title of Federal Grant or Trust	Account No.	FY2017	FY2018
Clean Vessel Act	2330-9222	$1,114,000	$556,000
Fisheries Statistics	2330-9712	$151,000	$164,000
Boating Infrastructure	2330-9725	$600,000	$208,000
Interstate Fisheries	2330-9730	$244,000	$247,000
ACCSP	2330-9732	$31,000	$19,000
Saltonstall-Kennedy	2330-9733	$157,000	$275,000
Turtle Disentanglement/Protected Species	2330-9739	$738,000	$825,000
Economic Relief	2330-9741	$614,000	$257,000
Fish Age & Growth	2330-9742	$266,000	$247,000
Sport Fish Coordination	2330-9743	$87,000	$86,000
MFI Grants	2330-9744		$28,000
Marine Fisheries Research Trust	2330-0101	$1,570,000	$1,020,000
	Total	**$5,572,000**	**$3,932,000**

The Revolving Loan Fund (RLF)

The Massachusetts Commercial Fisheries RLF Program, operating under a Memorandum of Agreement between NOAA Fisheries and DMF, seeks to promote the effective implementation of catch-share management in New England while minimizing the potential adverse socio-economic impacts to fishing communities and small-scale fishing businesses sometimes attributed to them. Under the program, DMF has contracted with two financial institutions, Tremont Credit Union and Community Development Partnership, to provide approved loan services to eligible applicants throughout the Commonwealth, and with a third organization, the Gloucester-based New England Fishery Sector (NEFS) II, to administer funds for groundfish quota leasing.

During CY2018, Tremont Credit Union and Community Development Partnership together continued administration of six active loans totaling $162,992 in RLF funds. Three new loans were issued to existing borrowers, one existing loan was adjusted, and two loans were closed during 2018. All borrowers except one remain compliant with their repayment terms; Community Development Partnership is working with the borrower to modify repayment terms. The lenders also assisted borrowers with technical assistance and business planning. NEFS II utilized $59,607 in revolving funds to lease-in additional groundfish quota.

Groundfish Disaster Economic Assistance Program

DMF concluded a four-year grant program (August 2014–September 2018) that distributed over $21-million in federal groundfish disaster funds to aid affected entities and support future sustainability. Throughout, DMF strove to affect timely financial aid to impacted groundfish entities, provide clear guidance and assistance to applicants and colleagues from other states, and advance longer-term mitigation strategies including alternative fishing opportunities, survey work, and safety training.

Prior to submission of a final report, DMF spent much of 2018 re-programming $200,000 allocated to design of an industry-funded buyback program. In 2017, the Industry Outreach Group established to assist with buyback design decided to suspend further development of a buyback program and indicated that any additional development would not be beneficial until conditions for the groundfish fishery change, including increased interest in permit buying and selling and stock status of key species. DMF requested to NOAA Fisheries a repurposing of the funds dedicated to the buyback administration in April. The re-budget included funds to: 1) continue the Industry-Based Survey (IBS) in the Gulf of Maine; 2) conduct a gear efficiency study for the IBS survey gear; and 3) conduct crew member safety trainings.

During 2018, the Cod IBS continued with eight one-month cruises, plus additional survey work to conduct the adjunct efficiency study examining the herding effect of the trawl net. Details are provided under Fisheries Research Project (page 60). DMF contracted with Fishing Partnership Support Services to administer two crew safety training programs. Training programs were held in Gloucester and New Bedford. Analyses were completed to explore possible regulatory amendments to improve access for the small mesh whiting fishery in the Gulf of Maine. See Conservation Engineering (page 67) for more information.

The Clean Vessel Act Program

DMF administers the Clean Vessel Act Program (*Mass*CVA) 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 2018, the 24th 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 X), 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. To date, the *Mass*CVA Program has kept over 9 million gallons of effluent from state coastal waters.

Our capital reinvestment program has enabled *Mass*CVA to expand with minimal cost to new pumpout operators

that lack the capital for investment in new infrastructure. Through this program, when an operator replaces an existing *Mass*CVA pumpout boat or fixed-location station, the replaced equipment can be provided to another new or existing operator who can pay to have it refurbished at a fraction of the cost of new equipment.

In 2018, our CVA-funded pumpout facilities included 44 private marinas, one non-profit organization, and 49 cities and towns. *Mass*CVA staff stayed in close contact with all our pumpout operators, assessing programmatic needs and shortfalls. We addressed existing equipment concerns and facility growth requests as allowed by available Federal funds (Table 31, Figure 47). Total reimbursement for all new and replacement equipment was $137,386. An additional $615,608 was spent on facility operation and maintenance costs in support of 64 pumpout boats, 83 fixed-location pumpout stations, and 13 mobile pumpout carts available to the recreational boating public along the Massachusetts coastline.

Recreational boater outreach remained a critical component of *Mass*CVA. Over 8,000 pumpout location guides were distributed to the public at marinas and other boating or fishing-related outreach events. Another widely-distributed brochure includes a "how-to" guide for pumpout station use.

Table 31. New and Replacement *Mass*CVA Infrastructure for 2018.

Recipient	Equipment
Brewer Onset Bay Marina	Replacement pumpout station
Buzzards Bay Coalition	New Pumpout Station and Tight tank
Danvers	Replacement pumpout boat engine
Wareham	Replacement pumpout boat
Sandwich Marina	Replacement of tight tank and shore-side pumpout station

Figure 47. *Mass*CVA infrastructure funded in 2018 included the Buzzards Bay Coalition's Cuttyhunk pumpout station (left) and Wareham's pumpout boat (right).

Boating Infrastructure Grant Program

The Massachusetts Boating Infrastructure Grant Program (*Mass*BIG) is a two-tiered federal grant program, directed through the USFWS and administered by DMF. *Mass*BIG is funded by the Sport Fish Restoration Fund which in turn is funded by a small percentage of the Federal Gasoline Tax (an amount representing fuel purchased by boaters across the nation). *Mass*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.

Under Tier I, *Mass*BIG may receive funding for eligible projects up to $200,000 annually. Proposed projects filed under Tier II can be much larger in scope. 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 in 2018 (Table 32). Massachusetts Department of Conservation and Recreation was awarded a Tier I grant to add transient recreational boater access to the Boston Harbor Islands through the construction and installation of 49 transient moorings off of Peddocks Island. This project will provide dependable public access via recreational boat to the Boston Harbor Islands.

During 2018, *Mass*BIG partnered with the City of New Bedford to apply for a Tier I grant to improve transient recreational boater access at Pope's Island Marina. If awarded, the grant will help with the installation of three finger piers, three electric/water pedestals, six double pennants, and a transient mooring to accommodate a vessel up to 75'.

Figure 48. Manchester-by-the-Sea worked towards completion of the Tier II funded Reed Park Transient Boater Improvement Project in 2018.

*Mass*BIG also extended Manchester's Transient Boater Infrastructure improvement project into 2018 to allow for completion (Figure 48).

Table 32. Massachusetts BIG Project Summary for the past four years.

Year	Project	Award	% Complete
2015	Solomon Jacobs Park Harbormaster Facility Project (Gloucester Harbor)	$263,930	100%
	Newburyport Visiting Transient Boater Project (Merrimack River)	$448,059	100%
	Manchester-by-the-Sea Transient Boater Infrastructure Improvement Project (Manchester Harbor)	$360,222	30%
2016	Nantucket Transient Boater Navigational Project (Nantucket and Madaket Harbors)	$45,056	90%
2017	Mattapoisett Transient Boater Access Project (Mattapoisett Harbor)	$180,000	25%
2018	Boston Harbor Islands Transient Boater Access Project (Peddocks Island)	$180,623	15%

Outreach

DMF's outreach efforts are focused on engaging and informing the Massachusetts saltwater fishing community and the general public. Activities are supported in large part by the sale of recreational saltwater fishing permits.

Information & Education

The Information & Education Project (I&E) focuses specifically on establishing and maintaining meaningful connections with Massachusetts recreational saltwater anglers. Staff achieve this in a number of ways.

Public Events: Staff were present at various trade shows and events throughout the year, such as the New England Boat Show in Boston, the New England Saltwater Fishing Show, and the Topsfield Fair.

Publications: New *Sharks of Massachusetts* and *Saltwater Fish of Massachusetts* educational coloring books were produced in the last quarter of 2018. In addition to all new images and layout, the books now include DMF specific program highlights and updated species information. 10,000 of each book were printed, and they are available for free at all offices and at public events.

A new *River Herring Viewing Guide* was completed in March for distribution throughout the region. The guide features background information on alewife, blueback herring, american eel, and rainbow smelt, as well as a description of the different types of fish ladders found in Massachusetts. The inside of the full color tri-fold brochure has a map of 15 fish passage locations and information on number of fish, parking, and viewing dates (Figure 49). The goal of the guide is to engage the public in learning more about sea-run fish and the importance of preserving fish passage through an in-person viewing of a run.

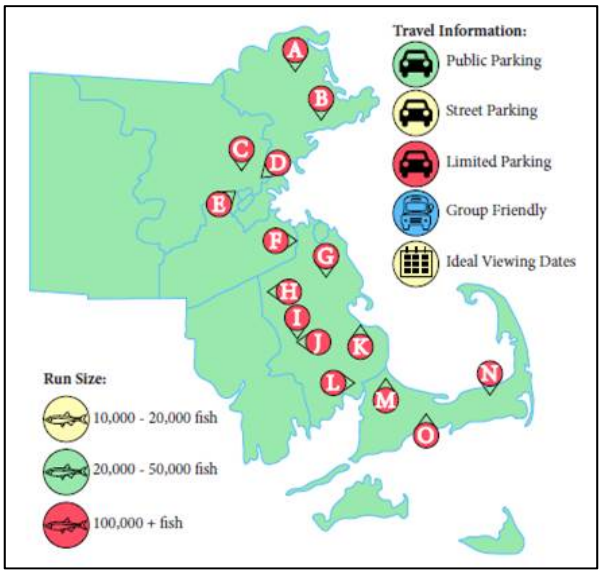

Figure 49. Map of runs included in the Division's new River Herring Viewing Guide.

Social Media: Communications with constituents through our social media platforms continued on Facebook, Twitter, YouTube, Flickr, and Instagram. DMF used these platforms to share information regarding policy and research as well as to cross promote with sister agencies within the Commonwealth.

In 2018, content for Facebook and Twitter was more focused on providing regulatory updates and near real time progress from field research, while Instagram was utilized for the telling of larger stories centered around our research programs and fisheries partnerships. Overall, the Facebook page grew 27% (1,270 new followers), Twitter 23% (601 new followers), and Instagram 80% (1,222 new followers). DMF also saw an increase in engagement rates with constituents on these platforms.

In the summer of 2018, I&E continued the "*What is it? Wednesday"* social media campaign on Facebook, targeting recreational anglers. An informational game, photographs and videos of Division research were posted to engage the community. Correct guesses were entered into an end of summer drawing for a spinning rod/reel combo, donated by Bass Pro Shops. Follow-up postings offered additional information and promoted various projects in addition to highlighting many of the species found in Massachusetts waters.

R3 Initiatives: Every year, DMF works in conjunction with the Recreational Boating and Fishing Foundation (RBFF) to increase participation in recreational saltwater angling. In 2018, the Division's R3 initiatives focused on improving the user experience on our recreational licensing platform. Working with the licensing vendor, Aspira, DMF and *Mass*Wildlife improved the look and functionality of the MassFishHunt homepage. The new homepage not only makes it easier for a user to search for their account, but also provides critical recreational fishing information.

Also in 2018, DMF continued development of a plan to deliver effective angler recruitment, retention, and reactivation (R3) efforts. Division staff attended the RBFF State Marketing Workshop in Atlanta, Georgia to learn about new and evolving marketing techniques and resources to provide our saltwater permit holders.

Other: Staff continued to represent the Division on Massachusetts Marine Educators, the National Marine Educators Association, and the New England Ocean Science Education Collaborative.

Saltwater Angler Education

Our Saltwater Angler Education initiative works to promote responsible recreational saltwater fishing in coastal Massachusetts waters, specifically reaching out to those who are new to the sport. Major components include fishing clinics (Figure 50) and a small grant program, which awards up to $500 per proposal for outside entities to create event(s) promoting saltwater angler education within Massachusetts.

In 2018, DMF hosted or participated in two youth fishing events, two events open to all ages, and one school fishing seminar (Table 33). Two other planned youth fishing clinics were cancelled due to weather. Events occurred from May through August, were free to participants, and included over 150 youths under the age of 15. At these events, Division staff taught basic angling skills, how to responsibly handle fish, the importance of recycling monofilament, and other fun activities such as knot tying and painted fish prints. Educational handouts were distributed to registered youth, as were mini tackle kits which included circle hooks and a measuring tape. At the end of each 3-hour event, our goal is to have participants feel confident enough to saltwater fish on their own. Providing tackle to participants greatly increases those odds.

Also this year, DMF administered funding to the Salem Parks and Recreation Department to assist in their development of a youth-focused saltwater fishing program, and to a non-profit group, The Fishing Academy, Inc., which works with inner-city children around the Boston area to engage them in saltwater fishing.

Figure 50. "Let's Go Fishing" youth clinic participants getting geared-up.

Table 33. 2018 Saltwater Angler Education Fishing Events.

Event	Partnering Organization(s)	Participants
Phoenix School Fishing Seminar	City of Beverly	20
Boating & Water Safety Day	Canal Visitor Center	35
Family Fishing Night at Cape Cod Canal	Canal Visitor Center	50
Bass River Youth Fishing Clinic	Town of Yarmouth	30
Fort Taber Youth Fishing Clinic	City of New Bedford & Buzzards Bay Anglers Club	20

Seafood Marketing

The Seafood Marketing Program continued to partner with organizations to educate consumers and promote local seafood. The first annual Seafood Day at the Statehouse was co-organized with the Massachusetts Fishing Partnership Support Services, and took place in October with industry organizations and a locally-sourced lunch. Two new partnerships in 2018 were specifically geared towards events and seafood sampling: Red's Best put on events at the Boston Public Market in the form of species-specific classes, and Eating with the Ecosystem brought a seafood boat to farmer's markets around the state to do chef demonstrations and tastings over the summer. Existing relationships also continued with such organizations as MA Farm to School.

The Seafood Marketing Program commissioned a report about the state of the dogfish market which was widely distributed and used by fisheries managers. The Seafood Marketing Program is active with groups of all kinds such as the Alternative Species Working Group (on Cape Cod), MA Food Policy Council, and participates in MA Agriculture Day, the Boston Local Seafood Festival, and other events.

The grant program distributed $72,000 in funding to seven marketing campaigns designed to increase awareness and demand for our underutilized or undervalued Massachusetts seafood products:

- Metropolitan Area Planning Council, Boston ($10,000): Developing and issuing a collective procurement for local seafood products, focusing on underutilized or undervalued species, on behalf of school districts across eastern and central Massachusetts.
- Our Wicked Fish, South Deerfield ($10,000): Western Massachusetts regional market accessibility evaluation of restaurants, workshops for restaurant staff, and outreach events on underutilized species to increase access and approachability.
- Williams Agency, Cambridge ($15,000): Promotion of Cape Shark (otherwise known as dogfish) to new domestic markets, including ethnic and Caribbean consumers/eaters in the Greater Boston area as a highlight of the year's Boston JerkFest, a Caribbean food festival.
- City of Gloucester/Gloucester Fishermen's Wives Association, Gloucester ($12,000): For the "Gloucester Fresh" Yellowtail Flounder and Monkfish demonstration and promotional program at the New England Food Show and Seafood Expo North America.
- Green Crab R & D Group, Ipswich ($5,000): To increase the culinary supply and demand of value-added green crab products to ease the pressure on native shellfish species and eelgrass through partnerships with seafood wholesalers and other organizations doing green crab research and development.
- New Bedford Harbor Development Commission, New Bedford ($10,000): Consumer education about underutilized species through cooking classes, educational material, work with retailers to document the local supply chain, and development of a stakeholder group.
- Wellfleet Shellfish Company, Wellfleet ($10,000): Signage, marketing, employee training, take-home recipe cards, and tasting events to promote lesser-known but plentiful local species with sales monitoring and a survey of customers and staff on willingness to try new species.

Scientific Diving

Scientific Diving is responsible for management of all scientific diving activities conducted by the Division. 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 DMF training and dive operations, affording Division divers greater protection from accidental injury and helping to ensure the success of research performed by diving.

DMF scientific divers conducted over 500 research dives to support on-going research and monitoring programs, including artificial reef site surveys; benthic temperature monitoring; early-benthic-phase lobster suction surveys; eelgrass monitoring and restoration; shellfish abundance and habitat surveys; maintenance of acoustic telemetry receivers; PCB monitoring sample collection; and diver training. 2018 highlights included bottom surveys for new artificial reef sites in Cape Cod Bay, continued post-deployment monitoring of the new artificial reef off Harwich, and the successful completion of dry suit training for DMF, *MassWildlife*, and SMAST biologists and students. DMF also maintained reciprocity agreements with the EPA, Boston University, and Northeastern University, permitting cooperative diving research. DMF divers also assisted the Massachusetts Board of Underwater Archeological Resources and the Nipmuc Nation with an underwater survey of Native American dug-out canoes in Central Massachusetts.

Routine program management duties included diver training, equipment maintenance and repair, maintenance of the air system, and educational and outreach efforts to dive clubs, schools, and local dive shows. Outreach highlights included a DMF booth at the Boston Sea Rovers Show, World Oceans Day at the New England Aquarium, and the Beneath the Sea Show in New Jersey. DMF hosted the 2018 Boston Sea Rovers Summer Intern and the 2018 Our World Underwater Scholar during the summer field season. Staff served on the Board of Directors of the Our World Underwater Scholarship Society and the American Academy of Underwater Sciences, and as President of the American Academy of Underwater Sciences Foundation.

Capital Assets and Facilities Management

Facilities

DMF maintains facilities at several coastal locations throughout the state. Headquarters are located in Boston, with the two primary field stations being 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 and field support facility in New Bedford, and a subsidiary field office and storage facility in Sandwich.

In FY2018, DMF spent approximately $85,000 in facility planning, infrastructure maintenance, emergency repairs, and equipment throughout the agency. At the Gloucester Field Station, damaged fencing around the property was repaired, the front gate was replaced, certain lab equipment was replacement, an industrial dishwasher was installed in the lab, and a high volume postage machine was added to the front office. At the Shellfish Purification Plant, low water alarms were installed in the shellfish tanks to allow their holding of product on weekends when no personnel are on site, an overhaul of the gantry crane was completed, and routine maintenance to the process area floor was performed. At the Hughes Hatchery, minor repairs were made to the roof and a new exterior door was installed.

In addition, the agency contributed $10 million in capital funds granted by the Office of Administration and Finance as part of the $55 million dollar facility shared by SMAST and DMF. Construction of the new SMAST East facility was completed in early 2018, and most of the South Coast staff moved into the new facility in February (Figure 51). Renovations of SMAST West were completed by mid-March, and the South Coast Shellfish Program moved into their new offices by early April. Completion of this facility brings the South Coast personnel to a single location for the first time since 2005.

Figure 51. The new SMAST East facility in New Bedford.

Vehicles and Boats

DMF maintains a fleet of 40 vehicles and 16 boats. In 2018, over $134,000 was paid to the Office of Vehicle Management for lease vehicles, and an additional $45,000 was spent on maintenance and repair for all stock. Two new small SUVs were received in 2018, replacing extremely worn and sidelined vehicles. No vessels, trailers, or outboards were replaced in the DMF fleet for 2018, but routine maintenance of the vessels and trailers cost just over $25,000.

Appendix A. 2018 Publications

DMF Technical Reports

Nelson, G.A., Wilcox, S.H., Glenn, R., and **Pugh T. L.** 2018. A Stock Assessment of Channeled Whelk (*Busycotypus canaliculatus*) in Nantucket Sound, Massachusetts. DMF TR-66.

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