Seining for Menhaden in Boston Harbor
Photo Credit: Julia Kaplan

Department of Fish and Game

Massachusetts Division of Marine Fisheries

2021 Annual Report

Department of Fish and Game

Massachusetts Division of Marine Fisheries

2021 Annual Report

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

Executive Office of Energy and Environmental Affairs
Secretary Kathleen Theoharides

Department of Fish and Game
Commissioner Ronald Amidon

Division of Marine Fisheries
Director Daniel J. McKiernan

www.mass.gov/marinefisheries

January 1–December 31, 2021

Table of Contents

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

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

Achieve sustainable fisheries and healthy marine ecosystems through sound science, innovation, collaboration, effective leadership, and stewardship all serving to enrich the productivity and socioeconomic value of marine fisheries to the Commonwealth.

Goals

Advance understanding and stewardship of our living marine resources, including fish, habitat, and marine protected species.

Support sustainable commercial and recreational fisheries.

Protect public health through monitoring and management of shellfish resources and advance the development of a sustainable marine aquaculture industry.

Expand and foster regional science, management, and education partnerships.

Build and maintain a high level of staff professionalism and administrative leadership.

Frequently Used Acronyms and Abbreviations

USACE	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

Daniel J. McKiernan, Director, Section Leader

Fisheries Policy and Management Program

Personnel

Daniel McKiernan, Director
Melanie Griffin, Federal Fisheries Policy Analyst
Nichola Meserve, Interstate Fisheries Policy Analyst
Jared Silva, State/Local Fisheries Policy Analyst
Kelly Whitmore, Federal Fisheries Policy Analyst
Julia Kaplan, Communications Specialist

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 2021 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 across 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. Extensive staff preparation occurs for these meeting including the development of recommendation memoranda on proposed regulatory changes that summarize public comment and review the biological and socio-economic impacts of alternatives; and preparation of informational presentations and written briefing on state, interstate, and federal fisheries management issues to keep the MFAC apprised of recent developments.

The MFAC was convened for nine business meetings during 2021, all of which were held virtually due to the Covid-19 pandemic. Regulatory revisions and fishery specifications approved by the Commission during 2021 are included in the summary of fisheries management actions beginning on page 14. The MFAC's law enforcement subcommittee also met during the year. There were no changes to MFAC membership in 2021.

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 engage with the Division on 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 improving public access to marine recreational fisheries.

The panel held two meetings during 2021, both conducted virtually due to the Covid-19 pandemic. The first meeting focused on the Division's recommended spending plan for the expected FY2022 fund appropriation of roughly $1.7 million, while the second meeting focused on recreational permitting and project updates. The panel endorsed the Division's FY2022 spending plan, which included: design and engineering costs for a replacement fishing pier in Salem Harbor at the historic Salem Willows Park; the Small Grants Program through which municipalities can compete for funds to finance public access improvement projects; enhanced sampling and assessment of the recreational fishery; public informational and educational materials and programs; monitoring diadromous fish populations; monitoring fish populations at artificial reefs; and research into striped bass catch and release mortality rates. Panel members also attended a June 24 ribbon-cutting ceremony for the completion of the Deer Island Recreational Fishing Pier in Boston Harbor (Figure 1).

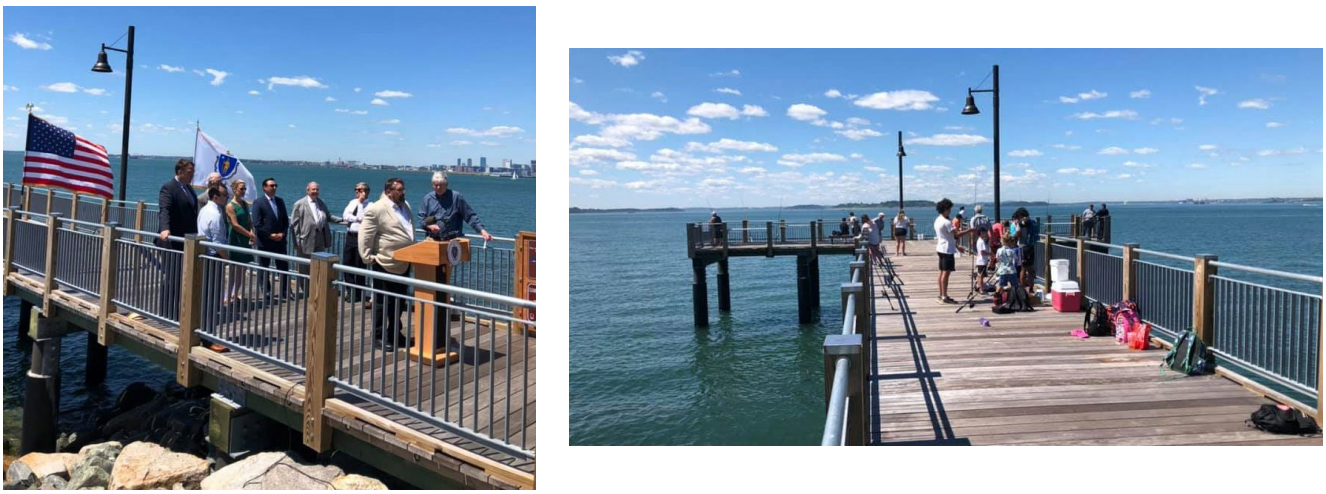


Figure 1. Images from the Deer Island Fishing Pier ribbon cutting ceremony. Left: Panel member Patrick Paquette, alongside state and local officials, addresses the crowd of fishing advocates. Right: youth anglers tested out the pier as part of the event.

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 the DMF Director, met two times during the year (both in a virtual setting due to the Covid-19 pandemic). See Seafood Marketing (page 107) for more information.

Shellfish Advisory Panel

DMF formed an ad-hoc shellfish advisory panel in 2014 to increase agency-industry communication on emerging issues, matters of concern, and possible solutions with regards to the shellfish fisheries in the Commonwealth. The group included harvesters, dealers, researchers, aquaculturists, and municipal shellfish officials and met on an ad-needed basis through early 2021. A Shellfish Advisory Panel (SAP) was formally established by the Massachusetts legislature in 2021 (G.L. c. 130, §1C). The formation of the SAP was a primary objective of the Massachusetts Shellfish Initiative's Strategic Plan. The MSI was a stakeholder-driven, multi-year process led by a 21-member task force to develop a plan to enhance the economic, environmental and social benefits of shellfish resources in Massachusetts and forge a clear and better path forward. The SAP membership includes eight legislatively appointed officials from state government (or their designees) and 14 members from Massachusetts' shellfish community appointed by the DMF Director. The SAP held its inaugural meeting in November 2021, receiving updates from DMF on emerging issues including classification issues in areas within and adjacent to mooring areas and wastewater treatment plants, and discussing the panel members' priorities regarding shellfish management in the Commonwealth.

Public Input & Stakeholder Engagement

Input from commercial and recreational fishery participants and other stakeholder groups is integral to the Division's initiation, development, implementation, and monitoring of fisheries management initiatives. Stakeholder engagement is achieved through various structured processes including public hearings and comment periods; scoping and informational meetings; and the distribution of Advisories, the Division's newsletters, annual reports, and other publications. Such activities for 2021 are described below. Policy and Management staff also routinely participate in informal meetings with commercial, recreational, and non-traditional fisheries stakeholders at their request to discuss items of interest; and respond to constituent inquiries about fisheries management issues in the Commonwealth.

DMF Public Hearings & Comment Periods

State law requires DMF to conduct a public comment period and hold a public hearing(s) on most types of proposed amendments to the state's marine fisheries regulations. During 2021, three such comment periods were held including a total of three public hearings (all held virtually due to the Covid-19 pandemic). Two additional public comment periods were initiated during late 2021 but because their hearings and comment period deadlines occurred in 2022, they will be documented in next year's Annual Report.

- February 4–March 5 comment period, with a hearing on March 2 (virtual): circle hook requirement for recreationally fishing for striped bass with bait; recreational Gulf of Maine cod and haddock limits; and a blue crab trap prohibition.
- March 5–April 2 comment period, with a hearing on March 29 (virtual): commercial striped bass season and open fishing days; commercial menhaden gear, catch storage, and reporting requirements;

commercial black sea bass pot gear specifications for ghost panels; a prohibition on Atlantic bluefish tuna purse seining; and a housekeeping correction to the seasonal mobile gear closure language.

- April 16–May 20 comment period, with a hearing on May 11 (virtual): buoy line marking rules for commercial lobster and crab trap fishery.

Certain other actions, such as Director's Declaration to adjust commercial fishery limits for quota managed species, require a public comment period only. During 2021, written public comment was accepted on the following proposed actions:

- February 19–March 5: lifting the conditional April commercial groundfish closure between Marblehead and Plymouth for 2021.
- July 30–August 13: in-season adjustments to commercial black sea bass trip limits and open fishing days.
- August 28–September 10: in-season adjustments to commercial summer flounder trip limits and open fishing days.
- September 9–September 23: establishment of 2021 commercial scup Winter II trip limit.
- November 8–November 22: establishment of 2022 commercial scup Winter I trip limit.
- November 12–November 22: in-season adjustment to 2022 commercial summer flounder Period I trip limit.

DMF Scoping and Informational Meetings

DMF occasionally holds additional ad hoc meetings to inform the industry of and/or accept informal scoping comment on upcoming issues. During 2021, the following such events were held:

- February 2–12 scoping period to accept written input on options to modify the recreational black sea bass season through conservation equivalency.
- March 23 informational session (held virtually) to provide updates and clarification to commercial lobster trap, fish pot, and whelk pot fishermen regarding how to comply with new gear modification regulations, specifically the use of 1,700-pound "weak rope" and the installation of contrivances in the buoy line to meet the 1,700-pound breaking strength standard.
- November 18 scoping meeting (held virtually) to discuss summer flounder commercial management and industry's preferred measures to better utilize available quota.

Publications

Advisories: DMF released 82 electronic notices to our subscriber list on various rule changes, public hearings, quota closures, and other important information. The use of the subscription service (Granicus' GovDelivery platform adopted in 2020) continued to prove effective in greatly improving the quality and expanding the reach of our electronic communications with stakeholders. Advisories are also posted to the Division's website and social media platforms.

DMF News: DMF published its newsletter twice in 2021 (Figure 2). These publications serve to inform and educate our constituents on major management, science, and administrative happenings at the Division. Large-scale distribution of the newsletter occurs primarily in electronic format through the Division's website and listserv. Small-scale printing of copies for distribution at trade shows and other events was suspended for 2021 given the cancellation of events due to the ongoing Covid-19 pandemic.

Annual Report: DMF published its *2020 Annual Report*.

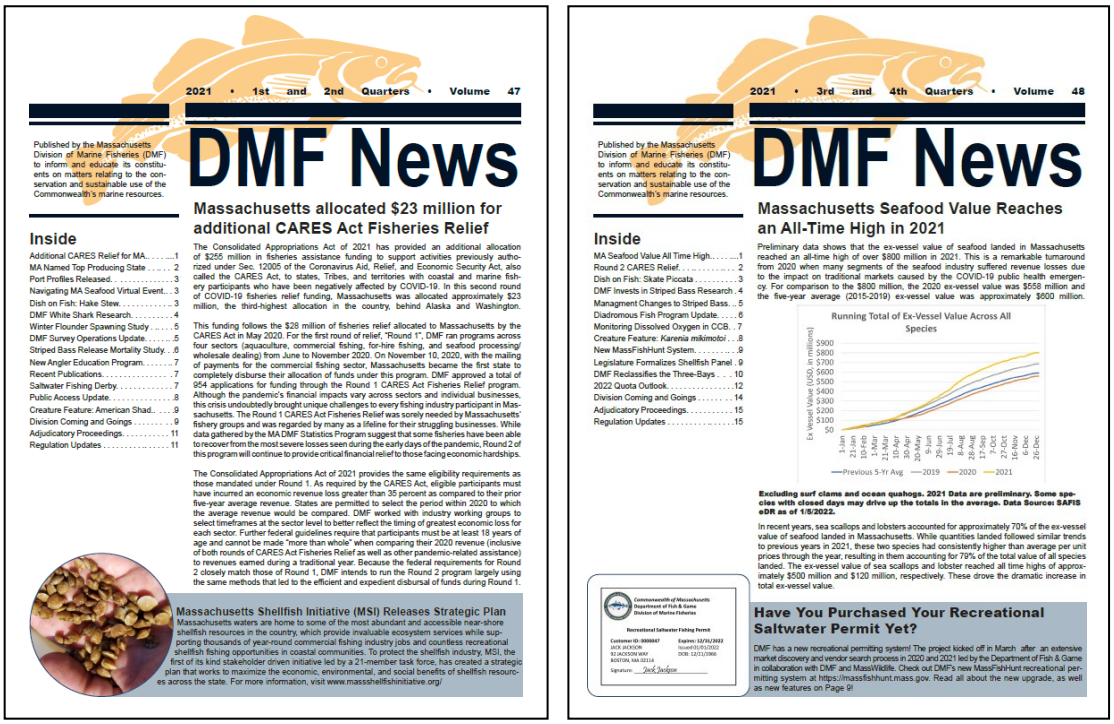


Figure 2. The covers of the two 2021 editions of the DMF News.

Regional Councils and Interstate Commissions

New England Fishery Management Council

Some fisheries go beyond state level and are managed regionally in collaboration with the federal government. The Director of the Commonwealth's Division of Marine Fisheries serves as one of 18 voting members on the New England Fishery Management Council (NEFMC). One of eight regional fishery councils established in 1976 under the Magnuson-Stevens Fishery Conservation and Management Act, the NEFMC supports management of the living marine resources within the United States exclusive economic zone (EEZ), spanning from 3 to 200 miles offshore, from Maine through Connecticut. The regional councils develop federal fishery management plans (FMPs), which are implemented by NOAA Fisheries after it ensures that 10 National Standards within the Magnuson-Stevens Act have been met. The NEFMC has federal FMPs for: Northeast Multispecies (13 groundfish stocks), Atlantic Sea Scallop, Monkfish, Atlantic Herring, Northeast Skate Complex (seven species), Small-Mesh Multispecies (five groundfish stocks), Red Crab, Spiny Dogfish, Atlantic Salmon, and Habitat. Since regional fisheries don't recognize jurisdictional boundaries, the Division also seeks to balance state waters management of regional fisheries in a manner consistent with and in support of federal FMPs, in some cases this is done with the ASMFC to coordinate management plans between federal and state waters.

Meetings: During 2021, staff represented Massachusetts at five NEFMC meetings; served on the Atlantic Herring, Atlantic Sea Scallop (Chair), Executive, Groundfish, Monkfish, Skate, and Spiny Dogfish Committees; acted as NEFMC liaisons to the MAFMC River Herring/Shad, Squid/Mackerel/Butterfish, and Spiny Dogfish (Vice-Chair) Committees; provided technical expertise to the Groundfish, Atlantic Sea Scallop, Atlantic Herring, and Habitat Plan Development Teams, the Northeast Trawl Advisory Panel, and Research Set-Aside (RSA) programs for Atlantic Herring and Atlantic Sea Scallops; and participated in over 100 Council related meetings, hearings, and workshops. In recognition of these cooperative activities and their benefit to the successful management of fisheries, the Council once again granted the Commonwealth funds to support management and technical

assistance (see Grants section, page 98, for further details). Due to public health circumstances surrounding the COVID pandemic, all meetings were held virtually with limited exceptions.

Actions: Working through the COVID pandemic brought challenges common to various fishery management bodies such as advancing virtual meeting capabilities and addressing data gaps (e.g., loss of observer and fishery independent survey information for both commercial and recreational fisheries).

Throughout 2021, the Council finalized specifications for access to its various managed fisheries while advancing longer-term priorities including reviews of scallop rotational management and surveys, comments on offshore wind and aquaculture projects consistent with revised policies, workshops on cod stock structure, and contributions to climate change scenario planning.

Staff continued to contribute to technical analyses (see Fishery Dependent Investigations) and policy decisions at the NEFMC in support of 2021 work on Atlantic Herring FMP Framework 9 (rebuilding plan and revision of accountability measures), Groundfish Frameworks 61 (2021–2023 specifications and universal sector exemption for redfish) & 63 (2022–2024 specifications, including 2022 recreational Georges Bank cod measures), recreational recommendations to the Greater Atlantic Regional Fisheries Office for management of Gulf of Maine cod and haddock, limited entry for party/charter groundfish vessels (rejected), and control dates for skate bait and wing fisheries (rescinded).

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. Mr. Michael Pierdinock of Plymouth, MA was appointed by the Secretary of Commerce to fill the Massachusetts obligatory seat formerly held by Dr. John Quinn of New Bedford, MA, who termed out after his third consecutive three-year appointment. Dr. Quinn's tenure included serving as the Council's chair for his final five years.

Atlantic Mackerel Recreational Fishery Management: Atlantic mackerel is managed by the MAFMC; however, the fishery (both commercially and recreationally) has shifted northward to New England waters. This shift along with continuing rebuilding concerns pulled the Commonwealth more directly into regional management. Staff held one of two NEFMC liaison seats on the MAFMC's Atlantic Mackerel Committee in 2021 and the MAFMC reached out to the states of Maine, Massachusetts, and New Hampshire in November 2021, requesting that the states reduce recreational Atlantic mackerel catch in their waters by half. In December 2021, the three states provided an initial response to the MAFMC, noting their support for sustainable management and the importance of rebuilding the Atlantic mackerel stock but also sharing a few concerns. Staff (DMF and MAFMC) analyses and public informational webinars for New England stakeholders helped support a deeper understanding of survey coverage, potential stock geographic shift, and uncertainties in available data. At the end of 2021, DMF staff was continuing to develop state regulatory responses (e.g., potential bag limit) and contribute to development of Mid-Atlantic rebuilding options.

Atlantic States Marine Fisheries Commission

The Atlantic States Marine Fisheries Commission (ASMFC) coordinates the conservation and management of 27 nearshore, migratory fish and shellfish species along the Atlantic coast. The Commission was formed through an Interstate Compact, ratified by the states and approved by the U.S. Congress in 1942. Each member state from Maine through Florida is represented by three Commissioners—the director of the state's marine fisheries management agency, a state legislator, and an individual appointed by the state's governor to represent stakeholder interests—who collectively have one combined ballot on votes taken by the Commission's species management boards. These species management boards develop and adopt interstate FMPs, which are then implemented at the state level. Failure to implement interstate FMP requirements can result in a non-compliance determination triggering the U.S. Department of Commerce to close a state's fisheries until

regulatory compliance occurs. In addition to interstate fisheries management, Commission deliberations also address fisheries science, habitat conservation, and law enforcement.

Meetings: During 2021, Massachusetts had a declared interest and served on 16 species management boards, including American Eel, American Lobster/Jonah Crab, Atlantic Herring, Atlantic Menhaden, Atlantic Striped Bass, Atlantic Sturgeon, Bluefish, Coastal Sharks, Horseshoe Crab, Northern Shrimp, Shad/River Herring, Spiny Dogfish, Summer Flounder/Scup/Black Sea Bass, Tautog, Weakfish, and Winter Flounder. DMF represented Massachusetts at the four routine quarterly meetings of the ASMFC (Winter, Spring, Summer and Fall), plus four additional Board-specific meetings (Striped Bass, Tautog, Lobster, and Northern Shrimp), five additional meetings held jointly with the Mid-Atlantic Fishery Management Council on co-managed species (Summer Flounder/Scup/Black Sea Bass and Bluefish), and three Atlantic herring days out meetings. All of these meetings were held virtually due to the Covid-19 pandemic, with the exception of the December Joint MAFMC/ASMFC meeting which offered both remote and in-person options for attendees. Staff chaired the ASMFC management boards (for at least part of the year) for American Lobster/Jonah Crab and Shad/River Herring.

State representation was also provided on the ASMFC Executive Committee and Interstate Fisheries Management Program Policy Board. The Executive Committee continued to meet remotely with great frequency to address such issues as the coordination and distribution of Round 2 of CARES Act Fisheries Relief (see page 98). Management and Policy staff also served on various committees that were active in 2021 including the Striped Bass Circle Hook Ad Hoc Committee (addressing refinements to a new recreational fishing requirement); the Striped Bass Plan Development Team (for Amendment 7); the Atlantic Menhaden Workgroup (identifying management issues and possible strategies for the next management action); the Northern Shrimp Management Strategy Evaluation Workgroup (addressing changes in species abundance and environmental changes in the Gulf of Maine); and the Tautog Plan Review Team (reviewing state management proposals and compliance reports); and also attended the meetings of various other technical, scientific, and monitoring committees to stay informed of the latest developments in interstate management issues.

Public Hearings: States are afforded the opportunity of a public hearing for any draft addendum or amendment to the ASMFC's interstate fishery management plans. DMF assists ASMFC in the scheduling and moderation of hearings. During 2021, DMF hosted (or co-hosted with other states) three ASMFC public hearings to collect stakeholder input on the following management actions: the Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment (February 17); the Striped Bass Draft Amendment 7 Public Information Document (March 18); and the Bluefish Allocation and Rebuilding Amendment (April 1). The hearings addressing summer flounder, scup, black sea bass, and bluefish management were held as joint hearings for the Mid-Atlantic Fishery Management Council's complimentary federal FMP actions. Due to the Covid-19 pandemic, all hearings were held virtually.

Actions: Several of the more remarkable fishery management actions that DMF staff played an integral role in 2021 included: the Summer Flounder, Scup, and Black Sea Bass Management Board's approval of new commercial state quota allocations for black sea bass in recognition of stock redistribution, and revised commercial/recreational allocations for all three species incorporating improvements to the catch estimates from the historic reference periods; the Striped Bass Management Board's clarification on the recreational circle hook requirement and the development of Draft Amendment 7; the Bluefish Management Board's approval of a rebuilding plan and revised commercial/recreational and state-by-state commercial allocations; and the Northern Shrimp Section's extension of the ongoing fishery moratorium through 2024.

Fisheries Management Actions

Described below are the fishery management actions enacted by DMF during 2021. Actions fall into several categories: permanent regulatory changes to 322 CMR (Code of Massachusetts Regulations) which can occur only after a public hearing and comment period on the proposals and are subject to the MFAC and Commissioner of DFG's approval of the Director's recommendation; temporary (90-day) regulatory changes to 322 CMR under the Director's Emergency Authority for the preservation of the public health, safety or general welfare; annual specifications and adjustments under the Director's Declaration Authority as established in pertinent regulations, some of which require public comment periods; time-specific authorizations or restrictions per Letters of Authorization, Permit Conditions, Pilot Programs, and Quota Transfers.

Atlantic Herring

Area 1A Effort Control Permit Conditions: DMF implemented landing days, possession limits, and seasonal closures for the directed herring fishery in Area 1A (inshore Gulf of Maine) consistent with ASMFC Herring Management Board decisions. Letters of Authorization were issued to vessels which had declared into the directed fishery through DMF's opt-in process and according to their federal category permit. The Massachusetts/New Hampshire spawning area closure was also implemented per the FMP's default closure dates (September 23–November 3).

Atlantic Menhaden

Commercial Regulations: Effective June 11, DMF enacted a series of new rules to enhance enforcement and compliance in the state's commercial menhaden fishery when it is conducted under the 6,000-pound trip limit. This included a maximum purse seine size of 450-feet long by 48-feet deep and a requirement that all menhaden caught be immediately brought on board and stowed in 55-gallon barrels or standard fish totes upon retention. A volume-to-weight equivalency was developed for these containers with a level filled fish tote weighing the equivalent of 117 pounds and a level filled barrel weighing 350 pounds. Therefore, 51 fish totes or 17 barrels are the equivalent to the 6,000-pound trip limit. Fish totes and barrels may be used interchangeably, with a three fish tote to one barrel ratio used to determine trip limit compliance. Additionally, to conform state regulations to the Interstate Fishery Management Plan for menhaden, if Massachusetts opts into the Episodic Event Set-Aside Fishery, then all participants are required to obtain a bait dealer permit and report their catch into SAFIS as a bait dealer on a nightly basis.

Episodic Event Set-aside Permit Conditions: For the second year, Massachusetts participated in the Episodic Event Set-aside Fishery, landing approximately 1.96-million pounds of the 4.28-million pound set aside during June 18–July 16. DMF closed the state's quota managed fishery effective June 17, and immediately enrolled in the program through a request to the ASMFC. To control the pace of landings from this shared quota set-aside, DMF issued permit conditions restricting limited entry participants to a 25,000-pound trip limit (rather than the applicable regulation's 120,000-pound trip limit); the 6,000-pound open access limit continued to apply to those participants.

Commercial Quota Transfers: Massachusetts received six transfers of commercial menhaden quota totaling 2.49 million pounds, bringing the state's quota to roughly 7.91 million pounds. These transfers from Connecticut, North Carolina, South Carolina, Georgia, Pennsylvania, and Florida were made in response to persistent high inshore availability of menhaden after the state's quota and the EESA were taken in mid-July, and enabled the fleet to continue harvesting at a 25,000-pound trip limit accountable to the quota, rather than under the 6,000-pound small scale/incidental catch limit which is not accountable to the quota. Maine, Massachusetts, and Rhode Island took a cooperative approach to requesting transfers from these states to lessen their

administrative burden and then allocating the transfers in agreed-upon portions. Menhaden quota transfers require multi-state agreement and ASMFC approval per FMP requirements.

Bluefish

Commercial Quota Transfers: Massachusetts received a 50,000-pound transfer of bluefish commercial quota from New Jersey in 2021 in order to extend the season into the fall. Bluefish quota transfers require multi-state agreement and ASMFC and NOAA Fisheries approval per FMP requirements.

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 Period I Pilot Program: DMF renewed its seasonal wintertime summer flounder pilot program for 2021. Under this program (begun in 2020), vessels fishing offshore in the federal zone during the Period I fishery (January 1–April 22) that are also permitted to land summer flounder (and black sea bass) in Rhode Island, Connecticut, and New York were authorized to possess multiple states' trip limits when offloading in Massachusetts. This allowance, which provides additional flexibility and efficiency to the fleet, is contingent on the vessel properly labeling the catch destined for each state, not exceeding the aggregate trip limit for the participating states where they are permitted, and not offloading more than the state's applicable landing limit. Additionally, participating vessels must be equipped with a Vessel Monitoring System authorized by NOAA Fisheries. Participation in the pilot program was granted through Letters of Authorization issued to eligible harvesters.

Fluke Commercial Period I Declarations: DMF made a temporary adjustment to the Fluke Period I (January 1–April 22) commercial trip limit to increase the fleet's access to the state's available quota, which was increasing 29% from the prior year. Due to timing issues, a Director's Declaration was used to increase the limit for the whole of the Period 1 fishery from the regulatorily-set 1,000 pounds to 2,000 pounds. The Period I fishery has a target allocation of 30% of the state's annual quota, and the trip limit is reduced to 100 pounds when 25% of the annual state quota is projected to be taken. This occurred on April 11 in 2021, the first time since 2017.

Fluke Commercial Period II Pilot Program: Via Letters of Authorization, DMF renewed the pilot program begun in 2019 allowing trawlers during the summertime fishery (June 10–October 31) to retain and land two consecutive days' limits of fluke (and black sea bass where properly permitted to avoid unnecessary discarding in the mixed-species trawl fishery). The program contains provisions that require the vessel operator to segregate the first day's catch into a sealed container and provide documentation regarding each day's fishing activity in a DMF issued logbook. This program was designed to provide small-scale trawlers increased flexibility, safety, and efficiency in targeting the available fluke quota.

Fluke Commercial Period II Declarations: In response to quota utilization, DMF made several temporary adjustments to the Period II commercial summer flounder limits in 2021 via a Director's Declaration. Effective September 26, Fridays and Saturdays were added as open fishing days, allowing commercial fishing to occur seven days per week (rather than waiting until November 1 as in regulation). Additionally, the trip limits were increased to 800 pounds for all gear types on September 26, with a scheduled increase to 2,000 pounds effective October 10. Without these adjustments, the limits would have been 400 pounds for net fishermen and 250 pounds for hook and line fishermen through the end of October and 1,000 pounds for all gear types during November–December.

Scup Commercial Winter I & II Declarations: Two Director's Declarations set the 2021 Winter I (January–April) and Winter II (October–December) trip limits at 50,000 pounds and 21,000 pounds, respectively, to complement the federal measures.

Black Sea Bass Commercial Declarations: DMF made several temporary adjustments via Director's Declaration to the 2021 commercial black sea bass limits in response to fishery performance and quota utilization. Effective August 30, the daily trip limit for both pot and hook and line fishermen were increased by 25%, from 400 pounds to 500 pounds for pot fishermen and from 200 pounds to 250 pounds for hook and line fishermen. In addition, Mondays and Wednesdays were added as open commercial fishing days, providing five open days per week (Sundays–Thursdays), followed by the scheduled addition of Fridays and Saturdays effective October 1.

Black Sea Bass Pot Ghost Panel Requirement: DMF's long-standing requirement for all black sea bass pots to be rigged with a panel that is fitted to the trap with biodegradable materials was amended to clarify that the opening covered by this panel is to be at least 3-inches by 6-inches, consistent with the Interstate Fishery Management Plan for black sea bass. Such "ghost panels" are intended to break from the pot if the gear is lost or abandoned, thereby allowing fish to escape from the pot and the pot to cease catching fish. This went into effect on June 21, in advance of the directed pot fishery's season opening on July 8.

Commercial Quota Transfers: DMF accepted a transfer of commercial fluke quota (9,980 pounds) from North Carolina in February to account for landings made by a vessel bound for that state but granted safe harbor in Massachusetts after experiencing mechanical issues. In May, DMF agreed to transfer 200,000 pounds of scup Summer Period commercial quota to Connecticut based on prior years' fishery performance indicating that this would not impact the Massachusetts scup fishery while assisting the Connecticut fishery with their low allocation. In December, DMF agreed to transfer 40,000 pounds of summer flounder commercial quota projected to go unused to Connecticut to help the state mitigate a quota overage. All such transfers require multi-state agreement and ASMFC and/or NOAA Fisheries approval per FMP requirements.

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. DMF also includes monkfish in its definition of multispecies groundfish. Any management actions affecting these species are thus grouped.

State-waters Commercial Groundfish Declaration and Permit Conditions: DMF lifted the Conditional April Groundfish Closure in Massachusetts Bay from Plymouth to Marblehead for certain gear types in 2021. As specified in regulation, this closure may be annually rescinded with a Director's Declaration when it is determined that doing so will not result in an exceedance of the annual federally allocated state-waters sub-components for regulated groundfish stocks or will not compromise federal conservation objectives. However, due to the observed presence of endangered right whales in Massachusetts Bay during April in recent years, Permit Conditions were used to limit the opening to mobile gear and actively tended hook gear. The use of passively fixed fishing gears (i.e., gillnets and longlines set over night) was not authorized so as to not present an entanglement concern.

Recreational Gulf of Maine Cod and Haddock Regulations: To complement federal waters rules for 2021 as they stood at the beginning of the year, DMF added the two-week period of April 1–14 to the GOM cod and haddock seasons. For GOM cod, this resulted in a 1-fish limit at a 21" minimum size during April 1–April 14 and September 15–September 30. For GOM haddock, this resulted in a 15-fish limit at a 17" minimum size during April 1–February 28. These regulations were codified on April 2.

Gulf of Maine Cod For-Hire Permit Conditions: In August, DMF issued permit conditions to extend the recreational GOM cod season for anglers aboard for-hire trips from September 15–September 30 to September 8–October 7, consist with NOAA Fisheries' action to amend the rules for the 2021 fishing year. Permit conditions were used rather than a regulatory change given the late timing of the federal announcement.

Protected Species

DMF adopted a suite of regulations in early 2021 in relation to its ongoing efforts to protect the endangered North Atlantic right whale. In total, these measures are estimated to reduce the risk of serious injury and mortality to right whales from entanglement by 90% compared to 2014 levels. While enacted into the regulations on March 5, certain rules did not become effective until May 2021 to provide fishermen with time to adapt to the measures. In addition to the rules listed below, DMF adopted new buoy line marking rules affecting the state's commercial lobster and crab trap fishermen to take effect on February 1, 2022 (to be detailed in the 2022 Annual Report).

Seasonal Commercial Trap Gear Closure: The existing seasonal commercial trap gear closure to protect right whales was expanded in both time and space. Previously, the Massachusetts Restricted Area—which included all state waters north of Cape Cod south of 42°12' north latitude and state waters east of 70°00' west longitude—was closed from February 1–April 30. Effective March 5, 2021, this closure was expanded northward to include all state waters north of Cape Cod to the New Hampshire border, and extended through May 15. However, the regulation allows DMF to lift or extend this closure during the May 1–15 period based on the presence or absence of right whales. For 2021, DMF lifted this closure on May 14, as aerial surveillance indicated right whales had migrated out of state waters. Similarly, the pre-existing March 1–April 30 10-knot speed limit for vessels less than 65 feet overall length operating in Cape Cod Bay was also temporarily extended through May 13 for 2021.

Seasonal Commercial Gillnet Closure: DMF modified the spatial boundaries of its January 1–May 15 gillnet closure in Cape Cod Bay to protect right whales. Effective March 5, this action extended the closure to include those waters west of 70°30' west longitude between 42°00' north latitude (Plymouth) and 42°12' north latitude (Scituate).

Weak Rope Requirements for Commercial Trap Gear: Effective May 1, a new regulation required all commercial trap fishermen to fish buoy lines with a breaking strength of 1,700 pounds, rope which according to a New England Aquarium study presents a much lower risk of injury or mortality to right whales should an entanglement occur. Fulfilling this requirement may be accomplished by fishing specially manufactured buoy lines with a custom 1,700-pound breaking strength or by rigging existing buoy lines with NOAA Fisheries-approved contrivances into the top 75% of line every 60 feet. In 2021, approved contrivances included the South Shore Sleeve and a variety of splices involving 1,700-pound weak rope.

Trap Gear Maximum Buoy Line Diameters: New regulations established a maximum buoy line diameter for all traps set in Massachusetts. Effective May 1, the maximum buoy line diameter for commercial trap gear became 3/8-inch, and effective May 15, the maximum buoy line diameter for recreational trap gear became 5/16-inch. Establishing maximum buoy line diameters prevents Massachusetts fishermen from setting gear with heavy buoy lines, reducing the potential for injury and mortality to protected species should buoy line entanglement occur. It also establishes a *de facto* gear marking system to differentiate Massachusetts trap gear from heavier gear fished offshore and in Canadian waters.

Seasonal Recreational Trap Gear Closure: DMF enacted a November 1–May 15 closed season for recreational lobster and crab trap gear. This closure applies only to buoyed recreational lobster and crab trap gear and not unbuoyed gear that is fished and retrieved from the shoreline. In addition to eliminating the risk of right whale entanglement in this gear directly, the closure reduces the likelihood of gear loss during winter weather and

provides DMF and the Massachusetts Environmental Police opportunity to remove any abandoned or lost gear before the migration of right whales into our waters. Because this rule was implemented mid-season on March 5, DMF worked with MEP to remove and return to their owner any gear that was already in the water.

Sharks

Spiny Dogfish Commercial Quota Transfers: Between January and March, the Northern Region states of Maine–Connecticut transferred a total of 2.3 million pounds of their shared Fishing Year (FY) 2020 commercial spiny dogfish quota. These quota transfers were to New Jersey (300,000 pounds) and Virginia (2 million pounds). Given the seasonality of the Northern Region fishery, which occurs predominantly during the summer and fall months, these transfers were not expected to impact the region's fishery, while assisting these southern states to avoid premature closures of their fisheries which last later into the fishing year. Spiny dogfish quota transfers require multi-state agreement and ASMFC approval per FMP requirements.

Striped Bass

Recreational Regulations: Effective April 30, DMF amended its circle hook requirement applicable to striped bass recreational fishing activity for compliance with Addendum VI to Amendment 6. In advance of the interstate mandate, DMF had adopted a circle hook rule in 2020 which required all anglers fishing from shore or a private vessel (but not aboard for-hire vessels) to use a circle hook when recreationally fishing for striped bass with whole or cut natural bait, except when used in conjunction with an artificial lure. DMF initially sought but was not granted allowance to maintain either of these exemptions under the Addendum VI mandate; however, the Striped Bass Management Board was convinced to adopt further clarification on the definition of bait and exempt any artificial lure with bait attached. Under DMF's final rule for 2021, all recreational anglers—including those fishing onboard for-hire vessels—who are fishing for striped bass with bait are required to use inline (non-offset) circle hooks, with the exception of artificial lures with bait attached. Bait is defined as any marine or aquatic organism, live or dead, whole or parts thereof. Furthermore, striped bass caught on an unapproved method of take (while targeting other finfish species)— such as a baited J hook or treble hook—must be returned to the water immediately without unnecessary injury.

Commercial Regulations: Several adjustments were made to the commercial striped bass fishing rules for 2021 to increase access to the available quota. The fishery's start date was moved from June 23 to June 16, and the number of open commercial fishing days was increased. Specifically, Tuesday was added as an open fishing day for the season's start (making it a Monday–Wednesday fishery, notably accommodating interest to conduct fishing over consecutive days to take advantage of night fishing opportunities), and then, should the fishery remain open on October 1, the regulation establishes Thursdays and Fridays as open fishing days as well. A fishery closing date of November 15 was also adopted to aid in the end-of-year administration of the commercial tagging program. For 2021, these rule changes were effective in helping the fishery achieve the quota (underutilized for several years), which was projected to be taken on October 1. These rule changes were finalized on June 11.

General Matters and Other Species

Purse Seine Permit Conditions: DMF issued routine permit conditions setting forth restrictions on the use of purse seines in order to properly conserve and manage inshore bait fisheries. Two sets of permit conditions were issued specific to Inshore Net permits (which allow the use of purse seines in the Inshore Restricted Waters) and Coastal Access Permit Purse Seine endorsements (that do not). These conditions include such items as reporting requirements, maximum net size, spotter plane limitations, prohibited areas, and closed days.

Blue Crab Trapping Prohibition: Effective April 30, DMF prohibited the taking of blue crabs with cylindrical or six-sided traps (this continues to allow gears like dip nets and baited lines, as well as collapsible traps and lift traps that are actively tended and fished in an open configuration). This prohibition was implemented to prevent diamondback terrapin turtles from potentially being captured and subsequently drowning in crab traps. These turtles are listed as threatened under the Massachusetts Endangered Species Act and share nearshore estuarine habitat with blue crabs where they may otherwise be caught incidentally in blue crab trap gear.

Purse Seining for Bluefin Tuna: Effective June 11, DMF formally eliminated the regulated fishery permit endorsement for bluefin tuna purse seining and prohibited this activity in state waters. Since the early 2000s, DMF had heavily restricted this purse seining activity through permit conditions, which effectively ended the fishery in state waters. While certain permit holders continued to renew their bluefin tuna purse seine endorsement into this decade, the last bluefin tuna purse seine endorsement was not renewed and was therefor forfeited to the state in 2020. Accordingly, all remnant regulations were eliminated and replaced with a prohibition on the use of purse seining as a means of harvesting bluefin tuna in Massachusetts' waters.

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 2021, DMF initiated five adjudicatory proceedings based on violations that occurred during 2020 and 2021. The first proceeding was based on incident reports alleging violations of recreational black sea bass and tautog limits and the mixing of commercial and recreational activity during a charter trip. This matter went to hearing and the Director issued a Final Agency Action to revoke the permit holder's charter boat permits and commercial regulated fishery permit endorsements for black sea bass and tautog, consistent with the Presiding Officer's Recommended Final Decision. A second proceeding addressed incident reports alleging for-hire fishing activity occurred without a for-hire permit. This matter was settled prior to hearing subject to certain permit sanctions and a probationary period. A third proceeding dealt with a wholesale dealer purchasing shellfish from an unpermitted individual and unable to produce records of shellfish harvester tags from certain transactions. This matter was settled prior to hearing subject to the implementation of a corrective action plan and a probationary period. The fourth matter dealt with non-compliant lobster gear. This included whale safe buoy line violations, trap tag violations, and oversized trawl violations. This was carried into 2022. The last matter dealt with the issuance of a student lobster permit to a non-resident. DMF withdrew this claim and settled the issue of residency and the student lobster permit via the adoption of a permitting policy.

Three adjudicatory proceedings that were initiated in 2020 were concluded in 2021. The first matter addressed alleged violations of the state's commercial black sea bass limits, dealer permitting requirements, and dealer and fisherman reporting requirements. This matter was resolved prior to hearing through a settlement agreement with the Respondent agreeing to forfeit his retail dealer permit and transfer certain commercial fishing permits and regulated fishery permit endorsements. The second matter addressed alleged violations of state laws and regulations relevant to the possession and scrubbing of egg-bearing lobsters. This matter was resolved prior to hearing through a settlement agreement with the Respondent agreeing to certain permit sanctions and a probationary period. The last matter addressed the possession on undersized channeled whelk. This matter was resolved prior to hearing through a settlement agreement with the Respondent agreeing to forfeit his regulated fishery permit endorsement for conch pots.

Other Activities

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. DMF's Director and SMAST's Dean co-chair the MFI.

In 2021, the MFI continued its record of providing independent scientific research applied to regional, national, and international marine fisheries with an emphasis on cooperative research between scientists and fishermen. MFI researchers have been highly productive in a variety of areas, including bycatch reduction, conservation engineering, population dynamics, stock assessment, survey methodology, and management research. In addition to MFI contributions to research, MFI has also been a vehicle for advancing graduate education in fisheries-related fields. This includes direct involvement by and support for students in MFI research and workshop activities, participation by DMF scientists in graduate and post-doctoral advising and development of courses, enrollment of DMF personnel in graduate programs, as well as other educational efforts. Additional details can be found in the MFI Annual Report.

Striped Bass Conservation License Plate

During 2019, DMF and the Massachusetts Environmental Trust (MET) collaborated to develop a new Striped Bass Conservation Plate; funds generated from its sale will be dedicated to striped bass studies, fish passage improvement projects, and angler education. By early 2020, the minimum number of orders to launch a new license plate was met; however, the Covid-19 pandemic dramatically interrupted what would have normally been a 6-8 month process to get a plate approved, produced, and distributed through the Registry of Motor Vehicles. At the end of 2021, direct distribution of new plates to pre-applicants was being planned for early 2022.

Additional Committee Work

Staff served as the state's representative to the Stellwagen Bank Sanctuary Advisory Council (SAC), which included attendance at four (virtual) Council or sub-committee meetings in 2021. The SAC is a community-based body, established by the Secretary of Commerce per the National Marine Sanctuaries Act, that advises the sanctuary superintendent on issues relevant to the effective implementation of the Sanctuary management plan. In 2021, the SAC developed action plans and recommendations for revisions to the Sanctuary's management plan, last updated in 2010. The 2021 draft management plan and environmental assessment were released in November; DMF submitted comments.

Permitting and Statistics Program

Personnel

Story Reed, Program Manager
Anna Webb, Fisheries Statistics Project Leader
Kerry Allard, Permitting Project Coordinator
Kim Lundy, Dealer Reporting Coordination & Quota Monitoring
Erich Druskat, Fisheries Data Analyst
Scott Schaffer, Fixed Gear Data Analyst
Nicholas Buchan, Harvester Reporting Coordination
Mary Ann Fletcher, Fisheries Statistics Support
Rosemary Mitchell, Permitting & Support for Fisheries Reporting
Whitney Sargent, Permitting & Support for Fisheries Reporting
Matthew Duggan, Permitting Receiving Teller
Sandra Downing, Permitting Receiving Teller
Kim Trotto, Permitting Receiving Teller
Lynne Besse, Permitting Receiving Teller
George Davis, Permitting & Support for Fisheries Reporting
Amanda Meli, Seasonal Receiving Teller
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 involved in the initial sale of food and shellfish, and 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, staff act as a liaison to the Administration's Energy & Environmental Affairs Information Technology Group for the Division and 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 MA must have a DMF commercial fishing permit and must sell only to permitted Massachusetts dealers. DMF issued a total of 7,609 commercial fisherman permits in 2021 (Table 1). Over the past decade, DMF has seen a general increase in commercial fisherman permit sales, particularly for small Boat 0–59' in length (Figure 3).

Table 1. 2021 commercial fisherman permit issuance.

Permit Type	Permits Issued (#)	
	Residents	Non-residents
Coastal Lobster	1,025	6
Offshore Lobster	271	93
Seasonal Lobster	105	1
Boat 99+’	12	18
Boat 60-99’	79	223
Boat 0-59’	3,456	378
Individual	210	4
Shellfish and Seaworm	798	0
Shellfish and Rod & Reel	388	0
Rod & Reel	513	29
Total	**6,857**	**752**

Coastal Lobster Permit allows the taking, landing, and sale of lobsters and edible crabs 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 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 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 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 and may be endorsed for shellfish. No lobster or edible crabs may be taken.

Shellfish Permit allows an individual to take, land, and sell shellfish and seaworms. A Shellfish Transaction 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 2019, DMF issued 3,578 shellfish transaction cards; of which, 242 were issued as employee shellfish transaction cards to 44 shellfish businesses.)

Rod & Reel Permit allows the holder only, to catch and sell finfish caught by Rod & Reel only. No other gear types may be used.

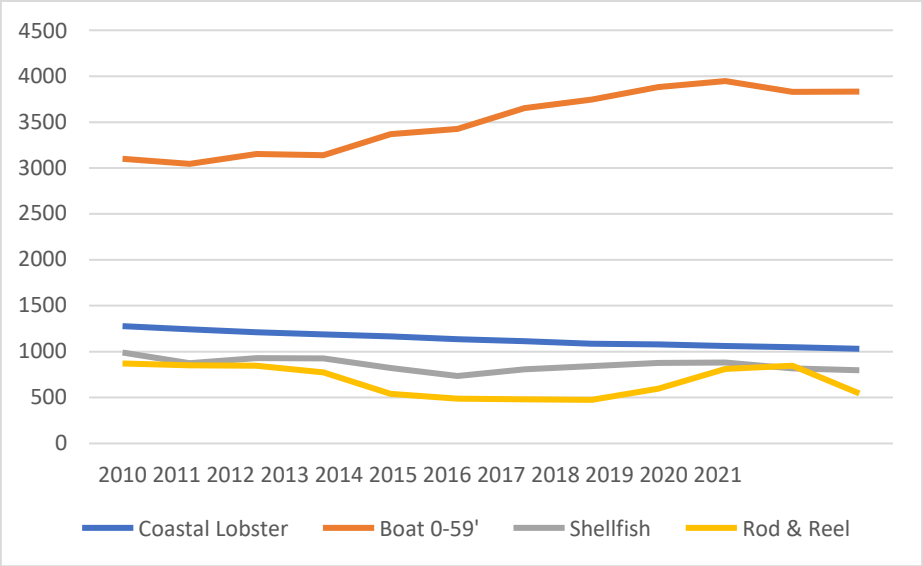


Figure 3. Trend in sales of four frequently issued commercial fisherman permits, 2010–2021.

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 1,946 seafood dealer permits in 2021 (Table 2), a number relatively unchanged over the past ten years.

Table 2. 2021 dealer permit issuance.

Permit Type	Permits Issued (#)	
	Resident	Non-resident
Wholesale Dealer	382	8
Wholesale Truck	85	123
Wholesale Broker	30	9
Retail Dealer	815	98
Retail Truck	34	2
Retail Boat	201	3
Bait Dealer	130	15
Retail Farmer's Market	10	1
Total	**1,687**	**259**

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 MassDPH 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 also 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, relabel, 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 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. After issuing a record 303 Retail Boat permits in 2020 due to COVID-related market conditions, 206 were issued in 2021 as market conditions began to return to normal.

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

Retail Seafood Farmer's Market Dealer Permit allows the holder to sell certain raw fish and fish products at a farmer's market subject to written approval by the Department of Public Health, or the municipal or county board of health. This permit was established by regulation in 2019 in order to make the permitting process for farmer's markets more intuitive.

Special Permits & Regulated Fishery Endorsements

Special Permits are required for certain activities in the marine environment, as described below. DMF issued a total of 23,342 special permits in 2021 (Table 3).

Table 3. 2021 special permit & regulated fishery endorsement issuance.

Permit Type	Permits Issued (#)	
	Resident	Non-resident
Non-commercial Lobster	6,192	101
Regulated Fishery Endorsements	15,351	1,119
Master Digger	4	0
Subordinate Digger	27	0
Scientific Collection	74	16
Shellfish Propagation & Aquaculture	458	0
Total	**22,106**	**1,236**

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 clam/ocean quahog, sea herring, sea urchins, fluke, black sea bass, scup, striped bass, dogfish, American eel, horseshoe crab, groundfish, tautog, and menhaden.

Master Digger Permit is required for an individual who wants to harvest contaminated clams from areas classified as "restricted." Shellfish are depurated at the Shellfish Purification Plant in Newburyport in accordance with regulations and established procedures. In addition to 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. DMF issued a total of 192,712 recreational saltwater fishing permits in 2021 (Table 4).

Table 4. 2021 recreational saltwater fishing permit issuance.

Permit Type	Permits Issued (#)	
	Resident	Non-resident
Recreational Saltwater, Age 16–59	113,464	17,136
Recreational Saltwater, Age 60+	54,308	6,989
Charter Boat	705	58
Head Boat	46	6
Total	**168,523**	**24,189**

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 (NH, RI, and CT) 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 for-hire vessel that can carry up to six persons fishing as passengers.

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

New Recreational Permitting Vendor: The Department of Fish & Game (*Mass*DFG), including DMF and *MassWildlife*, selected a new vendor to provide and administer the *MassFishHunt* recreational permitting system. Kalkomey was chosen through a competitive bidding process. Permitting staff spent a considerable amount of time working with the vendor on the new application leading up to "go live" on December 1, 2021. This system is used to issue Recreational Saltwater Fishing, For-Hire, Non-Commercial Lobster permits, as well as *MassWildlife* licenses for freshwater fishing and hunting.

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) may be 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. 2021 Preliminary Limited Entry Permit Transfer Statistics.

Permit/Endorsement Type	Permits Transferred (#)	
	Resident	Non-resident
Coastal Lobster	34	0
Mobile Gear Coastal Access	8	1
Fish Pot	10	0
Fluke	20	1
Black Sea Bass	31	0
Groundfish	2	0
Surf Clam/ Ocean Quahog	2	0
Quahog Dredge	3	0
Horseshoe Crab	7	0
Menhaden	1	0
Tautog	8	0
Inshore Net	1	0

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. Through 2019, 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. Beginning January 1, 2020, all state-reporting dealers were required to submit data electronically via SAFIS applications, the file upload method, and/or a certified third-party vendor.

In 2021, 1,948 businesses obtained a Massachusetts seafood dealer permit. Of those, 559 (or 29%) 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 559 dealers, 277 had a federal dealer permit and the remaining 282 dealers were categorized as "state-reporting." The number of primary buyers was considerably lower than 2020 when many businesses pivoted to

selling product direct to customers via boat retail sales to mitigate some of the losses due to the COVID-19 pandemic. In 2020, DMF offered the retail boat seafood dealer permit free of charge to any permit holder interested in this business plan and issued almost 200 more permits than in previous years. This fee exemption was removed for 2021 and many businesses did not renew the permit resulting in a 15% reduction in total primary buyers for the year. However, 2021 still had an 18% increase over 2019.

As is the case every year, all primary buyers 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, 137,427 dealer reports were entered into the SAFIS database, and while this is an increase over 2020, the number of trips did not rebound to pre-COVID levels remaining at 14% lower than the average number of trips across 2017–2019. Federal-reporting dealers electronically submitted 76% of these transactions. The percentage of federal landings is unchanged compared to 2019 and 2020.

Despite the appearance of reduced effort in 2021, total landings (in whole pounds), as reported through the SAFIS database or other federal reporting programs, amounted to an only slightly reduced 593 million pounds, but was valued at $840 million (ex-vessel; calculated from price paid to fishermen) setting a record for the highest value recorded to date. The top five species in order of value were sea scallop, American lobster, Eastern oyster, haddock, and Atlantic surf clam totaling $704 million, or 83% of the total. While the value for 2021 was expected to increase in comparison to 2020, trends substantially exceeded expectations. The ex-vessel value of seafood landed in Massachusetts was 34% higher in 2021 than 2020 and a 19% increase over 2019 (Figure 4). Sea scallops and lobster prices drove this increase with each seeing a significant increase in value. Other species had more limited changes such as Eastern oyster which showed little to no increase over 2019.

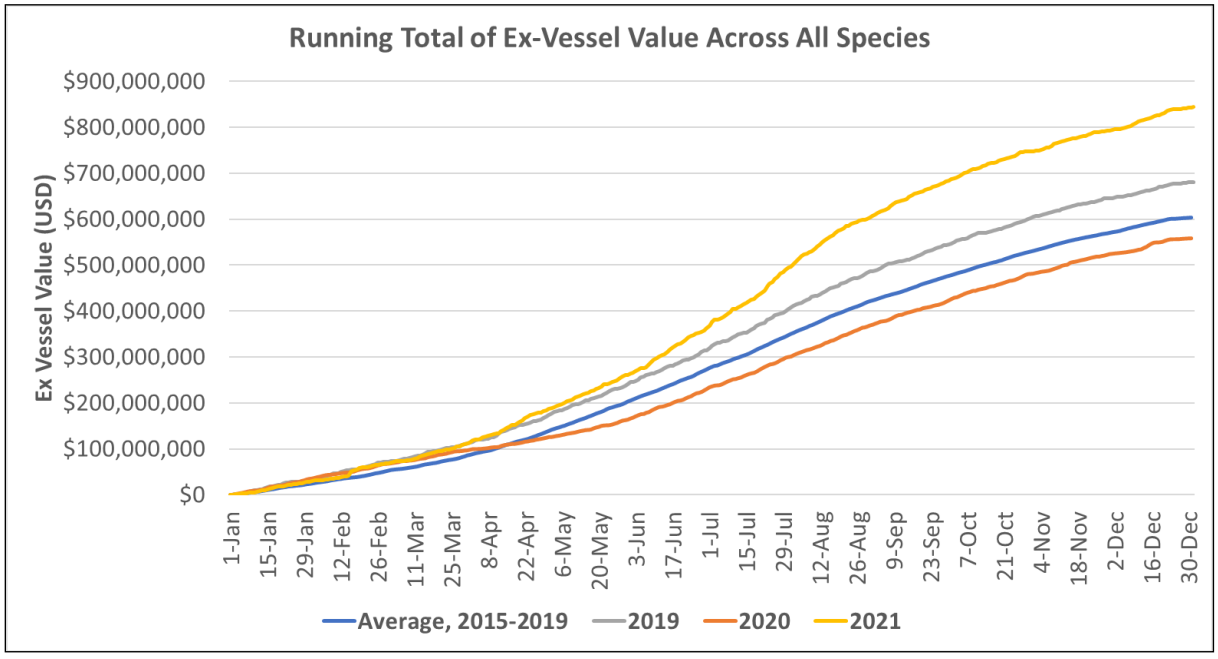


Figure 4. Daily running total ex-vessel value for 2019-2021 and the average of 2015-2019.
Source: ACCSP Data Warehouse; 4/25/2022.

Offshore shellfish (sea scallop, Atlantic surf clam, and ocean quahog) made up 63% of the total value landed in Massachusetts, whereas inshore and intertidal landings of shellfish, such as soft shell clam, northern quahog,

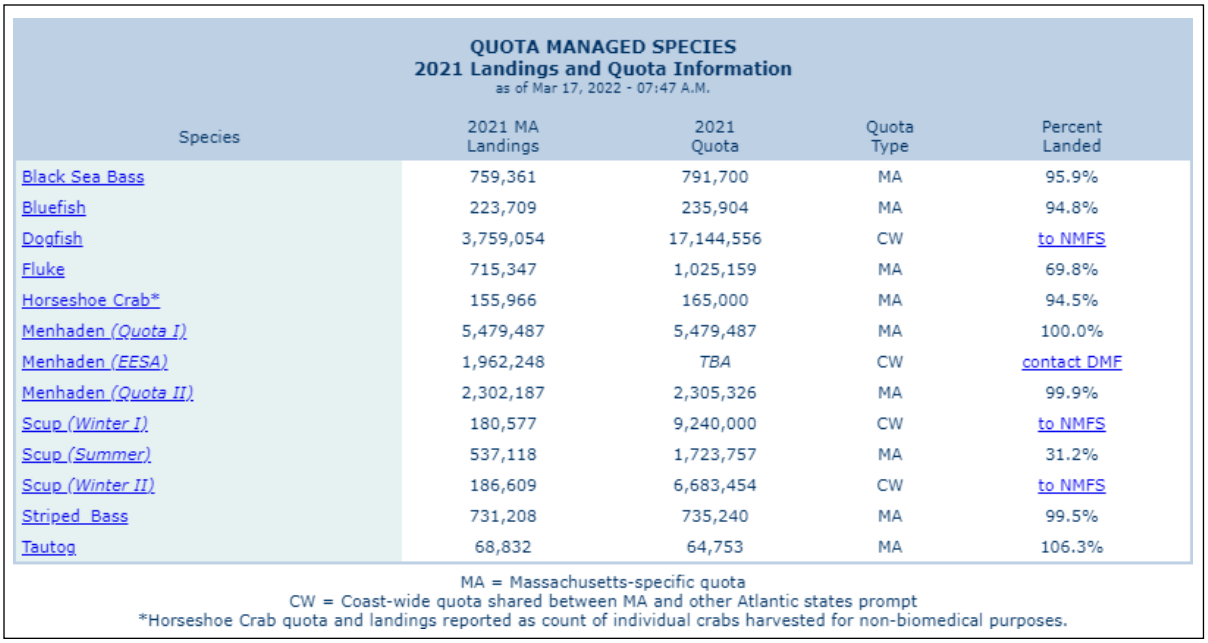
blue mussel, and oyster amounted to six percent of total value landed. Landings of invertebrate species (lobster, crabs, and whelk) amounted to 28 million pounds, valued at $140 million, or 17% of the total value landed. Cumulative finfish landings, including both pelagic and benthic species, made up 14% of the total value with groundfish species amounting to 11% 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.

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 5) 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. An estimated closure date was calculated based on a regression analysis run at least once per week for each open fishery.

Table 6. 2021 MA-landed species with ex-vessel value >$2 million.* Source: ACCSP Data Warehouse, 4/25/22.

Species*	Landings (whole pounds)	Ex-Vessel Value (USD)
Sea scallop	280,351,833	$514,959,735
American lobster	16,853,274	$125,703,148
Eastern oyster	9,800,883	$30,744,283
Haddock	15,486,308	$19,038,064
Atlantic surf clam	62,689,437	$13,979,669
Atlantic Mackerel	9,446,081	$10,267,845
Pollock	6,890,293	$8,860,176
Soft shell clam	3,447,059	$8,751,775
Acadian redfish	12,415,222	$7,074,226
Monkfish	10,699,714	$7,002,928
Ocean quahog	79,977,974	$6,981,099
Jonah crab	5,376,155	$6,337,090
Bluefin tuna	1,113,503	$6,215,194
Northern shortfin squid (*Illex*)	15,046,031	$5,893,468
Silver hake (whiting)	5,168,550	$5,872,148
Northern quahog	4,533,947	$4,952,326
White hake	3,698,089	$4,859,883
Striped bass	732,071	$3,424,587
Channeled whelk	766,975	$3,064,014
Longfin squid (Loligo)	1,704,816	$3,020,380
Witch flounder (gray sole)	1,712,841	$3,011,230
Atlantic cod	1,194,750	$2,616,331
American plaice (dab)	1,413,825	$2,484,686
Winter flounder	904,456	$2,426,632
Black sea bass	761,834	$2,336,187
Summer flounder (fluke)	715,342	$2,133,232

* Deep-sea red crab is also in this list, but the data are confidential. Menhaden is also included but removed from this report due to ongoing data discrepancies.



QUOTA MANAGED SPECIES
2021 Landings and Quota Information
as of Mar 17, 2022 - 07:47 A.M.

Species	2021 MA Landings	2021 Quota	Quota Type	Percent Landed
Black Sea Bass	759,361	791,700	MA	95.9%
Bluefish	223,709	235,904	MA	94.8%
Dogfish	3,759,054	17,144,556	CW	to NMFS
Fluke	715,347	1,025,159	MA	69.8%
Horseshoe Crab*	155,966	165,000	MA	94.5%
Menhaden *(Quota I)*	5,479,487	5,479,487	MA	100.0%
Menhaden *(EESA)*	1,962,248	*TBA*	CW	contact DMF
Menhaden *(Quota II)*	2,302,187	2,305,326	MA	99.9%
Scup *(Winter I)*	180,577	9,240,000	CW	to NMFS
Scup *(Summer)*	537,118	1,723,757	MA	31.2%
Scup *(Winter II)*	186,609	6,683,454	CW	to NMFS
Striped Bass	731,208	735,240	MA	99.5%
Tautog	68,832	64,753	MA	106.3%

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

Figure 5. Example 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 NOAA Fisheries (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 NOAA Fisheries Highly Migratory Species Division. All other individuals were required to report to DMF.

Fishermen either submitted their trip-level reports in paper form or entered their fishing activities themselves using a SAFIS eTRIPS application. SAFIS eTRIPS Online is a web-based program (available since 2010), while SAFIS eTRIPS Mobile is a newer application available on all major platforms for phones and tablets, as well as Windows. Project staff used the online application, or a bulk upload process called eTRIPS Upload to enter data submitted on paper forms. Thus, the primary repository for all trip-level data, except those reported to NOAA Fisheries, was the SAFIS database. Data were easily downloaded from the SAFIS database and used for compliance and fisheries analyses by project staff; fishermen also have easy access to their own landings within SAFIS.

Following a redesign of the administrative interface in SAFIS that made possible a more flexible data collection program, eTRIPS Online underwent a significant redesign in 2020 which went live on January 1, 2021. This launch enabled DMF and other partners to meet the requirements set forth in recent addenda to both the lobster and Jonah crab interstate FMPs. This included collecting several new fixed gear specific fields including but not limited to effort specific ten-minute squares and number of buoy lines. Project staff were integral to that project, meeting frequently with ACCSP throughout the development process. In 2021, DMF staff worked with ACCSP post-deployment to review the application, convey end-user concerns, continue testing as needed, work through data access issues, and begin enhancement development.

In 2021, DMF issued 7,606 commercial harvester permits, of which 20% were for federal reporting vessels, and the remaining 6,498 commercial permits were designated as "state-reporting." Thirty-eight percent of all permit

holders reported electronically using the SAFIS eTRIPS Online or Mobile applications, which was similar to 2020. This left 42% of all harvesters submitting paper reports to DMF. Of the greater than 91,700 commercial trips that were entered into the SAFIS database for state reporting harvesters for the 2021 calendar year, approximately 34% were entered by commercial permit holders using one of the SAFIS eTRIPS applications, with the remaining trips entered by DMF staff. This percentage of electronically entered trips is a slight increase over previous years. Compared to 2019, the total number of trips reported for 2021 was down approximately 13%, but was approximately seven percent more trips than 2020 when covid impacted effort levels.

Data Analysis and Dissemination

Impacts from the COVID-19 global pandemic continued to impact the Fisheries Statistics Project in 2021. Delays in typical workflows were frequently encountered and were compounded by unexpected additional workloads. The primary task added to the project during 2021 was assisting in the management of the distribution of Round 2 Coronavirus Aid, Relief, and Economic Security Act Fisheries Relief Program (CARES) funds to Massachusetts permit holders. This work was prioritized and required less time than the round 1 effort in 2020, but still required weeks of work to finalize and complete. Related to this, project staff were continuously asked to provide updates on documented COVID-related losses to the commercial and aquaculture industries and the subsequent rebound and inflation witnessed in 2021. Significant time was dedicated to routine activities such as ensuring correct harvester reporting methods, and maintaining compliance metrics for harvester and dealer reporting. Additionally, significant time was spent working with ACCSP to validate landings for a variety of species throughout this time as stock assessments and other data heavy projects continued. A few projects are highlighted below.

CARES, Round 2: Project staff participated heavily in the CARES Program. To pre-qualify permit holders into sector specific income-based tiers, project staff conducted extensive analyses of total annual landings for individual permit holders. Additionally, permit holders were able to appeal their pre-qualification status, and project staff worked closely with the sector leads to verify submissions. See the CARES Act Fisheries Relief section of DMF's 2020 Annual Report for more information.

Incidental Take Permit Habitat Conservation Plan: DMF undertook a significant effort to apply for a federal Incidental Take Permit as described in the Protected Species section on page 80. The Fisheries Statistics Project hired an additional analyst in April 2021 to conduct analyses dedicated to this permit application and production of the Habitat Conservation Plan. This analyst began extensive fixed gear analyses in the second half of the year to support this work. The application process continued into 2022.

Real Time Daily Running Landings and Value Totals: By summer 2021, reports of inflation in the seafood market were spreading. DMF began tracking the divergence of 2021 ex-vessel value as compared to 2019 and the average of 2015–2019 on a regular basis. While these in-year analyses excluded surf clams and ocean quahogs as they are reported to a separate system, the results clearly showed a significant increase in overall value primarily driven by the sea scallop and lobster fleets. Analyses were updated at least monthly, often more frequently, to monitor the quasi-real-time trends. Results were presented to the Director for internal communications, at MFAC meetings, as well as distributed to the public via newsletter articles.

Striped Bass Tagging Program: 2021 was the eighth year of a commercial striped bass fishery tagging program mandated by ASMFC to reduce poaching coast-wide. This program is conducted at the dealer level in Massachusetts (Table 7). Program staff estimated the 2021 tags required 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.

Table 7. 2021 striped bass tagging statistics (as of June 2022)**.**

# of Dealers Receiving Tags	# of Tags Purchased by DMF	# of Tags Distributed	# of Tags Returned	# of Tags Used	# of Tags Missing
131	65,000	46,760	9,061	36,865	834

Tautog Tagging Program: 2021 was the second year of a commercial tautog fishery tagging program mandated by ASMFC to reduce poaching coast-wide. Per the FMP, this program is conducted at the harvester level in all states (Table 8). Commercial fishermen must tag their commercial tautog catch through the operculum prior to offloading the fish from the fishing vessel and selling the fish into commerce. The tautog tags are single use metal tags inscribed with the calendar year, state of issuance, and sequential tag number.

Table 8. 2021 tautog tagging statistics (as of June 2022)**.**

# of Eligible Fishermen	# of Fishermen Receiving Tags	# of Tags Purchased by DMF	# of Tags Distributed	# of Tags Returned	# of Tags Used
214	154	35,000	34,575	12,270	22,305

ACCSP Participation and Planning

DMF staff continued to participate in all partner-based committees within ACCSP. Staff served on the Operations, Information Systems, Commercial Technical, and Standard Codes committees, while staff from the recreational program served on the Recreational Technical committee. 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, policies, vessel monitoring (as described below) and the eTRIPS redesign project as described above. ACCSP tasks demanded even more time from project staff throughout the year, and this is expected to continue moving forward as their applications continue to expand.

Vessel Tracking Projects: Work continued investigating cellular-based vessel monitoring systems (VMS), which carry lower costs and may be just as effective in inshore waters, or even offshore waters, as compared to satellite-based systems. Project staff completed the ACCSP-funded pilot project, *Integration of Vessel Monitoring Systems and Electronic Reporting in SAFIS and SAFIS Applications Through API Development and Field Testing of Multiple Hardware Options*, in the fall of 2021 with report writing continuing throughout the remainder of the year. The project focused on the integration of VMS data with eTRIPS Mobile reporting and was done in collaboration with Rhode Island DMF and ACCSP. Project partners expected to submit the final report, which focuses on the outcomes of the project's integration work and lessons learned, in early 2022.

In August of 2021 and in collaboration with Rhode Island, project staff submitted a proposal to ACCSP to begin phase 2 of this project. The proposed work includes further testing of additional vessel tracking devices, comparisons of low-cost tracking devices and federal approved vessel monitoring systems, expanding on geofencing capabilities, and enhancement of the ACCSP administrative tool or development of new tools to enhance real time track viewing and analysis.

In the fall of 2021, staff participated in the ASMFC Plan Development Team to produce Draft Addendum XXIX to Amendment 3 to the Interstate Fishery Management Plan for American Lobster and Addendum IV to the Jonah Crab Fishery Management Plan, which was expected to be approved in early 2022. The addendum proposes requiring vessel tracking devices be deployed on federally permitted lobster vessels under the administration of state fisheries agencies. The PDT negotiated the details of this addendum including state administrative processes, data management systems at ACCSP, specifications of vessel tracking devices, and requirements for permit holder ultimately defining workloads for all affected stakeholders including the industry, state agencies, and federal partners.

Swipe Card Pilot Project: Discussions between state and federal partners of ACCSP to codify the requirements necessary to expand the use of the SAFIS eDR/Mobile application to federal dealers were still in progress at the end of 2021. This free application, launched into production in Massachusetts (and Maine) in August 2016, utilizes a harvester's shellfish transaction card to consummate a point-of-sale transaction between the harvester and dealer, promoting a single-ticket commercial data collection system. This reporting option works well for small dealers who buy from a handful of harvesters.

Local IT Management

Information systems/technology is primarily conducted through the Executive Office of Energy and Environmental Affairs' Information Technology Group (EOEEA-IT) under the larger direction of the Executive Office of Technology Services and Security (EOTSS). During 2021, 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. 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, made more time consuming due to staff working remotely.

Oracle Database/Application Development & Maintenance: DMF continued to use three production databases and associated applications during 2021: Commercial Permits and Statistics; Lobster Sampling; and Shellfish Sampling & Area Management. The Aquaculture Permits application remained paused during 2021. EOEEA-IT initiated a project to redesign the current Oracle system and associated applications in late 2018; however, the project was paused throughout 2020 due to funding and time limitations from EOEEA-IT. The project resumed in early 2021 with a focus on the commercial permitting application. The new permitting application is intended to include all details of commercial, seafood dealer, and special (e.g., aquaculture, propagation, scientific collection) permit categories, incorporate online credit card permit sales, in-office sales, reporting options, and administrative tools. A permitting lead, a statistics lead, and the CFO were heavily involved in the requirements gathering portion of the project and met with EOEEA-IT several hours per week beginning in February. Additionally, almost all other permitting and statistics staff contributed to areas in which they are the expert. Requirements gathering continued into 2022 and development began in earnest in late 2021. The permitting application is expected to launch in fall 2022.

Remote Work: The abrupt shift to telework due to the pandemic resulted in a significant amount of unexpected work on IT staff. Getting all DMF staff up and running remotely required coordination of assets, VPNs, and other tools. Additionally, EOEEA-IT and EOTSS continuously pushed out new software to aid employees in telework. By the end of 2021, all staff were using mobile assets and Microsoft tools such as OneDrive, SharePoint, and Teams to work collaboratively and remotely. This ultimately supports the adoption of a successful hybrid return to work model implemented by most secretariats and their departments.

SHELLFISH AND HABITAT SECTION

Shellfish Sanitation and Management Program

Personnel

Jeff Kennedy, Program Manager

Gloucester
Gregory Bettencourt, Biologist II (Jan.–Sept.)/EA IV & Gloucester Regional Shellfish Supervisor (starting Oct.)
Florence Cenci, Bacteriologist III, Shellfish Lab Supervisor
Ryan Joyce, Biologist II
Devon Winkler, Biologist II
Melissa Campbell, Biologist II
Ashley Lawson, Bacteriologist I
Jennifer Poniatowski, Bacteriologist I (resigned August)

New Bedford
Gregory Sawyer, Biologist III
Susan Boehler, Bacteriologist III, Shellfish Lab Supervisor (retired June)
Dr. Christian Petitpas, Biologist III, Aquaculture & Vibrio Specialist
John Mendes, Biologist II
Terry O'Neil, Biologist II
Simone Wright, Biologist II
Holly Williams, Biologist II
Kaley Towns, Biologist II
Gabriel Lundgren, Biologist I
Brianne Shanks, Bacteriologist I
Einat Sandbank, Biologist I (resigned December)
Thomas Shields, Environmental Analyst IV for Shellfish

Newburyport
Diane Regan, Bacteriologist III, Shellfish Lab Supervisor
Conor Byrne, Depuration Coordinator I
Richard Hardy, Wildlife Technician II
Peter Kimball, Wildlife Technician II
Rachel Tripp, Seasonal Laborer (beginning August)

Overview

The Shellfish Sanitation and Management Program focuses on public health protection, as well as the management of the Commonwealth's molluscan shellfish resources. Public health protection is ensured through sanitary classification, monitoring of marine biotoxins and implementation of a *Vibrio parahaemolyticus* Control Plan 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 the ISSC.

Shellfisheries management is accomplished by a multipronged approach including direct DMF regulation of the commercial surf clam, ocean quahog, and quahog dredge boat fisheries; and indirectly managing other shellfish resources through partnerships with coastal communities by providing technical assistance to local management authorities in the development of management plans and local regulations for control and conservation. In addition, DMF regulations cover safe harvest and handling practices for market-bound shellfish, the harvest of contaminated shellfish for depuration and relay, and establish minimum 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.

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 harvest. Minimum requirements are set by the ISSC and outlined in section two of the NSSP *Guide for the Control of Molluscan Shellfish* (a.k.a., Model Ordinance). Two biologists completed the USFDA Sanitary Survey of Shellfish Growing Areas course in March of 2021.

To satisfy NSSP requirements in 2021, staff biologists completed 288 annual reports, 58 triennial evaluations, and 10 sanitary surveys (Table 9). Thirty-one conditional area management plans were re-evaluated. A total of 9,699 water samples were collected and analyzed for fecal coliform bacteria from 288 shellfish growing areas in 63 cities and towns of the Commonwealth. All samples were tested at one of the Division's shellfish laboratories using the mTEC method. During the annual USFDA evaluation for compliance with NSSP requirements, shellfish growing area files were reviewed with regards to standards for sampling frequency, completion of required reports, conditional area management plan updates, and conformity with appropriate water quality criteria.

Table 9. Summary of 2021 shellfish growing area report and sampling activity.

	North Shore	South Shore	Total
Annual Reports	30	258	288
Triennial Evaluations	8	50	58
Sanitary Surveys	0	10	10
Management Plans/MOUs Reviewed	20	11	31
Total Water Samples	2,420	7,279	9,699
Classification Station Water Samples	2,261	7,152	9,413
Pollution Source Water Samples	113	81	194
Ad-hoc Water Samples	46	46	92
Shellfish Growing Areas Sampled	20	268	288
Classification Sub-Areas sampled	104	648	752
Cities/Towns Sampled	19	44	63

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 categories: Approved, Conditionally Approved, Restricted, Conditionally Restricted, and Prohibited (defined below). If water quality within a growing area trends towards permanent improvement or impairment, its Classification is upgraded or downgraded depending on the 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, harmful algal bloom/biotoxin 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 (Approved or Conditionally Approved) for natural contaminant reduction 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. Also, with a contaminated relay permit municipalities may relay shellfish to Approved or Conditionally Approved propagation areas.

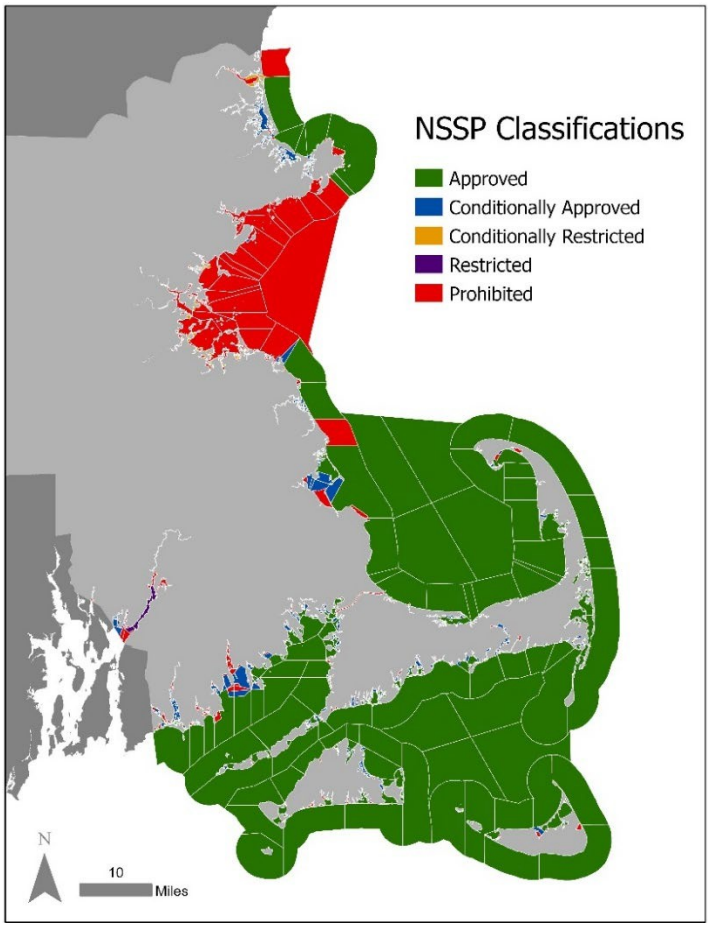


Figure 6. 2021 NSSP classification map of MA waters.

5. PROHIBITED: Closed to the harvest of shellfish under all conditions, except the gathering and culture of seed for commercial shellfish aquaculture and municipal propagation programs under a DMF permit.

In 2021, a total of 1,744,023 acres were assigned a Classification (Figure 6, Table 10). The total acreage of Approved areas decreased, and total acreage of Conditionally Approved and Prohibited areas increased in 2021. These changes were primarily due to stricter NSSP requirements and guidelines that were defined in the 2019 revision of the Model Ordinance. Total acreage of Classified growing areas increased during 2021 by 31 acres due to an improvement of shoreline detail around Wingaersheek Beach in Gloucester (N10).

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, Mass Environmental Police (MEP), Massachusetts DPH, USFDA, and other interested parties. In 2021, staff generated 463 legal notices which were distributed for sanitary reclassification, rainfall closures and re-openings, paralytic shellfish poisoning events, oil spills, and more typical emergency closures (e.g., extreme rainfall, flooding, sewage discharge).

Area Classification	Acreage		
	2020	2021	Change
Approved	1456158	1445495	-10663
Conditionally Approved	24642	34596	9954
Restricted	2525	2525	0
Conditionally Restricted	4430	4430	0
Prohibited	256267	256976	709
Total	1,743,992	1,744,023	31

Table 10. Change in Massachusetts shellfish growing area classification, 2020 to 2021.

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), commonly called "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 (Figure 7). A total of 353 shellfish samples from state waters were processed for PSP during 2021, plus ten mussel samples collected by Salem State University in federal waters.

Closure of the Nauset system is a nearly annual event, whereas PSP closures elsewhere occur more sporadically. In 2021, the Nauset system closure was enacted on March 17 and remained in effect for three months with closures being lifted on June 17.

North shore and particularly South shore closures are less frequent. 2021 was an anomalous year for North and South shore PSP blooms. North shore blooms typically begin when the southward flowing coastal current transports cells into Massachusetts from the Gulf of Maine to the north. Coastal bloom toxicity in shellfish usually appears in Essex or Gloucester first. However, in 2021 after receiving notification from the Massachusetts Water Resources Authority of a bloom in Western Mass Bay, first toxicity was detected in the Scituate and Cohasset mussel stations on June 28. Toxicity was detected at the Essex and Gloucester stations on July 6 and peaked the following week in

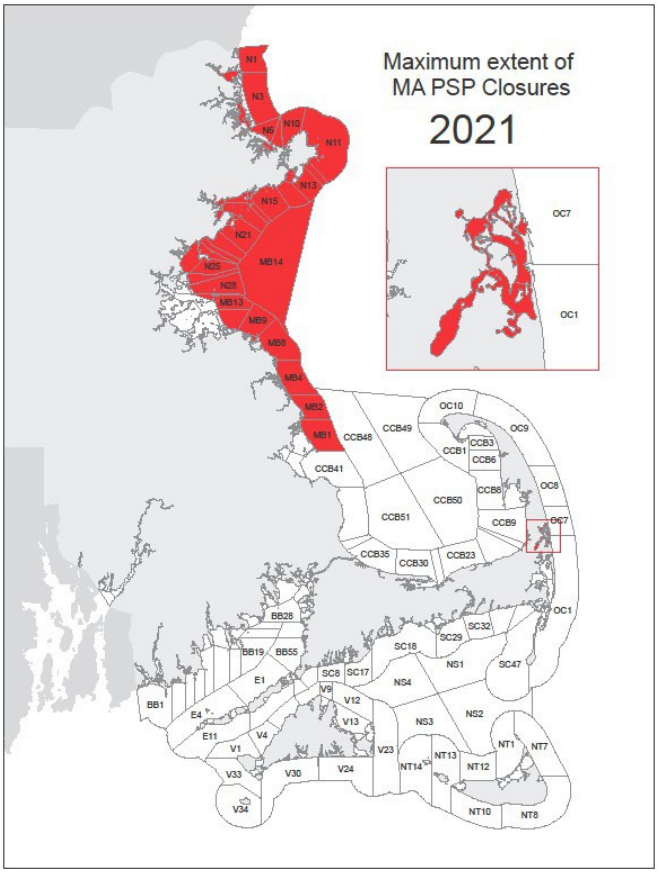


Figure 7. 2021 PSP closure map.

Essex. A coastal closure of harvest areas from the New Hampshire border to Duxbury Beach was implemented on July 16. Toxicity dropped quickly in late July and all closures put in place on July 16 were lifted on July 31.

The South coast experienced a bloom of PSP causing algae in Swansea on May 13. Quahogs and softshell clams were tested but no toxicity was detected. This bloom did not result in a closure, but is noteworthy as it is unprecedented, or at least undocumented, for the South coast area to experience a bloom not related to a large regional event originating in the Gulf of Maine.

There were no reported illnesses due to PSP from Massachusetts shellfish in 2021, as is typical.

Phytoplankton Monitoring: There are many kinds of microscopic algae that potentially pose a public health risk due to biotoxin production. Though PSP, caused by the dinoflagellate *Alexandrium*, has historically been the primary threat in the northeast, DMF monitors the phytoplankton community for the presence of many other potentially toxic algae and/or nuisance species that can form Harmful Algal Blooms (HABs). Phytoplankton monitoring occurred year-round on the North shore, with 197 samples collected from the four primary regional stations located in Newburyport, Ipswich, Essex, and Gloucester. Seven additional samples were collected from Revere, Marblehead, and Deer Island in an effort to document the extent of the *Alexandrium* bloom southward during the month of July. In 2021, *Alexandrium* was first observed on April 9. Cell counts remained low through May and June and then peaked in July coinciding with shellfish meat sample toxicity. A maximum of 21,000 cells per liter were observed on July 15 at the Gloucester station, which tapered off quickly and were absent by the end of July. Varying abundances were observed of both small and large *Pseudo-nitzschia* cells throughout the year; however, neither were in large enough concentrations to warrant concern. *Dinophysis* sp. cell concentrations remained relatively low throughout the year in the North Shore except for a spike in July. Other HAB species were observed in low abundances.

The South shore region has eight routine phytoplankton monitoring stations that are sampled bi-weekly year-round, alternating between Duxbury, Barnstable (Cape Cod Bay side), Wellfleet and Westport one week, and Barnstable (Hyannis Harbor), Eastham (Nauset), Mattapoisett, and Swansea the following week. When elevated concentrations of HAB cells are observed the sampling frequency at a given monitoring station increases. In 2021, 273 individual samples were collected for analysis at the New Bedford office for analysis. *Alexandrium* was first observed in Nauset February 4 (two weeks earlier than 2020) with a peak of 11,115 cells/liter on May 3 (three weeks earlier than 2020). On December 20, a new bloom started (720 cells/l) that carried into 2022. This was the first documentation of an early winter bloom in the Nauset system. Another anomalous *Alexandrium* bloom occurred at DMF's Swansea primary station on May 13 with concentrations reaching 2,025 cells/liter. Quahogs and softshell clam were tested, with results below the limit of detection. No closure was required.

Varying abundances of small and large *Pseudo-nitzschia* which produce domoic acid (amnesic shellfish poisoning; ASP) were observed at all South shore monitoring stations. On two occasions, abundances of *Pseudo-nitzschia* approached or exceeded 50,000 cells/liter: Hyannis Harbor (45,734 cells/liter) in June and Barnstable Harbor (108,250 cells/liter) in December. Replicate Scotia rapid screening kits for ASP were used to test water samples in both cases. Results were negative for Hyannis Harbor in June. Follow-up sampling showed concentrations decreased in the subsequent weeks and no further toxin testing was necessary. However, the Barnstable Harbor event resulted in a positive toxin screening. Colleagues at Florida Fish and Wildlife Conservation Commission tested water and shellfish samples for DMF. *Pseudo-nitzschia plurisecta* was identified as the dominant species present. Very low amounts of toxin were measured in quahogs and blue mussels and no toxin was detected in oysters, so no closure was implemented. The *Pseudo-nitzschia* bloom subsided in the following week.

Dinophysis is a phytoplankton genus responsible for diarrhetic shellfish poisoning (DSP). A sample in Town Cove (Eastham/Nauset) was collected on April 25, in response to a report of discolored water in which >1.7 million cells/liter of *Dinophysis acuminata* were observed. DSP toxins were detected in very low levels in blue

mussels, quahogs, and oysters from Town Cove. No toxin was detected in oysters from Nauset Marsh outside Town Cove.

In addition to monitoring of primary stations for biotoxins and potentially toxic algae, Shellfish staff responded to reports of discolored water and potential cyanobacteria blooms throughout the region. In most cases, non-toxic algal blooms were identified, and no further action was necessary. Staff presented a synopsis of MA HAB/biotoxin events at the 2021 Gulf of Maine HAB Science Symposium.

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 for confidentiality reasons.

Contaminated Relay: DMF permits municipalities to relocate (between and within communities) bacterially contaminated shellfish to Approved and Conditionally Approved waters for natural purification (depuration) and municipal propagation. All activities are conducted under strict NSSP guidelines and are heavily supervised by state and local enforcement authorities. No shellfish can be harvested from the receiving relay sites until bacterial (fecal coliform) testing of the shellfish meats has been completed. Generally, after the completion of the transplant, the Division requires shellfish remain in the water through at least one spawning season.

Table 11. 2021 Municipal Spring Relays of contaminated quahogs.

Harvest Site	Receiving Municipality	Transplant Site	Classification Area	Bushels	Last Day Planted
Taunton River	Truro	Pamet Harbor	CCB7.1	244	May 5
Taunton River	Yarmouth	Lewis Bay	SC28.7	728	Jun 8
Taunton River	Oak Bluffs	Sengekontacket	V16.24, 16.27, 16.28	225	Sept 15
Taunton River	Dennis	Bass River Center	SC34.23	70	Sept 20
Taunton River	Edgartown	Sengekontacket Pond	V16.22	232	Nov 2
Taunton River	Westport	East Branch	BB4.21, 4.24, 4.27	4,169	Aug 6
Taunton River	Swansea	Cole River	MHB4.24, 4.26	300	Aug 31
Taunton River	Sandwich	Sandwich Harbor	CCB37.0	400	Oct 14
Taunton River	Fairhaven	North Cove	BB21.21	500	Sept 9
Taunton River	Wellfleet	Inner Harbor & Harbor	CCB13.21, 13.22, 11.20	579	May 21
Bumps River*	Barnstable	East Bay	SC24.0	264	Aug 18

* within town relay

Quahogs (*Mercenaria mercenaria*) were the only species transplanted throughout 2021 (Table 11). A single dredge boat was contracted by ten towns and permitted for contaminated relay activities, with all quahogs originating from the Taunton River. Prior to harvest, shellfish veterinary disease monitoring was conducted on quahogs from several locations within the donor site (pathology conducted by Kennebec River Biosciences in Richmond, Maine). While relay harvesting in the Taunton River typically commences in late April, it was delayed

until May in 2021 due to pandemic-related disruptions. As a result, the spawning season requirement for post-transplant harvest was waived, with a minimum 60-day depuration period required prior to harvest; acceptable indicator levels in shellfish meat samples were required prior to reopening and harvest. The dredge boat harvested a total of 7,447 bushels of quahogs for the 10 communities during the season which ended in November due to low water temperatures. An additional 264 bushels of quahogs were harvested from Barnstable contaminated waters by wild harvesters and relocated to East Bay under the supervision of Barnstable DNR staff. Veterinary disease testing of the relayed quahogs was not required because the donor site and relay site were within the same contiguous water body.

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

Clams are harvested from Conditionally Restricted areas in Boston Harbor, the Pines River in Revere and Saugus, and the Merrimack River in Newburyport and Salisbury, as well as out-of-state in 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 who pay a depuration fee. The purified clams are then sold into commerce.

Throughout 2021, the Purification Plant received clams on 148 days out of the year. The plant allowed harvesters to dig five days per week. The total number of days harvested increased by 19. The Purification Plant saw an increase in overall racks processed for depuration. Four Master Digger Permits were active throughout 2021, in addition to an out-of-state harvester who transported product from Maine to be processed and released for in-state consumption. The plant saw an increase in areas frequented by harvesters in 2021. As in 2020 digging continued in GBH 5.2, Logan Airport, as well as various locations throughout the Weymouth area. Areas in Hull, GBH 1.2-1.6 (excluding GBH 1.2 as restricted) were harvested. This was the first time the area has been routinely frequented since the die off caused by neoplasia.

The summer months of 2021 were some of the wettest on record. Boston experienced a record 21 inches of rain for the three months of July, August, and September. Although the flats were not subject to COVID closures, the frequency of tropical systems moving through the area put the damper on summer clam digging, with only 49 harvest days from June through September. While the frequency of harvests during that four-month period declined from 2020, the average number of racks harvested per harvest day increased 183%. Had it not been for an extraordinarily wet season, the shellfish plant likely would have seen a dramatic increase in shellfish processed.

Shellfish Purification Plant Laboratory

The Shellfish Purification Plant's laboratory analyzed 577 shellfish samples from the 154 lots of shellfish received at the Plant. The samples were analyzed for fecal coliform in compliance with federal and state depuration standards. In addition, 347 UV effluent and sea water samples and 292 tap water and control samples were bacteriologically tested for the more stringent drinking water standard of total coliform. The laboratory also tested 226 shellfish and water samples for the presence of Male Specific Coliphage (MSC). MSC is a virus of *E. coli* and indicates when an increased risk of Norovirus and other human viral pathogens may be found in shellfish and shellfish waters. The plant's MSC testing included 55 wastewater treatment plants tested for

influent, prechlorination and effluent water samples processed in conjunction with the DMF New Bedford laboratory for fecal coliform assessment. The Newburyport laboratory also continued its collaboration with the New Hampshire Department of Environmental Services analyzing for MSC in NH shellfish and environmental waters.

In April 2021, the plant laboratory in partnership with Gloucester Marine Genomics Institute of Gloucester, MA received an Innovation Grant from the Seaport Economic Council to continue assessing the relationship of MSC in shellfish with the risk of Norovirus through the utilization of specific genetic tools. This work continues to ensure public health measures and the safe promotion of the shellfish economy of Massachusetts' coastal communities.

For the sixth year, the Purification Plant laboratory participated in DMF *Vibrio parahaemolyticus* (*Vibrio*) assessments used to determine *Vibrio* management plan protocols. The Newburyport laboratory received frozen samples processed from the DMF New Bedford laboratory. These were analyzed by qPCR for total and pathogenic *Vibrio*. Positive samples were transferred to researchers at the University of New Hampshire, Durham, NH for *Vibrio* strain type identification.

Plant laboratory staff successfully participated in the FDA regulatory proficiencies for water and shellfish. Despite the resignation of the plant's part-time bacteriologist in August (without a backfill), the Shellfish Plant Laboratory continued to remain open seven days a week processing depuration, shellfish MSC, wastewater MSC and DMF/GMGI study samples with the staff of one full time Bacteriologist and alternating weekend shellfish management biologists. Laboratory staff continued to participate in monthly ISSC Laboratory Committee and Laboratory subcommittee conference calls, laboratory maintenance, quality control, and preparation of laboratory supporting documentation.

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 refers to replacement of shellfish that have been permanently lost due to direct human actions, including shoreline alteration projects, dredging activities, and placement of pipelines 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 filling and dredging activities involved with the project. In fulfillment of an agreement between the Massachusetts Clean Energy Center and DMF to oversee and execute 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 under the plan of selecting one of 10 subareas around the South End peninsula for seeding with 2 million juvenile quahogs (20–25mm size range) in pre-identified optimal habitat areas each year. Between 2015 and 2017, Division staff broadcast seeded more than 3.2 million seed quahogs over 16.6 acres within three subareas, including two experimental plots used to monitor quahog growth and survival. During this 3-year period, annual planting numbers were far below the targeted 2 million seed quahogs per year due to a shortage in supply from commercial hatcheries. This shortage of available seed combined with lower

than predicted annual survival rates of planted quahogs indicated this mitigation approach was insufficient to reach the program objectives. As a result, no seed quahogs were planted in 2018.

Beginning in 2019, DMF modified the mitigation strategy from planting small hatchery seed quahogs to transplanting adult contaminated quahogs from the Mount Hope Bay/Taunton River complex to New Bedford waters. Working collaboratively with commercial fishermen and New Bedford Shellfish Department staff, a total of 4,609 bushels of mildly contaminated adult quahogs from the Taunton River were planted in a 13-acre mitigation site off Fort Tabor in New Bedford Outer Harbor. In November 2020, DMF conducted a two-day dive survey of the Fort Tabor mitigation site to assess survival of planted quahogs and success of the previous year's work. It was determined that 710,168 quahogs survived the transplant, representing a 90% survival of planted quahogs.

An additional three mitigation sites were chosen in early 2020 for adult contaminated quahog relays that summer. However, due to required closures of shellfish growing areas in Clarks Cove and New Bedford Outer Harbor, DMF and the New Bedford Shellfish Constable agreed to postpone the relay of quahogs until the classification issues could be resolved. During 2021, DMF continued to work with the City of New Bedford to resolve the challenges associated with contamination associated with combined sewer outfalls in New Bedford waters, with the hope of resuming quahog mitigation activities within New Bedford and/or Fairhaven waters during 2022.

Buzzards Bay Shellfish Restoration Project: In April of 2003, the grounding of the B-120 oil barge, owned and operated by the Bouchard Transportation Company, resulted in an estimated 98,000-gallon oil spill in Buzzards Bay. Federal and state Trustee representatives were tasked, through the Natural Resource Damage Assessment process, with managing and supporting restoration of natural resources and mitigating 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 B-120 Buzzards Bay Trustee Council to implement specified restoration strategies.

As a result, DMF oversaw a six-year program to restore shellfish resources and benefit public recreational shellfishing through three activities: 1) quahog broodstock relocation 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; 2) quahog seed grow-out and planting within the municipal waters of Wareham, Dartmouth, and Fairhaven; and 3) oyster seed grow-out and planting within the municipal waters of Bourne, Marion, and Wareham. DMF worked collaboratively with the Trustees and town shellfish departments on all aspects of these projects (see prior year Annul Reports for more information). During 2021, Shellfish Program staff prepared a 6-year report for review by the Buzzards Bay Trustees. The final report was expected to be posted on DMF's website along with previous B-120 progress reports sometime in the fall of 2022.

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 private molluscan shellfish aquaculture. DMF's duties involve three major areas of concern: 1) certifying the issuance of aquaculture licenses by municipalities; 2) permitting of aquaculturists, towns, and hatcheries to obtain, possess, and sell sub-legal shellfish (seed) for transplant and grow-out to legal size; and 3) reviewing shellfish pathology reports to add hatcheries to DMF's list of approved seed sources to prevent new introductions and spread of shellfish diseases in Massachusetts waters.

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 2021, Project staff certified 15 new shellfish aquaculture license sites which involved surveying 34.2 acres of tidelands (Table 12). Staff also conducted an eelgrass survey of Lake Tashmoo in Tisbury with DMF's Habitat Program at the request of Tisbury municipal officials.

Town	License Sites	Acres
Bourne	1	0.04
Duxbury	1	1.6
Eastham	1	1
Edgartown	1	2
Fairhaven	3	6
Harwich	1	0.01
Oak Bluffs	1	2
Rowley	1	16
Tisbury	2	2
Wellfleet	3	3.5
Total	**15**	**34.2**

Table 12. New License Certifications in 2021.

Permitting

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

In the case of shellfish, a propagation permit is issued annually to both private growers and municipalities conducting shellfish planting activities. The permit allows the possession, transplant, and grow-out of seed shellfish from approved sources. In 2021, DMF issued shellfish propagation permits to 398private aquaculture license site holders (Table 13), and 25 municipalities (for public propagation activities) operating shellfish aquaculture projects in 33 coastal municipalities throughout the Commonwealth.

In 2021, DMF also issued aquaculture permits for the culture of sugar kelp and horseshoe crabs (solely for the purpose of wild population enhancement).

Table 13. 2021 private aquaculture and shellfish propagation permits and acreage under cultivation by municipality.

Municipality	# Growers	Acres	Species Grown
Aquinnah	1	2.6	Quahog
Barnstable	48	158	Oyster, Quahog, Soft Shell Clam, Surf Clam
Bourne	6	17	Oyster, Quahog, Soft Shell Clam, Bay Scallop
Brewster	10	11.5	Oyster, Quahog, Soft Shell Clam, Surf Clam
Chatham	2	7	Oyster, Quahog, Sugar Kelp
Chilmark	10	20	Oyster, Blue Mussel
Dartmouth	2	1	Oyster
Dennis	23	32	Oyster, Quahog, Soft Shell Clam, Surf Clam
Duxbury	31	79.1	Oyster, Quahog, Soft shell Clam, Surf Clam, Bay Scallop, Sugar Kelp
Eastham	25	43.6	Oyster, Quahog, Soft Shell Clam, Surf Clam
Edgartown	11	20	Oyster
Essex	1	8.5	Oyster
Fairhaven	6	44	Oyster, Quahog
Falmouth	8	54	Oyster, Quahog, Surf Clam, Bay Scallop, Horseshoe Crab
Gloucester	1	8.5	Oyster
Gosnold	1	32	Oyster
Harwich	1	0.01	Bay Scallop, Sugar Kelp
Ipswich	1	1	Soft Shell Clam
Kingston	3	8.5	Oyster, Quahog
Marion	3	1.5	Oyster, Quahog
Mashpee	4	19	Oyster, Quahog, Bay Scallop
Mattapoisett	3	60	Oyster, Bay Scallop
Nantucket	8	73	Oyster, Quahog
Oak Bluffs	1	4	Oyster, Quahog, Sugar Kelp
Orleans	14	18.5	Oyster, Quahog, Blue Mussel, Surf Clam
Plymouth	31	81.5	Oyster, Quahog, Soft Shell Clam, Surf Clam, Bay Scallop
Provincetown	17	39	Oyster, Quahog, Soft Shell Clam, Surf Clam
Rowley	2	24	Oyster, Quahog, Soft Shell Clam
Tisbury	3	3	Oyster, Bay Scallop
Truro	7	20	Oyster
Wareham	8	83	Oyster, Quahog
Wellfleet	94	264.5	Oyster, Quahog, Soft Shell, Surf Clam, Blood Arc
Westport	6	80	Oyster, Quahog
Yarmouth	6	33	Oyster, Quahog
Grand Total	**398**	**1352.3**	

Aquaculture Landings

Aquaculture landings and value for oysters and quahogs are presented in Table 14. Oyster culture continues to dominate the aquaculture industry in Massachusetts. The COVID-19 pandemic created much hardship throughout the seafood industry in 2020 but impacted the oyster aquaculture fishery the hardest with a greater than 41% loss compared to the industry's value in 2019. Oyster landings value in 2021 rebounded to more than $29,643,320, slightly above the pre-pandemic value of $29,035,187 in 2019. Quahog aquaculture revenue was driven mostly by growers in Barnstable and Wellfleet and increased by 21% from 2020 to $1,311,203 in 2021.

The value of other cultured shellfish species including bay scallops, softshell clams and surf clams, and kelp does not substantially add to aquaculture landings value and are not reported here due to confidentiality issues.

Table 14. 2021 Aquaculture Landings and Value for Oysters and Quahogs.

Eastern Oyster		
Town or Region	**Pieces**	**Reported Value**
Barnstable	11,112,882	$5,978,972
Bourne	98,400	$49,287
Brewster	939,300	$511,610
Chatham/Mashpee	623,815	$368,449
Dennis	2,830,699	$1,514,273
Duxbury	12,866,525	$7,043,403
Eastham	1,929,877	$1,019,513
Edgartown	1,611,754	$918,142
Falmouth	1,914,738	$1,020,095
Gloucester	*	*
Nantucket	675,920	$509,574
Orleans	1,003,874	$544,607
Other Buzzards Bay Towns	3,219,779	$1,660,182
Other Island Towns	523,240	$437,532
Plymouth/Kingston	2,896,061	$1,466,437
Provincetown	111,794	$64,716
Truro	152,312	$89,599
Wareham	1,126,980	$649,052
Wellfleet	10,174,253	$5,377,244
Yarmouth	802,554	$420,633
TOTAL	**54,614,757**	**$29,643,320**
Quahog		
Town or Region	**Pieces**	**Reported Value**
Barnstable	1,395,136	$432,868
Duxbury/Eastham	77,340	$19,371
Wellfleet	2,851,454	$858,964
TOTAL	**4,323,929**	**$1,311,203**
Total Aquaculture Landings Value		**$30,954,523**

*Confidential Data; Totals reflect only displayed values
Source: SAFIS Dealer Reports on April 25, 2022 and staff edits.

Aquaculture Program staff dedicated a substantial amount of time in 2021 to administering a second round of CARES Act fisheries relief grants to the Aquaculture Sector. Program staff also provided support to The Nature Conservancy's Supporting Oyster Aquaculture and Restoration (SOAR) Program that created an alternative market for cultured oysters, particularly oversized oysters and Sea Grant's Second round of COVID-19 Response Funding for Municipal Shellfish Programs and Industry Support (See the Other Activities section on page 47).

Aquaculture staff engaged in additional external outreach activities including providing guest lectures/presentations for the Fundamentals of Shellfish Farming course sponsored by Cape Cod Cooperative Extension and Woods Hole Sea Grant and the Applied Shellfish Farming course at Roger Williams University; serving on the Woods Hole Sea Grant Marine Outreach Guidance Group (MOGG), MIT Sea Grant Aquaculture Advisory Panel (MITSGAAP) and Atlantic States Marine Fisheries Commission (ASMFC) Aquaculture Committee; serving on several competitive grant review panels (NH Sea Grant, MIT Sea Grant, Woods Hole Sea Grant); and providing peer review for several scientific journal publications.

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 exposure to *Vibrio parahaemolyticus* bacteria (*Vp*; *Vibrio*) from the consumption of raw oysters. Consumption of raw shellfish exposed to high levels of *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 outbreaks to monitor conditions in oyster harvest areas, implement *Vibrio* control measures, and respond in the event of a *Vibrio* illness 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 or Vibrio Control Plan in 2021. The *Vibrio* Control Season in Massachusetts currently runs from May 19 to October 19, 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* bacteria; 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 Environmental Police, work with harvesters and growers to educate and verify compliance with the *Vibrio* Control Plan through routine compliance monitoring and industry 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.

Table 15. Single-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
2019	8
2020	11
2021	16

*Mass*DPH and DMF investigated 33 confirmed *Vp* illnesses involving consumption of raw oysters in 2021. There were 16 single-source (traced to a single shellfish growing area) *Vibrio* illnesses in 2021 (Table 15). The highest number of single-source illnesses were from Katama Bay (V20) with six cases. Three cases were harvested from Buzzards Bay growing areas, five cases were harvested from various Cape Cod Bay growing areas, one case from the Elizabeth Islands, and a single case was from a Mount Hope Bay (MHB4) growing area. One of the Buzzards Bay illnesses and the MHB4 illness were associated with recreational harvest for personal consumption. Three multi-source illness tracebacks involved oysters from only MA growing areas, nine cases implicated both in-state and out-of-state growing areas, and five illnesses involved only out-of-state oysters. Eight additional investigations and tracebacks were completed for illnesses associated with raw oyster consumption that were confirmed *Vibrio* genus, but species was not identified. Two involved single-source tracebacks to MA growing areas (CCB45 and V20), two implicated multiple in-state growing areas, two involved out-of-state sources (NY, RI and Canada) and two were lost to traceback. Despite the substantial efforts made in Massachusetts to curb *Vibrio* illness, certain harvest areas have continued to experience annual *Vibrio* cases, specifically Plymouth,

Kingston, and Duxbury Bays (CCB42, 43, 45), and Katama Bay (V20) on Martha's Vineyard. Those areas have a shorter window of one hour between harvest and icing from July 1 to September 15.

DMF conducted *Vibrio* analyses on 20 samples collected on September 23 to get a snap shot of *Vibrio* abundance and presence of genes associated with pathogenicity in various growing areas in the towns of Barnstable, Dennis, Eastham, Wellfleet, Wareham, Westport, Duxbury, Plymouth, Edgartown, and Nantucket. There was great variability in total *Vp* abundance ranging from a low of 3 MPN/g in Nantucket Harbor (NT5) to a high of 2,303 MPN/g in Barnstable Harbor (CCB31). Total *Vp* exhibited poor correlation with the presence of potentially pathogenic *Vp* genes *tdh* and *trh*, which were highest in areas where total *Vp* was an order of magnitude lower than Barnstable Harbor levels. Collaborators at the University of New Hampshire will be conducting genetic analyses to determine which *Vibrio* strain types were present in those samples. Results of the 2020 *Vibrio* resubmergence study was presented at the 113th Annual Meeting of the National Shellfish Association and DMF Seminar Series.

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 culture larval and post-set shellfish, microalgae, and eelgrass, and to conduct a shell recycling program. Seed shellfish are produced for eventual transplant to public 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 2021, MVSG continued bivalve culture activities at three facilities: DMF's Hughes Hatchery, the MVSG hatchery in Tisbury, and the shellfish nursery facility on Chappaquiddick Island. Culture activities in the main building and two greenhouses at Hughes Hatchery continue to include larval culture of bay scallops and oysters, nursery grow-out of quahogs and oysters in land-based upweller silos, tanks, and tables, utilizing fresh seawater from Lagoon Pond and aeration.

In 2021, MVSG set 1 million oyster larvae onto shell at the Hughes Hatchery for an ongoing, pilot-scale project in Sengekontacket Pond. The spat-on-shell will be kept in bags and cages, safe from predators, until September of 2022, at which point it will be planted onto small beds of shells and oysters which were established in 2018. The goal is to increase microbial denitrification in Sengekontacket by promoting on-bottom oyster beds. This project is funded by the Friends of Sengekontacket and operates in partnership with the Oak Bluffs Shellfish Department.

MVSG continued with its aquaculture research at Hughes Hatchery in 2021 by developing methods to culture ''southern'' surf clams (*Spisula solidissima similis*). This inshore species of surf clams is more tolerant of higher water temperatures than their offshore deeper water counterparts. Considered an "alternative species" among aquaculturists in the northeast, surf clams may offer oyster growers the capacity to diversify their crop. When young surf clams reach 2 inches, they make perfectly sweet, tender clams for pasta and raw bars; thus, the affectionate name of "butter clams". In the fall of 2021, MVSG grew 370,000 seed surf clams at Hughes Hatchery (an increase from 100,000 in 2020) for the Southeastern Massachusetts Aquaculture Center (SEMAC), which are now on several shellfish farms on Cape Cod.

In September 2021, the Baker-Polito Administration announced that DMF and MVSG approved a new 15-year lease agreement authorizing MVSG to continue use of the Hughes Hatchery to spawn and culture shellfish for transplant into harvestable shellfish beds throughout Martha's Vineyard. The agreement, authorized by legislation sponsored by State Senator Julian Cyr and Rep. Dylan Fernandes, was enacted by the Massachusetts Legislature in January 2021. With the long-term agreement in place, MVSG expects to make additional

infrastructure investments, enabling them to ensure the continued and reliable production of shellfish in support of the Island's public fisheries.

John T. Hughes, former DMF lobster biologist, and the namesake of the Hatchery and Research station, died on Nov. 28, 2021 at the age of 99. To the national and international scientific community, he was a pioneer in lobster research, author of many research publications, and recipient of countless awards. John became the director of the Lobster Research Station in 1975, serving in that role until he retired in 1984. He was the first to successfully breed the American lobster in captivity, with the goal of restocking lobster populations in New England waters.

Other Activities

Staff participated in numerous professional organizations such as the Massachusetts Shellfish Officers Association and New England Estuarine Research Society.

For a second year, Shellfish Program staff worked with The Nature Conservancy (TNC) and Pew Charitable Trusts on an initiative termed the SOAR program (Supporting Oyster Aquaculture and Restoration) to purchase oysters from growers for the purpose of shellfish restoration. DMF permitted the planting of oysters on Municipal Shellfish Propagation Permits and issued Letters of Authorization (LOAs) to growers and TNC for the purchase and sale of market-sized oysters.

The Shellfish Program also supported the Sea Grant COVID-19 Response Funding for Municipal Shellfish Programs and Industry Support Program, Fiscal Year 2021–2022. This Program provided mini-grants up to $10,000 to Massachusetts towns to enhance their shellfish resources and provide assistance to mitigate COVID-related impacts to their local propagation programs. In addition to reviewing submitted proposals, DMF issued LOAs to municipalities and shellfish growers for projects that purchased shellfish from local aquaculturists for planting in recreational harvest areas.

In 2021, DMF applied for and was awarded a third FDA Milk and Shellfish Grant to purchase shellfish program equipment. DMF used the $10,000 received to purchase needed supplies and equipment for the laboratory. This included a salinity meter, analytical balance, laboratory refrigerator, micropipette verification system and coliform waterbath. DMF is grateful for the support of the FDA, ISSC, NCIMS and AFDO National Shellfish Sanitation Grant Program that has provided over $35,000 to the Shellfish Sanitation and Management Program in capital and educational funding.

A team of individuals from DMF, MSOA, and MEP planned a two week in-person Shellfish Constable training course to be held in February 2021 at the MA Maritime Academy. The course was cancelled due to the COVID pandemic, but acknowledging that many registrants for the course had been waiting three years for certification, the planning team revised the training course to be held virtually, with an expected date of spring 2022 to be administered.

Habitat Program

Personnel

Dr. Kathryn Ford, Program Manager (through May 7)
Mark Rousseau, Program Manager (beginning August 9)

Gloucester
Tay Evans, Marine Fisheries Biologist
Kate Frew, Marine Fisheries Biologist
Dr. Forest Schenck, Marine Fisheries Biologist
Kelly Kowal, Student Intern (June–December)

New Bedford
Eileen Feeney, Marine Fisheries Biologist (through May 28)
Dr. John Logan, Marine Fisheries Biologist
Simonetta Harrison, Marine Fisheries Biologist (beginning October 25)
Steve Voss, Marine Fisheries Biologist
Ryan Nuttall, Contract Assistant (through September 30)
Emma Gallagher, Contract Assistant (beginning August 30)
Kerri Goncalves, Contract Assistant (beginning August 30)

Overview

The Habitat Program protects and enhances marine fisheries resources through its Technical Review and Fisheries Habitat Research 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 studies focus on marshes, embayments, artificial reefs, eelgrass, and food webs.

Technical Review Project

Technical Review

DMF reviews coastal construction projects and provides information to municipal, state, and federal agencies to ensure projects avoid, minimize, or mitigate potential impacts to marine fisheries resources and habitats. Each project is included in an Access database with pertinent information about the type of project, the potential habitat impacts, and the size of impacts. In 2021, staff reviewed 599 projects in 87 municipalities (Figure 8). Of these, 407 were new applications (192 had been previously reviewed) which is consistent with the average of 387 new projects per year over the past 10 years. The dominant project type was residential docks again.

Not all projects represent new construction or new impacts; 126 projects were replacements or repairs of existing infrastructure. Approximately 48% of all reviewed projects had the potential to directly impact habitat (n=285), including 153 projects in or near salt marsh and 22 in or near eelgrass (Figure 9). In 2021, DMF recommended time of year restrictions (TOYs) for 34 of the 407 new projects reviewed (8%).

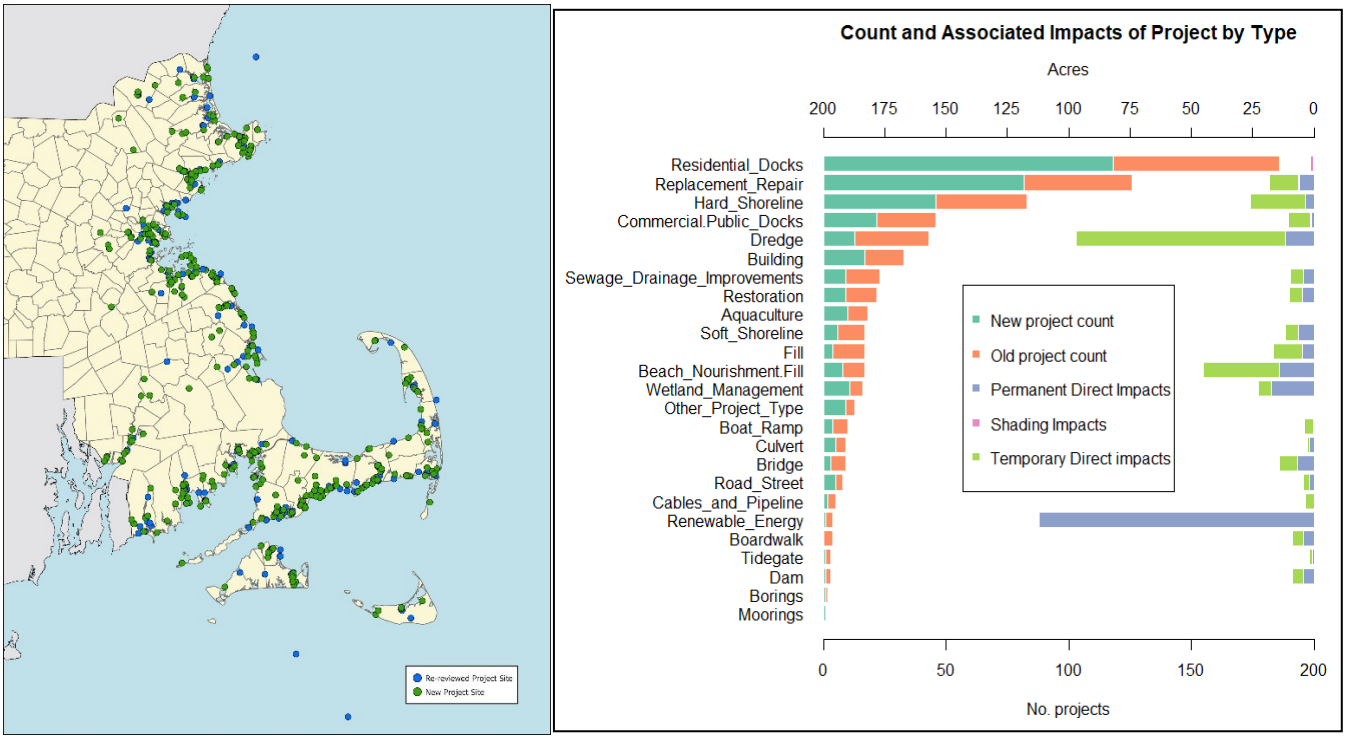


Figure 8. Coastal alteration projects reviewed in 2021 by location (left), and number and cumulative impact size (right). A single project can include multiple project types. "Other" includes boat lifts, groin repair, wellfield developments, sediment remediation, marine railway removals, and park improvements.

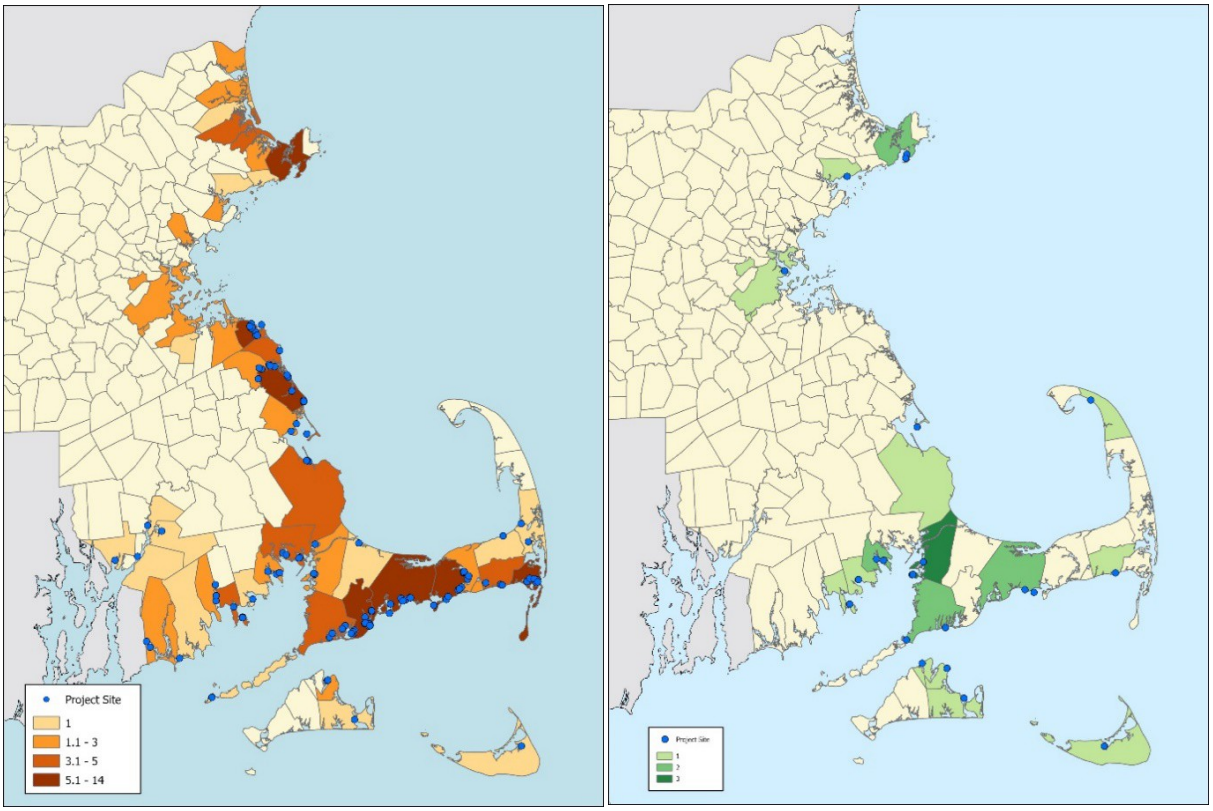


Figure 9. Projects with potential impacts to salt marsh (left) and eelgrass (right).

Some of the notable projects reviewed this year included the Park City Wind and South Fork Wind offshore wind projects; Amitié submarine cable; HEEC cable; Logan Airport runway 7; and Dewey Daggot landfill. Major dredging projects included Newburyport and Boston Harbors.

The north shore office reviews projects from the Town of Hull and north to the New Hampshire border and the south shore office reviews projects from the Town of Cohasset and south to the Rhode Island border, including the Islands. The north shore office generally reviews fewer but more complex, urban projects, while the south coast office generally reviews more projects that are smaller in size.

During 2021, Habitat Staff continued efforts to improve response information for comment letters and tracking of coastal construction projects. Program staff published a dock impact review paper to a peer-reviewed journal and developed a programmatic response for addressing impacts from docks and piers. Staff also consolidated the Habitat Review Log databases from the two field stations and initiated a migration of project review data from MS Access platform to an ArcGIS Online platform designed for concurrent use across both field offices.

In Lieu Fee Program

The In Lieu Fee (ILF) Program is the mechanism by which the U.S. Army Corps of Engineers (USACE) 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 USACE General Permit and Individual Permit. Staff participate in the ILF Program's proposal review for projects submitted for funding consideration, the tracking of payments received and credits sold, and the development and review of the Department's annual reports on the program.

Coastal ILF Program: The Draka Dam fishway in Taunton is the final project to be completed under the Coastal ILF Program. The fishway was partially funded through the Coastal ILF Program with additional support from Save the Bay, the Massachusetts Environmental Trust, and the US Fish and Wildlife Service. Construction was completed on the project in 2019 and seasonal monitoring and stocking will continue through 2024.

***Mass*DFG ILF Program:** In 2020, MassDFG initiated an annual selection process for identifying coastal restoration projects to submit to the USACE for funding approval. Projects approved for funding are typically required to include monitoring for five years or more. While no DMF proposals were funded in 2021, the Habitat Program worked on three active ILF-funded projects during the year. Additional information on Eelgrass Restoration/Middle Ground-Salem, MA project can be found on page 55. MA Eelgrass Site Selection Model and Targeted Planting Study is further described on page 55, and Marine Habitat enhancement, Artificial Reef-Yarmouth.

Offshore Wind

In 2012, the Bureau of Ocean Energy Management (BOEM) established two Wind Energy Areas (WEAs) south of Martha's Vineyard and Nantucket. By 2021, these WEAs had been divided into nine Lease Areas held by eight developers. Projects in these WEAs, including three in the Rhode Island–Massachusetts area and six in the Massachusetts area, were undergoing varying stages of site assessment and permit review (Table 16). In 2021, Beacon Wind received approval for its Site Assessment Plan; Mayflower Wind submitted its Construction and Operations Plan; and BOEM submitted four Notices of Intent (NOI) to prepare Environmental Impact Statements for Revolution Wind, New England Wind, Sunrise Wind, and Mayflower Wind. Vineyard Wind 1 and South Fork were the nation's first and second commercial-scale offshore wind projects to receive Records of Decision approving project construction and operations, respectively.

Table 16. Leasing & Permitting Status of Massachusetts and Rhode Island Wind Energy Areas (WEAs)[1,2]

Lease Number	Project Name	Developer(s)	Site Assessment Plan Status	Construction and Operations Plan Status	Environmental Impact Statement Status	Record of Decision Status
RI OCS-A 0486	Revolution Wind	Ørstead/ Eversource	Approved	Submitted	NOI to Prepare	N/A
RI OCS-A 0517 (Formerly 0486)	South Fork	Ørstead/ Eversource	Approved	Approved	Final Published	Approved
RI OCS-A 0487	Sunrise Wind	Ørstead/ Eversource	Extension Approved	Submitted	NOI to Prepare	N/A
MA OCS-A 0500	Bay State Wind	Ørstead/ Eversource	Approved	N/A	N/A	N/A
MA OCS-A 0534 (Formerly 0501)	New England Wind (Park City Wind & Commonwealth Wind)	Avangrid	Approved	Submitted	NOI to Prepare	N/A
MA OCS-A 0501	Vineyard Wind 1	Avangrid/ Copenhagen Infrastructure Partners	Approved	Approved	Final Published	Approved
MA OCS-A 0520	Beacon Wind	Equinor/BP	Approved	N/A	N/A	N/A
MA OCS-A 0521	Mayflower Wind	Energias de Portugal Renováeis/Shell	Approved	Submitted	NOI to Prepare	N/A
MA OCS-A 0522	Vineyard Wind – Liberty Wind	Copenhagen Infrastructure Partners	Approved	N/A	N/A	N/A

[1]Source: State Activities | Bureau of Ocean Energy Management (boem.gov)
[2]Table does not provide an exhaustive list of permitting and consultation activities.

In 2021, DMF hired an Offshore Wind Specialist to address water-dependent renewable energy projects with a focus on related Massachusetts fishing industry and marine habitat impacts. DMF continued its participation in multiple wind-energy activities, including conducting technical review of projects in the Massachusetts WEA, attending workshops and webinar series focused on offshore wind research and monitoring priorities, and fulfilling advisory roles for research and stakeholder engagement efforts. In 2021, DMF reviewed marine resource and habitat monitoring plans, impact assessments, and permits for offshore export cables in Commonwealth waters associated with the South Fork Wind, Park City Wind, and Sunrise Wind projects. Topics of concern included impact-producing factors associated with project construction, species vulnerabilities in Nantucket Sound, benthic and finfish monitoring design, and compensatory mitigation for affected fisheries.

In May 2020, Vineyard Wind, LLC and the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) signed an agreement establishing the Fisheries Innovation Fund. The purpose of the Fund is to support programs and projects that ensure safe and profitable fishing continue as Vineyard Wind 1 and future offshore wind projects are developed in Northern Atlantic Waters. DMF's Director serves as trustee of the Fund and chairs an Offshore Wind Fisheries Research, Innovation, and Science advisory panel dedicated to advising on proposed expenditures from the Fund. In winter 2021, DMF assisted in selecting advisory panel members; the advisory panel will convene for its first meeting in June 2022.

In Spring 2021, DMF assisted in establishing Terms of Reference for the Massachusetts Fisheries Working Group (FWG) on Offshore Wind Energy. EEA, the Office of Coastal Zone Management (CZM), and DMF convene and manage the FWG in close coordination with the Massachusetts Clean Energy Center (Mass CEC) to engage with the Commonwealth's fishing industry on the development and operation of offshore wind projects on the Atlantic outer continental shelf. Following the siting and leasing process, the FWG evolved into a forum for developers, state and federal agencies, and the fishing community to discuss topics relating to the offshore wind projects proposed for Lease Areas within the WEAs. Held quarterly, FWG meetings in 2021 covered topics

including but not limited to proposed projects, permitting processes, navigation and transit, habitat and fisheries monitoring, fishing activity, construction and operation considerations, and research needs and opportunities.

DMF continued to participate in ongoing coordination with BOEM and the states of Maine and New Hampshire to establish siting principles for potential WEAs in the Gulf of Maine, including discussions regarding the State of Maine Offshore Wind Research Array. The last meeting of the Gulf of Maine Intergovernmental Renewable Energy Task Force was December 12, 2019. The next Task Force meeting is scheduled for May 2022.

Ocean Planning

In 2021, the Massachusetts Ocean Management Plan (the Commonwealth's blueprint for the protection and sustainable use of state ocean waters) completed the plan's five-year review and revision. Program staff participated in the Science Advisory Council and the Ocean Advisory Commission meetings and contributed to the development of maps to inform Ocean Planning discussions. DMF chaired the Fisheries Working Group.

DMF continued to participate on the Northeast Regional Ocean Council and the Northeast Habitat Assessment team. Both entities work to improve regional coordination of the management and permitting of offshore activities.

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, coordinates materials acquisitions and deployments, and provides technical guidance to advance artificial reef development and uses in MA coastal waters.

Reef Monitoring: In 2021, all reef sites were monitored for community composition, biomass, invasive species presence, permit compliance, and temperature. Acoustic receivers were utilized year-round to assess the patterns of tagged fish. Most fish documented through the acoustic receiver data were striped bass. We also documented fish visiting multiple reef sites and returning to the same reef site over multiple years. Work continued on the development of protocols to guide future reef monitoring efforts.

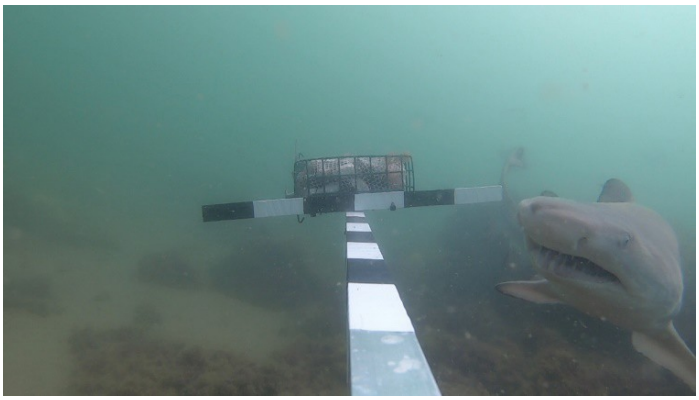


Figure 10. Screenshot of BRUVS video monitoring footage.

DMF continued a study using Baited Remote Underwater Video Stations (BRUVS) to compare reef productivity of artificial reefs in Nantucket Sound (Figure 10). The BRUVS were used to measure species richness, diversity, abundance, and age structure of black sea bass and scup and compare fish aggregations on artificial reefs to those on nearby natural reefs and sand bottom habitats. Staff continued to utilize BRUVS to assess structured habitat connectivity to determine appropriate spacing of new artificial reefs.

Material Storage and Procurement: DMF entered into a lease agreement with the Massachusetts Clean Energy Center in 2019 for a one-acre area at the New Bedford Commerce Terminal to stage artificial reef material. Over 2,000 cubic yards of material from the Massachusetts Department of Transportation's (*Mass*DOT) South Coast Railway Redevelopment Project have been stored at the site and were planned to remain there until funding

could be secured for a deployment. An effort to obtain surplus materials from *Mass*DOT maintenance depots was ongoing at year's end. Efforts were also continued to orchestrate future direct material deployments to reef sites from large coastal construction projects.

Deployments: In June 2021, DMF, the Town of Yarmouth, and the US Coast Guard–Woods Hole Station deployed retired ATON mooring blocks to undeveloped sections of the Yarmouth artificial reef site at no cost to the Commonwealth as part of the USCG maritime stewardship efforts in support of local coastal communities (Figure 11).

Figure 11. Deployment of retired ATON mooring blocks at the Yarmouth artificial reef site.

Cape Cod Bay Site Selection: In 2018, DMF began exploring the potential for four to five new artificial reef locations in lower Cape Cod Bay between Sandwich and Barnstable. In 2021, project staff met with Massachusetts Environmental Policy Act (MEPA) representatives from EEA to discuss the appropriate permitting pathway for these sites. Proposed sites in Brewster and Dennis were under review as potential sites to explore for permitting.

Intern: In 2021, program staff advised Northeastern University student Kelly Kowal on a master's graduate thesis project analyzing 15 years of HubLine artificial reef monitoring data to assess temporal changes in species composition. Preliminary findings of the assessment include identifying higher abundance of cunner on artificial versus natural reefs and a decline in lobster abundance at both natural and artificial reef sites in Boston Harbor.

Outreach: Habitat staff presented updates on DMF artificial reef activities to various groups, including DMF's Marine Recreational Fisheries Development Panel, the Cape Cod Commercial Charter Boat Association, the Cape Cod Salties, and the ASMFC Artificial Reef Committee.

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 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. Efforts to advance the database to a publicly accessible platform were ongoing in 2021.

Ocean Acidification Commission: The Ocean Acidification Commission was created in 2018 by legislation and is comprised of Massachusetts legislators, coastal and ocean acidification scientists, commercial fishermen and aquaculturists, and representatives from environmental agencies and organizations, including DMF. In 2021, the Commission released *The Report on The Ocean Acidification Crisis in Massachusetts*. Recommendations made in the report were being used in drafting Legislation to address this issue.

Food Webs: Project staff have been researching the processes by which ocean warming and other physiological changes from climate change may alter food webs. Staff have been involved in diet and stable isotope studies of tunas in New England shelf and offshore waters in collaboration with the University of Maine and Gulf of Maine Research Institute. DMF staff served on the Master's thesis committee for University of Maine graduate student Sammi Nadeau, who successfully defended her thesis, "Evaluating the foraging ecology and energetics of Atlantic bluefin tuna (*Thunnus thynnus*) in the Gulf of Maine" in Fall 2021.

A study initiated in 2012 to examine the interplay between eutrophication and transfer of contaminants into Cape Cod estuarine food webs continued in 2021. Through a new partnership with researchers from the Harvard School of Public Health, analysis of archived samples for total mercury content continued while new samples collected in 2021 were analyzed for per- and polyfluoroalkyl substances (PFAS). Archived samples were also analyzed for carbon and nitrogen stable isotopes to relate observed patterns in mercury accumulation in estuarine fish and invertebrates to primary production sources and trophic position.

Eelgrass Monitoring and Restoration

Eelgrass is a critical marine fisheries habitat. Project staff conduct research, monitoring, and restoration of eelgrass in Massachusetts. The eelgrass experts at DMF also play an important role advising other groups studying eelgrass and protecting eelgrass through technical review of construction projects.

Seagrass Monitoring: Project staff completed the 14th year of dive surveys at a site off West Beach, Beverly in Salem Sound as part of the international SeagrassNet monitoring program and Mass CZM's Marine Invader Monitoring and Information Collaborative. Long term monitoring at this site provides the region with data on the response of seagrass meadows to changing temperature and the resilience of the site to storms, algal blooms and eelgrass wasting disease. Results from the long-term monitoring are shared in a regional synthesis paper that was submitted for publication in 2021 to a special edition of *Frontiers in Marine Science*. In 2021, we finalized methods to digitally scan high resolution images of eelgrass samples from West Beach for a wasting disease assessment. Our SeagrassNet station data show a consistently stable eelgrass meadow with little annual variation in percent cover, shoot density or biomass. These data and this method are now incorporated into our SeagrassNet long-term monitoring protocol to assess change. In 2021, we recorded higher density of tunicates on eelgrass than in years prior. To better understand tunicate prevalence on eelgrass regionwide, collaboration continued with scientists at WHOI, EPA, DFO, USGS, NPS, and state representatives along the East Coast. Staff continued diver surveys of reference meadows in Salem and Marblehead (in addition to the SeagrassNet site) established during 2013–2014 for annual monitoring of baseline trends in shoot density, percent cover, leaf area index, wasting disease, light, and temperature in natural eelgrass meadows. We have measured eelgrass density ranges from 150 and 350 shoots/m^2 across different sites. Some sites are consistently lower density than others. We also have recorded episodic changes in density due to storm events and direct impacts from lobster gear, but there have been no notable long-term eelgrass declines or indications of increased stress at these sites.

Project staff also use acoustic side scan sonar to monitor seagrass at targeted areas of interest. In 2021, we continued acoustic monitoring in Marblehead as part of a study investigating the impacts of docks on eelgrass in collaboration with Salem Sound Coast Watch, and in Sandwich at Town Neck Beach in relation to ongoing beach management.

Habitat project staff, in collaboration with Massachusetts Bays National Estuarine Program (MassBays), EPA, and local watershed groups, continued a "Citizen Science" program where volunteers submit standardized eelgrass presence and condition data to document eelgrass distribution and health in Massachusetts. Mitigation funding from Mass DEP and Veolia allowed for a fourth year of the Citizen Science Eelgrass Rapid Assessment in the Duxbury-Kingston-Plymouth embayment coordinated by North and South Rivers Watershed Association (NSRWA). A total of 19 volunteers contributed to the eelgrass rapid assessment, sampling at 60 locations in

August, 45 of which occurred within areas where eelgrass was consistently mapped by DEP between 1995 and 2012. These data suggest the distribution of eelgrass remains well below the historic baseline in the Duxbury-Kingston-Plymouth embayment, with eelgrass persisting at 12 stations, still absent from 28 stations, lost from one station where it was present in 2020, and reestablished at four stations where it was absent in 2020. Other local watershed groups expressed interest in contributing to the Citizen Science program in 2022 including Salem Sound Coast Watch, Seaside Sustainability, and Cohasset Center for Student Coastal Research.

Salem Sound Eelgrass Restoration: In 2021, DMF staff completed the fourth of five years of required annual monitoring at our eelgrass restoration site at Middle Ground in Salem Sound—the first ILF funded eelgrass restoration project in Massachusetts. A half-acre site was planted with eelgrass in 2017 and 2018. The planted plots are on target to meet success criteria by 2023 as planned. Of the originally planted plots, 71% remained and had expanded at each set. Shoot density increased since the previous monitoring in 2020 as did planted square area, at all sets.

Eelgrass Restoration Site Selection Project: With funding from the MassDFG ILF Program, a study to identify suitable sites for future eelgrass restoration was launched in 2020. The first phase of the project, using available data layers in GIS to determine potential suitable planting sites, was started in 2020. This included working collaboratively with *Mass*DFG GIS staff to develop a model using applicable data. In 2021, staff collected light attenuation and percent of surface irradiance at sites that rate well in the model, in Manchester-By-The-Sea, Weymouth, Hingham, and Duxbury (Figure 12). Analysis of the sediment and light data show promising habitat conditions for eelgrass at the Duxbury site. Plans for 2022 included test planting the Duxbury site and field sampling six sites on the south shore.

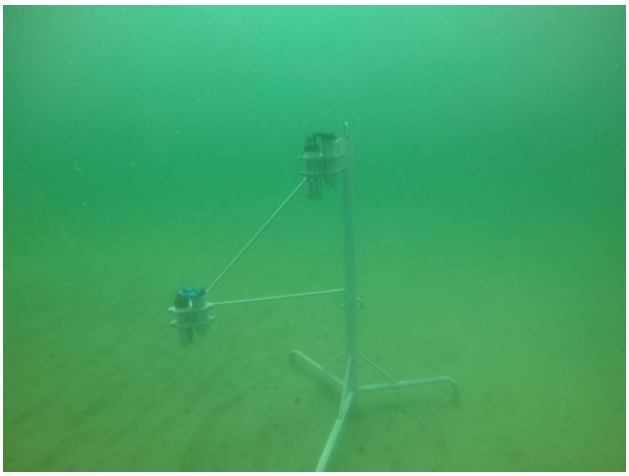


Figure 12. Temperature and light sensors installed at potential eelgrass restoration sites.

Salt Marsh

Private docks are frequently constructed over salt marsh, potentially impacting this important habitat through shading impacts. In quantitative research studies from 2013–2015, DMF showed that current dock design guidelines recommending dock height be set equivalent to dock width (i.e., 1:1 ratio) was inadequate for minimizing shading impacts. In 2021, DMF continued outreach efforts to convey these findings to regulatory agencies by presenting findings of the previous dock shading studies at the MassBays Science Walk in summer 2021. Also in 2021, a comprehensive assessment of dock impacts and associated best management practices were documented in a paper published in the journal *Estuaries and Coasts*. Habitat staff presented the results of this review document at a *Mass*DEP-led workshop on state and federal permitting in November 2021.

Bay Scalloping Impacts to Eelgrass

Bay scallops are found predominantly in eelgrass meadows. To better understand if a winter bay scallop fishery was impacting eelgrass, DMF started studying the impact of dragging for bay scallops on eelgrass in 2018 and has conducted field work multiple times per year since then. The first study relies on a natural experiment. In

Figure 13. DMF staff working in Westport on the scalloping in eelgrass project.

2017, the Westport River supported a large and prolonged bay scallop harvest for the first time in decades, presenting a unique opportunity to characterize eelgrass meadows during the growing season following a single season of scalloping. From 2018–2021, the Habitat team 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 (Figure 13). Data were still being analyzed at year's end, but preliminary work has not demonstrated any declines in eelgrass clearly linked to scalloping activity.

The second study is a controlled impact assessment whereby DMF established experimental scallop dragging sites in an eelgrass meadow in Nasketucket Bay in Fairhaven and in the West Branch of the Westport River. In each area, high and low intensity dragging was conducted during the November–December bay scalloping season for three consecutive years (beginning in 2018 in Fairhaven and in 2019 in Westport), followed by subsequent summer season measuring of eelgrass density in both the fished sites and adjacent unfished reference sites. In 2021, efforts included the final year of eelgrass monitoring in Fairhaven and the final year of dragging in Westport. The final round of eelgrass monitoring for Westport was planned for summer 2022 to complete all field work for the study.

Winter Flounder eDNA

Winter flounder spawn demersal, adhesive eggs in winter months. These eggs are sensitive to turbidity and burial so dredging projects in all Massachusetts embayments are limited by time of year (TOY) restrictions during the spawning and larval development periods as an impact minimization strategy. Because detailed information regarding the timing and location of spawning within embayments is currently lacking, the winter flounder TOY spawning recommendation is broad and long. When combined with user conflicts during summer months, this generally restricts the dredging window to the fall and early winter. There is great interest in better understanding how to adequately protect winter flounder while providing more flexibility for dredge projects in time and space.

Figure 14. Sampling locations for the 2021 pilot winter flounder eDNA study.

In 2019, the Habitat team began a sampling program to assess the feasibility of using environmental DNA (eDNA) to establish when and where winter flounder are located. South of the Cape, the Habitat team collected water samples in partnership with the Rhode Island Department of Environmental Management's (RI DEM) winter flounder fyke net survey in the winters of 2019 and 2020. These samples will allow eDNA data to be compared with traditional survey assessments of winter flounder presence and abundance during winter months. Additional field validation samples were collected in summer 2020 and 2021 in association with our young-of-year winter flounder seine survey on Cape Cod to provide similar summer month comparisons to traditional survey results.

In 2021, the Habitat team initiated a one-year pilot winter flounder eDNA study. The study consists of collecting monthly to bi-monthly bottom water samples from six Cape Cod embayments: Sesuit Harbor, Wellfleet Harbor, and Pamet Harbor on the north side and Green Pond, Waquoit Bay, and the Bass River on the south side (Figure 14). The pilot study is a partnership with the Gloucester Marine Genomics Institute (GMGI), which is using qPCR techniques to detect winter flounder eDNA in bottom water samples from these sites. During 2021, GMGI staff worked on developing primers and analyzing the validation samples from the paired fyke and seine survey collections with further analyses of the pilot study samples planned for 2022. Field water sampling is planned to continue through summer 2022.

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 (ACFHP), the ACFHP Science and Data Committee, the NEFMC Habitat Plan Development Team, the NROC Ocean Planning Committee and Habitat Classification and Ocean Mapping Subcommittee, the MA State Interagency Aerial Spraying Technical Committee, the MA Ocean Acidification Commission, 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 MA DFG ILF Steering Committee and Project Proposal Review Team, the New England Estuarine Research Society's Executive Committee, the PEW National Coastal Habitat Report review team, the TNC Offshore Wind Siting Tool steering committee, the Woods Hole/MIT Sea Grant Fellowship Review Panel, the MIT Sea Grant Research Proposal Review Committee, and the Gloucester Marine Genomics Institute (GMGI) Security of Food Resources concept development and strategic plan steering committee.

Publications: In 2021, the Habitat Program developed a Fisheries Habitat Publications web page to provide access to white papers, standard operating procedures, and peer reviewed publications written by program staff. Topics covered by the Publications page include artificial reefs, climate change, eelgrass, ILF project reports, ocean planning, offshore wind, salt marshes and estuaries, and seafloor studies. Additionally, staff authored a peer-reviewed article reviewing habitat impacts of residential docks and associated best management practices.

Support Activities: Staff reviewed proposals for NOAA, MIT Sea Grant, ACFHP, and performed peer review for eight academic journals. Staff represented the agency at the EEA Summer Internship Speaker series, DMF weekly seminar series, and DEP permitting workshop. Staff provided presentations to MFAC, MSOA, and the SAC. Staff also participated on thesis committees for PhD and Master's candidates at the University of Maine, UMass Boston, and UNH. Project staff advised one NEU graduate student intern from June to December and one Pawling, NY high school student researcher throughout 2021.

FISHERIES BIOLOGY SECTION

Dr. Michael Armstrong, Assistant Director, Section Leader

Fish Biology Program

Personnel

Dr. Gary Nelson, Program Manager
Dr. Micah Dean, Senior Biologist
William Hoffman, Senior Biologist
Scott Elzey, Biologist
Brad Schondelmeier, Biologist
Kimberly Trull, Assistant Biologist
Nicole Ward, Assistant Biologist
Elise Koob, Ageing Technician
Christy Draghetti, Ageing Technician
Joe Holbeche, Technician

Overview

The objectives of the Fish Biology Program are to collect, process, and analyze biological data on recreationally and commercially important fishes needed for effective, science-based management of Massachusetts' fishery resources. Biological data collected from harvested and released fish include age structures (i.e., scales, otoliths, 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 2021, 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 2021 are highlighted below.

Although 2021 marked many improvements over 2020, the COVID-19 pandemic continued to challenge the daily activities of the Age and Growth staff. Staff was able to return to the lab with increased frequency but the processing of samples was slightly impacted by varying schedules and social distancing. An unrelated challenge for 2021 was the transitioning of one staff member to the Fisheries-Dependent Sampling project. This left the Age and Growth project short-staffed for a large portion of the year.

River herring: In early 2021, the Age and Growth project worked with the Passamaquoddy tribe conducting research on river herring in the St. Croix River along the U.S./Canada border. Otoliths were collected from 205 fish (subject to staff's written protocols for river herring) that were aged by the Age and Growth Project.

Black sea bass: In 2021, previous work by staff on age validation of black sea bass was published. Age and Growth staff's leading knowledge of the ageing practices for this species led researchers from the University of Connecticut and Northeastern University to visit the lab to learn best practices for processing otoliths and for training in ageing.

Striped bass: In 2021, work began on a project to explore the influences of environmental and population variables (e.g., temperature, abundance, oxygen) on growth of Chesapeake Bay striped bass. Sectioned otoliths from 2002–2021 were being provided by the Virginia Marine Resource Commission. Annuli will be measured, and the data analyzed in a mixed effect model framework (Figure 15).

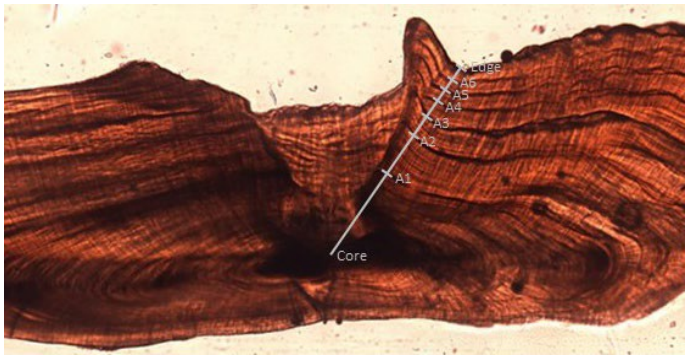


Figure 15. A striped bass otolith cross section showing markings for measurements taken from the core to each annulus and the edge.

Table 17. Samples processed for ageing in 2021

Species	Structure	Process	Number
American shad	Otoliths and scales	Scales aged and checked for repeat spawning	335
Black sea bass	Otoliths and scales	Cleaned, mounted, aged	675
Bluefish	Otoliths	Baked, sectioned, aged	99
Fluke	Scales	Cleaned, pressed	114
Menhaden	Scales	Cleaned, mounted, sent to NMFS	132
Rainbow Smelt	Scales	Cleaned, mounted, aged	523
River herring	Otoliths	Cleaned, aged	4322
Scup	Scales	Cleaned, pressed	180
Striped bass	Otoliths	Sectioned, aged	202
Striped bass	Scales	Cleaned, pressed, aged	1490
Tautog	Otoliths and fin spines	Cleaned, sectioned, aged	210
Winter flounder	Otoliths	Sectioned, aged	538

Other Activities: In 2020, the ASMFC began a structure exchange to evaluate ageing precision between member states that age tautog. The COVID-19 pandemic slowed this process considerably, but late in 2021, the exchange was completed and the ageing committee recommended that pelvic fin spines be included as an acceptable ageing structure for use in future stock assessments. This effort was spurred by Age and Growth staff's 2015 peer-reviewed paper which compared structures for age determination of tautog and recommended that fin spines be used as the primary ageing structure. Using fin spines is advantageous because it allows the fish to be sampled without affecting its marketability or appearance.

In 2021, manuscripts on Atlantic wolffish and Atlantic halibut work from collaborations between Age and Growth staff and external agencies were submitted for publication (expected in 2022).

Fisheries Dependent Sampling Project

The Fisheries Dependent Sampling (FDS) Project is responsible for the at-sea and shore-side sampling of commercial fisheries that occur in and adjacent to Massachusetts territorial waters. The Project also conducts fish biology research studies, provides field and vessel support to other projects and fisheries data analysis and summarization to senior staff.

Commercial Fisheries Sampling

Project staff collect 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. In 2021, as COVID-19 restrictions implemented by state and private entities were eased, access to fish samples returned. Where access did not fully return, Project staff remained in contact with industry members, stakeholders, and fisheries managers in order to minimize the impact of reduced data collection.

Port sampling of commercial catch, specifically striped bass and menhaden, was conducted in collaboration with Recreational Fisheries Project staff (Table 18). In 2021, the commercial striped bass season (open through October 1) provided ample time and landings to sample seafood dealers and collect biological data. Samplers based out of the Gloucester field station were able to collect high-priority South Shore/Chatham striped bass samples at a Boston fish processing facility. Project staff worked with members of the Age and Growth Project to refine and implement a method for removing striped bass otoliths without compromising the condition of the wholesale fish. Use of this ageing structure will improve the ability to age larger, older fish that are routinely landed in the commercial fishery. Similar to prior years, a large biomass of menhaden located in accessible inshore waters created a prolific fishery, which increased the state's sampling obligations. Through the state's allocated quota, additional quota transfers, entry into the Episodic Event Set-aside fishery, and small-scale landings, a total of 9.9 million pounds was landed, starting in mid-May (earlier than in recent years). This increased harvest helped bolster the lobster bait market, which has struggled to deal with recent Atlantic herring quota cuts.

Table 18. Number of port sampling events, or trips, made to intercept commercial vessels or seafood dealers where information was collected in 2021.

Species	Intercepts	Number individuals	Number age samples
Menhaden	13	131	131 (scales)
Striped Bass	40	382	529 (scales & otoliths)

At-sea sampling activities by Project staff were consistent with past years. Monitoring of the state's coastal lobster fishery was a major priority. Sampling occurred between May and November and was conducted out of five ports: Rockport, Gloucester, Beverly, Quincy, and Boston (Table 19). A summary of 2021 commercial sampling efforts is covered in the Invertebrate Fisheries Project section.

Multiple sea days were spent aboard R/V *Michael Crave*n and R/V *Alosa* to support other Division projects and external collaborations. These efforts included collecting biological samples for UMass-Boston/New England Aquarium and Gloucester Marine Genomics Institute, procurement of fisheries-independent spawning sea herring samples, recovery and deployment of an autonomous glider for Woods Hole Oceanographic Institute, and hosting a wildlife conservationist and television crew for a day of striped bass research.

Project staff helped the Massachusetts Environmental Police remove illegal and/or non-compliant lobster gear from the Massachusetts large whale seasonal trap closure area created to protect seasonal aggregations of endangered right whales. Using *R/V Michael Craven* and *R/V Alosa* as platforms to haul the unlawful lobster gear, staff removed gear for four days and spent many hours transporting gear to a storage facility.

Table 19. Summary of at-sea sampling efforts by Project staff in 2021.

Sea Days (#)	Project
80	Winter Flounder Acoustic Telemetry and Beam Trawl Survey
39	Acoustic Telemetry- Striped Bass
11	BREP – Cod Avoidance
27	Coastal Lobster
5	Resource Assessment
7	Lobster Gear Compliance
20	Vessel Support for External Projects (e.g., White Shark, Outreach/Education)

Commercial Fisheries Data Analysis

Project staff provided commercial fisheries sampling data and analyses to support efforts by the Conservation Engineering Project, Diadromous Fisheries Project, Invertebrate Fisheries Project, and other agency initiatives. In addition, staff compiled commercial herring catch and sampling data to inform management initiatives, and presented the findings of the 2020 "Squid Report" at multiple venues.

River Herring Bycatch Avoidance in the Atlantic Herring Fishery

After concluding the large-scale portside sampling program in 2020, project partners (DMF, SMAST, and the herring and mackerel mid-water trawl fleet) planned to continue collaborating on the River Herring Bycatch Avoidance program for 2021. However, further reductions to the coast-wide Atlantic herring quota (of which 3% is allocated to the Research Set-Aside (RSA)) meant that this funding mechanism could no longer sustain the administration of the program. By 2021, the compensation quota under the RSA was less than 150 metric tons, split across three fishing areas. Despite industry partners' offers to compensate in advance of harvest, it was decided in early 2021 to terminate the RSA. This collaborative bycatch avoidance program, developed in 2010 and supported by NMFS and the NEFMC since 2015, stands as an international example of how fishing industry, academia, and a fisheries agency can work successfully towards a common conservation goal.

Building on the foundation of the DMF/SMAST portside sampling program, project staff continued assisting NOAA Fisheries Sampling Branch with development of a federal portside sampling program for the Atlantic herring and mackerel fisheries. Having assisted in the development of sampling strategies, guidelines and protocols used by the Sampling Branch, project staff sat on expert panels for two sampler training sessions in 2021. In mid-2021, the NMFS Industry-Funded Monitoring Amendment, which requires vessels to fund trip coverage up to 50%, became operational. Project staff continued to assist the Sampling Branch as requested.

In 2021, staff conducted GSI sampling for Atlantic herring, acquiring one fisheries-independent sample prior to the spawning closure by setting a gillnet in local waters and one GSI sample from inshore waters collected after the GOM spawning closure was lifted. While reduced access to spawning fish may persist as quotas remain low, staff will continue to collect and sample herring for spawning maturity to inform monitoring and future management decisions.

Fisheries Research Projects

DMF continued its commitment to applied fisheries research to improve the management and assessment of the Commonwealth's marine resources through various collaborations with university, non-profit, state, and federal organizations.

Industry-Based Survey of Gulf of Maine Cod

DMF staff published two peer-reviewed scientific articles in 2021 using data from DMF's industry-based trawl survey (IBS). The spatially and seasonally-intensive sampling of this survey, conducted from 2016–2019 in a portion of the GOM that encompasses the core area of the cod population (see prior annual reports for more information), has created a unique dataset that will inform stock assessments and fisheries management for years to come. The first article demonstrated that the size selectivity of the Gulf of Maine cod fishery is "dome-shaped", meaning that medium-sized cod are removed from the population at a faster rate than all other sizes. This finding, which is at odds with the current stock assessment, may have caused significant inaccuracies in previous stock reference points and harvest limits. The second article provided estimates of survey trawl efficiency by determining the amount of fish that escape beneath the net, as well as the amount of fish that are "herded" into the net path by the doors and sweeps (Figure 16). These efficiency estimates will allow DMF to extrapolate survey observations of fish density into estimates of population size that are directly comparable to the stock assessment.

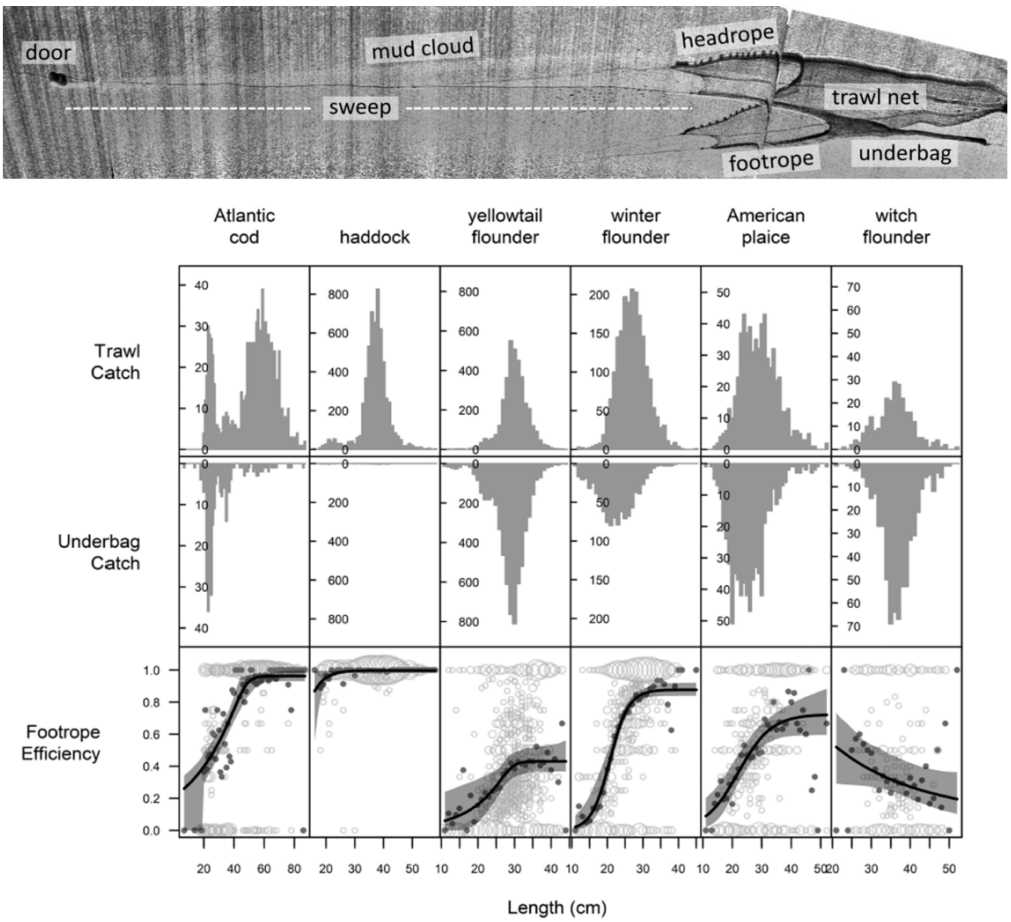


Figure 16. [top] Sidescan sonar image of the survey net being used during the footrope efficiency experiment. Note the "underbag" beneath the primary trawl to capture fish escaping beneath the footrope. [Bottom] Size distributions of fish caught in the primary trawl and underbag. The bottom row shows the survey trawl's efficiency at capturing available groundfish within its path.

Minimizing Discard Mortality

The portion of fish that die from being caught and released can represent a major source of unintended losses for some key fish stocks. In particular, anglers pursuing the abundant haddock stock frequently encounter Atlantic cod, which occupy similar habitats but are subject to severe restrictions due to their depleted state. In 2020, DMF published a new Recreational Haddock Fishing Guide with funding from NOAA's Bycatch Reduction and Engineering Program, which contains detailed monthly maps of areas to target (good haddock fishing with little cod bycatch), and areas to avoid (not as good haddock fishing, with high cod bycatch). The maps were developed using geostatistical models fit to IBS trawl survey data and were rigorously tested in summer 2019 prior to their publication. These initial recreational fishing observations at over 800 locations found that target areas resulted in a 12% higher haddock catch rate and a 33% lower cod bycatch rate. Additional Citizen Science observations in 2020 and 2021 suggest these results have only improved (see Citizen Science section below). Through 2021, more than 30,000 paper guidebooks have been distributed to tackle shops, marinas, and permit offices. In addition, over 6,000 electronic map versions have been downloaded via a free location-aware smartphone app (Avenza Maps), which allows off-line tracking and navigation.

DMF biologists also participated in a recent study to evaluate the impact of different recreational tackle choices on the species composition, catch rates, and welfare of Massachusetts groundfish. We found that baited hooks caught far more haddock than jigs, and that jigs were more likely to cause fish injury and increased mortality. In addition, offset circle hooks produced higher catch rates and shorter unhooking times than J-hooks. Recreational haddock anglers are advised to use baited circle hooks (instead of the traditional cod jig) to increase their catch and reduce the impact on the depleted cod stock. These findings were published in a 2021 scientific article.

Citizen Science

With the creation on the Recreational Haddock Fishing Guide came the need to monitor the validity of the guidance maps. Fish populations are always changing and as we get further away from the IBS dataset (2016–2019) used to create the maps and the large-scale recreational testing effort (2019), there is a chance that the Haddock Guide will lose its relevance. Therefore, we established a "Citizen Science" program in 2020 with additional funding from NOAA Fisheries, in which volunteer anglers submit standardized catch, effort, and location data. Participating anglers receive fishing pliers after submitting their first report and a raffle entry to win a Yeti® cooler for each subsequent report.

Figure 17. (Left) A volunteer citizen scientist proudly displaying a keeper haddock. (Right) Stephano Tarantino winner of the 2021 Citizen Science raffle prize is shown next to DMF biologist Micah Dean.

Over 150 anglers signed up to participate in the program between 2020 and 2021, submitting almost 200 fishing reports (Figure 17). These data suggest that Recreational Haddock Fishing Guide maps continue to be relevant and useful, with fishing in target areas achieving +94% higher haddock catch rate and -42% lower cod bycatch rate.

Protecting Spawning Cod

Many electronic tagging studies (including several conducted by DMF) have demonstrated that individual Atlantic cod return to the same precise seafloor feature each spawning season. These unique spawning sites support dense aggregations of cod for several months at a time and represent a highly vulnerable part of their life cycle. Once a spawning site becomes depleted through targeted fishing or disrupting activities, there is little evidence that aggregations will form at that location in the future. For this reason, DMF has conducted extensive research over the past two decades to identify and describe cod spawning sites, in order to develop regulations that prevent their depletion and loss.

Several offshore wind energy development areas south of Martha's Vineyard are located near the southernmost cod spawning ground, in an area known as Coxes Ledge. DMF staff are collaborating with researchers from UMass-Dartmouth, Woods Hole Oceanographic Institution, the NEFSC, and The Nature Conservancy to study the distribution and timing of these cod spawning in Southern New England. The research team is using a combination of electronic tagging, passive acoustic monitoring (to listen for cod spawning grunts), and autonomous underwater vehicles to conduct this work. Beginning in 2019 and through 2021, 81 cod have been tagged (including 43 in 2021) with acoustic transmitters, and their movements and residency on the spawning ground is being recorded via an array of 10 fixed station receivers, as well as from mobile autonomous underwater vehicles (AUVs). Passive acoustic recorders are also listening for cod spawning grunts via both fixed stations and mobile AUV surveys. Preliminary results suggest that cod spawning in Southern New England has similar seasonal and lunar patterns as winter-spawning cod in Massachusetts Bay, albeit with some finer-scale differences. Outcomes from this five-year project (2019–2024) will be a description of the spawning dynamics of cod in Southern New England, and an assessment of their connectivity with other cod populations. The anticipated benefits include an understanding of seasonal habitat usage to help evaluate the potential impacts of offshore wind development.

Atlantic Cod Stock Assessment

Between 2018 and 2020, 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 population structure of Atlantic cod stock structure for use in regional stock assessments. This group broadly reviewed all available scientific information (tagging, genetics, natural markers, fishermen knowledge, and life history) and determined that cod in US waters function as five separate stocks (Figure 18). Two of these stocks overlap in the western Gulf of Maine yet spawn at opposite times of year and are genetically distinct. DMF scientists lead sub-groups on early life history and fishermen ecological knowledge. A series of public workshops were held in 2021 to gather input on how best to account for this population structure in the fishery management system. In addition, a "research track" stock assessment was initiated in 2021 with a scheduled completion date in 2023. DMF scientists and survey datasets will be instrumental in this major stock assessment overhaul, the first in more than a decade.

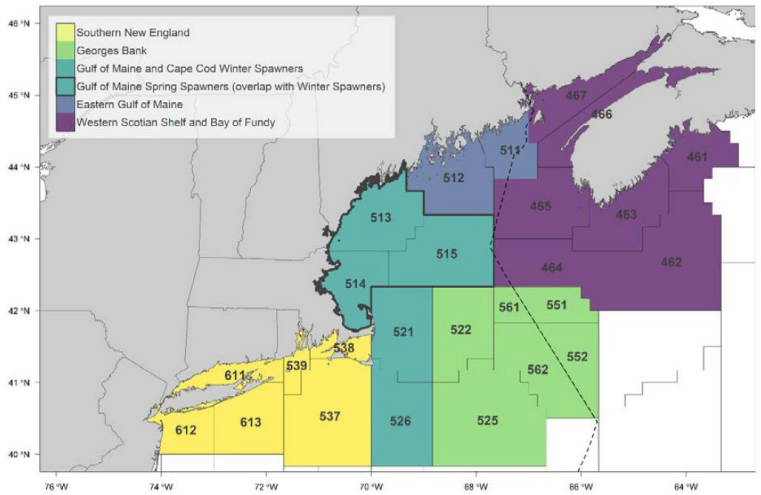


Figure 18. Map of new stock units for Atlantic cod.

Ecosystem Approach to Menhaden Management

Atlantic menhaden support the largest fishery by volume on the US East Coast, while also playing an important role as a forage species. Managers' and stakeholders' increasing concerns about the impact of menhaden harvest on ecosystem processes led to an evolution in the assessment and management of this species from a purely single-species approach to an ecosystem approach. After more than a decade of development, the Atlantic States Marine Fisheries Commission in 2020 formally adopted an ecological modeling framework as a tool to set reference points and harvest limits for Atlantic menhaden that considers their role as a forage fish. This is the first example of a quantitative ecosystem approach to setting reference points on the US Atlantic Coast and it represents a significant advance for forage fish management. DMF biologists participated in this effort from the beginning and co-authored a scientific journal article in 2021 that describes the path from single-species to ecosystem-based management of menhaden.

Boston Harbor Winter Flounder Study

Winter flounder is an important commercial and recreational species throughout its range, from Maine to Delaware, and is the most common shallow water flounder in the Gulf of Maine. While DMF conducted comprehensive habitat studies on winter flounder during the 1960s–1970s, vast habitat changes, urbanization, climate change, and a decrease in flounder populations have created a need for updated science. In particular, data on GOM winter flounder within coastal embayments are incomplete and outdated, likely impacting the efficacy and efficiency of current broad-scale time-of-year restrictions on coastal projects.

A multi-year study between DMF and UMass-Amherst began in 2021 with the objectives to generate additional information on the spatial and temporal habitat use, distribution, and residency of juvenile and adult winter flounder in Boston Harbor. To fully characterize the distribution of winter flounder in Boston Harbor, DMF and UMass-Amherst will complete three tasks to determine the following: 1) the time and location of spawning; 2) the distribution of YOY and juvenile winter flounder throughout the harbor; and 3) the hatch and spawning date. Together these tasks will characterize the distribution of all life stages of winter flounder in relation to available habitats defined by depth, substrate, salinity, and temperature.

To achieve task 1, acoustic tagging and telemetry are being used to track adult winter flounder in Boston Harbor. In mid-April 2021, DMF staff along with a UMass-Amherst graduate student deployed 43 acoustic hydrophones in the harbor. Between late-April and early-June, staff used bottom otter trawl and rod and reel gear to capture and tag 95 winter flounder (Figure 19) inside the array of receivers. The acoustic tags are programmed to transmit for three years and it is anticipated that the tagged flounder will return to the Boston Harbor in following years.

Figure 19: An adult winter flounder dorsally tagged with an acoustic transmitter.

Figure 20: A tow of young-of-year winter flounder waiting to be measured.

For task 2, a beam trawl survey was initiated in 2021 to quantify relative abundance of winter flounder YOY and track their usage over various habitats. Starting in July, DMF and UMass-Amherst staff began the weekly beam trawl survey (Figure 20). Using a stratified-random survey design, 24 tows a week were conducted on DMF's *R/V Alosa* and UMass-Amherst's *R/V Sweet Caroline*. Both teams recorded data and lengths with custom-designed BigFin Scientific software and hardware, and retained all winter flounder YOY for further age and genetic analysis to accomplish task 3. Overall, 32 surveys were conducted, nearly 400 tows were completed, and over 3,000 winter flounder were collected. The beam trawl survey and acoustic tagging activities were expected to continue in 2022.

Project staff dedicated 30 sea days to tagging and telemetry efforts, 50 sea days to the Beam Trawl Survey, and were greatly aided by sampling assistance from the Age and Growth, Diadromous, and Habitat Projects.

Alewife and Blueback Herring Run Size Estimates from Visual Counting

Several community watershed organizations provide data on river herring passage based on visual counting following procedures recommended by DMF staff. The estimates of run counts are often reported to regulatory bodies like the ASMFC for assessment purposes. However, the sampling procedures and designs used by counting groups had never been evaluated for consistency and adherence to the designs recommended by DMF. During 2021, data from 41 runs were evaluated for consistency in daily counting duration, randomization of counting intervals, sample sizes, and annual run length counting duration. Staff discovered that all programs had inconsistencies that biased run size estimates because daily count intervals, number of days spent counting, and other procedures were inconsistent from year-to-year. Staff developed new visual tools for detecting problems with the visual count data, developed a Shiny R web application for data entry, made recommendations on how to correct the biases, and developed R code to allow correct estimation of run sizes.

Striped Bass Research 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.

Striped Bass Circle Hook Study

Figure 21. A striped bass tagged with an acoustic transmitter and ready for release.
Photo credit: Joseph Holbeche.

In response to declining striped bass stocks, the ASMFC mandated states require all recreational anglers use an in-line circle hook when targeting striped bass with natural bait beginning in 2021 (which DMF had already adopted for anglers fishing from shore and private vessels in 2020 and expanded to anglers aboard for-hire vessels in 2021). Circle hooks have been shown to have a positive effect on post-release mortality in many small and big game fisheries, but surprisingly little work has been done estimating their benefit in the striped bass fishery.

Recognizing this paucity of information, DMF initiated a multi-year study in 2020 using acoustic telemetry that will determine the benefits of using circle hooks over j-hooks. In 2020, 175 striped bass that were caught using dead and live bait using both circle and J-hooks and acoustic transmitters were attached externally. In 2021, 176 striped bass were caught using two additional sized circle hooks and acoustic transmitters were attached (Figure 21). An acoustic array of 50 receivers was deployed in the study area, Salem Sound, which was complemented by an additional 60 receivers that already existed throughout MA state waters. The highly anticipated results of this study were expected to be completed in 2022 and will help inform managers, researchers, and the public on the conservation benefit of the newly enacted circle hook regulation.

Coastwide 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. Stiped bass tagging resumed in 2021 (after being suspended during 2020 due to Covid restrictions), with 465 fish tagged. These fish ranged in size from 20 inches to 45 inches total length, and were collected during September–October southeast of Cape Cod off Monomoy and Nantucket Shoals.

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 structures (scales) are collected during market sampling trips, in accordance with ASMFC target sampling levels. During 2021, FDS and Recreational Fisheries Project staff conducted 40 market sampling trips and collected length, weight, and age structures (scales) from 382 striped bass.

Acoustic Tagging Study

Staff continued to process data and samples from an acoustic telemetry study of striped bass in Massachusetts waters that was conducted during 2015–2019. This study examines how mortality of striped bass is influenced by habitat selection and migratory route to and from Massachusetts waters. The design combines analysis of fish tagged with acoustic transmitters and estimates of population composition of summering aggregations derived from genetics. Staff co-authored a genomic population baseline for striped bass that will allow DMF to establish spawning-population-specific mortality rates for striped bass harvested by Massachusetts anglers. DMF biologists are also collaborating with researchers from UMass-Amherst, University of Montana, and University of New Brunswick-St. John to develop genomic tools and analyze collected data.

DMF was awarded a grant from ACCSP in the fall of 2021 that will fund the analysis of 5,000 DNA samples collected from Massachusetts recreational and commercial fisheries during 2015–2019. These data will connect to the data from acoustically tagged fish and reveal potential patterns in stock composition based on size class and summering area. As part of the grant, DMF will also use the data to simulate sampling program accuracies to create recommendations for a coastwide sampling program that can be used to vastly improve the ASMFC striped bass stock assessment.

Volunteer Recreational Angler Data Collection Program

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. In 2013, black sea bass, summer flounder, and scup were added to the program. During 2021, 39 participating anglers returned 1,143 paired length/age samples from striped bass. The size composition of striped bass reported by participating anglers is shown in Figure 22. Participating anglers also collected 294 black sea bass samples, 114 fluke samples, and 180 scup samples. The striped bass carcass collection program also continued in 2021, but the COVID-19 pandemic has impacted the number of anglers participating; only 57 fish were donated by volunteer anglers.

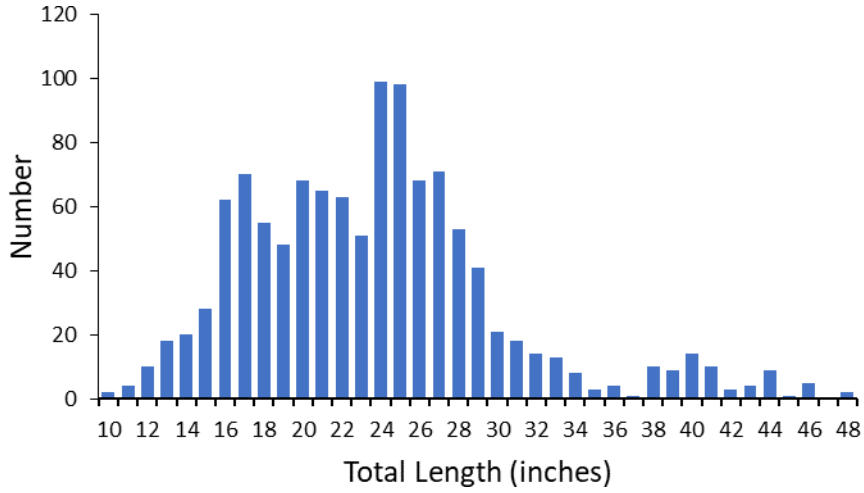


Figure 22. Size composition of striped bass collected by SADCT anglers in 2021.

Striped Bass Stock Assessment

Staff conducted analyses for the ASMFC striped bass technical committee to examine the influence of changing size limits on rebuilding of the striped bass spawning stock biomass and protecting of the 2015, 2017 and 2018 year-classes. The results were incorporated as options into draft Amendment 7 to the striped bass ASMFC fishery management plan that is under review in 2022.

Other Activities

Assessment and Management Support: Program staff provided technical expertise to other governmental organizations, private groups, and individuals with concerns about marine fisheries via on-line meetings and served on technical and advisory committees to support management efforts of important marine species. In 2021, staff served on ASMFC's Striped Bass Technical and Stock Assessment Committees, Menhaden Technical Committee, Multispecies Committee, and Age and Growth Committee; the NEFMC's Atlantic Herring Plan Development Team; the ACCSP's Bycatch and Biological Sampling Priorities Committees. Several presentations were given by staff to other governmental organizations and private groups. Staff also served as a virtual ASMFC representative to the NEFSC Assessment Operation Panel in Woods Hole, MA.

Additional Publications: Staff authored one DMF Technical Report Series report (striped bass monitoring report).

Assessment and Survey Program

Personnel

Robert Glenn, Program Manager

Conservation Engineering Project
Dr. Mike Pol, Senior Marine Fisheries Biologist, Project Leader (January–June)
David Chosid, Marine Fisheries Biologist

Invertebrate Fisheries Project
Dr. Tracy Pugh, Senior Marine Fisheries Biologist, Project Leader
Derek Perry, Marine Fisheries Biologist
Steve Wilcox, Marine Fisheries Biologist
Alex Boeri, Assistant Marine Fisheries Biologist
Brendan Reilly, Assistant Marine Fisheries Biologist
Rachel Vollemans, Assistant Marine Fisheries Biologist
Nathalie Staiger, Contracted Scientist (January–May)
Anna Dorrance, Seasonal Fisheries Technician (May–December)

Protected Species Project
Erin Burke, Protected Species Specialist
Taylor Stoni, Protected Species Permit Specialist
Justin Wilson, Protected Species Gear 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. Samuel Truesdell, Senior Marine Fisheries Biologist

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 this work. Conservation Engineering also focuses on issues relating to marine debris and abandoned, lost, or otherwise discarded fishing gear.

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

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

The **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 summer flounder, 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

Small Channeled Whelk Bycatch Reduction Device for Pots in Massachusetts

Staff continued to collaborate with the Invertebrate Fisheries Project to modify channeled whelk pots (traps) to reduce bycatch of undersized individuals. Preliminary results were shared at a meeting in June 2021 with personnel from the University of New Hampshire who are conducting additional research in whelk behaviors and methods to reduce small whelk from whelk traps. Further research was completed at the SMAST East seawater lab with additional whelks acquired from fishermen. Summer examinations focused on testing of whelks' food-type preference and then new escape trials (continued from 2020) were conducted where whelks were placed in tanks with modified traps and bait placed outside of the traps. Based on the results gained in 2020 from testing various escape gaps and vents in the traps' walls, an additional experimental trap design included a 2-inch vertical escape vent on opposite sides of the trap. Shells of whelks used in escape trials were tagged with identifying colors and alphanumeric characters; video was collected using a modified GoPro camera (Figure 23). Staff explored the feasibility of using video tracking software to follow individual whelk and characterize behaviors. Processing of escape data and video observations continued at year's end.

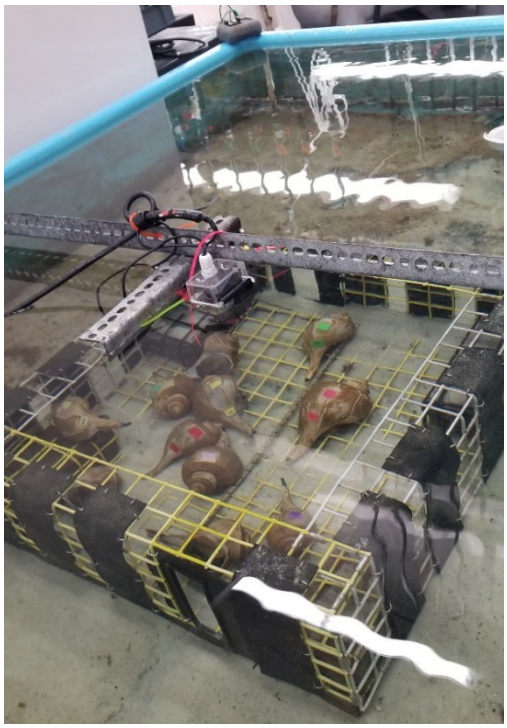


Figure 23. Whelk trap escapement trial.

Since the start of the project, 17 valid escape trials were completed and over 769 hours of video were collected. Four trap designs were tested: a trap with variable-space wooden slats; a wire trap with a horizontal escape vent; a wire trap with a vertical escape vent; and a wire trap with two vertical escape vents. All escape vents were 2-inch widths. The wire trap with two vertical escape vents demonstrated the best proportion of escapement and matched closest to the selectivity of the current and future standard whelk gauges. More detailed behavioral analyses were

conducted on whelk within the wooden slat trap. Staff began assembling a report of the protocols that were followed for all work to-date and recommendations for future work, including field trials using industry vessels. The data analyses and report were planned for completion in 2022.

Bycatch Reduction of Red Hake in the Southern New England Silver Hake Trawl Fishery

The NOAA Fisheries Bycatch Reduction Engineering Program (BREP) awarded DMF this project in 2019 to test a large mesh belly panel as a bycatch reduction method for red hake in the whiting/silver hake fishery in southern New England. Red hake populations in southern New England continue to decline despite effort reduction measures. Due to delays from the Covid-19 pandemic, in 2021 the project applied for and received a grant extension until December 2022. While planned fieldwork was pushed back until May 2022, tasks completed through 2021 included permit applications for conducting research trips, safety (covid-related) planning, equipment acquisitions and maintenance, budgeting, contracting, and attending a relevant NEFMC meeting.

Protecting Right Whales through an Industry-Cooperative Gear Recovery Program in MA

Conservation Engineering worked with the Protected Species Project to address potential solutions to solving the challenges of removing abandoned, lost, or otherwise discarded fishing gear during Massachusetts time-area closures and the need for a formal recovery program was identified. The recovery program would ensure that the state's fixed gear closures created to protect right whales from entanglements when aggregated here are as effective as intended. Establishing this program would require legislative changes due to the strict ownership laws of fishing gear, whereby only environmental police can currently handle gear left in the water, as well as regulatory changes. Staff consulted with DFG to build a web-based app for the logging and reporting of such gear, and with the National Fish and Wildlife Foundation, MA port managers, and recycling companies to arrange for the reuse, recycling, and/or disposal of collected gear.

DMF further advanced plans to pursue a trap removal program operated through Conservation Engineering. Staff researched similar programs established in other states and the feasibility of implementing such a program in Massachusetts. As part of this effort, a virtual meeting was held with representative from Oregon, Washington, and California to discuss their programs, which was also attended by MA state legislators and general counsel, MA enforcement personnel, MA lobster industry representatives, a research institution, and NOAA representatives from the Marine Debris program. Conservation Engineering staff provided supportive legal materials to the DFG General Counsel to begin investigations for legislative changes. Staff also attended multiple relevant meetings regarding marine debris and whale mortality and gear entanglements related topics.

Complementary Testing of Off-Bottom Trawls to Target Georges Bank Haddock

Work on this project was focused on outreach in 2021. In prior years, this federally-funded project (NOAA Fisheries' Saltonstall-Kennedy Program) tested the effectiveness of two different off-bottom, mid-water trawls to target Georges Bank haddock and redfish. Haddock catches in both nets successfully matched the catch of haddock in the Eliminator/Ruhle trawl in weight and in size, with generally lower bycatch of bottom-oriented species and lower overall bottom impact. These results were presented to The International Council for the Exploration of the Sea (ICES) at the Joint ICES/FAO Working Group on Fishing Technology and Fish Behaviour in early 2021. The final grant report was also shared with the NEFMC's Habitat Plan Development Team. An article for publication was under development at year's end.

Other Activities

Publications: Staff co-authored a manuscript on research needs for cod behavior in trawls that was published in the ICES Journal of Marine Science in 2021.

Committee Work: Staff presented research and served on the ICES-FAO Working Group on Fishing Technology and Fish Behaviour and as chair of the Working Group on Species and Size Selectivity Experiments. Staff served on the NEFMC/MAFMC Northeast Trawl Advisory Panel, and as editor or advisor on academic journals. Staff continued contributing to the MA Wind Energy Fisheries Working Group, New York Fisheries Technical Working Group, and as the state representative to the Advisory Council of the Responsible Offshore Science Alliance.

Grant Activities: Staff acted as a proposal reviewer on EEA's Food Security Infrastructure Grant Program, which seeks to ensure that farmers, fisherman and other local food producers are better connected to a strong, resilient food system to help mitigate future food supply and distribution disruption. Staff also submitted a proposal to the 2022 Saltonstall-Kennedy Grant Competition to investigate the potential for a longfin squid night-time, jig fishery using lights as attractants.

Support Activities: Staff assisted other project's fieldwork and provided conservation engineering advise to DMF. Staff participated on the DMF dive team, including acting as a support diver and continuing education to increase field operation versatility. Special attention was placed on marine debris/derelict gear related issues. Staff edited a public video demonstrating the proper use of a whelk gauge. Videos from other DMF projects were archived. Staff completed a worldwide assessment of commercial use of ropeless marking of fixed gear.

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 2021, the 41st year of operation, a total of 55 trips were conducted by staff members of the Invertebrate Fisheries Project (10 trips) and the Fisheries Dependent Investigations Project (45 trips), during which 22,604 lobsters were sampled from 10,409 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. In 2021, a total of 5,500 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).

Staff spent considerable time in 2021 organizing all the historical lobster data from the commercial trap sampling program into a modernized format. Throughout the 41-year time series there have been three different databases, and raw data were not easily combined. Through this overhaul, the entire time series of data became accessible in a common file format. Additional QA/QC was performed throughout this process to further improve data quality. As a result, all audits, data organization, and time series indices can be generated with existing R-scripts on an annual basis, and further data exploration will be much simpler with the modernized structure.

Ventless Lobster Trap Survey: 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. Data from the Ventless Trap Survey are used to generate indices of lobster relative abundance, to monitor various population characteristics (such as sex ratio, abundance of egg-bearing females, and disease), and to examine spatial patterns in abundance (Figure 24). 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.

The 2021 Ventless Trap Survey took place from June through September (June through August in SNE, see below) with six contracted vessels. Project staff completed a total of 44 sea days in 2021. A total of 9,252 lobsters were sampled from 2,831 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 1,382 lobsters were sampled from 351 trap hauls.

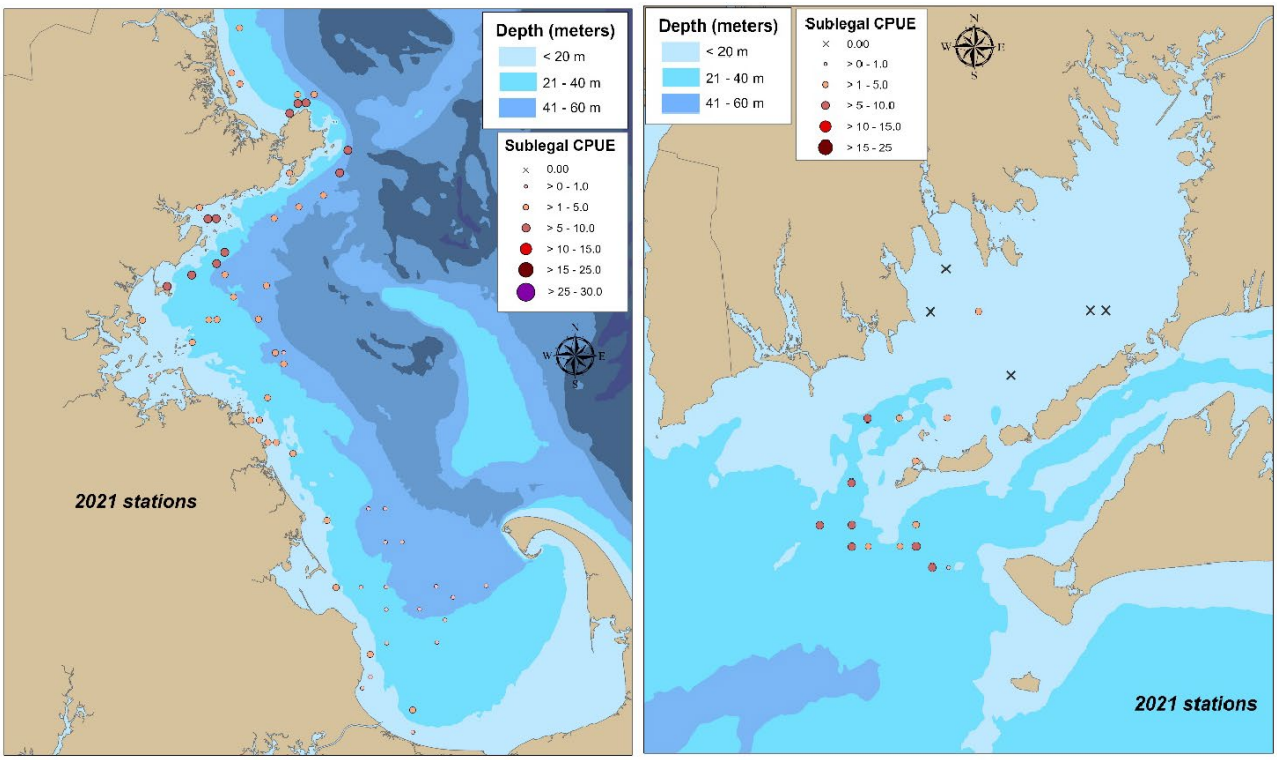


Figure 24. Average catch per trap haul (CPUE) of sublegal-sized lobsters at the 2021 ventless trap survey stations in the northern (left) and southern (right) survey areas.

Additional biological sampling of bycatch species was continued in 2021, 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.

Due to lack of interested participants in the SNE survey area in 2021 (no bids were submitted in response to a call for participants), the SNE survey footprint was reduced, the number of hauls was reduced, and the time frame was reduced by one month to just June–August. This was done during negotiations with the captain who was eventually contracted to conduct the sea days. These changes to the SNE survey will necessitate re-analysis of the abundance time series to adjust to the reduced survey design.

Annually, significant time is dedicated to maintenance of the DMF-owned gear needed to conduct the survey. Over 600 traps and 6+ miles of groundline must be checked and standardized each year. Trap maintenance includes twine repair, wire mesh repair, runner replacement, bungee replacement, and minor wire mesh patches. Each ground line is checked for wear and damage and repaired as needed, while also assuring proper spacing between gangions (to maintain standardized trap spacing). To minimize data loss, spare traps and groundlines must be ready to replace any survey gear that is lost or damaged throughout the season. In addition to the gear maintenance, a total of 12 days each year are dedicated to trap delivery and retrieval to and from participating captains. Finally, all gear needs to comply with current vertical line configuration and marking standards which enhance precautions for protected species. This requires constant communication with participating fishers, purchasing supplies for associated changes, and ensuring all gear is retrofitted.

Annual Early-Benthic-Phase Lobster Suction Sampling: Project staff completed the 27th year of this sampling program in 2021. The program is conducted to track year-class strength of newly settled post-larval American lobsters (Figure 25) and to delineate coastal habitat important to the settlement of these juveniles. Project staff conducted the SCUBA-based survey over nine field days in August and September, sampling 16 coastal sites spanning Cape Ann to Buzzards Bay. Two new sites were added to the Cape Ann region, one on the north side (Hodgkins Cove) and one on the south side (Brace Cove); data from these new sites have not yet been incorporated into the time series. Average density of YOY lobster was nearly twice the time series average for the Cape Ann region, but all other regions were at or below the time series means (Table 20). Densities of YOY lobsters generally declined from northern to southern regions. Data from this program contribute annually to the American Lobster Settlement Index, an international research collaborative that compiles data and tracks changes in the recruitment of American lobsters in U.S. and Canadian waters.

Figure 25. A young-of-the-year lobster observed by DMF biologists during lobster suction sampling.

Table 20. Comparison of 2021 YOY lobster densities to time series averages, by region.

Region	# years sampled	2021 YOY Average (#/m²)	Time Series Average (#/m²)
Cape Ann	12	0.83	0.42
Beverly/Salem	26	0.50	0.55
Boston Harbor	25	0.11	0.21
South Shore	10	0.00	0.09
Buzzards Bay	27	0.04	0.07

Assessment and Management Support: Staff served as the vice-chair for the ASMFC American Lobster Technical Committee and served on the ASMFC American Lobster Stock Assessment Subcommittee. Work focused primarily on data analyses and meetings to support the development of Addendum XXVII (on increasing the resiliency of the GOM/GBK stock), as well as addressing some follow-up requests from the ASMFC Lobster Management Board relative to the results of the 2020 stock assessment.

Applied Research: Staff completed work on a large NOAA Fisheries Saltonstall-Kennedy grant-funded project to examine potential sub-lethal impacts of stress on the reproductive output of SNE lobsters. This project was led

by DMF staff and was a collaborative effort with a team of researchers from University of New Hampshire, Wells National Estuarine Research Reserve, and Department of Fisheries and Oceans Canada. One of the major highlights of the work shows a decline in female fecundity in southern MA since it was last examined by DMF in the 1980s. In the winter of 2021 staff completed a comprehensive final report to the funding agency detailing the results of the study. The products of this study include a Ph.D. dissertation and three submitted manuscripts thus far.

Figure 26. One of the 125 lobsters that successfully molted for the growth study, next to its cast shell. Molt increments ranged from 2 to 17 mm.

Invertebrate Project staff continued work on a laboratory-based growth study of large lobsters (>100 mm CL), addressing a data need for an improved growth matrix for the ASMFC lobster stock assessment. This study was funded by the National Sea Grant American Lobster Research Initiative. Large lobsters that were preparing to molt were held in the wet lab at SMAST for measurement before and after molting (Figure 26). Staff presented preliminary data from this study during a DMF lunch seminar series talk and were in the process of finalizing results for a report to the funding agency at year's end.

Staff continued work with the Lobster Foundation of Massachusetts' Cape Cod Bay Study Fleet to monitor temperature and dissolved oxygen (DO) conditions in Cape Cod Bay. DMF covered the costs of annual maintenance on the Fleet's monitoring equipment, and the Fleet deployed 25 sensors to monitor conditions from July through November of 2021. Staff monitor the Fleet's incoming data and have continued work with the DFG GIS team to develop GIS tools for monitoring, summarizing, and sharing data. Staff deployed and tended additional temperature and DO sensors and collaborators at Center for Coastal Studies conducted multiple vessel-based surveys to improve the resolution of incoming data. Based on declining DO conditions in August of 2021 DMF issued an advisory to notify stakeholders that hypoxic conditions might develop in the area, but thankfully conditions changed and hypoxia did not develop in 2021. Staff are continuing to work with collaborators at Center for Coastal Studies and the Woods Hole Oceanographic Institution to understand the drivers of low DO in Cape Cod Bay, and to work towards predicting occurrence of hypoxic conditions. Project collaborators prepared and submitted a manuscript for peer-review that reviewed conditions observed in 2019 and 2020 and described those years in context with historical records of physical conditions (wind, temperature stratification, and nutrients) and phytoplankton dynamics. The paper presents a hypothesis linking changing physical conditions and the exploitation of a specific niche by a recently observed dinoflagellate species, and how this may have driven the hypoxic conditions observed in 2019 and 2020. Staff participated in a forum convened by MassBays in October to present data and discuss potential causes, implications, and next steps regarding the low DO situation in Cape Cod Bay. This work is partially funded by a grant to DMF from the National Sea Grant American Lobster Research Initiative.

Enforcement: Based on the success of the scrubbed egger training course conducted collaboratively between Invertebrate Fisheries Project staff and the Massachusetts Environmental Police in 2020, staff prepared 10 field

kits for officers to use to collect evidence and conduct initial tests for scrubbed or bleached egg-bearing lobsters. These kits include the chemical tests for detecting exposure to bleach (along with step-by-step instructions).

Outreach and Publications: The work in Cape Cod Bay related to the low dissolved oxygen events continued to generate attention from local media outlets, and staff were interviewed by WBZ and WBUR (among others) on this topic in 2021. Covid-19 continued to impact industry events and science conferences that staff would normally attend, with cancellation or postponement of several planned events.

Horseshoe Crab Monitoring

Commercial Fishery Sampling: Monitoring of the commercial bait and biomedical harvests of horseshoe crab continued in accordance with the interstate FMP. DMF has collected prosomal width measurements from horseshoe crabs in bait and biomedical facilities since 2008. Widths were obtained from 1,815 crabs from the bait fishery and 904 crabs from the biomedical fishery in 2021. The size distributions of male crabs from both fisheries and female crabs from the biomedical fishery have been relatively consistent over the entire time series. However, the average size of female crabs observed in the bait fishery has decreased since 2014. This may be related to increased landings and to expanding our sampling time period to include crabs caught after the spawning season by the mobile gear fleet, which would be more likely to include smaller crabs.

Fisheries-Independent Surveys: DMF and numerous volunteer organizations conducted spawning beach surveys at 15 beaches along the South Coast, Cape Cod, and the islands in 2021 (Figure 27). Surveys were conducted at high tide two days prior, the day of, and two days after the new and full moons from May through the end of June. April surveys, which had been conducted since 2013, were discontinued due to a lack of observed spawning activity and limited volunteer participation. DMF staff conducted 24 surveys at Swift's Beach in Wareham. The number of female crabs observed in the survey was above time series medians for most beaches in 2021 (Table 21). Four beaches (Millway, Indian Neck, Marsh 2-3, Tashmoo) reported more spawning female crabs than any other year of their respective surveys.

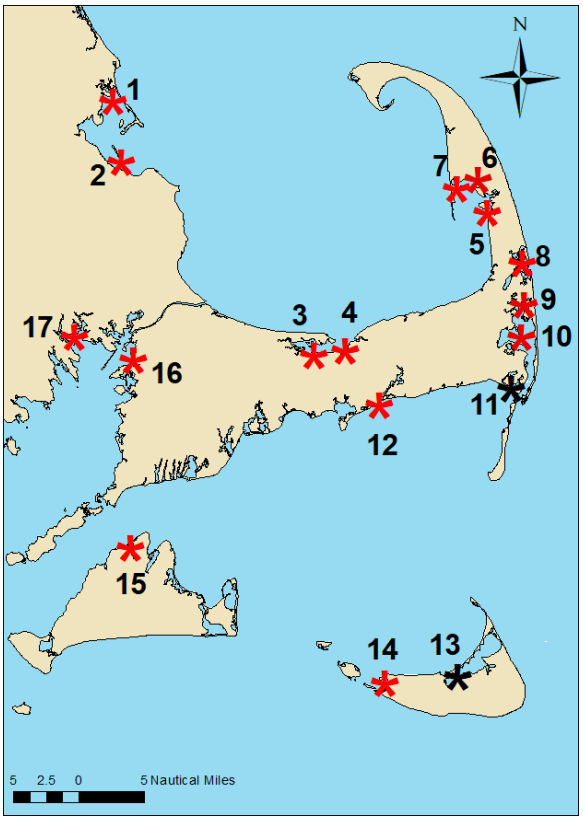


Figure 27. Map of horseshoe crab spawning survey beaches. Beaches that conducted surveys in 2021 are marked with red stars, beaches not surveyed in 2021 are marked in black.

Table 21. 2021 data points relative to time series median, and 10 and 5-year survey trends by beach from the Massachusetts Horseshoe Crab Spawning Beach Survey.

Beach	Region	Time of Day	2021 vs Median	10-year trend	5-year trend
Duxbury	Cape Cod Bay	Day	equal	mixed	decreasing
Duxbury	Cape Cod Bay	Night	equal	mixed	neutral
Long Beach	Cape Cod Bay	Day	equal	N/A	N/A
Long Beach	Cape Cod Bay	Night	above	N/A	N/A
Millway	Cape Cod Bay	Day	above	mixed	increasing
Millway	Cape Cod Bay	Night	above	mixed	increasing
Long Pasture	Cape Cod Bay	Day	above	mixed	increasing
Long Pasture	Cape Cod Bay	Night	below	N/A	N/A
Sanctuary Beach	Cape Cod Bay	Day	below	decreasing	increasing
Indian Neck	Cape Cod Bay	Day	above	mixed	increasing
Indian Neck	Cape Cod Bay	Night	above	mixed	increasing
Great Island	Cape Cod Bay	Day	above	decreasing	increasing
Priscillas Landing	Outer Cape Cod	Day	above	increasing	increasing
Marsh 2-3	Outer Cape Cod	Day	above	increasing	increasing
Erica's Beach	Outer Cape Cod	Day	above	decreasing	increasing
Bass River	Nantucket Sound	Day	above	N/A	mixed
Bass River	Nantucket Sound	Night	below	N/A	N/A
Warrens Landing	Nantucket Sound	Day	above	increasing	increasing
Warrens Landing	Nantucket Sound	Night	above	increasing	increasing
Tashmoo	Nantucket Sound	Day	above	increasing	increasing
Tashmoo	Nantucket Sound	Night	above	increasing	increasing
Tahanto	Buzzards Bay	Day	equal	mixed	neutral
Tahanto	Buzzards Bay	Night	above	decreasing	increasing
Swifts Beach	Buzzards Bay	Day	equal	decreasing	neutral
Swifts Beach	Buzzards Bay	Night	below	decreasing	decreasing

Assessment, Management Support, and Outreach: Staff continued to serve on the ASMFC Horseshoe Crab Technical Committee in 2021 and gave virtual presentations on the status of horseshoe crabs and the biomedical industry to Elder Services of Cape Cod and the Islands, and the DMF seminar series (https://www.youtube.com/watch?v=g6tSv8gIvAo). In 2021 DMF provided spawning beach survey volunteers with specially designed survey t-shirts as a thank you for their participation. The Horseshoe Crab Science Committee Meeting annually hosted by staff was canceled due to the continuing Covid-19 pandemic.

Jonah Crab Research and Monitoring

Commercial Fishery Sampling: Monitoring of the commercial Jonah crab catch has been required by the interstate FMP since 2015. Project biologists conducted 11 port sampling trips from seven individual boats to collect length frequency and sex ratio data from the commercial fishery in 2021. These trips sampled a total of 5,086 crabs from NMFS statistical areas. Most crabs are harvested in waters south of Martha's Vineyard and east to Georges Bank (NMFS statistical areas 537, 525, and 526). The median size in these areas was similar to prior years.

Assessment and Management Support: Staff served as chair of the ASMFC Jonah Crab Technical Committee and participated in the development of the Jonah crab pre-assessment document for ASMFC and gave a presentation on the pre-assessment document to the ASMFC Lobster/Jonah Crab Management Board. Staff also served on the newly formed Jonah crab stock assessment sub-committee and began working toward the first Jonah crab benchmark stock assessment, scheduled for 2023. Staff also participated on the ASMFC Jonah Crab Plan Review Team, evaluating state compliance with FMP requirements.

Whelk Research and Monitoring

Commercial Fishery Sampling: Staff conducted five sampling trips aboard commercial vessels fishing whelk pots in 2021, measuring 7,604 whelks. Three trips were conducted in Nantucket Sound (one in the spring and two in the fall) and two in Buzzards Bay (one in the spring and one in the fall). 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 width of channeled whelk observed, and fewer whelk observed above the size at which females reach maturity, despite minimum legal-size increases in 2014, 2015, 2017, 2019, and 2021. A regulatorily-set schedule of biennial minimum size increases has been established to reach that associated with 50% female maturity in 2029.

Assessment and Management Support: Staff continued engagement with industry representatives to provide biological information related to concerns regarding the regulatory schedule for minimum size increases. There was one meeting with industry and several informational requests on this topic. Staff also responded to regulatory and management inquiries from other state agencies.

Whelk Working Group: Staff participated in a working group that met over the course of six weeks early in the year. Participants from the Atlantic states from South Carolina to Massachusetts met virtually to discuss whelk related research, fishing trends, management, and stock assessment. DMF staff provided three presentations to the group on various aspects of MA whelk research, monitoring and population status, and fishery dynamics. Discussions resulted in a better understanding of whelk resources and common issues faced by all states. The group intends to reconvene in the future to remain current on all whelk topics.

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 40 whelks were measured and dissected to determine maturity status. Maturity information was used to help monitor the population and provide management advice.

Publications: Staff authored a 2021 journal article on channeled whelk biology in Massachusetts.

Northern Shrimp Research and Monitoring

Assessment and Management Support: Staff served on the ASMFC Northern Shrimp Technical Committee to prepare the 2021 Gulf of Maine Northern Shrimp Stock Assessment Update Report. In response to the continued depleted condition of the resource, the ASMFC Northern Shrimp Section extended the moratorium on harvest through 2024.

Other Activities

Wind Energy Development: Staff continued to contribute to DMF's review of regional offshore wind energy development plans and provided comments on invertebrate fishery resources in and around project and lease areas.

Other: Staff acted as reviewers for peer-reviewed journals. Staff served on the thesis committee for one SMAST graduate student. Invertebrate Project staff participated in the development of four manuscripts that were submitted to journals for peer-review in late 2021.

Protected Species Project

Cape Cod Bay Right Whale Surveillance Program

In 2021, DMF continued its partnership with the Provincetown Center for Coastal Studies (PCCS) and NOAA Fisheries to carry out the 23rd year of the Cape Cod Bay Right Whale Surveillance Program. The program conducts aerial surveillance and habitat monitoring of right whales in the Cape Cod Bay portion of Right Whale Critical Habitat. The team documented nearly 84% (n=285) of the known right whale population in Cape Cod Bay and adjacent waters, including sightings south of Nantucket (Figure 28). The high abundance of right whales visiting Cape Cod Bay and adjacent coastal waters demonstrates how critical Massachusetts waters are to the North Atlantic population and the importance of protecting them.

Right whale mortalities (throughout the species range) in 2021 were relatively low in comparison to the high mortality seen in 2017 and 2019. Two mortalities occurred in 2021: one was a vessel collision with a calf off Florida and the other was an adult right whale with a chronic entanglement of Canadian origin that was observed dead off South Carolina. During the 2021 right whale calving season, 19 live calves were identified. This was nearly double the number of calves born in 2020 and the highest number of calves born in a calving season since 2013.

In 2021, Project Staff administered the grant from NMFS that supports aerial surveillance and habitat monitoring and assisted in coordination of all large whale conservation activities.

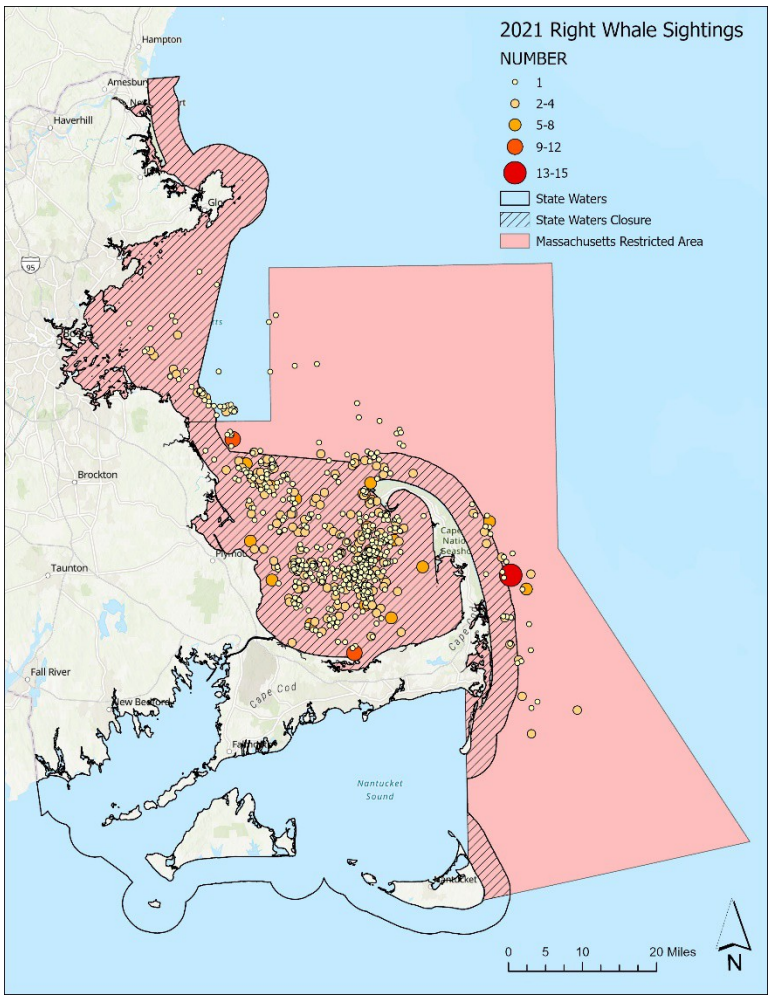


Figure 28. Map of PCCS 2021 right whale sightings.

Large Whale and Sea Turtle Disentanglement

DMF and PCCS cooperatively administer the large whale and sea turtle disentanglement efforts around Massachusetts through grants from NMFS and the Massachusetts Environmental Trust. Project Staff assisted in

disentanglement efforts, gear analysis, and performed all grant management activities. A confirmed 36 whales were reported as entangled within the PCCS response area. The team either partially or fully disentangled three North Atlantic right whales, eight humpback whales, and one minke whale. Additionally, PCCS confirmed 25 sea turtle entanglements. All entanglements were confirmed as leatherbacks, with 23 live and two dead animals.

Incidental Take Permit Application

Project staff are part of DMF's ITP Task Force, which is applying for a federal Endangered Species Act Section 10 Incidental Take Permit (ITP) for fixed gear fisheries in state waters that might interact with endangered species, specifically North Atlantic right whales and leatherback sea turtles. In 2021, staff began drafting the ITP application, which includes a Habitat Conservation Plan (HCP). The HCP encompasses the history of fishing activity for fixed gear fisheries in Massachusetts, the presence of endangered species in state waters, an analysis of their co-occurrence, and conservation and mitigation measures DMF has implemented to protect endangered species during the fishing season. DMF's new regulations in 2021 to reduce the potential risk of entanglements (see page 17) were critical to the ITP application; staff played a major role in their development.

Ropeless Fishing Scoping Project

DMF received $135,000 in funding from the National Fish and Wildlife Service to develop a framework for the implementation of ropeless fishing in New England. Through assistance by a contractor, DMF initiated a scoping process with a variety of stakeholders to address the regulatory, logistical, technological, and financial challenges with this potential gear modification. This project was the first of its kind designed to evaluate how implementation of the gear would impact our iconic fisheries and ocean management system from all perspectives. In 2021, the contractor conducted roughly 80 semi-structured telephone interviews with a range of stakeholders to identify key concepts and issues that need additional exploration during later phases of the project. An in-person workshop was held in October 2021 with 60 of the interview participants, of which 50% were from the fishing industry, to further discuss issues raised during the interviews. The contractor then evaluated the issues using interviews with experts in the field, synthesized perspectives across diverse sectors including fishermen, scientists, and law enforcement officials, and analyzed the technical, legal, regulatory, and socioeconomic challenges and opportunities of on-call fishing gear. The contractor's synthesis report on these issues and recommendations for further policy development work was expected to be released in early 2022.

Weak Rope Implementation

To assist fishermen in complying with the weak rope regulations, Protected Species staff worked with commercial fishermen, NOAA Fisheries, and other state agencies to development weak contrivances that would be inexpensive and easy for fishermen to implement. This would provide fishermen with a variety of options for outfitting their gear to meet the weak rope requirement, including the use of fully formed weak rope or the use of weak inserts/contrivances every 60 feet. A range of contrivances were tested and approved by NOAA Fisheries. Using funds from the ASMFC and the Baker Administration, staff purchases 2,500 coils of weak rope and 7,000 South Shore Sleeves, a commercially available low-breaking strength contrivance. The goal was to provide every Massachusetts trap/pot fisherman with two coils of weak rope and up to 20 sleeves. DMF staff hosted gear distribution events across the state in early 2021, leading up to the May 1, 2021 weak rope implementation date. DMF conducted 14 events from Gloucester down to New Bedford and Cape Cod, where 1,254 coils and 12,540 sleeves were distributed to approximately 630 fishermen.

Other Activities

Staff participated as a member of the Massachusetts Habitat Working Group. This body assists EEOEA, the federal Bureau of Ocean Energy Management, and the Massachusetts Clean Energy Center with analysis of natural resource data as it relates to potential impacts in the Massachusetts Wind Energy Area. State and federal governments are assessing the potential impact of wind energy development on marine mammals that inhabit the area south of Martha's Vineyard and Nantucket.

Resource Assessment Project

2021 Trawl Survey

After having to cancel the entire survey in 2020 (for the first time since its inception) due to Covid-19, the 43rd annual spring and fall surveys were successfully completed aboard NOAA's *R/V Gloria Michelle* in 2021. Under modified protocols to maintain the safety of crew, the spring survey completed 99 stations from May 5–22 and the fall survey completed 102 stations from September 7–21 (Figures 29 & 30). Both spring and fall surveys provided weights, counts and measurements for over 100 different species of fish and invertebrates. The collections of over 1300 otoliths and sex and maturity observations from cod, haddock, summer flounder, winter flounder, yellowtail flounder, black sea bass, scup, tautog, American lobster, and Jonah crabs will aid cooperative fisheries assessments.

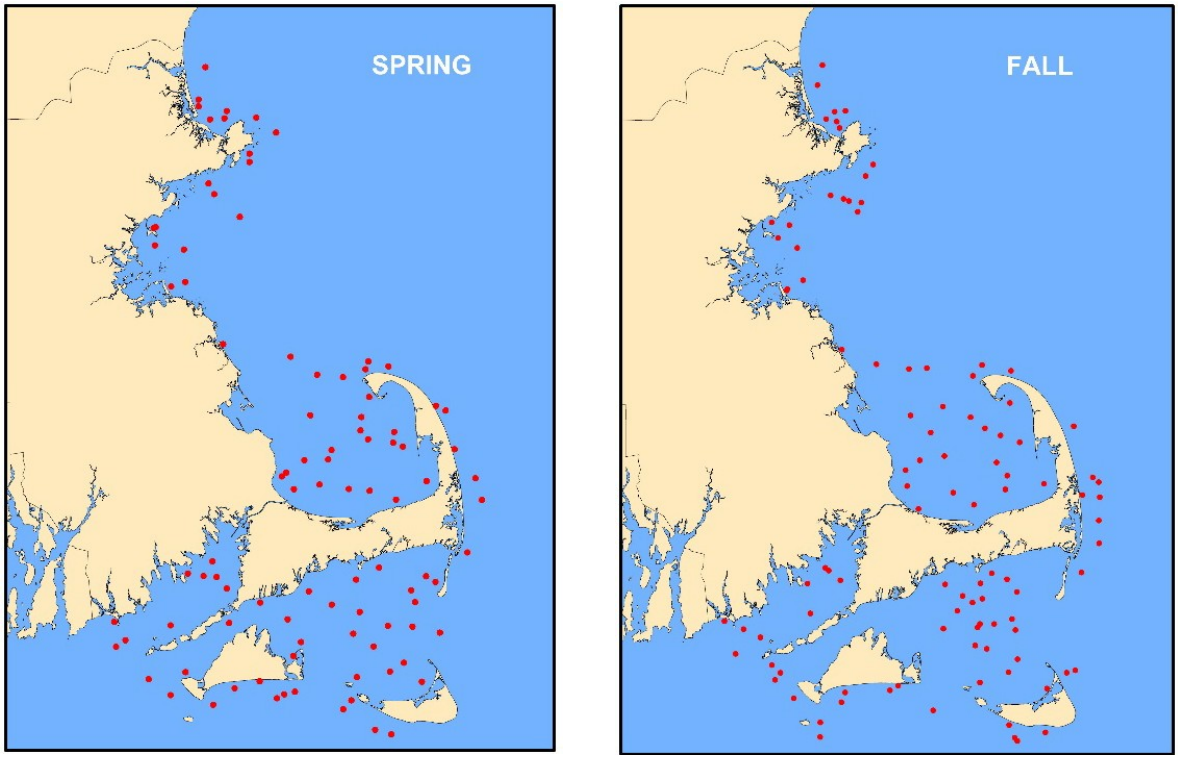


Figure 29. Completed 2021 spring and fall trawl survey station locations.

In order to minimize the risk of Covid-19 infection, the spring survey schedule was modified into three 6-day legs with a maximum of four scientific crew. Additionally, all crew members had to provide proof of two negative Covid PCR tests and complete a 10-day "shelter in place" prior to sailing on their scheduled leg. As a result, only nine DMF employees participated in the spring survey as part of the scientific party. The fall 2021 survey

schedule was altered slightly by limiting the number of scientific crew changes. Twenty-four DMF employees and one biologist from Responsible Offshore Science Alliance participated on the fall survey.

These surveys were marked with some noteworthy first-time catches. The spring survey saw its first spring catch of hogchoker, and the largest biomass catch of scup and blue crab. The fall survey saw its first catch of Atlantic stingray and smooth pufferfish. The largest biomass catches of juvenile bluefish, weakfish, yellowtail flounder and brown shrimp, along with the largest abundance of silver rag, occurred during the fall survey in 2021.

Figure 30. Photo collage from the 2021 spring and fall trawl surveys.

2021 Seine Survey

The 46th Nantucket Sound Estuarine Winter Flounder Young-of-Year (YOY) Seine Survey was completed from June 18–July 6. This survey provides an index of abundance for YOY winter flounder in the Southern New England/Mid-Atlantic stock. Additionally, we count all commercially and recreationally important finfish and invertebrates, and record presence/absence for all other species. Thirty-eight species occurred in the year's seine survey hauls. The 2021 stratified mean index for YOY winter flounder abundance decreased slightly but remained above the time series median. While five of the last ten 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.

Recreational Fish Assessment and Management Support

Staff represented DMF on ASMFC and MAFMC Technical Committees and Monitoring Committees for bluefish (vice chair of Technical Committee), black sea bass, scup, summer flounder, tautog, and weakfish. These assignments included conducting analyses and bringing proposals to the groups in support of adjustments to MA fishery regulations as well as evaluating potential regulatory changes in other states and in federal waters.

DMF's black sea bass spawning survey continued during April–July 2021, marking the fourth year of this sampling program. The purpose of this rod-and-reel survey is to collect data on Buzzards Bay black sea bass as the spawning season progresses. Twelve sampling trips were made during 2021. Biological data collected on this survey include length, weight, age, sex and spawning condition. The information supports our understanding of black sea bass life history (i.e., how they grow and reproduce) and allows us to monitor the progression of individual year classes over time.

Staff participated in ASMFC's tautog stock assessment process during 2021. Data from Massachusetts and Rhode Island were used together as these states comprise the "MARI" region, which is designated its own stock unit. The assessment results indicated that the MARI stock was not overfished and overfishing was not occurring. Aside from tautog, staff participated in two ongoing NOAA Fisheries research track stock assessments: one for black sea bass and one for bluefish. These research track assessments (similar to benchmark assessments of previous years) are scheduled for completion during 2022.

Recreational and Diadromous Fisheries Program

Personnel

Dr. Gregory Skomal, Program Manager

Recreational Fisheries Project
John Boardman, Marine Fisheries Biologist
Matt Ayer, Marine Fisheries Biologist
Ross Kessler, Public Access Coordinator
David Martins, MRIP Coordinator
Kristen Thiebault, MRIP/FHTS Sampler

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

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 Commonwealth's marine recreational fisheries. The goals of the Project 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; assess habitat and prey needs of key species; measure harvest and release of key species; facilitate 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; participate in the state, regional, federal, and international management processes; and provide public education and technical information on the biology, management, and utilization of highly migratory species.

The **Diadromous Fisheries Project** works to sustain and improve sea-run fish passage, habitat, and populations. The project also conducts fish biology monitoring and research that contributes to fisheries management. Fish passage and habitat restoration is accomplished through coordinated efforts of DMF staff, state and federal agencies, municipalities, and private groups to facilitate, design, and execute projects to enhance diadromous fish populations. Technical assistance is provided as needed for individual restoration projects and coastal watersheds. Project efforts cover 10 species of diadromous fish stocks in Massachusetts, with a focus on river

herring, American shad, rainbow smelt, and American eel. These species are monitored for run counts, indices of population abundance, size and age composition, harvest, and restoration potential. The 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). 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. DMF has managed the at-sea head boat survey segment for Massachusetts waters since 2003 and assumed the shore-side Access Point Angler Intercept Survey (APAIS) 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 2020, DMF began the implementation and administration of the For-Hire Telephone Survey (FHTS) in Massachusetts.

Despite the ongoing Coronavirus pandemic, DMF continued its coordination of APAIS surveys in 2021—training 20 seasonal field interviewers, scheduling trips, logging data, maintaining equipment, attending virtual data review meetings, and maintaining regular communication with the Atlantic Coastal Cooperative Statistics Program (ACCSP) regarding survey performance and sampling. (ACCSP administers the program for NOAA Fisheries.) Headboat survey sampling was delayed from starting on April 1 until June 1 due to the pandemic. Special Coronavirus sampling guidelines remained in place to protect both DMF field interviewers and anglers alike. In 2021, MRIP field interviewers completed 1,282 assignments out of 1,326 scheduled for a total of 4,878 angler intercepts (slightly less than the year prior): 3,250 from private vessels, 658 from charter vessels, and 970 from shore anglers.

The FHTS, through which effort information from charter and head boats is collected throughout the fishing season continued in 2021. A total of 1,603 calls were completed to vessel representatives from March through December. FHTS staff also worked to update and improve the federal vessel directory to ensure that future survey work will be more efficient.

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. In 2021, there were 60 entries in the derby, including 37 winners and two Anglers of the Year. No new state records were set. Other activities in 2021 included creating, printing, and distributing derby rule pamphlets and entry forms. Project staff had regular communications with weigh stations, prepared press releases, distributed outreach materials, and tracked derby standings. Due to the ongoing Covid pandemic, the 2021 Derby Awards Ceremony was cancelled. Derby winners received their awards by mail (Figure 31).

Figure 31. John Clark, the 2021 Junior Angler of the Year.

Public Access

The Public Access Coordinator position, which is funded from the Marine Recreational Fisheries Development Fund, manages all DMF saltwater fishing access projects, working closely with the *Mass*DFG Office of Fishing and Boating Access (OFBA), NGOs, towns, and other state and federal agencies to identify, plan, and implement projects that will enhance 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 2021, DMF entered into a partnership with the City of Salem and initiated work to replace the historic Salem Willows Park Pier. The pier has been a mainstay in Salem and has served the fishing public for over one hundred years. Like the old pier, the new pier will extend 330 feet into Salem Sound. However, the end of the new pier will have a 60 x 16 foot 'T' section, which will accommodate far more anglers than its predecessor. A major improvement over the old pier will be Americans with Disabilities Act (ADA) accessibility. Demolition of the old pier, which was condemned as unsafe, began in late 2021. Engineering tasks, which include permitting and design, were ongoing at year's end.

DMF's annual small grants public access program provided $50,000 to assist municipalities with projects that promote or support local recreational fishing activities and access. Three projects were approved for funding in 2021: in Chilmark, lighting installation on piers in Menemsha, a popular fishing location; in Marshfield, a new float at the South River Boat Launch and a new platform at Damon's Point on the North River; and in Tisbury, improvements to the parking area at the mouth of Tashmoo Pond.

At DMF Craven's Landing access site on Scorton Creek in Sandwich, periodic site monitoring and maintenance were required. Seasonal contractors were hired for site patrol and coordinated for weekly summer assignments. Every year, DMF staff works closely with official plover monitors to comply with USFWS regulations. 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 continued to collaborate with the Massachusetts Natural Heritage Program and many other organizations to implement a Habitat Conservation Plan (HCP) for alternative management options in piping plover habitat.

During 2021, staff worked with various entities to develop proposals for public access sites; responded to inquiries regarding shoreside fishing sites, public access rights, and future access projects; and represented the agency remotely at multiple monthly meetings of various sportsmen's gatherings.

Outreach

Staff routinely answered public inquiries regarding recreational fisheries and attended virtual meetings of the recreational fishing community. However, due to the pandemic, all fishing and boating trade shows were cancelled in 2021.

The Massachusetts Saltwater Recreational Fishing Guide (Figure 32) was prepared and distributed to over 140 bait and tackle shops and to requesting anglers by mail and website downloads. In addition, important recreational fishing news was distributed to recreational permit holders through the Division's email distribution list.

Figure 32. 2021 Saltwater 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 that are subject to fisheries off the coast of Massachusetts. Staff conduct field research and opportunistically collect 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.

White Sharks: The aggregation of white sharks off the coast of Massachusetts is one of only a handful of hotspots in the world and unique along the east coast of the US. Consequently, the state of Massachusetts, and in particular, the towns on Cape Cod are faced with a growing potential for negative interactions between this species and people utilizing our coastal waters. As a result, DMF has intensified its research on the fine-scale predatory behavior of white sharks off the coast of Massachusetts using a variety of methods. Our acoustic receiver array has been expanded to fill gaps around Cape Cod and to include the majority of towns along the Massachusetts coastline. Tagging and survey efforts have been expanded into Cape Cod Bay. Two gridded acoustic arrays were deployed off Head of the Meadow Beach (Truro) and Nauset (Orleans) beaches with the Center for Coastal Studies to examine fine-scale movements of sharks as they relate to the habitat. Five real-time acoustic receivers were deployed off popular Outer Cape swimming beaches including: Newcomb Hollow (Figure 33) and Lecounts (Wellfleet), Head of the Meadow (Truro), Nauset Trail (Orleans), and North Beach (Chatham). These receivers provided beach managers and lifeguards with immediate notifications when acoustically-tagged white sharks were detected close to these beaches. Acceleration data logging camera tags were deployed on white sharks to record very fine-scale movements at sub-second intervals, including tailbeat frequency, amplitude, body posture, and swimming depth. These data will be used to examine swimming patterns (e.g., traveling, resting, hunting, foraging, mating), bioenergetics, and, ultimately, provide estimates of the intensity of white shark predation on gray seals. Last, a fixed aerial camera system was utilized in Orleans as a potential tool to observe nearshore white shark behavior.

Figure 33. A real-time acoustic receiver deployed off Newcomb Hollow Beach, Wellfleet.

As a result, 39 white sharks were tagged with acoustic transmitters off the Outer Cape in 2021; 10 of these also carried acceleration data logging camera tags for up to two days. This brings the total to 282 individuals tagged since 2009. These efforts were conducted with funding and logistical support from local nonprofits, including the Atlantic White Shark Conservancy. Data collected in 2021 will be used to enhance our understanding of white shark predatory behavior in these areas of high shark-human overlap to better inform public safety practices.

Shark Management: Staff participate in the state, interstate, federal, and international shark management processes. During 2021, staff served on the ASMFC Coastal Sharks and Spiny Dogfish Technical Committees; ICCAT Advisory Committee, Swordfish and Shark Working Group; and NMFS Highly Migratory Species Advisory Panel.

Outreach and Media: To meet the public demand for information on sharks, especially white sharks, numerous presentations were delivered. 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 served on the committees of nine graduate students who are working with DMF to study the relative abundance, life history, movements, and physiology of sharks.

Publications: Staff co-authored seven articles published in scholarly journals in 2021. Topics included: movements of juvenile porbeagle sharks in the western North Atlantic; reproductive hormones in the white shark; fine-scale habitat use by white sharks in nearshore Cape Cod waters; multispecies acoustic tracking of fishes in the Florida Keys; a novel method to predict habitat selection in fishes from acoustic data; sharks as exfoliators; and the use of drones in shark science.

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 is the most abundant and well-known anadromous fish in Massachusetts. Along with the closely related blueback herring, 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, DMF has increased monitoring efforts over the past decade to meet management goals of restoring populations and harvest. Current 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 now use electronic or video technologies to record spawning run counts at 19 river systems (Table 22).

In 2021, river herring counts ranged from 29 fish in the Concord River, North Billerica to 739,266 in the Nemasket River, Middleborough. River herring counts decreased at most herring runs in 2021, although some locations posted counts above their time series average, including Agawam River, Wareham;

River	Biological	Counts
Merrimack River, Lawrence	Yes	Fish Lift/Video
Concord River, North Billerica	No	Video
Parker River, Newbury	Yes	Video
Essex River, Essex	No	Electronic
Mystic River, Medford	Yes	Video
Back River, Weymouth	Yes	Electronic
Herring Brook, Pembroke	No	Electronic
Town Brook, Plymouth	Yes	Visual (*Volunteer*)
Town River, West Bridgewater	No	Electronic
Nemasket River, Middleboro	Yes	Visual *(Volunteer)*
Sippican River, Rochester	No	Electronic
Mattapoisett River, Mattapoisett	No	Electronic
Acushnet River, Acushnet	No	Electronic
Agawam River, Wareham	No	Electronic
Wankinco River, Wareham	No	Electronic
Monument River, Bournedale	Yes	Electronic
Cedar Lake, Falmouth	No	Electronic
Stony Brook, Brewster	No	Electronic
Herring River, Harwich	Yes	Electronic
Pilgrim Lake, Orleans	No	Electronic
Herring Creek, Aquinnah	No	Video

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

Nemasket River, Middleboro; Acushnet River, Acushnet; and Herring Creek, Aquinnah. Project staff provided technical assistance to local groups conducting volunteer visual counts at herring runs. In 2021, a total of 33 rivers in 24 towns were monitored in Massachusetts. Many of these local groups participate in the MA River Herring Network. At the Network's annual meeting, DMF staff presented information about management updates, population status, and restoration activities for diadromous fish in 2021.

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. In 2021, three stocking trips were conducted in which approximately 1,000 pre-spawning adult river herring were transferred from the Nemasket River to the Three Mile River in Dighton, approximately 440 river herring were transferred from the Parker River in Byfield to Hood Pond in Topsfield, and approximately 1,400 river herring were transferred from the Mystic River to the Ipswich River in Topsfield.

Technical Assistance

Project staff provided technical assistance to local authorities, private organizations, the DMF Habitat Program on environmental permit review, 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 2021 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. Two habitat assessments were concluded in 2021 at Mill Pond in Yarmouth and Island Creek Pond in Duxbury.

Diadromous Fish Restoration Priority List/*Mass*DOT Diadromous Fish GIS Datalayer: Ongoing efforts continued to update a GIS datalayer 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 over 450 fishways, impediments, and potential restoration sites, ranked by restoration potential within the major coastal regions of Massachusetts. The GIS datalayer was designed to support transportation infrastructure planning and environmental review activities conducted by *Mass*DOT and DMF, and also supports DMF and *Mass*DEP restoration planning. Efforts in 2021 focused on working with DFG's GIS staff to integrate the priority list with the GIS datalayer.

Mystic River Video and Counting: Project staff continued to provide 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 the Mystic Lakes Dam. During the season, staff provided technical assistance with videography and system maintenance to ensure footage was of suitable quality.

Diadromous Fish Research Studies

Alewife Tagging, Concord River: In 2021, project biologists collaborated with USFWS to study habitat use by spawning river herring in the potential restoration areas above Talbot Mills Dam in the Concord River. In total, 90 alewife were tagged and released in the Bedford/Carlisle section of the Concord River. DMF deployed acoustic receivers throughout the Concord and Sudbury Rivers as well as the mainstem Merrimack to monitor where tagged spawning alewife spent time and what dams might be impediments to downstream survival.

River Herring Monitoring, Mill River: Project staff monitored migrations of multiple diadromous species at Taunton's Lake Sabbatia Dam and fishway, as part of a continuing cooperative restoration effort in the Mill River watershed. An underwater video camera at the fishway exit recorded fish passage and a collection tank at an eel ramp was checked daily from spring through summer. The eel population in the lake was surveyed during the summer using eel pots to estimate the number of eels.

Diadromous Fish eDNA Sampling (various locations): Project staff in collaboration with UMass-Amherst participated in studies to utilize environmental DNA (eDNA) for diadromous fish monitoring. DMF biologists assisted in collecting water samples for eDNA extraction and analysis to detect the presence, distribution, and abundance of river herring, American shad, and rainbow smelt in various streams monitored by DMF.

Sea Lamprey Study, Parker River: Project staff assisted USGS researchers that were examining the biology and physiology of sea lamprey over the course of the spawning season. Researchers hope to use these results to better inform restoration in native waters and control in introduced populations in the Great Lakes.

American Shad Monitoring

Charles River Monitoring: In 2021, project staff were able to resume a collaboration with colleagues at *MassWildlife* to collect adult American shad from the Charles River to characterize the population and identify fish marked with oxytetracycline in year-specific patterns. This effort was sidelined by the pandemic in 2020. 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 2021 increased in comparison to 2020. This monitoring also includes other diadromous fish species.

American Shad Electrofishing Survey: In the spring of 2021, project staff completed the sixth season of a study to monitor the presence and abundance of American shad in the South River and Indian Head River in Marshfield and Pembroke. Monitoring was conducted in each river from the head of tide to the first obstruction using stream electroshocking surveys to detect the presence of spawning adult shad. During 2021, 13 sampling trips in the South River and 17 sampling trips in the Indian Head River were conducted between April and June; 54 and 90 shad were captured, respectively, for size, age, and genetic sampling. Scale-based aging indicated that these shad ranged from 4–9 years with some fish having spawned up to four times previously. Catch-per-unit-effort indices of abundance were calculated for each river. Monitoring is expected to continue in 2022 with the interest to develop biological and catch-per-unit-effort indices of population abundance.

American Eel Young-of-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. The Jones River trap catch in 2021 improved to 45 eels per haul, after a time-series low in 2020; however, this value is still well below the time-series average and contributes to a significant declining trend. The Essex River fyke net catch continued with the high rates seen during 2019–2020 with approximately 281 eels per haul in 2021.

Project staff has fabricated and installed 12 eel ramps in coastal rivers since 2007 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. Collectively, between the deployment of eel ramps and increase in coastal river dam removals, improvements to juvenile eel passage can be expected in some watersheds in the last 15 years. Data for the Saugus River eel ramp, the first ramp in coastal MA, is under consideration by ASMFC as a yellow eel index of abundance for the 2022 eel stock assessment.

Rainbow Smelt Population and Habitat Monitoring

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). The smelt catches in the Fore River declined in 2021 to near the series average after very high catches in 2018–2020. The Jones River had a time series low catch in 2021 and the Weweantic River and the Parker River captured a few smelt after no catches in 2020. Collectively, the fyke nets have caught over 40 species of fish in total, including 10 species of diadromous fish, with potential indices of abundance for eel, white perch, Atlantic tomcod, and lamprey.

Fish Passage and Habitat Restoration Projects

Numerous projects to improve and maintain diadromous fish passage, habitats, and populations are underway each year. In 2021, project staff devoted time to approximately 20 individual projects in various stages of development and implementation. This was not a typical year in terms of completed restoration projects. The record-setting summer and fall rainfall experienced in several coastal areas prevented fishway work due to unusually high river flows. The work-schedule inefficiencies related to the pandemic also contributed to a slower pace of project development in 2021, although less so than in 2020. Several larger cooperative projects were postponed, as was most small fishway repair work scheduled by the DMF Fishway Crew.

Tom Matthews Pond Fishway, Yarmouth: The DMF Fishway Crew replaced the wood entrance box during the summer of 2021 at the Tom Matthews Pond fishway in Yarmouth. The box appeared to have been damaged by ice/freezing in the prior winter. The crew also worked in the tidal channel downstream of the fishway to remove debris jams in the creek that could impede the emigration of juvenile river herring.

Fore River Watershed: Efforts continued in 2021 on a multi-site project to restore diadromous fish to the Fore River Watershed in the Boston Harbor region. The project partners, led by the Town of Braintree and MA Division of Ecological Restoration, advanced the permitting for the Armstrong Dam removal and Rock Falls fish passage improvement projects. DMF was active with final design preparations for the Rock Falls nature-like fishway and the construction bid process. A construction firm was selected and a project kick-off was held in July; however, the project was delayed due to permitting issues.

Forge Pond Dam, Kingston: Work continued on the 20-year objective of restoring sea-run fish access to Silver Lake in the Jones River watershed. A project scope was prepared in 2021 for a design/permitting contract for designing a fishway at Forge Pond Dam along with associated dredging in Forge Pond. This project scope was put out for bids late in 2021 with expectations that permits can be received in 2022 to allow construction. The design/permitting contract will be led by DMF working in coordination with the Jones River Watershed Association.

Forge Pond Dam, Westport River, Westport: The migration of diadromous fish to the 165-acre Lake Nochoquoke in Westport has been blocked by two dams for decades. DMF conducted diadromous fish monitoring and a river herring habitat assessment in Lake Nochoquoke to confirm species status and habitat conditions. DMF next contracted the USFWS Fish Passage Engineering Team to prepare a scoping design for a

fishway at Forge Pond Dam. This design was included in a project scope for preliminary site investigations and design for a fishway at Forge Pond that was put out to bid late in 2021.

Stump Brook Reservoir Bog Dam, East Bridgewater: The concept of providing river herring access to Stump Brook and the Monponsett ponds has been discussed for decades. The removal of the Cotton Gin Mill Dam on the Satucket River in 2017 left the Stump Brook Bog Reservoir Dam as the primary obstacle to this migration route. DMF began site investigations in 2019 at the dam and prepared a project scope in 2021 to solicit bids for final design/permitting of a fishway at this presently unpassable dam (Figure 34). DMF received a grant from the Taunton River Stewardship Council in 2021 and the project scope was put out for bids late in 2021.

Figure 34. DMF staff surveying for a fishway design at the Stump Brook Reservoir Dam in East

Ipswich River, Ipswich: Efforts to improve fish passage at the Willowdale Dam on the Ipswich River continued. The project was fully designed and permitted and the Alaskan steeppass sections secured in 2020. Construction was slated for the summer of 2021 (after postponement in 2020 due to the pandemic), but no work was possible due to the high rainfall during summer. The construction schedule was shifted to occur in 2022.

Howlett Brook, Topsfield: DMF led the permitting of a fishway rebuild project that would begin restoring access for river herring to Hood Pond in Topsfield. Stocking of herring began in 2021 to complement this project. The project was designed and permits were acquired but high-water levels prevented the work from being completed. Construction was shifted to occur in 2022.

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. Efforts continued in 2021 as project staff worked with the Mystic River Watershed Association and Town of Woburn to manage flows and fish passage at the Scalley Dam. A visual count was resumed in 2021 and project staff observed many herring using the spillway and additionally moved 5000 herring over the dam. New fishway construction was chosen as a preferred project within an environmental mitigation process with this activity due to go out to bid in early 2022.

Talbot Mills, North Billerica: DMF led a contracted secondary feasibility study to examine the removal of the Talbot Mills Dam on the Concord River. Passage at the dam would open over 40 river miles to river herring, American shad, and American eel. The study demonstrated that removal would not affect the Town's water supply. The project was selected for the Division of Ecological Restoration's Priority Project Program bringing additional funds and expertise to the removal effort.

Larkin Mill Dam, Byfield: Project staff assisted the Town of Newbury in preparing an application to DER's Priority Project List. The removal project was selected, and the enlarged team was expected to be move forward with renewed feasibility studies and design and permitting efforts in 2022.

Diadromous Fish Coast-Wide Survey

DMF began a survey of diadromous fish passage in Massachusetts coastal rivers in the summer of 2021 (Figure 35). This effort is a continuation of sea-run fish surveys first conducted by DMF's precursor, the Division of Fisheries and Game, and reported in Dr. David L. Belding's seminal report "Alewife Fisheries of Massachusetts" in 1921. The survey was next conducted in 1967 by DMF and repeated in 2001–2002. These surveys focused on fishways in river herring runs and dams that obstructed passage. The surveys have been invaluable for documenting the status of sea-run fish in coastal rivers and making recommendations on improvements. The survey update will be conducted during 2021–2022 and will broaden the focus to include additional types of fishways and more information on migratory habitats and other species. Further, the survey will be directly integrated into DMF's Diadromous Fish Restoration Priority List and the Diadromous Fish GIS datalayer that was developed by DMF and *Mass*DOT and now managed as an MassGIS datalayer. The integrated survey, priority list, and GIS datalayer should become valuable tools for restoration, resiliency, and transportation planning at local, state, and federal levels. During 2021, nearly all locations in the Cape Cod and Southeastern MA regions were assessed by the survey.

Figure 35. DMF staff surveying the fishway at Carter Beal Park on the Monument River, Bourne.

River Herring Stream Channel Maintenance

Project staff routinely fields requests to assist Towns in maintaining passageways for river herring. The work can involve developing cooperative 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 (Figure 36). Our Stream Maintenance Protocol for Diadromous Fish Passage provides coastwide guidance for these practices. A large effort was made in 2021 to develop a policy with *Mass*DEP on stream maintenance for diadromous fish runs, and a draft policy was nearing finalization in late 2021. Stream maintenance plan updates were prepared for Essex River, Essex; Herring Brook, Pembroke; and Island Creek, Duxbury. The large increase in stream maintenance efforts that began in 2020, as the pandemic limited other activities, continued in 2021. Project staff worked in 12 rivers with local partners in 2021 and made needed passage improvements in the Fore River, Braintree; Acushnet River, Acushnet; Jones River, Kingston; Island Creek, Duxbury; and Mill Creek, Yarmouth.

Figure 36. DMF staff working on stream maintenance in the Fore River watershed, Braintree.

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 to the Director under Chapter 130, Section 19 of Massachusetts General Laws. Five working draft O&M plans were circulated for review in 2021 with two new plans for fishways at the South River, Marshfield and White Island Pond, Wareham.

DMF issues Fishway Construction Permits following the review of final engineering plans to construct, rebuild, or alter fishways. During 2021, one Fishway Construction Permit was issued for the Rock Falls fishway in the Monatiquot River, Braintree and a draft permit was prepared for Sylvia Place Pond in Furnace Brook, Kingston.

Other Activities

Technical Committee Participation: Staff actively participated on management and technical committees related to diadromous fish including the ASMFC technical committees for river herring, shad, American eel, sturgeon, and fish passage. Annual ASMFC compliance reports were prepared for American eel, river herring, American shad, and Atlantic sturgeon. Staff also served on the NMFS River Herring Technical Expert Working Group, technical committees for the Connecticut River Atlantic Salmon Commission, and Anadromous Fishery Management of the Merrimack River Basin.

Presentations & Publications: Project staff provided several virtual presentations and technical assistance related to peers, education, outreach, and constituency groups, although fewer than typical due to the pandemic. Staff contributed to journal articles examining the effects of small-scale environmental factors on adult river herring spawning migrations, adult run size and habitat availability limitations on juvenile river herring densities in lakes, and the surgical implantation of acoustic tags in American shad to resolve riverine and marine restoration challenges. Staff also drafted the update of the ASMFC American Shad Habitat Plan for Massachusetts.

ADMINISTRATION

Kevin Creighton, Chief Fiscal Operator, Section Leader

Personnel

Finance
Darlene Pari, Accounts Payable Coordinator
Eva Morales, Accountant III (retired February 2021)
Kim Trotto, Accountant III (beginning July 2021)
Jeanne Hayes, Accounts Receivable Coordinator
Shannon Davis, Program Coordinator – Revenue

Administrative Support
Kim Trotto, Administrative Support (through June 2021)
Lynne Besse, Administrative Support
Rosemary Mitchell, Administrative Support (retired August 2021)

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 and State Fishery Management & Technical Assistance
Maggie Nazarenus, Program Coordinator – CARES Act and Revolving Loan Fund

Outreach
Christine Cassidy, Information & Education Coordinator
Kimberly Fine, 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
Conor Byrne, Shellfish Purification Plant, Facilities and Capital Assets

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 decreased 3.42% from Fiscal Year (FY) 2020 to FY2021 (Table 23).

Table 23. Fiscal Year 2020 and 2021 appropriations (available funds for operations).

Title	Acct. Number	FY2020	FY2021	Change
General Fund Accounts				
General Operating	2330-0100	[1]$6,611,146	[2]$6,242,794	-5.57%
Sportfish Program	2330-0120	$809,121	[2]$799,954	-1.13%
General Fund Total		$7,420,267	$7,042,748	-5.09%
Retained Revenue Accounts				
Sportfish Retained Revenue	2330-0121	$217,989	$217,989	0.00%
Purification Retained Revenue	2330-0150	$43,142	$25,210	-41.57%
Ventless Trap Retained Revenue	2330-0199	$250,000	$250,000	0.00%
Retained Revenue Total		$511,040	$493,108	-3.51%
Special Fund Accounts				
Saltwater Sport Fish Licensing	2330-0300	$1,688,993	$1,746,763	+3.42%
Seafood Marketing	2330-0104	$250,000	$250,000	0.00%
Special Fund Total		$1,983,993	$1,996,763	+2.98%
Appropriations Grand Total		**$9,870,300**	**$9,532,619**	**-3.42%**

[1] The final budget FY2020 in Chapter 41 of the Acts of 2019 was $8,169,533. DMF's general operating budget was affected by: 1) earmarks totaling $1,585,000 ($450,000 to SMAST; $100,000 for the Great Marsh Green Crab Trapping Program; $50,000 for the Fishing Academy, Inc.; $175,000 for Coastal Marsh Restoration; $175,000 for shellfish propagation in Barnstable, Dukes, and Nantucket counties; $20,000 for shellfish propagation in the Town of Westport; $75,000 for a great white shark tagging program; $75,000 for ecosystem based study of great white shark presence in nearshore areas of Cape Cod; $40,000 for the Cape Cod Commercial Fishermen's Alliance for a youth program; $200,000 for shellfish research with the Gloucester Marine Genomics Institute; $25,000 for GMGI broadband; $100,000 for restoration to Town Pier and Historic Fish House in Swampscott; $100,000 maintenance of Herring Run in Weymouth); 2) $26,613 made available from a reserve draw account to cover employee longevity.

[2] The final budget FY2021 in Chapter 227 of the Acts of 2020 for appropriation 2330-0100 was $6,845,501 and $808,034 for 2330-0120. DMF's general operating budget was affected by: 1) earmarks totaling $525,000 ($450,000 to SMAST; $75,000 for the Gloucester Marine Genomics Institute); 2) $67,707 in 2330-0100 and $8,080 in 2330-0120 that was moved by ANF for the purpose of debt reduction.

Appropriated funds for the operating budget decreased by just over 5%. The decrease in funds can be attributed to the completion of the Industry Based Survey in FY2020 and the subsequent reduction in funds earmarked for that program. In addition, the Office of Administration and Finance (ANF) targeted all general fund accounts with mandatory cost saving measures and directed a portion of appropriated funds to a "Debt Payment" subsidiary not available for DMF expenditure. Late in FY2021, DMF received $371,107 in a supplemental budget for the Protected Species Project. Some of the funds approved in the supplemental budget were used to pay for late season surveillance for right whales and turtles; the remainder of almost $200,000 was approved to "balance forward" for expenditure on needs of the Protected Species Project in FY2022.

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 from 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 decreased by 3.5% in FY2021, resulting from the continued decline of shellfish depuration at the Shellfish Purification Plant.

Appropriations from special fund accounts increased by about 3%. The Legislature slightly increased the appropriation on the Saltwater Sport Fish Licensing account to adjust for increased personnel and research costs; and also to cover final costs of construction on the Deer Island Fishing Pier out of this 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 24 provides the breakdown of costs by primary spending category for the DMF operating accounts.

Table 24. FY2021 expenditures by account type and primary spending category (rounded to whole dollars).

	General Fund	Retained Revenue	Special Fund	Total
Salaries	$5,949,997	$130,210	$667,019	$6,747,226
Employee Expenses	$18,589	$84	$2,070	$20,743
Contracted Employees	$39,752	$16,774	$227,407	$283,932
Contracts	$7,799	$204,640	$166,791	$379,229
Facility Maintenance	$53,610	$14,874	$335,053	$403,537
Field & Lab Supplies	$259,489	$86,107	$90,914	$436,510
Fringe Costs	$120,015	$2,849	$16,641	$139,505
Fuel	$46,385	$642	$833	$47,859
Utilities	$67,578	$0	$0	$67,578
Lease/Rent	$207,436	$0	$0	$207,436
Maintenance/Repair	$90,440	$819	$0	$91,259
Office & Administrative	$223,816	$27,201	$39,317	$290,334
Services/Equipment Lease	$309	$0	$0	$309
Outside Agencies	$143,262	$1,477	$553	$145,292
Grants	$535,122	$0	$63,633	$598,755
Total	**$7,763,599**	**$485,676**	**$1,610,230**	**$9,859,505**

Staffing

Staffing levels were down just over 5% by the end of calendar year (CY) 2021 primarily due to the timing of personnel turnover in DMF's main account. Overall, staffing level decreased by five positions between CY2020 and CY2021 (Table 25).

Table 25. Calendar Year 2020 and 2021 Authorized Personnel Levels.

Title	Acct. Number	CY2020	CY2021
DMF General Operating	2330-0100	65	60
Sport Fish Program	2330-0120	10	10
Saltwater Sport Fish Licensing	2330-0300	9	7
Federal Grants and Trust Account	2330-xxxx*	18	18
Total Employees in All Appropriations		**102**	**97**

*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 41,255 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 $2,143,700 in 2021 (Table 26). Overall, there was a drop in permit revenue by approximately 2% as compared to 2020.

The Shellfish Purification Plant processed 3,878 racks of soft shell clams in 2021, resulting in General Fund revenues of $23,268. This represents an 8% decrease in revenue from 2020 and is the lowest amount ever recorded. Overall, there has been a declining trend in racks processed and resulting revenues since 2009.

Table 26. Calendar Year 2019 and 2020 General Fund Permitting Revenue.

Permit Categories	CY2020	CY2021	Change
Commercial Fishing	$1,237,970	$1,217,435	-1.7%
Seafood Dealer	$186,940	$186,940	+3.7%
Special	$766,620	$732,435	-4.5%
Total General Fund Permit Revenue	**$2,191,530**	**$2,143,700**	**-2.2%**

Dedicated Fund Revenue

In addition to General Fund revenue, DMF generated $1,447,854 in revenue for the Marine Recreational Fisheries Development Fund in 2021 (Table 27). 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. The increase in outdoor recreational pursuits during COVID-19 was evident throughout the country, and in 2020, the fund saw a significant increase in revenue (~16%) over that of the previous year. In 2021, recreational permit sales dropped back down to pre-pandemic numbers and have leveled off.

Table 27. CY2020 and CY2021 Marine Recreational Fisheries Development Fund Revenue.

Permit Categories	CY2020	CY2021	Change
Recreational Saltwater	$1,552,430	$1,306,000	-19%
For-Hire (charter & head boat)	$61,880	$60,905	-1.6%
Recreational Fund Donations	$79,985	$80,949	+1.2%
Total Rec. Fisheries Fund Revenue	**$1,694,295**	**$1,447,854**	**-17.0%**

Grants

In FY2021, DMF spent approximately $3.7 million on federal grants and mitigation projects operating out of the DMF Trust Account. This was an increase of almost 7% as compared to FY2020 (Table 28). Most of the increased spending can be attributed to a new lobster research project funded through Sea Grant, and the completion of a large public access infrastructure project that was funded, in part, out of the DMF Trust Account.

Table 28. Fiscal Year 2020 and 2021 Expenditures.

Title of Federal Grant or Trust	Account No.	FY2020	FY2021
Clean Vessel Act	2330-9222	$803,000	$926,000
Fisheries Statistics	2330-9712	$187,000	$180,000
Boating Infrastructure	2330-9725	$177,000	$27,000
Interstate Fisheries	2330-9730	$293,000	$288,000
ACCSP	2330-9732	$18,000	$21,000
Saltonstall-Kennedy	2330-9733	$148,000	$13,000
Turtle Disentanglement/Protected Species	2330-9739	$761,000	$668,000
Fish Age & Growth	2330-9742	$271,000	$302,000
Sport Fish Coordination	2330-9743	$130,000	$106,000
MFI Grants	2330-9744	$54,000	$0
Sea Grant Lobster	2330-9745	$4,000	$158,000
Marine Fisheries Research Trust	2330-0101	$625,000	$1,018,000
Total		**$3,471,000**	**$3,708,000**

Coronavirus Aid, Relief, and Economic Security Act Fisheries Relief

In CY 2021, the Coronavirus Disease 2019 (COVID-19) crisis continued to present challenges to the fishing industry in Massachusetts. Although the 2021 ex-vessel value of seafood landed in Massachusetts reached record highs, many businesses were still recovering from losses incurred early in the pandemic and continued to experience disruptions to their standard operations. The federal Consolidated Appropriations Act of 2021 allocated an additional $255 million to fund activities previously authorized under the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) for those seafood and fishing industry sectors negatively affected by the COVID-19 pandemic. Approximately $23 million of this funding was allocated by NOAA Fisheries to the Commonwealth of Massachusetts, the third highest allocation in the country.

The Consolidated Appropriations Act of 2021 provided the same eligibility requirements as those mandated under Round 1 of the CARES relief program. As required by the CARES Act, eligible participants must have incurred an economic revenue loss of at least 35 percent as compared to their prior five-year average revenue. States were permitted to select the period within 2020 to which the average revenue would be compared. DMF coordinated with industry working groups to select timeframes at the sector level to better reflect the timing of greatest economic loss for each sector (seafood processors/wholesale dealers, commercial fishing, aquaculture, and for-hire fishing). Further federal guidelines required that participants must be at least 18 years of age and could not be made “more than whole” when comparing their 2020 revenue (inclusive of both rounds of CARES Act Fisheries Relief as well as other pandemic-related assistance) to revenues earned during a traditional year.

For the Round 2 CARES Act Fisheries Relief program, DMF kept much of the same structure of the Round 1 CARES program, with modifications where allowable to streamline the application process and qualify new applicants. One modification to the program was the addition of another time period within each sector that

could be used to calculate revenue loss. Flexibility in selecting a different time for comparison allowed some applicants who were ineligible in Round 1 based on the revenue loss requirement to qualify under Round 2.

DMF mailed applications to all relevant permit holders on July 20, 2021, and set an application deadline of August 28, 2021. During the application process, staff worked intensively with applicants to ensure that submitted applications were complete and correct. DMF held four in-person workshops along the Massachusetts coast, in coordination with the Massachusetts Lobstermen's Association and the Cape Cod Commercial Fisherman's Alliance, to assist with the application process. Following the completion of appeal review, the ASMFC mailed checks to qualified Massachusetts Round 2 CARES Act Fisheries Relief applicants on October 7, 2021.

Across the four program sectors, the number of Round 2 applicants decreased slightly compared to Round 1, but interest in the program remained high. Due to the requirement that applicants could not be made more than "whole", some applicants were found to be ineligible based on their 2020 revenue and Round 1 CARES program payment, while others received a partial share so they did not exceed their made "whole" amount.

Table 29. Round 2 CARES Act Payment Distribution

Sector	Allocation	No. of Recipients	Median Payment
Seafood Processor	$11,548,170	103	$88,934
Commercial Fishing	$9,912,809	474	$20,645
Aquaculture	$965,982	103	$5,642
For-Hire Head Boat Fishing	$502,831	24	$20,651
For-hire Charter Boat Fishing	$335,220	29	$11,431

Both rounds of the CARES Act Fisheries Relief implemented by DMF provided critical assistance to Massachusetts' fisheries (Table 29). Such programs helped many local businesses stay afloat during the ups and downs of the COVID-19 crisis, allowing them to continue to provide fresh seafood to the Commonwealth and provide jobs to Commonwealth residents.

State Fishery Management & Technical Assistance

Staff provide technical assistance and support to the New England Fishery Management Council in the development, implementation, and monitoring of FMPs and Amendments. These cooperative activities enhance the management of fisheries occurring in the Exclusive Economic Zone. Since 2018, the Council has provided the Commonwealth with $80,000 biennially, split evenly between two years. The $40,000 allocated to fishing year 2021 supported the Commonwealth's participation in Council meetings and other Committee meetings as well as in working groups, technical groups, and plan development teams. Some of this work is summarized in the policy section and DMF submitted a summary report of the State's technical assistance activities to the Council in August.

The Revolving Loan Fund

The Massachusetts Commercial Fisheries Revolving Loan Fund (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 contracted with two financial institutions, Tremont Credit Union and Community Development Partnership (CDP), to provide approved loan services to eligible applicants throughout the Commonwealth, and with a third organization, the Gloucester-based Northeast Fishery Sector II, to administer funds for groundfish quota leasing.

Over the years, DMF implemented a variety of amendments to the Memorandum of Agreement in order to address fishermen concerns and create a larger pool of applicants to better serve smaller scale groundfish vessels adversely affected by the catch share management plan. However, despite continued modifications to the RLF and Revolving ACE Leasing Fund (RALF) programs, a significant underutilization of loan funds and lack of new participation persisted. This continued lack of loan utilization demonstrated that the RLF and RALF programs did not have their intended impacts, especially at the envisioned scale of small vessel owners in the groundfish fishery. Therefore, at the end of CY2019, DMF recalled funds from its three RLF partners and, in CY2020, began to receive unused funds from one of its RLF lending partners.

During CY2021, DMF worked with the remaining two of its RLF partner organizations to close out their loan programs through the required reporting and return of unused funds. DMF hosted meetings with representatives of the Massachusetts Fishermen's Partnership (MFP) to review the RLF and RALF programs. DMF is committed to standing-up an industry advisory group to help repurpose the program one final time. The group was unable to meet in-person (group preference) due to pandemic-related restrictions in 2021. The Community Development Partnership remains under contract with DMF through 2024 to repay existing loans.

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.

Figure 37. Cuttyhunks's pumpout station funded for operation and maintenance in 2021.

In 2021, the 27th 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 Covid affecting our short, intense New England boating season. We have been a leader in the implementation of pumpout vessel use. Our matrix of pumpout vessels and shore-side pumpouts (Figure 37), 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' establishment of a statewide NDZ. To date, the *Mass*CVA Program has kept over 10 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 that can pay to have it refurbished at a fraction of the cost of new equipment.

In 2021, 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. PPE was in high demand for operators navigating pumpout operations during a pandemic. A pilot project to develop an electronic pumpout log to collect pumpout data was initiated in mooring areas in Ipswich Bay in collaboration with DMF's Shellfish Program. Project partners also included a town harbormaster's department and a private marina. The electronic log was a success with data collected in real time by handheld devices on the water during the boating season (Figure 38). 2021 also included a review of the definition of a "recreational vessel" by the Department of Fish and Game legal staff to confirm *Mass*CVA is adhering to all federal regulations while providing maximum pumpout availability to Massachusetts boaters.

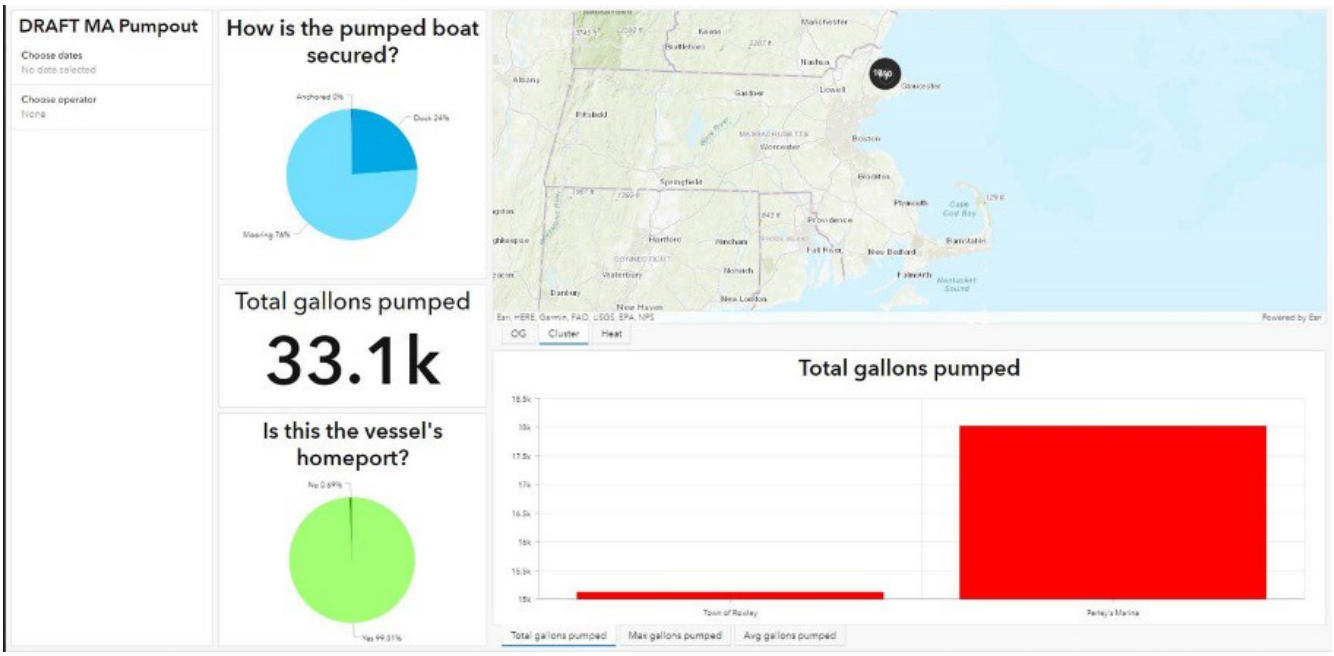


Figure 38. *Mass*CVA electronic pumpout log.

We addressed existing equipment concerns and facility growth requests as allowed by available federal funds (Table 30, Figure 39). Total reimbursement for all new and replacement equipment was $154,594. An additional $504,086 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.

Table 30. New and Replacement *Mass*CVA Infrastructure for 2021.

Recipient	Equipment
Charlestown Marina	Replacement pumpout boat
Hull	Replacement pumpout boat engine
Safe Harbor Green Harbor Marina	New pumpout station
Dartmouth	Replacement pumpout station
Oak Bluffs	Replacement pumpout boat

Figure 39. *Mass*CVA infrastructure funded in 2021 included this replacement pumpout boat for Oak Bluff's busy harbor.

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.

During 2021, staff discussed several possible BIG projects with cities and towns but no projects were applied for or awarded during the year. One grant project was completed in 2021, in which the Boston Harbor Islands received 118 new moorings for transient boaters at Gallops, Georges, Peddocks and Spectacle Islands, improving boater access to these popular destinations through a successful partnership with *Mass*DCR (Figure 40). Staff also wrapped up the administrative work for New Bedford's 2020 project which included new finger piers, pedestals, and a transient boater mooring at the city's Popes Island Marina (Figure 41).

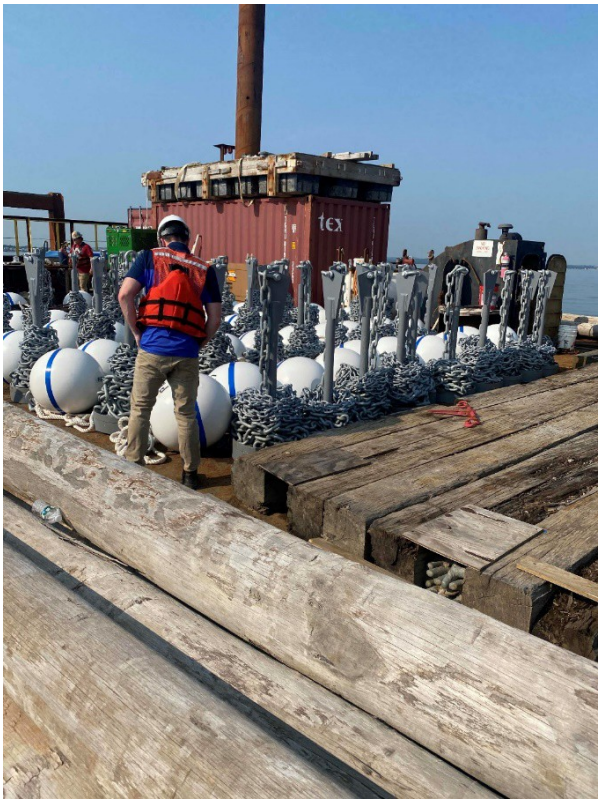


Figure 40. Moorings funded by *Mass*BIG for the Boston Harbor Islands in 2021.

Figure 41. Popes Island Marina finger piers funded by the *Mass*BIG grant.

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 the following ways:

Public Events: 2021 was closed to in-person trade events early in the year. During the fall, staff attended and tabled at the Topsfield Fair, which has an annual attendance of ~500,000 people. Event materials included gunnel stickers with a striped bass slot marker, size 8/0 circle hooks (targeting striped bass anglers), coloring books, and #fishma stickers. Roughly 1,500 circle hooks and 2,000 coloring books were distributed. Unfortunately, due to restrictions for in-person gatherings, the planned circle hook pop-up tent activities at various boat ramps throughout the state were canceled, as were in-person striped bass educational outreach activities.

Publications and Design: The pilot year of the *Take Me Saltwater Fishing* initiative, a program to support adults in teaching kids how to fish, was moved to spring of 2022 due to the pandemic. Production of program materials and promotional items was performed throughout the spring season and into the summer of 2021. Testing and distribution of program materials and activities was ongoing throughout the summer, with *Take Me Saltwater Fishing* guides being distributed to various programs along the coast. Notably, the Gloucester Police Department's "Kops N Kids Youth Anglers Fishing Trips", the Cohasset Recreation Department, and the Kennedy Summer Day Program all utilized the books for angler education throughout the summer.

Production of companion videos for the *Take Me Saltwater Fishing* guide was completed and loaded into the Divisions' YouTube channel (Figure 42). QR codes and direct links to the videos from the guide ensure that future readers will have quick access to visual learning as they move through the program. Video content includes knot tying, casting a spinning rod, fishing from shore and a pier, and responsible angler practices. Videos were produced in partnership with Shields Design Group and Creative Media Services.

Figure 42. A still shot from the *Take Me Saltwater Fishing* video series which teaches angling skills.

Finally, staff produced content for striped bass regulation awareness, included social media postings and the development of a new poster (Figure 43). The poster was delivered for free to bait and tackle shops throughout the region for display.

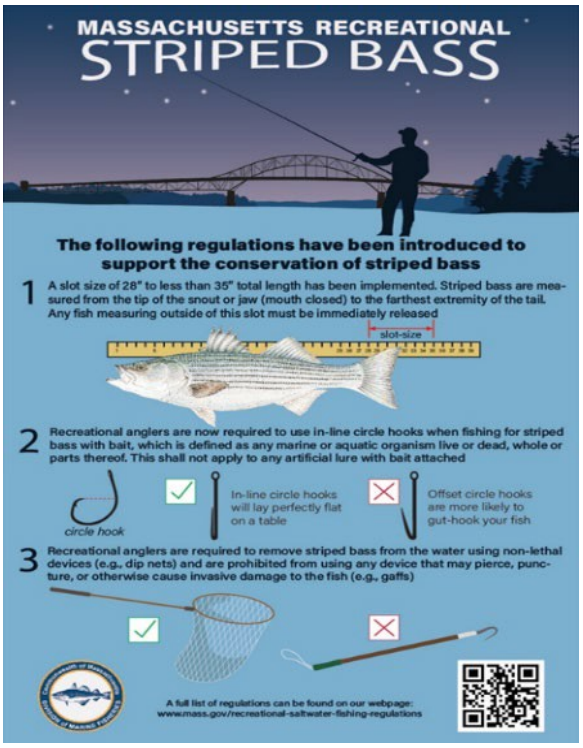


Figure 43. Striped bass regulations poster.

Social Media: Communications with constituents through our social media platforms continued through Facebook, Twitter, YouTube, and Instagram. In 2021, Facebook and Twitter content continued to focus on providing regulatory updates and progress from field research, whereas Instagram focused on seafood marketing programs, recreational fishing, and the saltwater derby. Overall, the Facebook account maintained its following with 9,500 individuals. Instagram grew 11% in 2021, adding 462 new followers. In the summer of 2021, I&E continued the "What is it? Wednesday" social media campaign on Facebook, targeting recreational anglers. In this informational game, photographs, or videos of DMF research were posted to engage the community. Correct guesses were entered into an end-of-summer drawing for one of three Saltwater Spinning rod/reel combos. Follow-up postings offered additional information and promoted various projects in addition to highlighting many of the species found in Massachusetts waters. Engagement insights on post clicks and reactions were among some of the year's highest, routinely breaking 300 post clicks and were among some of the most shared content on Facebook for the year.

R3 Initiatives: In 2021, the Division's R3 initiatives focused on developing access to angler education documents in Spanish as well as adding the new instructional videos for *Take Me Saltwater Fishing* to the YouTube channel.

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 and a small grant program, which awards up to $500 per proposal for outside entities to create an event promoting saltwater angler education within Massachusetts.

In 2021, DMF hosted two pop-up clinics that were co-sponsored events with limited participation due to COVID-19 safety protocols. Educational materials and circle hooks were distributed and participants engaged in safely distanced fishing. Clinics were 2–4 hours and participation was limited to the number of rods provided so each participant had their own sanitized rod for the duration of the clinic. A casting demonstration was given and DMF staff aided in fishing assistance when needed. Participants in the pop-up clinics ranged from 5–15 years of age.

DMF was also involved with a co-sponsored virtual event with NOAA and the Hispanic Access Foundation. The virtual clinic was held for the Hispanic community of Lawrence and Lowell. There were 20 participants that attended the virtual clinic. DMF created virtual videos on knot tying and casting demonstrations and discussed fishing regulations and how to safely handle fish.

DMF worked with the Fishing Academy to coordinate a fishing clinic at the dedication event for the new Deer Island Pier, and also passed out educational materials and gave away fishing bags to all clinic participants.

Seafood Marketing

DMF's Seafood Marketing Program seeks to increase consumer awareness and preference for local seafood products. The program supports the state's commercial fishing and seafood industries and communities.

Marketing and Outreach

In May of 2021 the Seafood Marketing Program held a virtual buyer's event, *Navigating Massachusetts Seafood*. This event was a recommendation of the steering committee and was planned as an in-person event at the Seafood Expo North America, but became virtual due to COVID-19. Staff worked with a food events marketing group, the Williams Agency, who administered and hosted this virtual buyer's event on Zoom. Twenty seafood sellers had 10-minute speed dates with buyers. There were a few day-of cancelations but overall this event was a huge success. In the future, we hope to do more in person. An additional outcome of the *Navigating Massachusetts Seafood* event was a "Seafood 101" PowerPoint Presentation that is used as a teaching tool for audiences.

For the second year, the program ran a state-wide radio campaign with the iHeartradio family from July through August. This received 6 million impressions including social media at a total cost of $72,000. "Celebrate the summer," "support your health and our fishermen" was the messaging that was purposefully made positive and light during the second COVID-19 summer. Director Dan McKiernan appeared on two accompanying podcasts, including Billy Costa's "Food for Thought," as part of this radio package.

A goal of summer 2021 was to provide consumers with real time seafood availability from our landings data on our state website platform. Over the summer we had meetings with various groups to create a seafood availability website. DMF posted the availability data every week on our social media in our stories, and we know that hundreds and hundreds of people looked at this in summer 2021.

Grant Program

The Seafood Marketing Program established a partnership with Woods Hole Sea Grant to give away the most funds in the six-year history of the program. Woods Hole Sea Grant contributed $100,000 to the Seafood Marketing Grant Program budget and the remainder of the grant program was funded by the Seafood Marketing Program. The goal of the grant program is to enhance the viability and stabilize the economic environment for the state's local commercial fishing and seafood industries and communities. Unique this year was a pitch event held in December 2021 where selected applicants were invited to do a five-minute virtual presentation in front of a panel of industry judges. Successful applicants were expected to be notified in 2022 with projects required to be completed by June 30, 2023.

Other Activities

The Executive Office of Energy and Environmental Affairs' (EOEEA) Food Security Infrastructure Grant announced a round of funding in September 2021. This program sought to ensure that individuals and families throughout the Commonwealth have access to food, with a special focus on food that is produced locally and equitable access to food, and that farmers, fisherman and other local food producers are better connected to a strong, resilient food system to help mitigate future food supply and distribution disruption. The Seafood Marketing Program notified the industry of this opportunity, fielded questions, and DMF provided ten grant application reviewers to advise EOEEA on the applications. Hundreds of seafood industry applications were received.

The Seafood Marketing Program participated in an internship program with UMass-Amherst Gloucester Marine Station and the Urban Harbors Institute at UMass-Boston as part of the Seafood System Incubator project funded by the Massachusetts Seaport Economic Council. We worked with an intern to build and execute a survey to capture the impact of COVID-19 on distribution of seafood and the seafood retailers in Massachusetts. This survey was online and outreach was done summer of 2021. Over 30 retailers responded to the survey and the results can be found on DMF's website.

Scientific Diving

Scientific Diving is responsible for the 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's training and dive operations, affording Division divers greater protection from accidental injury and helping to ensure the success of research performed by diving.

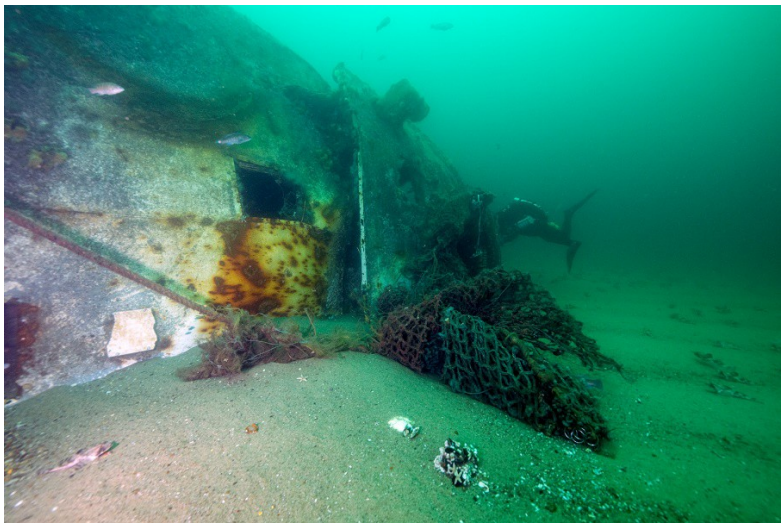


Figure 44. A diver surveys the net from the F/V Patriot on Stellwagen Bank. Photo credit; Heather Knowles, NADE.

Despite continued limitations caused by the pandemic, DMF's scientific divers conducted over 382 research dives to support on-going research and monitoring programs, including artificial reef site surveys, coast-wide benthic temperature monitoring, early-benthic-phase lobster suction surveys, eelgrass monitoring and restoration, shellfish abundance and habitat surveys, maintenance of acoustic telemetry receivers for numerous finfish species, polychlorinated biphenyl monitoring sample collection, and dive program training. 2021 highlights include: removing a substantial piece of net from the wreck of the F/V Patriot in partnership with divers from Stellwagen Bank National Marine Sanctuary (Figure 44), along with deploying an acoustic receiver on the wreck; the deployment of a new acoustic receiver mooring on the wreck of the Mars; continued post-deployment monitoring of the new artificial reef off Harwich; and the successful completion of training for DMF biologists.

The Scientific Diving Program also maintains reciprocity agreements with the U.S. Environmental Protection Agency (EPA), Boston University, the Marine Biological Laboratory, Northeastern University, and Woods Hole Oceanographic Institution, permitting cooperative diving research. Routine program management duties included diver training, equipment maintenance and repair, and maintenance of the air system.

Educational and outreach efforts to dive clubs, schools, and local dive shows were greatly limited due to the restrictions on travel and public gatherings. Several educational sessions were conducted for local dive clubs using videoconference platforms. The Diving Safety Officer continued to serve on the boards of the American Academy of Underwater Sciences Foundation, Bay State Council of Divers, the Foundation for Underwater Research and Education, and the Our World Underwater Scholarship Society.

Capital Assets and Facilities Management

Facilities

DMF maintains facilities at several locations throughout the state. Headquarters are located in Boston, with the two primary field stations 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 FY2021, DMF spent approximately $168,000 in facility planning, infrastructure maintenance, and emergency repairs. At the Gloucester Field Station, a dedicated HVAC system was added to the shellfish wing and a 20+ year old roof was replaced on one wing of the main building. Autoclaves were replaced in both the Newburyport and Gloucester shellfish laboratories, and all scientific dive equipment was evaluated and replaced as necessary.

Vehicles and Boats

DMF maintains a fleet of 40 vehicles and 16 boats. In 2021, $80,000 was paid to the Office of Vehicle Management for lease vehicles, and an additional $30,000 was spent on maintenance and repair for all stock. 10 vehicles were scheduled for replacement in 2021; however, lack of available stock caused by the pandemic pushed back the ordering of all vehicles. DMF continued to work with OVM as existing vehicles are getting costly to keep operable.

DMF continued the vessel maintenance program that began in 2019 (Figure 45). The total cost of upgrades, replacements and general maintenance was in excess of $50,000.

Other Projects: Support continued for the multi-year effort to collect marine life in and around New Bedford Harbor in partnership with the DEP to support EPA's Superfund monitoring efforts. Personnel were assigned to the EEA Health and Safety Team, the Pilgrim Nuclear Power Station Decommissioning Committee, and as a DFG representative to EEA's MA Ingestion Pathway Team for responses to potential releases from Seabrook Station in NH.

Figure 45. DMF R/V Mya in New

Appendix A. 2021 Publications

DMF Technical Reports

Nelson, G. A. 2021. Massachusetts striped bass monitoring report for 2020. DMF TR-76.

Contributions

Logan, J.M., **A. Boeri**, **J. Carr**, **T. Evans**, **E. Feeney**, **K. Frew**, **F. Schenck**, and **K. Ford**. 2021. Review of Habitat Impacts from Residential Docks and Recommended Best Management Practices with an Emphasis on the Northeastern United States. *Estuaries and Coasts.* https://doi.org/10.1007/s12237-021-01006-0.

Capizzano, C.W., D.R. Zemeckis, E.A. Jones, **W.S. Hoffman**, **M.J. Dean**, **M.H. Ayer**, N. Ribblett, and J.W. Mandelman. 2021. Reducing bycatch impacts in recreational fisheries: Case study examining terminal tackle in the multispecies Gulf of Maine groundfish fishery. *Fisheries Management and Ecology.* https://doi.org/10.1111/fme.12480.

Anstead, K.A., K. Drew, D. Chagaris, M. Cieri, A.M. Schueller, J.E. McNamee, A. Buchheister, G. Nesslage, J.H. Uphoff Jr, M.J. Wilberg, A. Sharov, **M.J. Dean**, J. Brust, M. Celestino, S. Madsen, S. Murray, M. Appelman, J.C. Ballenger, J. Brito, E. Cosby, C. Craig, C. Flora, K. Gottschall, R.J. Latour, E. Leonard, R. Mroch, J. Newhard, D. Orner, C. Swanson, J. Tinsman, E.D. Houde, T.J. Miller and H. Townsend. 2021. *The Path to an Ecosystem Approach for Forage Fish Management: A Case Study of Atlantic Menhaden*. Front. Mar. Sci. 8:607657. https://doi.org/10.3389/fmars.2021.607657.

Koob, E.R., **S.P. Elzey**, J.W. Mandelman, and **M.P. Armstrong**. Age validation of the northern stock of black sea bass (*Centropristis striata*) in the Atlantic Ocean. 2021. Fishery Bulletin, 119(4): 261-273.

Dean, M.J., **Hoffman, W.S., Buchan, N.C.**, Cadrin, S.X., and Grabowski, J.H., 2021. The influence of trawl efficiency assumptions on survey-based population metrics. ICES Journal of Marine Science. 78, 2858–2874.

Dean, M.J., Hoffman, W.S., Buchan, N.C., Cadrin, S.X., and Grabowski, J.H., 2021. Deconstructing size selectivity to evaluate the influence of fishery management. Fisheries Research, 234: 105782

Pol, M. and S. Eayrs. 2021. Behaviour in a bottom trawl: moving forward to limit catches of Atlantic cod. *ICES Journal of Marine Science*, 78(7): 2317–2324. https://doi.org/10.1093/icesjms/fsab106.

Legett, H., A. Jordaan, A. Roy, **J. Sheppard**, M. Somos-Valenzuela, and M. Staudinger. Daily Patterns of River Herring (*Alosa* spp.) Spawning Migrations: Environmental Drivers and Variation among Coastal Streams in Massachusetts. *Transactions of the American Fisheries Society*. DOI: 10.1002/tafs.10301. Article.

Wilcox, S.H., **T.L. Pugh**, **R.P. Glenn**, and K. Oliveira. 2021. Spatial variation in size and age at maturation and growth of the channeled whelk (*Busycotypus canaliculatus*) in Southern Massachusetts. Fisheries Research, 239: doi.org/10.1016/j.fishres.2021.105926

Other Reports

DMF. 2021. Massachusetts Division of Marine Fisheries 2020 Annual Report. 109 pp.

DMF. 2021. DMF News, 2021 Q3&4 (48). 16 pp. https://www.mass.gov/news/dmf-news-2021-q3-q4

DMF. 2021. DMF News, 2021 Q1&2 (47). 13 pp. https://www.mass.gov/news/dmf-news-2021-q1-q2