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INITIATIVE
2020 Assessment Report

Massachusetts Shellfish Initiative

Assessment Report

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MSI Assessment Committee

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Contents

Overview and Mission of the Massachusetts Shellfish Initiative

The Massachusetts Shellfish Initiative (MSI) is an iterative and collaborative process with the goal of enhancing the economic, environmental, and social benefits of shellfish resources to the Commonwealth of Massachusetts. The MSI is led by a Task Force, which consists of representatives from state government, municipal government, industry organizations and non-governmental organizations. It is chaired by Daniel McKiernan, the Director of the Massachusetts Division of Marine Fisheries.

To achieve the MSI's overarching goals, the Task Force has set out to develop a Strategic Plan. Given the iterative and collaborative nature of the MSI, the development of this plan will be driven by stakeholder recommendations and will rely heavily on input from commercial fishermen, recreational fishermen, aquaculturists, tribal members, the restoration community, town and state officials, and the general public. To inform the development of this plan, the Task Force established a Scoping Committee and an Assessment Committee. Both committees included members from a broad geographic range and from a broad range of shellfish-related sectors to ensure that the work that would ultimately inform the Task Force's Strategic Plan was thorough and inclusive.

The Scoping Committee was assigned to solicit and consolidate public feedback regarding issues of public concern pertinent to shellfish resources and shellfish fisheries in the Commonwealth. Public hearings were held during the fall of 2019; written public comment was also accepted at that time. These comments were synthesized into a Scoping Committee Report, which was approved and released by the Scoping Committee in February 2020. This report identifies six broad objective categories of public interest, and numerous more specific priority goals within each objective, to be considered by the Task Force when drafting their Strategic Plan.

The Assessment Committee was charged with assessing and describing how shellfish resources and shellfish fisheries are managed in Massachusetts, as well as what institutional infrastructure and capacities exist to support shellfish resources and shellfish fisheries. During the second half of 2019, the Assessment Committee collected data through questionnaires of state agencies and non-governmental organizations and a survey of coastal municipalities; the Division of Marine Fisheries also provided an analysis of state laws and commercial shellfish landings data. This information was then synthesized into this Assessment Committee Report.

Glossary of Terms

For the purpose of this Assessment Committee Report, the following acronyms and terms hold the following meanings:

AC means the MSI's Assessment Committee.

ACCSP means the Atlantic Coastal Cooperative Statistics Program.

American Oyster or Oyster means that species of molluscan shellfish know as *Crassostrea virginica*.

APCC means the Associates to Preserve Cape Cod.

Approved area means any shellfish growing area classified by DMF as Approved or Conditionally Approved and not in a closed status under the provisions of a Conditional Area Management Plan.

Aquaculture means the farming of aquatic marine organisms including, but not limited to fish, mollusks, crustaceans, echinoderms and plants. Farming implies some sort of intervention in the rearing process to enhance production including, but not limited to controlled propagation, feeding, and protection from predators.

ARC means the Aquaculture Research Corporation.

ASP means Amnesic Shellfish Poisoning.

BARS means the Barnstable Association for Recreational Shellfishing.

Bay Scallop means that species of molluscan shellfish known as *Argopecten irradians*.

Blue Mussel means that species of molluscan shellfish known as *Mytilus edulis.*

CCCFA means the Cape Cod Commercial Fishermen's Alliance

Closed Status means any growing are classified by DMF as Approved, Conditionally Approved, Restricted, or Conditionally Restricted that has been closed to shellfish harvesting, or in the case of a Conditionally Approved Area, when a municipality closes an area under the provisions of a Conditional Area Management Plan.

Commercial Shellfish Fisherman means any person who may catch, possess and land shellfish for sale barter or exchange. This shall include shellfish aquaculturists and wild harvesters.

Commercial Shellfish Fishing means any shellfish fishing activity conducted by a commercial shellfish fisherman for the purpose of sale, barter or exchange.

Contaminated Area means any shellfish growing area classified as Prohibited, Restricted, Conditionally Restricted, Conditionally Approved or Approved and in a closed status.

Contaminated shellfish means any shellfish shellstock within or taken from any contaminated area.

CPR means coastal pollution remediation.

Culture Activity means those activities conducted by aquaculturists (or employees thereof) that are authorized in writing by DMF and may occur at locations other than the aquaculture grant site. Culture activities include, but are not limited to, sorting, cleaning, culling, grading, pitting, or over-wintering of cultured shellfish.

CWA means the Clean Water Act.

CZM means the Massachusetts Office of Coastal Zone Management within the Secretariat of Energy and Environmental Affairs.

DCR means the Massachusetts Department of Conservation and Recreation.

DEP means the Massachusetts Department of Environmental Protection.

DFG means the Massachusetts Department of Fish and Game.

DFW means the Massachusetts Division of Fisheries and Wildlife

DMF means the Massachusetts Division of Marine Fisheries.

DPH means the Massachusetts Department of Public Health.

Designated Shellfish Growing Area (DSGA) means any site which supports or could support the propagation of shellstock by natural artificial means. DMF has listed and mapped all growing areas in the waters under the jurisdiction of the Commonwealth and these geographic maps are made available on DMF's website.

ECSGA means the East Coast Shellfish Growers Association.

EEA means the Massachusetts Secretariat of Energy and Environmental Affairs.

Ex-vessel value means the monetary worth of commercial landings calculated at the first sale to a primary buyer.

FDA means the United States Food and Drug Administration.

Fishing or Fish For means to harvest, catch, or take, or attempt to harvest, catch, or take shellfish. This includes the taking of aquaculture reared shellfish for purposes other than culture activity.

FPP means the Food Protection Program within the Department of Public Health.

GIS means geographic information system.

GMGI means the Gloucester Marine Genomics Institute.

HABS means harmful algal blooms.

HACCP means Hazard Analysis Critical Control Point.

Home Rule means the authority vested in municipal government to manage the shellfish resources and shellfish fisheries within its waters pursuant to state law at G.L. c. 130.

ISSC means the Interstate Shellfish Sanitation Conference

Long Term Transplants means the transfer of seed shellfish only by municipalities from growing areas classified as Prohibited to growing areas classified as Approved or Conditionally Approved to reduce pathogens. Transplants require one or more spawning seasons and a minimum of 6 months of natural depuration before harvest. Areas used as a source of shellfish for transplants must have acceptably low levels of poisonous or deleterious substances as defined by the NSSP and any other contaminants of concern to DPH. Testing must demonstrate that the shellfish are free of shellfish diseases prior to transplanting. The NSSP defines seed as shellstock (shellfish) which is less than market size.

MAA means the Massachusetts Aquaculture Association.

MAPP means the Massachusetts Aquaculture Permitting Project.

MDAR means the Massachusetts Department of Agricultural Resources.

MEP means the Massachusetts Environmental Police.

MEPA means the Office of the Massachusetts Environmental Protection Act within the Secretariat of Energy and Environmental Affairs.

MIT means the Massachusetts Institute of Technology.

Mitigation means any shellfish planting done as compensation for alterations resulting in losses or damage to existing shellfish resources or habitat.

MMA means the Massachusetts' Maritime Academy.

Model Ordinance (MO) means that part of the most recent version of the National Shellfish Sanitation Program's Guide for the Control of Molluscan Shellfish that sets the requirements that the states have agreed to enforce through their participation in the Interstate Shellfish Sanitation Conference, which are minimally necessary for the sanitary control of shellfish produced from that state to ensure that it is safe for human consumption.

MOP means the Massachusetts Oyster Project.

MOU means Memorandum of Understanding.

MSC means that group of viruses known as male specific coliphage.

MSOA means the Massachusetts Shellfish Officers Association.

MSI means the Massachusetts Shellfish Initiative.

MVSG means the Martha's Vineyard Shellfish Group.

MWRA means the Massachusetts Water Resources Authority

Natural Heritage means the Natural Heritage and Endangered Species Program within the Department of Fish and Game's Division of Fisheries and Wildlife.

NDZ means No Discharge Zone.

NEAQ means the New England Aquarium.

NEMAC means the Northeastern Massachusetts Aquaculture Center.

NGO (NGO) means Non-Governmental Organization or any non-profit organization that operates independently of any government.

NOAA means the United States National Oceanic and Atmospheric Association.

NOAA Fisheries means the National Marine Fisheries Service within the United States National Oceanic and Atmospheric Association.

Northern quahog or quahog means that species of molluscan shellfish known as *Mercenaria sp*.

NPDES means the National Pollutant Discharge Elimination System.

NSRWA means the North and South River Watershed Association.

NSSP means the National Shellfish Sanitation Program. The NSSP is a cooperative state, FDA, industry program for the sanitary control of shellfish that is adequate to ensure that the shellfish produced in accordance with these guidelines will be safe and sanitary.

Nursery Culture means the culturing and grow-out of hatcher seed.

Ocean quahog means that species of molluscan shellfish known as *Artica Islandica*.

OHV means Massachusetts Off Highway Vehicle Program.

Open Status means a growing area classified as Approved, Conditional Approved, Restricted or Conditionally Restricted that is not in a closed status and allows for the direct harvest of shellfish. Planting means any type of human induced or human assisted method of increasing or creating shellfish resources regardless of the purpose.

PCCS means the Provincetown Center for Coastal Studies.

Primary Buyer means any wholesale dealer authorized by the Division of Marine Fisheries to purchase shellfish directly from commercial shellfish fishermen.

PSP means Paralytic Shellfish Poisoning, also referred to as Red Tide.

Razon Clam means that species of molluscan shellfish known as *Ensis directus*.

Recreational Shellfish Fishermen means those individuals who harvest shellfish for personal, familial, or cultural use where the shellfish harvested are not for sale, barter, or exchange.

Relay means the transfer of any sized contaminated shellfish by a municipality from a growing area classified as Restricted, Conditionally Restricted, Conditionally Approved in the closed status to a growing area classified as Approved or Conditionally Approved for the purpose of purging contamination in such shellfish. Relay activity is regulated by DMF pursuant to 322 CMR 16.08. This includes Long Term and Short Term Transplants.

Research Project means any planting activity designed for hypothesis testing, experimentation, scientific research or education, and is permitted annually by DMF. These permits include a monitoring and reporting component.

Rule of Three means that in any data summary that is publicly disclosed SAFS data must be aggregated to include landings from at least three dealers, three harvesters, and three vessels to be considered non-confidential.

RWU means Roger Williams University.

SAP means DMF's Shellfish Advisory Panel.

SAFIS means the Standard Atlantic Fisheries Information System.

SC means the MSI's Scoping Committee.

Sea scallop means that species of molluscan shellfish known as *Placopecten magellanicus*.

Seed means shellstock that is less than the minimum sizes established by DMF in regulation at 322 CMR 6.00.

SEMAC Southeastern Massachusetts Aquaculture Center.

Shellfish means species of molluscan shellfish available within the waters under the jurisdiction of the Commonwealth. This includes oysters, soft shell clams, surf clams, bay quahogs, ocean quahogs, razor clams, bay scallops, sea scallops, blood arcs and mussels.

Shellfish Aquaculture means the planting and raising of shellfish at a specific privately licensed shellfish aquaculture grant or license site resulting in the commercial production of shellfish.

Shellfish Aquaculturist or Aquaculturists means any person permitted by DMF to plant and raise shellfish at an aquaculture grant site, which results in the commercial production of shellfish.

Shellfish Aquaculture Grant Site or Shellfish Aquaculture License Site means that specific portion of the waters under the jurisdiction of the Commonwealth granted by the municipality where a shellfish aquaculturist is licensed to culture shellfish in accordance with G.L. c. 130 §57.

Shellfish Fishery means the take and harvest of shellfish resources by recreational or commercial shellfish fishermen.

Shellfish Industry means broadly commercial shellfish fishermen, seafood dealers and other dependent shore-side businesses.

Shellfish Planting means any type of human induced or assisted method of increasing or creating shellfish resources regardless of the purpose.

Shellfish Planting Guidelines means that document produced by DMF that describes the allowable practices, statutory and regulatory authorities, and permit requirements governing the planting of shellfish in the waters under the jurisdiction of the Commonwealth.

Shellfish Propagation means any planting activity conducted by municipalities or the state to increase the supply of shellfish available to the public fisheries.

Shellfish Restoration means propagation to recreate or enhance a shellfish resource that is historically known to have occurred in a water body but no longer exists as a naturally sustaining population. This term generally includes any propagation effort done for ecosystem service benefits.

Shellfish Resources mean those shellfish as they exist in the waters or tidal flats.

Shellstock means any live shellfish in the shell.

Short Term Relay means the transfer of any sized shellfish by municipalities from growing areas classified as Restricted or Conditionally Restricted to growing areas classified as Approved or Conditionally Approved to reduce pathogens. Shellfish may be harvested after 90 days and usually one spawning season. Shellfish are typically relocated (relayed) in late spring and opened to harvest in the fall. Areas used as a source of shellfish for relays must have a current sanitary survey and shellfish must meet NSSP and DPH guidelines for suitability. Testing must demonstrate that the shellfish are free of shellfish diseases prior to relaying.

SMAST means the UMass Dartmouth School for Marine Science and Technology.

Softshell Clams means that species of molluscan shellfish known as *Mya arenaria*.

SPAT means the Wellfleet Shellfish Promotion and Tasting.

Spat means those shellfish resources in the larval life stage.

State Waters or Waters Under the Jurisdiction of the Commonwealth means those marine and intertidal waters for which the state has the authority to manage fisheries within, as set forth in the Magnuson-Stevens Fisheries Conservation and Management Act (16 U.S.C. §1856).

Status Change means a change from open status to closed status or closed status to open status of any growing area classified as Approved, Conditional Approved, Restricted or Conditionally Restricted.

Surf Clams means that species of molluscan shellfish known as *Spisula solidissima*.

TF means the MSI's Task Force.

Tidelands means those lands submerged by water at high tide.

TNC means The Nature Conservancy.

UMass means the University of Massachusetts

UNH means the University of New Hampshire

URI means the University of Rhode Island

USCG means the United States Coast Guard.

USDA means the United States Department of Agriculture.

Vp means *Vibrio parahaemolyticus*.

VTRs means vessel trip report.

Wild fishery means any shellfish fishery that occurs on a naturally occurring or restored shellfish resource that is not part of a shellfish aquaculture grant.

WHOI means the Woods Hole Oceanographic Institute.

WPA means the Massachusetts Wetlands Protection Act.

Executive Summary

The waters under the jurisdiction of the Commonwealth, where shellfish resources are harvested and grown, are some of the most heavily utilized and economically, ecologically, and culturally valuable shared spaces in the state. This results in complex, interactive, and competing views from myriad of stakeholders who share and interact over this common resource. Accordingly, it is the priority of state agencies and local resource managers, to engage in a management system that balances the interests of various user groups, promotes ecosystem and resource health, protects public health, and provides economic opportunities.

This is a complex and difficult challenge to meet. The challenge is also heightened by new and emerging issues, including ocean acidification, veterinary disease, naturally occurring human pathogens and harmful algal blooms, invasive predators, pollution and growing coastal populations, and climate change. Much of this transcends municipal and state boundaries and requires a coordinate response across a wide range of stakeholders.

The MSI was initiated to meet this challenge in a thorough, inclusive, and collaborative manner. The MSI is led by the TF which was organized to help inform future decision making associated with the management of shellfish in Massachusetts. To achieve this goal, the TF assembled the SC and AC. The SC was assigned to solicit and consolidate public feedback regarding issues of public concern pertinent to shellfish resources and shellfish fisheries in the Commonwealth. The AC was charged with assessing and describing how shellfish resources and shellfish fisheries are managed in Massachusetts, as well as what institutional infrastructure and capacities exist to support shellfish resources and shellfish fisheries.

The AC identified management objectives and support capacity for three primary categories related to shellfish resources and shellfish industries in Massachusetts. These categories are: (1) capacity to support shellfish related public health objectives; (2) capacity to support shellfish resources and shellfish fisheries protection objectives; and (3) capacity to support shellfish planting activities such as aquaculture and propagation. Data was then collected on each of these three categories through questionnaires of state agencies and non-governmental organizations and a survey of coastal municipalities, as well as an analysis of state laws and commercial fisherman landings data collected by DMF.

This information was synthesized into this AC Report. In summary, this report reviews the management of shellfish in Massachusetts as it pertains to shellfish resources, shellfish fisheries, shellfish aquaculture, public health, and shellfish planting and propagation; trends affecting shellfish resources, shellfish fisheries, shellfish aquaculture, and shellfish planting and propagation; and those non-governmental resources and capacities that exist for shellfish stakeholders. This document also includes three extensive appendices. Appendix A provides data from DMF regarding commercial shellfish fishery permitting and landings. Appendix B includes all questionnaire responses received by the AC from non-governmental organizations. Appendix C contains responses to the AC's municipal survey. It should be noted that this report

was intentionally limited to a review of the state's shellfish fisheries and related governmental and non-governmental capacities; it does not study or address other areas of the shellfish industry including the considerable shellfish processing, handling, and distribution industry in Massachusetts.

The charge of the MSI's TF to its AC, and the subsequent scope of this report, is ambitious. Much of the information and data in this report has not been previously published and certainly never before compiled and organized to provide a comprehensive and transparent overview of shellfish in Massachusetts. It is noteworthy that this report is primarily an assemblage of the information and data requested by the TF; further analysis is provided only when necessary to explain context. This document is not to be read as conclusive, but rather serves as a starting point for more in-depth, pointed, and informed public discussions.

Several areas of common concern came to light during the preparation of this report. This includes: (1) the potential impacts climate change and ocean acidification may have on shellfish resources and the shellfish industry; (2) changing and evolving shellfish management and public health regulatory landscapes; (3) the need for more active communication among and between shellfish stakeholders; (4) shellfish predation; (5) veterinary disease; and (6) balancing the interests of wild harvest fisheries, public access, and shellfish aquaculture. These issues fell outside of the scope of this report and were not explicitly addressed or analyzed. However, they are highlighted as such here because the TF may want to give them additional consideration when moving forward with the Strategic Plan.

Introduction

The waters under the jurisdiction of the Commonwealth are home to some of the most abundant and accessible near-shore shellfish resources in the country. This includes eastern oysters (*Crassostrea virginica*), northern quahogs (*Mercenaria mercenaria*), bay scallops (*Argopecten irradians*), softshell clams (*Mya arenaria*), surf clams (*Spisula solidissima*), blue mussels (*Mytilus edulis)*, as well as a number of other species. These species provide invaluable ecosystem services while supporting thousands of year-round commercial fishing industry jobs and countless recreational shellfish fishing opportunities in coastal communities.

In Massachusetts, there is a long history of protecting public access to shellfish resources (Colony Ordinances of 1640 – 1647), and the commercial and recreational harvest of wild and cultured shellfish for consumption is of great importance to the cultural identity and economic stability of many coastal communities in the state. The state's shellfish resources and shellfish fisheries remain important for these reasons today. In fact, Massachusetts ranked first in the nation in the value of shellfish landings in 2018 (NOAA, 2018). While this was primarily driven by offshore sea scallop fisheries occurring in federal waters, Massachusetts state-waters shellfish landings were valued at over $45M that year. This economic activity is driven, in part, by rapid growth in the shellfish aquaculture industry, which contributed over $28M to that overall value.

Shellfish are also critical to the health of the Commonwealth's nearshore waters. As filter feeders, shellfish can concentrate nutrients and particulates from the surrounding environment, helping to control primary productivity and enhance water quality. Oysters and mussels can form reefs that serve as natural storm protection and nursery habitat for fishes. Many shellfish species also serve as an important food resource for other marine and estuarine species. Due to the ability for shellfish to shape the surrounding environment and control key factors important to storm protection, water quality, and fisheries production, promoting healthy shellfish populations is instrumental to the health of Massachusetts coastal waters. Accordingly, interest in shellfish planting to maintain commercial and recreational fisheries, restore historic populations, mitigate for adversely impacted stocks, and for ecological services or coastal resiliency have also increased in recent years.

However, when shellfish are exposed to human-derived or naturally occurring pathogens, the same filter feeding behavior that can result in a benefit to water quality can also elevate the risk of human illness if consumed. Human illness due to the consumption of contaminated shellfish can have serious implications for consumer health and produce significant negative economic impacts to the shellfish industry. Given the size and importance of the shellfish fishing industry in Massachusetts, it is an economic necessity to make the protection of public health a priority and maintain the reputation of the Commonwealth's shellfish industry.

As shellfish are important to the function of coastal ecosystems and as a food product, shellfish management is complex. Working in partnership, state and local resource managers and public

health agencies invest significant resources to balance various and often competing stakeholder interests. This includes the need for healthy coastal ecosystems; ensuring commercial and recreational shellfish fishing opportunities; advancing shellfish aquaculture, propagation, and restoration activities; and protecting consumer health. In addition, a broad range of non-governmental organizations – from industry, non-profit, and academic sectors - provide financial and technical resources to support healthy shellfish resources and shellfish fisheries in the state.

Despite the existing capacities and support mechanisms in Massachusetts, the complexity of managing shellfish resources in Massachusetts has never been greater. In recent years, numerous factors have conspired to increase the existing management burden, including: growing demands for domestic food production; rapid industry growth (specifically in the aquaculture sector); evolving regulatory landscapes affecting shellfish management, the environment, and public health; and emerging climatic, environmental and veterinary health issues. In some cases, this has occurred without a commensurate increase in management capacity. This unbalance has the potential to erode the state's shellfish resources and shellfish fisheries in the future.

To help the TF investigate how to potentially evaluate and address these existing and emerging issues, the AC was charged with describing the capacity and status of state and local governmental programs, as well as existing non-governmental resources related to shellfish resources and shellfish fisheries. This included, but was not limited to, reviewing the statutory and regulatory landscape in the state; current staffing levels across all programs; the availability of hatcheries and laboratories; and presence of research, monitoring, technical assistance and outreach programs. Additionally, the AC analyzed fishery trends from landings data reported to DMF. Lastly, the AC appraised the strategic goals of each of these programs and where resources may be constraining the ability for the program to meet its strategic goals. These tasks were accomplished by direct interfacing with non-governmental organizations and state agencies (Appendix B), as well as a detailed survey of coastal municipalities (Appendix C).

This AC Report represents the synthesis of this broad sweeping situational analysis that assesses existing resources and provides a starting point for more informed discussion. In essence, it provides an overview of the state's shellfish management structure affecting both the resource and public health; status and trends for our inshore shellfish fisheries; and those governmental and non-governmental programs associated with shellfish fisheries and shellfish resources. While the scope of this report is ambitious, it is not comprehensive. It is noteworthy that this report does not address all areas of the shellfish industry, including those aspects related the shellfish processing, handling, and distribution. It also does not provide any in depth analysis of those shellfish resources and shellfish fisheries that occur primarily seaward of state-waters, such as sea scallops, surf clams, and ocean quahogs.

Materials and Methods

Assessment Committee Charge

The MSI's TF charged the AC with identifying the extent of the challenges related to managing, supporting, and expanding shellfish resources and shellfish fisheries in state-waters. To achieve this task, the AC surveyed coastal municipalities, state agencies, NGOs, fishermen and other user groups. Additionally, it reviewed the existing infrastructure available to shellfish resource and shellfish fishery management and analyzed shellfish fishery data to quantify its economic value to the Commonwealth.

Assessment Committee Composition

The AC was initially comprised of 19 members. Membership drew from a broad range of stakeholders, including state and local managers, commercial and recreational shellfish fishermen, academics and researchers, and representatives from other non-governmental associations (NGOs). This was done to represent the variety of shellfish related interests in the Commonwealth. It is noteworthy that representatives to the AC changed overtime due to a variety of personal and professional commitments. However, the AC endeavored to maintain its diverse and inclusive representation (Table 1).

Table 1. Assessment committee members list and affiliation

Name	Affiliation
Abbie Archer	Cape Cod Cooperative Extension & Woods Hole Sea Grant
Brent Valli	Wellfleet Aquaculturist
Chris Manulla	Wellfleet Shellfish Department (Deputy Constable)
Daniel Morton	Wellfleet Wild Harvester
Ed Anthes Washburn	New Bedford Port Authority
Ginny Parker	Wellfleet Shellfishermen's Association
Jeff Kennedy (Chair)	Massachusetts Division of Marine Fisheries
Lindsey Williams	MIT Sea Grant
Liz Lewis	Barnstable Natural Resources (Shellfish Propagation Specialist)
Mark Begley	Barnstable Shellfish Grower
Melissa Sanderson	Cape Cod Commercial Fishermen's Alliance
Michele Insley	Wellfleet SPAT
Nancy Civetta	Wellfleet Shellfish Department (Constable)
Nathan Davis	Wild Harvester, Town of Orleans Shellfish & Waterways Committee
Renee Gagne	Town of Chatham Shellfish Division (Constable)
Ron Bergstrom	Cape Cod Commission, Chatham Wild Harvester
Scott Soares	Massachusetts Aquaculture Association
Steve Kirk	The Nature Conservancy

Name	Affiliation
Suzanne (Phil) Phillips	**Town of Orleans Shellfish & Waterways Committee, Town of Chatham Shellfish Division (Deputy Constable), Harvester**
Todd Callaghan	**Massachusetts Office of Coastal Zone Management**

Municipal Survey

Massachusetts coastal municipalities jointly manage shellfish fisheries and shellfish resources with DMF. The AC developed an online municipal survey to provide coastal municipalities with the opportunity to describe the various shellfish related programs and plans that exist within their communities. Municipal officials - including shellfish constables, clerks, and natural resources officers - were contacted via e-mail on March 28 and March 29, 2019 via and were asked to participate the online survey.

The survey contained a total of 193 questions. Individual responses were collected and compiled within this report (Appendix C). The questions were related to recreational and commercial permitting statistics, landing trends, shellfish propagation and restoration programs, staffing and funding, external assistance, strategic goals, and emerging trends. The municipal survey questions focused on the most recent calendar year (2018), though ten-year retrospective assessment was also requested. Participation in the survey was entirely voluntary and communities were free to choose not to answer any specific questions.

The following 65 coastal municipalities were asked to complete the Municipal Survey: Aquinnah, Barnstable, Beverly, Boston, Bourne, Braintree, Brewster, Chatham, Chilmark, Cohasset, Danvers, Dartmouth, Dennis, Duxbury, Eastham, Edgartown, Essex, Fairhaven, Fall River, Falmouth, Gloucester, Gosnold, Harwich, Hingham, Hull, Ipswich, Kingston, Lynn, Manchester, Marblehead, Marion, Marshfield, Mashpee, Mattapoisett, Nahant, Nantucket, New Bedford, Newbury, Newburyport, Oak Bluffs, Orleans, Peabody, Plymouth, Provincetown, Quincy, Revere, Rockport, Rowley, Salem, Salisbury, Sandwich, Saugus, Scituate, Somerset, Swampscott, Swansea, Tisbury, Truro, Wareham, Wellfleet, West Tisbury, Westport, Weymouth, Winthrop, Yarmouth.

Of the 65 municipalities surveyed, only 54 have at least one shellfish management related program. The 11 municipalities that do not have a shellfish managed related program include: Beverly, Boston, Braintree, Danvers, Lynn, Manchester, Nahant, Peabody, Salem, Swampscott, Winthrop. Of the remaining 54 municipalities that do have at least one shellfish managed related program, 13 did not respond to the survey. These 13 municipalities include: Aquinnah, Brewster, Chilmark, Cohassett, Dartmouth, Gosnold, Mattapoisett, Plymouth, Quincy, Rowley, Scituate, Swansea, and Weymouth. In total, 41 coastal municipalities have at least one shellfish management related program and participated in this survey.

For the purposes of reporting and analyzing the survey, data from these 54 coastal communities with at least one shellfish management related program were aggregated into three geographic regions – Cape Cod and Islands, South Shore and South Coast, Boston Harbor and North Shore (Table 2). These geographic regions have similar shellfish resources, shellfish fisheries, coastal development and infrastructure, municipal governance, and historic shellfish resource usage.

- Boston Harbor and North Shore (BH/NS) communities share the predominant commercial shellfishery for softshell clams. Most of Boston Harbor communities have similar wastewater infrastructure being serviced by MWRA. North Shore communities have similar infrastructure age and associated challenges. Most communities in this region would be considered urban or suburban.

- Cape Cod, Martha's Vineyard and Nantucket (CC/I) share similar shellfisheries, extensive aquaculture and similar geology. Communities on Cape Cod and the Islands share similar seasonal industries, all organized as towns. Communities share similar infrastructure issues and have extensive county associations.

- The South Shore and South Coast consists of urban, suburban and rural communities. Aquaculture is common in this region and share similar wild fisheries. The regions shellfish area classifications distribution is similar coastwide.

Table 2. Regional breakdown of municipal particpants

Region	Number of Towns	Town(s)
Cape Cod & Islands	22	Aquinnah
		Barnstable
		Brewster
		Chatham
		Chilmark
		Dennis
		Eastham
		Edgartown
		Falmouth
		Gosnold
		Harwich
		Mashpee
		Nantucket
		Oak Bluffs
		Orleans
		Provincetown
		Sandwich
		Tisbury
		Truro
		Wellfleet
		West Tisbury
		Yarmouth

Region	Number of Towns	Town(s)
South Shore & South Coast	17	Bourne
		Cohasset
		Dartmouth
		Duxbury
		Fairhaven
		Fall River
		Kingston
		Marion
		Marshfield
		Mattapoisett
		New Bedford
		Plymouth
		Scituate
		Somerset
		Swansea
		Wareham
		Westport

Region	Number of Towns	Town(s)
Boston Harbor & North Shore	15	Essex
		Gloucester
		Hingham
		Hull
		Ipswich
		Marblehead
		Newbury
		Newburyport
		Quincy
		Revere
		Rockport
		Rowley
		Salisbury
		Saugus
		Weymouth

NGO and State Agencies Input

The AC also directly solicited information from the various state agencies and offices (Table 3). Most of these entities also have direct representation on the TF. Additionally, through the municipal survey, the AC was able to develop a list of 28 NGOs involved with shellfish resources and shellfish fisheries (Table 4). State agencies and NGOs were then asked to identify the

organizational mission, historic shellfish program activity, geographic range, current levels of staffing, and those emerging internal and external shellfish related trends affecting the organization. These responses are compiled in Appendix B.

Table 3. State Government Agencies and Offices Contacted

State Government Agency/Office	Role
Division of Marine Fisheries (DMF)	Permitting, Public Health, Resource Health, Technical Assistance, Management
Department of Public Health (DPH) Food Protection Program (FPP)	Permitting, Public Health
Massachusetts Environmental Police (MEP)	Enforcement
Office of Coastal Zone Management (CZM)	Resource Health
Department of Environmental Protection (DEP)	Resource Health, Navigation
Division of Fisheries and Wildlife (DFW) Natural Heritage and Endangered Species Program (Natural Heritage)	Protected Species
Department of Agricultural Resources (MDAR)	Technical Assistance
Massachusetts Environmental Policy Act Office (MEPA)	Resource Health, Public Trust

Table 4. NGO Organizations Contacted

Organization Name
Association to Preserve Cape Cod (APCC)
Barnstable Association for Recreational Shellfishing (BARS)
Barnstable Clean Water Coalition
Cape Cod Commercial Fisherman's Alliance (CCCFA)
Cape Cod Cooperative Extension
Coonamesset Farm Foundation
Eight Towns and the Great Marsh/Merrimack Valley Planning Commission
Gloucester Marine Genomics Institute (GMGI)
Martha's Vineyard Shellfish Group (MVSG)
Massachusetts Aquaculture Association (MAA)
Massachusetts Institute of Technology Sea Grant (MIT Sea Grant)
Massachusetts Maritime Academy (MMA)
Massachusetts Oyster Project (MOP)
Massachusetts Shellfish Officers Association (MSOA)
New England Aquarium (NEAQ) Anderson Cabot Center for Ocean Life
North and South Rivers Watershed Association (NSRWA)
Northeast Massachusetts Aquaculture Center (NEMAC)
Northeastern University – Nahant
Provincetown Center for Coastal Studies (PCCS)
Salem Sound Coastwatch

Organization Name
Shellfish Promotion and Tasting (SPAT)
Southeast Massachusetts Aquaculture Center (SEMAC)
The Nature Conservancy (TNC)
University of Massachusetts Amherst (UMASS Amherst)
University of Massachusetts Boston (UMASS Boston)
University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST)
Waquoit Bay National Estuarine Research Reserve
Wellfleet Shellfisherman's Association
Woods Hole Oceangraphic Instituition (WHOI)
Woods Hole Oceangraphic Institution Sea Grant (WHOI Sea Grant)

State Commercial Landings Data

Commercial shellfish landings data is collected via a "two-ticket system" whereby primary buyers report sales directly from commercial fishermen and commercial fishermen report harvest and sales. These data are uploaded into the SAFIS database – an Atlantic coastal commercial fisheries landings data portal. For commercial state-waters shellfish fisheries, these data are primarily collected by DMF through monthly trip level reports, pursuant to the agency's authority at G.L. c. 130 §21 and 322 CMR 7.01(7). However, some commercial fisherman with federal permits issued by the NOAA Fisheries report their harvest data via vessel trip reports (VTRs).

The SAFIS database is maintained by the ACCSP to produce dependable and timely marine fishery statistics for Atlantic coastal fisheries. The data are collected, processed, and disseminated pursuant to common standards agreed upon by all program partners. One of these standards is the so-called "rule of three".

The SAFIS landings data contained in this report have been aggregated for confidentiality purposes. This 'rule of three' is a confidential standard, it requires that for data to be made public that it is presented in aggregate and has been reported by at least three fishermen or dealers. If certain data is deemed to be confidential, it may be aggregated and presented at a higher level (e.g., from species specific data to unclassified shellfish data) in order to meet this confidentiality standard. This is done to prevent the identification of how much a certain individual may have harvested, landed and sold, while also preserving the ability to quantify and present commercial fisheries landings and values at local, regional, state and national levels. Landings and value data are subject to change due to additions and auditing. Confidentiality of an individual or corporation's data is protected by only displaying summarized values and quantities that could not be used to identify data attributed to a single permitted entity. Units for quantity are converted for reporting purposes using standardized conversion factors developed by the DMF's Statistics Program.

To standardize data collection a five-year study timeframe was used as the primary time-period for an analysis of commercial shellfish landings. However, mandatory dealer reporting to SAFIS began in 2006 and allows for the AC Report to lookback over a period of 14-years (2005-2019) for commercial shellfish landing trends, as reported through SAFIS dealer reports.

Overview of Shellfish Management Structure and Capacity

Shellfish Fisheries and Shellfish Resource Management Structure and Capacity

State law at G.L. c. 130, §§ 17A, 17B, 20, 20A, 52 – 77, 80-82, 92 and 98 establishes an extensive management system whereby shellfish resources; shellfish fisheries; shellfish planting aquaculture and propagation; and shellfish sanitation are managed jointly by the municipality and the state. This results in a complex shellfish resource and shellfish management structure.

At the state level, DMF is delegated a number of specific and general authorities. Principal among them is the sanitary assessment and classification the state's 1.7M acres of DSGAs for public health purposes. DMF also has certain shellfish resource and shellfish fishery management authorities. This includes the management of any shellfish resource or fishery that occurs in a DSGA classified as contaminated and unsuitable for harvest and direct human consumption; the exclusive authority to manage commercial surf clam and ocean quahog fisheries, as well as shellfish resources and fisheries that occur within state-waters seaward of a municipalities jurisdiction; and set minimum size standards for the harvest of shellfish species. DMF may also set baseline standards for the harvest and handling of shellfish by commercial shellfish fishermen and permit commercial shellfish fishing activities.

Municipalities are then provided the authority to manage shellfish resources and shellfish fisheries that occur in their waters and are classified by the state as open to direct harvest and consumption. This authority includes: commercial and recreational fisheries management and permitting; shellfish aquaculture licensing; shellfish propagation; and closure of harvest areas for the purpose of shellfish resource management. Municipal shellfish officers are also trained and authorized to enforce local and state shellfish laws and regulations. Accordingly, both state and local authorities may enforce the Commonwealth's laws and regulations pertaining to shellfish.

This joint management structure vests substantial authority at the municipal level and creates a home rule management system. This is critical for several reasons. First, home rule allows communities to manage their shellfish resources and fisheries in manner that best reflects the individual character of the community. Secondly, it fosters opportunities for municipalities to develop innovative management strategies that are best suited to their community and local trends in resource abundance and use. Lastly, it ensures the necessary public health and resource management objectives critical to ensuring a safe and sustainable supply of shellfish for consumption are met, and access to public shellfish resources and public tidelands are maintained.

There are a myriad of factors and considerations involved in managing the Commonwealth's shellfish resources; shellfish fisheries; and planting, propagation, aquaculture, and restoration activities. However, for the purposes of this report we have broken down the management objectives and support capacity into three primary categories: (1) capacity to support shellfish related public health protection objectives; (2) capacity to support shellfish resources and shellfish fisheries protection objectives; and (3) the capacity to support shellfish planting activities, such as aquaculture and propagation.

Within these categories there are state and local agencies and entities that are directly and indirectly responsible for management and oversight of the associated activities. There are also non-regulatory agencies and entities that provide support to resource and public health managers and the shellfish industry. This AC Report details this framework and highlights some of the resources identified by surveyed stakeholders as being important to meeting objectives related to shellfish resources and shellfish fisheries and the economic, ecological and cultural services they provide.

Public Health Management Structure and Capacity

As shellfish are filter feeders, contaminants may accumulate in shellfish, including at levels more than a hundred times higher than surrounding waters. Accordingly, it is necessary to safeguard public health and ensure that shellfish being sold into commerce are suitable for human consumption. This is done principally through the NSSP. By way of background, the NSSP is a program under the FDA that works cooperatively with coastal states, the ISSC, and the shellfish industry to safeguard public health in relation to the sanitary harvest, handling, transport, processing, and sale of shellfish. The NSSP's Model Ordinance – or MO - sets forth the regulatory framework necessary for shellfish to be harvested and sold into interstate commerce.

State compliance with the NSSP's MO in an iterative process. First, the MO is written and amended to address existing and emerging public health issues and changes in industry practice. Second, the FDA continually reviews state shellfish programs to ensure their effectiveness and compliance with the MO. If an element of the state's program is found to be deficient, FDA may place restrictions on the state (e.g., DSGA closures, shellfish recalls, and a total prohibition on the sale of shellfish into interstate commerce). States continually work to ensure their shellfish programs comply with the MO. This requires regular water quality testing, amendments to regulations and policies, staff and industry training, and upgrades to laboratories and equipment.

Because of the elevated risk of human illness associated with shellfish consumption, Massachusetts has established in statutory and regulatory measures to restrict the harvest of shellfish from DSGAs that are contaminated with human pathogens, and to ensure the proper handling and distribution of shellfish from harvest to consumption. The majority of shellfish related public health responsibilities in Massachusetts fall under the oversight of DMF, DPH and

MEP. These agencies also rely heavily on the support provided by municipal shellfish officers to meet shellfish sanitation mandates.

As stated above, DMF is provided the authority to conduct sanitary surveys and consequently classify DSGAs and control harvest within them as a result. DMF also has the authority to set regulations governing the harvest, handling, and transport of shellfish until its primary sale to a wholesale dealer. The MEP are responsible for conducting harvester inspections and enforcing DMF's laws and regulations. DPH manages the handling, sale, and processing of shellfish by seafood dealers and conducts inspections of these facilities to ensure compliance.

The backbone of shellfish sanitation management in Massachusetts is the DSGA sanitary survey and classification system. While many nearshore areas in Massachusetts have pristine water quality, and support the direct harvest of shellfish for consumption, others do not. According to the US Census Bureau, Massachusetts has the 5th highest population density among US states (US Census, 2010). This population density makes our near shore waters susceptible to degraded water quality. Of particular concern is contamination from sewer systems, combined sewer overflows, septic systems, and other sources of human pathogens. Accordingly, DMF's laws and regulations seek to limit shellfish fishing opportunities in shellfish growing areas with degraded water quality that may leave the shellfish in the area unfit for human consumption.

Shellfish related public health concerns are not limited to water quality issues. Some waters under the jurisdiction of the Commonwealth contain naturally occurring organisms that may accumulate in shellfish tissues and be harmful to human health. This includes certain phytoplankton that produce neurotoxins and species of the *Vibrio* bacterium. The improper handling, transport, and storage of shellfish, may also increase bacteria in shellfish to unsafe levels regardless of the water quality in the harvest area.

Shellfish Growing Area Classification

The NSSP's MO requires that states conduct routine and ad hoc monitoring of all DSGAs. This includes: testing for fecal coliform bacteria and other forms of contamination; intensive sanitary surveys of the harvest area to identify and evaluate all actual and potential pollution sources; a hydrographic and meteorological evaluation of the shellfish growing areas characteristics that may affect the distribution of pollutants and naturally occurring pathogens; and an assessment of the overlying water quality.

Pursuant to M.G.L. c. 130 §§74, 74A, 75 and 322 CMR 16.03, DMF conducts the state's sanitary surveys and DSGA classification. Based on the results of the sanitary survey, DMF assigns each DSGA one of the five NSSP classifications: Approved, Conditionally Approved, Restricted, Conditionally Restricted, and Prohibited (Figure 1). The assigned classification also stipulates what shellfish fishing activities may occur in the shellfish growing area.

- Approved: Area meets sanitary conditions to allow for shellfish harvest for direct human consumption. Shellfish harvest is allowed notwithstanding municipal regulations and emergency designations of contamination.

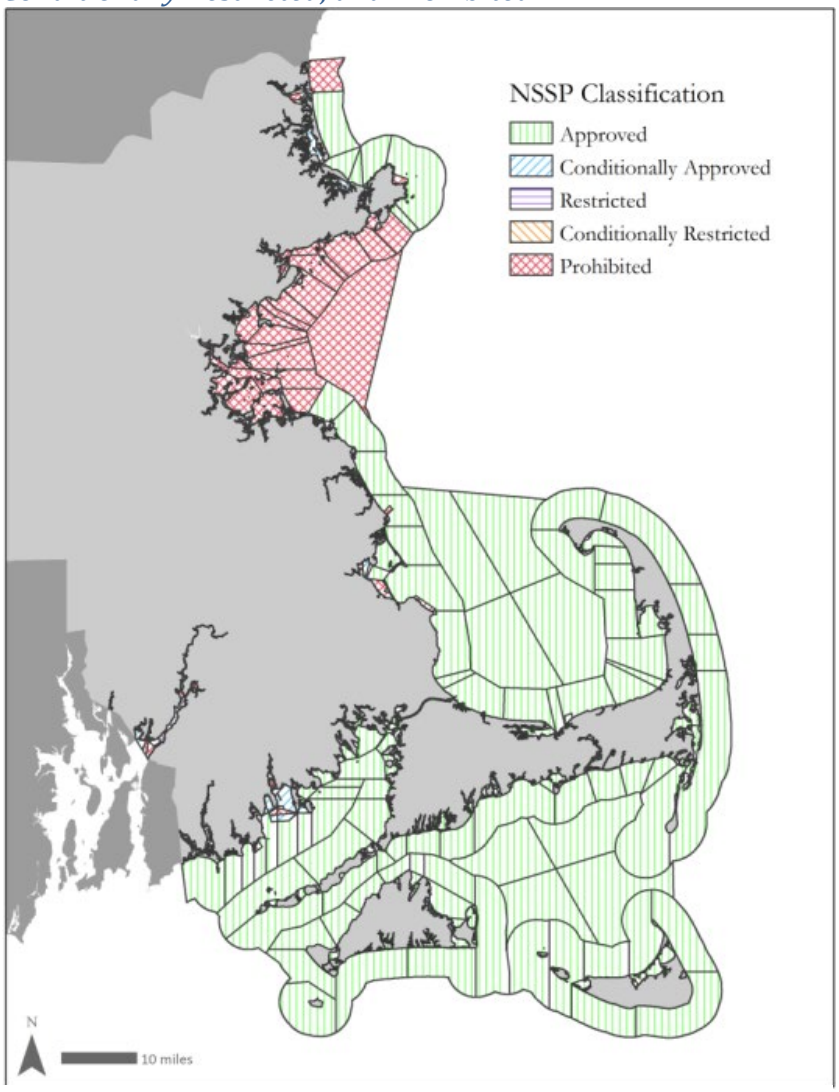
- Conditionally Approved: Area meets sanitary conditions to allow for shellfish harvest under certain conditions set forth in a Conditional Area Management Plan. Status of area may change from "Open" to "Closed" in response to environmental conditions. Under an Open status, shellfish harvest is allowed notwithstanding municipal regulations. Under Closed status shellfish harvest is prohibited.

- Restricted: Area does not meet sanitary conditions to allow for shellfish harvest for direct human consumption, as area is subject to a limited degree of contamination at all times. Shellfish fishing activity is limited to permitted contaminated relay, depuration fishery and nursery culture.

- Conditionally Restricted: Area predictably meets Restricted area criteria under known conditions and may be subject to intermittent pollution that predictably exceeds Restricted area criteria. The Status of the area may change from "Open" to "Closed" in response to degraded water quality. Shellfish fishing activity is limited to permitted contaminated relay, depuration fishery, and nursery culture.

- Prohibited: Area is subject to pollution and contamination at all times that pose a public health risk. Shellfish fishing activity is limited to permitted contaminated bait fisheries, contaminated relay, and nursery culture.

Figure 1. NSSP's five Classifications: Approved, Conditionally Approved, Restricted, Conditionally Restricted, and Prohibited



Map of DSGAs current as of June 2020. DSGA classifications subject to change over time.

The status of a DSGA (Open/Closed) is separate and distinct from its classification. DSGAs where direct harvest may be allowed (Approved, Conditionally Approved, Restricted) may be placed in the "Closed Status" for several reasons. This may be because of predictable changes in water quality (e.g., seasonal closure or after rainfall thresholds are exceeded) or in response to the sudden degradation of water quality due to emergency or unexpected circumstances (e.g., sewage discharge, petrochemical or hazardous material spillage, or coastal flooding). This allows for DSGAs to be temporarily closed until water quality improves and the source of contamination no longer exists. In such events, DMF is required to assess impacts on water quality and to determine the need for public health closures. Less frequent events, although their occurrence has increased in recent years, include shellfish related outbreaks associated with pathogens such as norovirus or *Vibrio* species. In the case of pollution-derived pathogen

outbreaks, under NSSP criteria, DMF is required to conduct a complete sanitary resurvey of the area prior to reopening. It should be noted that changes in DSGA status are separate and distinct from local management actions to open and close shellfish beds under municipal authority.

While DMF is primarily responsible for the management of shellfish resources in DSGA's closed to harvest, state law allows municipalities to enter into contaminated area management plans with DMF to assist with shellfish sanitation responsibilities in these areas. These state and local partnerships allow the Commonwealth to maintain harvest opportunities that would not be achievable with only those resources at the state level. For example, in Conditionally Approved DSGAs that are subject to rainfall closures, the NSSP requires the onsite monitoring of rainfall levels and the immediate notification and posting of closure signs when rainfall exceeds established thresholds. If local resources to monitor rainfall levels and notify harvesters of closures were not available, many of the state's conditionally approved waters would likely be placed in a permanently closed or seasonally closed status.

As the state and coastal communities are constantly working to improve storm and wastewater infrastructure in the Commonwealth, DMF is frequently asked to reassess the classification of shellfish growing areas to provide increased shellfish fishing and aquaculture opportunities. Under NSSP criteria, upgrading the classification of an area can require over three years of water quality data, including sampling immediately following routine and extreme rainfall events and the collection of detailed information on real and potential pollution sources.

In recent years, DMF has been limited in its ability to examine areas identified as having the potential for upward reclassification. This has been in part driven by staffing issues. DMF's Shellfish Program does not have sufficient sanitary survey personnel and resources to dedicate to such activities while conducting the routine work necessary to maintain the existing classifications of DSGAs open for the direct harvest of shellfish. Moreover, staff have been needed to address emerging pathogenic challenges (e.g., biotoxins, *Vp*) and other FDA mandates.

It is noteworthy that FDA recently enhanced the sanitary survey requirements necessary to maintain the existing DSGA classifications. These expanded requirements increased water quality monitoring following rainfall closures and within certain risk-prone areas (e.g., mooring fields). Additionally, in 2017, the FDA changed its longstanding interpretation of NSSP classification criteria resulting in the identification of a number of deficiencies in the state' classification program. This has required some shellfish growing areas or portions thereof to be downgraded or closed entirely to harvest (Table 5)[1].

[1] Though DSGA acreage changes are relatively small when viewed state-wide, the changes in productive near-shore acreage can be significant. Near-shore areas are - by nature - most at-risk for pollution and this can impact access the highly valuable shellfish resources in these areas.

Moreover, while Massachusetts' waters have been designated a No Discharge Zone, FDA recently cited Massachusetts for not closing shellfish growing areas around mooring fields due to the potential for overboard discharge. Given the vast number of small mooring fields across the state, this may impact DSGA classifications state-wide. In response, DMF (and a number of similarly affected northeast states) have submitted proposals (Proposal #17-100) to the ISSC to clarify NSSP requirements related to the sanitary classification of mooring fields.

Table 5. Changes in approved and cond. approved acreage in Massachusetts shellfish growing area classification, 2017 to 2018.

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

Additional Support for Shellfish Growing Area Classification

Under NSSP mandates, DMF staff must be present during the collection of water quality samples used to classify DSGAs. However, a number of state and local agencies/entities, academic institutions, and NGO groups help DMF achieve water quality monitoring and classification objectives. Local shellfish departments often provide critical support to DMF by providing staff and boats for water quality monitoring in coastal waters. NGOs (e.g., the Buzzards Bay Coalition and the North and South River Watershed Association) provide indirect support for classification objectives by identifying and reporting problem areas and pollution sources. These contributions allow DMF to target areas for routine water quality sampling, and for DEP to identify illegal sewer connections and other unpermitted discharges that can degrade water quality, impact public health, and limit opportunities for shellfish fishing. A number of other municipal agencies and NGOs (e.g., local Boards of Heath, WHOI Sea Grant, Barnstable Clean Water Coalition) provide materials and guidance for homeowners and communities on ways to limit residential non-point sources of pollution that can impact the suitability of areas for shellfish fishing.

CZM provides support for water quality improvement via the administration of the CPR grant program. This program provides municipalities with funding to assess and treat storm water pollution from paved surfaces and to design and construct commercial boat waste pump out facilities. One major goal of the program is to improve coastal water quality to allow for increased access for shellfish fishing opportunities. Since 1996, more than $11 million in CPR grants have been awarded. CZM is also oversees the proper disposal of boat sewage and No Discharge Zone management. These initiatives are designed to decrease bacteriological contamination along coastal beaches and shellfish beds. Local harbormasters also participate by monitoring overnight boat moorings and anchorages to ensure the proper disposal of vessel waste.

DEP is the principal state authority in addressing point source pollution that may impact shellfish resources and shellfish fishing. This is done through their state implementation of the federal CWA and the issuance of NPDES. DEP – in cooperation with CZM, DMF and other state and federal agencies – work to ensure that bacterial limits in NPDES permits meet the state's shellfish standards, where appropriate. These agencies work together to confirm that new or modified discharges do not adversely affect shellfish resources or shellfish fishing. Despite these efforts to limit point source pollution, many communities still rely on antiquated waste-water treatment systems that can experience disruptions in treatment capacity resulting in the discharge of raw or partially treated sewage. DMF implements substantial shellfish closures around sewage outfalls and works with sewage plant operators to guarantee that the agency is notified when plants malfunction so that affected areas are closed to shellfish harvesting.

Shellfish Related Naturally Occurring Pathogens

Another major shellfish related public health responsibility is the monitoring for naturally occurring marine pathogens that can concentrate in shellfish and cause human illness.

Biotoxin Monitoring

There are several phytoplankton species with the ability to naturally form toxins in response to environmental stimuli. When shellfish with concentrated levels of certain biotoxins are consumed, it can cause serious health implications and even death. The major biotoxin of concern in Massachusetts are the neurotoxins found in red algae blooms that cause PSP (red tide).

Under NSSP guidelines, DMF has established a PSP biotoxin monitoring plan. This monitoring plan requires the agency collect plankton samples year-round to monitor for blooms of toxin-forming phytoplankton species. This includes the weekly collection of shellfish samples from 13 primary stations during the period of March through October. Samples are analyzed at the DMF Gloucester lab, where bioassays are conducted to determine the levels of PSP toxin in shellfish. If toxin is found, both the frequency of sampling and the number of sample sites are increased. DSGAs must be closed if toxin levels exceed safe limits and extensive sampling is required before DSGAs may be reopened. As individual shellfish species can accumulate biotoxins at different rates, biotoxin closures and reopening's are conducted on a per species basis. DMF maintains a species-specific maps and data related to biotoxin sampling and closures on its website.

While PSP is the primary biotoxin of concern in the region, Massachusetts experienced its first-ever ASP closure in 2016. This resulted in the closure of all DSGAs south of Cape Cod for over six weeks. As a result, since 2016, DMF has been required to dedicate significant funding, staffing and resources to monitor this emerging public health concern. DMF currently lacks the equipment to conduct in-house ASP toxin testing and must rely on out-of-state private laboratories. This reliance on outside resources can result in delays from days to more than a week to re-open harvest areas.

In addition to monitoring for biotoxins in state waters, DMF also supports biotoxin sampling efforts in adjacent federal waters off the north shore. These sampling efforts provide Massachusetts-based fishermen with access to wild shellfish resources that would otherwise be closed for harvest due to lack of federally supported biotoxin monitoring consistent with NSSP biotoxin requirements. This has also allowed for the harvest of cultured mussels from the first-ever aquaculture site located in federal waters on the east coast of the US. The pilot scale mussel farm, located approximately 7 miles off the coast of Rockport, is operated by Salem State University in partnership with local fishermen.

DPH also provides support for biotoxin monitoring in federal waters. DPH partners with members of the ocean quahog and surf clam industry to implement the Massachusetts Program for Onboard Screening and Dockside Testing for PSP Toxins in Molluscan Shellfish in federally closed waters. DPH coordinates this program for industry-supported biotoxin monitoring of shellfish harvested from the waters of Georges Bank. In the absence of this program, Georges Bank is closed to the direct harvest of molluscan shellfish due to a lack of federally supported sampling. This first of its kind federally recognized state-industry partnership has allowed for the harvest of ocean quahogs and surf clams from federal waters since 2011 and has produced new shellfish industry jobs in Massachusetts through providing new offshore shellfish fishing opportunities, as well as resulting investments in shore-side shellfish processing infrastructure.

Massachusetts Vibrio Management

Vibrio are naturally occurring species of bacteria. Certain species found in shellfish may be pathogenic and cause illnesses in humans. In Massachusetts, the species of particular concern is *Vibrio parahaemolyticus* (*Vp*). *Vp* infections in Massachusetts have been exclusively associated with the consumption of raw oysters. Around 2012, reported infections in Massachusetts began to increase. This resulted in the development of a *Vp* Control Plan for the state, which has produced DSGA closures, shellfish recalls, and the implementation of costly control measures intended to limit the human health risks associated with the exposure to *Vp* from the consumption of raw oysters. Annual *Vp* infections have decrease since the implementation of this *Vp* Control Plan.

The NSSP requires the state to provide harvester education related to *Vp*, monitor conditions in oyster harvest areas, implement *Vp* control measures at point of harvest and in commerce, and respond in the event of a *Vp* illness outbreak. *Vp* controls are focused on minimizing the potential for time-to-temperature abuse, the rapid post-harvest cooling of shellfish, and extended re-submergence periods following common culture activities. These controls have placed a regulatory burden and additional operating costs on the state's oyster industry.

Vp controls have also required DMF, DPH, MEP and local shellfish constables to dedicate significant resources toward enforcement and monitoring. DMF, with support from academic and industry partners, the ISSC, NOAA Fisheries, and the legislature, has conducted research on *Vp*. In recent years, this research has reduced the regulatory burdens associated with *Vp*

controls and enabled the refinement of *Vp* controls to improve efficacy. While the number of *Vp* illnesses associated with Massachusetts harvested oysters has decreased in recent years, climate-associated warming trends and FDA efforts to lower NSSP recall and closure thresholds are likely to increase the industry and management burden associated with *Vp*.

Non-Regulatory Support for the Management of Naturally Occurring Pathogens

In addition to regulatory oversight of public health risks associated with naturally occurring pathogens, a number of NGO and academic institutions provide support for the management of naturally occurring pathogens that can impact the shellfish industry and consumer health. The state's two Sea Grant programs - at MIT and WHOI - offer technical assistance, outreach, and funding for applied research related to biotoxins, vibrio, and other shellfish related human health considerations. A number of in-state and regional academic institutions have also partnered with the shellfish industry and shellfish managers to conduct applied research directed at reducing public health risks associated with naturally occurring pathogens. WHOI and SMAST, with funding from NOAA Fisheries, have led major efforts related to the monitoring of toxin-forming phytoplankton species in Massachusetts shellfish harvest areas. In addition to WHOI and SMAST, other academic institutions, local constables, the MWRA and citizens often provide information on plankton blooms that can help the state target regulatory sampling for biotoxins. UMass Boston, UNH, Barnstable County Cooperative Extension Service, RWU, and others have worked in cooperation with DMF to collect data on background *Vp* abundance in harvest areas and evaluate the effects of harvest and handling practices on *Vp* abundance in oysters. Barnstable County Cooperative Extension Service's Marine Program deploys sensors to measures environmental conditions in a number of major harvest areas in the state. This data, in combination with DMF's *Vp* sampling, have been instrumental in the effort to identify how environmental conditions impact the risk of *Vp* related illness.

Shellfish Harvest & Handling

DMF is responsible for establishing harvest and handling regulations to ensure the sanitary harvest and transport of shellfish by commercial shellfish fishermen. In Massachusetts, commercial shellfish fishermen must obtain a commercial permit and shellfish transaction card from DMF for the commercial harvest and sale of shellfish. DMF has established regulations (322 CMR 16.00) pertaining to the harvest and handling of shellfish. These regulations include requirements for the tagging, record keeping, and the sanitary handling of shellfish from the harvest area until receipt by a permitted wholesale dealer. Due to the iterative nature of the NSSP, the MO is subject to change, which may require DMF to periodically amend its regulations, policies, or protocols.

Non-Regulatory Support for Shellfish Harvest and Handling

A number of state agencies and NGO groups provide support to industry and managers related to harvest and handling requirements. MDAR has offered support to the aquaculture industry

through their food safety improvement grant program. This program provided funding for oyster growers to purchase equipment (e.g., ice machines and coolers) needed to meet the regulatory mandates set forth in the state's *Vp* time-to-temperature controls. Unfortunately, since 2017, aquaculturists have not been eligible for funding under this program.

The ECSGA, SPAT, RWU, WHOI Sea Grant, and Barnstable County Cooperative Extension have provided educational materials and training courses on harvest and handling requirements for commercial shellfish fishermen. These materials frequently respond to questions from harvesters and the general public on shellfish sanitation.

Patrol to Prevent Illegal Harvest

MEP and local shellfish constables are responsible for patrolling the state's 1.7 million acres of DSGAs. The patrols are conducted to prevent illegal harvest and evaluate harvester compliance with DMF's public health and shellfish resource conservation-based regulations.

The NSSP establishes minimum patrol frequency criteria based on the potential public health risk of the area. MEP, DMF, and local shellfish constables work together to develop risk management plans for the state's DSGAs. Each DSGA is assigned a risk category based on the level of contamination, shellfish productivity, ease of harvest, and ease of patrol. The risk category assignment then dictates the level of patrol required.

MEP actively patrol and enforce DMF regulations over the entire Massachusetts coastline, but are specifically responsible for shellfish patrol in DSGAs classified as restricted, conditionally restricted, or prohibited, as well as conditionally approved and approved when in the closed status. Local shellfish constables are primarily responsible for patrol in harvest areas in the approved classification, and areas under a municipal contaminated area management. Local shellfish constables can enforce both state and local rules within their municipality, MEP can only enforce state rules.

Beyond patrolling for illegal harvest activities, MEP and local constables also audit harvester compliance with other shellfish regulations. Combined, these activities require significant resources at the state and local level. This is particularly true during the summer months when shellfish fishing activity increases, and managers and enforcement officers are also dealing with other fisheries oversight responsibilities. In instances where non-compliance with critical public health regulations are observed by MEP or local constables, DMF is authorized to immediately sanction a state-issued commercial fisherman permit to prevent adulterated shellfish from entering the market.

MEP reported a 50% decrease in staffing between 1998 and 2018. In 1998 there were approximately 140 MEP officers throughout the state, not including command staff. As of June 30, 2020, there were only 82 MEP officers (including recruits) and 9 MEP command staff personnel, with just 36 officers assigned to the coastal bureau. In addition to shellfish rules,

MEP coastal bureau officers are currently tasked with working as enforcement agents for DMF, DFG, DEP, DCR, USCG, NOAA Fisheries, and the OHV Advisory Board. Additionally, they have to address calls from the public related to environmental issues.

The FDA audits the state's patrol frequency through its annual Control of Harvest element of the Massachusetts State Shellfish Program. While Massachusetts' program has historically been in compliance with NSSP patrol criteria, in 2017 FDA cited Massachusetts for deficiencies related to inadequate record keeping of patrol activities and a lack of formal Memorandum of Understanding between MEP and local constables. To address FDA concerns, DMF, MEP, and local constables have cooperated to develop formal MOUs between individual towns and the two agencies. However, continued staff shortages at MEP and at the local level limit opportunities for the expansion of shellfish fishing opportunities in the Commonwealth due to an inability for these entities to meet the associated increased patrol responsibilities. This also highlights the importance of increasing patrol capacity as the shellfish industry grows.

Seafood Dealer Certification and Permitting

All commercial shellfish fishermen must sell their shellfish to a permitted wholesale seafood dealer that is authorized as a primary buyer of shellfish. While DMF is responsible for issuing wholesale seafood dealer permits and primary buyer authorizations, DPH is responsible for administering the dealer elements of the NSSP. This includes dealer certification and inspections and reviewing dealer HACCP plans that include provisions for the post-harvest transport, storage and processing of shellfish by wholesale seafood dealers in the state.

To be permitted as a primary buyer of shellfish in Massachusetts, the wholesale dealer must have a physical facility with cold storage and a vehicle with refrigeration capacity for transport of shellfish. Wholesale shellfish dealers must also meet requirements related to reporting, record keeping and training. DPH is required to conduct twice annual inspections for approved interstate shippers of shellfish, and once annual inspections for in-state shellfish dealers.

DPH inspectors are also responsible for conducting audits of manufactured food facilities, elements of the retail food program, and conducting time-sensitive and detailed food borne illness tracebacks related to shellfish or other seafood borne infections at the wholesale level and assist local boards of health with tracebacks at the retail level. The increase in staff time dedicated to shellfish related *Vp* illness follow-up, decreasing federal contracts that have historically provided funds to support inspector positions, and new NSSP and federal mandates requiring additional staff training and inspections, has been identified by DPH as an increasing strain on agency capacity.

Shellfish Resource Management Structure and Capacity Overview

The sustainable management of the Commonwealth's natural shellfish resources, aquaculture industry, and commercial and recreational shellfish fisheries are of great importance to the economic and environmental health of the state.

In 2018, SAFIS dealer records indicate Massachusetts seafood dealers payed $45M in ex-vessel value for cultured and wild shellfish harvested from the waters under the jurisdiction of the Commonwealth. Indirectly, these dockside revenues are estimated to result in a two-to-four fold economic multiplier associated with the resulting wholesale and retail activity, jobs related to processing of shellfish, the manufacture of shellfish related gear, and other economic activity associated with commercial harvest of shellfish[2]. An increasing volume, and now a majority of this value, is attributed to shellfish aquaculture activity; in 2019 aquaculture reared oysters had the third highest ex-vessel value for all seafood species landed in Massachusetts (behind only sea scallops and lobster).

Although the economic value has not been measured, coastal municipalities also issue thousands of recreational permits annually. These permits produce direct revenues that support local shellfisheries management. They also indirectly result in economic activity associated with the purchase of gear and equipment by recreational harvesters.

While shellfish fishing is often discussed in the context of the state's robust commercial and recreational fisheries, shellfish also provide critical ecosystem services necessary to the health of our coastal waters and future of shellfish fisheries. Shellfish can concentrate nutrients and particulates from the surrounding waters, helping to control primary productivity and enhance water quality. Oysters and mussels also naturally form reefs, which serve as natural storm and wetlands protection, and provide important nursery habitat for many marine and estuarine species. As a result of the ability for shellfish to shape the surrounding environment and control key factors important to storm protection, water quality and fisheries production, land containing shellfish is protected under the WPA. A number of federal, state and local programs, as well as NGO support is directed at protecting, restoring, and enhancing shellfish productivity in Massachusetts coastal waters.

Managing shellfish resources to support healthy coastal ecosystems and provide opportunities for commercial and recreational shellfish fishing are not mutually exclusive ventures. The Commonwealth has established a management framework – both in statute and regulation – that attempts to balance the ecological and economic services provided by shellfish so that they may continue to serve these vital functions into the future.

Management Overview

State law at G.L. c. 130, establishes a joint state-and-local management system for shellfish fisheries and shellfish resources within the Commonwealth. DMF is provided primary management authority over the commercial surf clam and ocean quahogs in all state waters. DMF also has primary management authority over shellfisheries in contaminated areas, certain

[2] Barnes, Nora, Kevin Augusto, Glenn Holmes. 2015. Massachusetts Shellfish Aquaculture Economic Impact Study. Prepared for Cape Cod Cooperative Extension,Woods Hole Sea Grant, SouthEastern Massachusetts Aquaculture Center. https://www.capecodextension.org/wp-content/uploads/2015/04/MA-Aquaculture-Economic-Impact-fStudy-2015.pdf

commercial activity in areas outside of municipal boundaries but within the jurisdiction of the Commonwealth, and jurisdiction over fisheries management in the federal waters of Nantucket Sound. Municipalities have primary authority over the management of shellfisheries in DSGAs classified as Approved and Conditionally Approved by DMF, and other areas under an approved contaminated area management plan.

Shellfisheries under Direct State Management

While municipalities are the primary managers of shellfish in waters not deemed contaminated, DMF has authority to institute shellfish related conservation restrictions state-wide. Based on this authority, DMF has established regulations related to size limits, trip limits, and seasons that apply to individual shellfish species in all waters of the Commonwealth (Table 6).

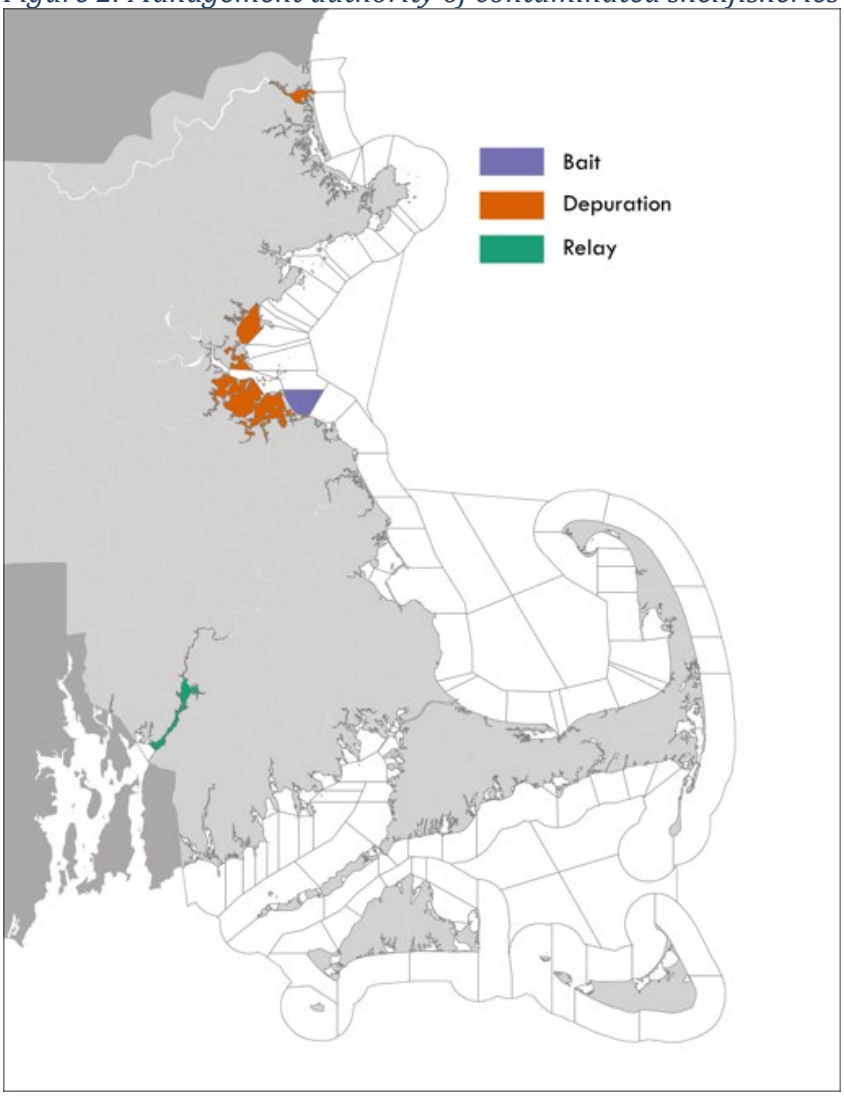
Table 6. Wild-harvest statewide restrictions by species

Species	Season	Trip Limit	Minimum Size
Bay scallop	Oct 01 – Mar 30	10 Bushels/day including Annual shells	Well-defined growth line
Surf clam	--	200 bu/day or 400 bu/hr	5" (wild) 1.5" (aquaculture reared)
Oyster	--	--	3" (wild), 2.5" (aquaculture reared)
Softshell clam	--	--	2"
Sea scallop	--	200 meat lbs or 2,000 lbs shell-on	3.5" height
Northern Quahog	--	40 Bushels/Day	1" thickness (wild) 7/8" thickness (aquaculture reared and must be distributed out-of-state after primary sale to MA Wholesale Dealer)
Ocean Quahog	--	832 bushels/Day/ equivalent to 26 cages	

Contaminated Shellfisheries Management

DMF has direct management authority over the Commonwealth's contaminated shellfisheries. These fisheries occur in DSGAs classified as Restricted or Conditionally Restricted, and include depuration, relay, and bait fisheries (Figure 2).

Figure 2. Management authority of contaminated shellfisheries



Contaminated Bait Fisheries

DMF issues permits authorizing a small-contaminated surf clam dredge-boat bait fishery off Nantasket Beach in Hull. Surf clams are harvested for bait purposes only and sold to a wholesale bait dealer. As a safeguard to protect public health, commercial fishermen participating in the contaminated bait fishery are restricted from participating in the wild harvest fishery for human consumption.

Depuration

The commercial harvest of mildly contaminated soft-shell clams from Conditionally Restricted DSGAs in Boston Harbor, the Pines River in Revere and Saugus, and the Merrimack River in Newbury, Newburyport and Salisbury is made possible through depuration at the DMF Shellfish Purification Plant in Newburyport.

During the depuration process, clams are held in tanks at the DMF facility and clean seawater is pumped from a saltwater aquifer into the tanks where the clams are allowed to pump and flush any potential pathogens, making them safe for consumption. Upon completion, shellfish are tested for bacteria to ensure they are below approved market standards and returned to the harvesters or their Massachusetts' wholesale dealer paying a depuration fee. The Boston Harbor depuration fisheries once accounted for over 30% of the state's soft-shell clam landings, whereas today it accounts for less than 2%. DMF has identified Hematopoietic Neoplasia - a disease that impacts a number of commercially important shellfish species in the US – as a major factor for the decline in the productivity of Boston Harbor's softshell clam fishery.

Contaminated Relays

DMF also permits municipalities to relay mildly contaminated shellfish to Approved and Conditionally Approved waters to support recreational and commercial shellfish fishing activities. All activities are conducted under strict NSSP guidelines and are heavily supervised by state and local enforcement authorities. DMF enacts closures of planted areas to ensure the shellfish are not harvested prior to being allowed to naturally purify. In addition, DMF requires relayed shellfish remain in planted areas through at least one spawning season to serve as local brood stock. Following bacterial testing on each lot, closed areas are opened for recreational and/or commercial harvest. Quahogs are the most frequently transplanted species followed by oysters. Prior to transplant operations, disease monitoring is conducted on shellfish collected from donor sites to prevent spread of shellfish disease.

Surf Clam and Ocean Quahog Fisheries

DMF has explicit management authority over the commercial surf clam and ocean quahog fisheries in all waters under the jurisdiction of the Commonwealth. Massachusetts' commercial surf clam and ocean quahog fisheries occur primarily in Cape Cod Bay, but also in the waters to the east and south of Cape Cod and along the South Coast. The commercial fishery is conducted principally by hydraulic and mechanical dredge gear. The use of hydraulic dredge gear is authorized by a limited entry regulated fishery permit endorsement for surf clam/ocean quahog dredge. However, there are also landings attributable to commercial hand harvest and dive fisheries, authorized by DMF's open entry shellfish permit.

DMF issues its limited entry surf clam/ocean quahog dredge permit endorsement to 38 entities. This endorsement allows the permit holder to fish for surf clams and ocean quahogs with this mechanized gear onboard the named vessel in DSGAs classified as Approved and open to direct harvest. In addition to this, DMF has established spatial and temporal closures affecting this gear. These closures are designed to protect certain critical habitat (e.g., eel grass beds) and mitigate user group conflicts (e.g., gear conflicts with fixed gear fisheries). This fishery is also subject to gear size restrictions, trip limits, and minimum size limits to manage the utilization of the resource.

In recent years, certain coastal municipalities have moved to regulate this gear under the authority of the state's WPA. The WPA provides the municipality with the ability to permit and regulate dredging activity. Historically, this authority has been reserved for that dredging activity associated with coastal development and navigational projects. The expanded use of this regulatory authority to regulate fishing gear has raised jurisdiction issues, principally between DEP, DMF and local conservation commissions. There is interest in resolving these jurisdictional issues to create a regulatory framework that will allow historic commercial shellfish fisheries opportunities to continue into the future.

Shellfisheries Under Direct Municipal Management

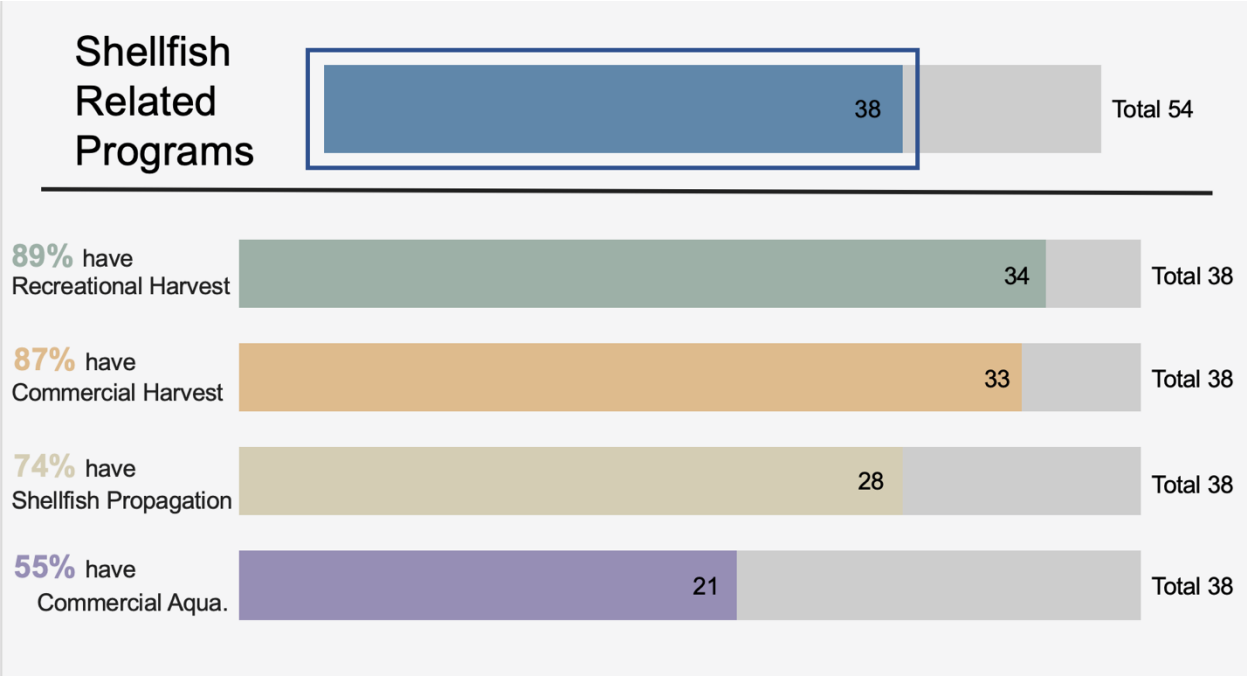
In areas under municipal management, Boards of Selectmen or City Council have the authority to control, regulate or prohibit the taking of shellfish for recreational and commercial harvest, to issue permits and establish permit fees, and make any regulations in regard to the times, places, methods, purposes, uses, sizes, quantities and any other particulars of shellfish harvest in the community. Municipal management may not be contrary to any existing DMF regulations.

In addition, municipalities – through their Boards of Selectmen and City Councils - have the authority to plant and propagate shellfish for fisheries enhancement, to enact temporary closures of harvest areas for resource management, and to issue private shellfish aquaculture licenses for the purposes of the commercial production of shellfish in the waters and flats within their jurisdiction.

Of the 54 coastal communities in Massachusetts with at least one shellfish management related program (Table 2), 38 participated in the MSI municipal survey and provided information on shellfish related programming in their community. Of the 38 communities that participated in the survey all of them contain 'Conditionally Approved' or 'Approved' DSGAs and exercise their management authority over shellfish resources in those waters.

The scale and type of shellfish related programs provided in individual communities vary but include recreational and commercial shellfish fishing, and shellfish planting activities such as municipal propagation, and commercial shellfish aquaculture (Figure 3).

Figure 3. Shellfish related programs as it relates to the AC municipal survey participants



Recreational Harvest

In Massachusetts, municipalities issue thousands of recreational shellfish fishing permits annually. Recreational permits authorize the non-commercial harvest of species like oysters, quahogs, mussels, softshell clams, as well as other species such as surf clams and bay scallops. The harvest of these species may be subject to certain catch restrictions (e.g. daily limits, seasons, days of harvest) imposed by the community, as well as the state-wide conservation measures established by DMF (e.g., minimum size). Recreational permit fees vary by category (e.g. family, individual, senior, etc.) and residency.

These permits provide valuable revenues to support local shellfish programming and authorize residents and non-residents to explore the flats and coastal waters of the Commonwealth and experience shellfish fishing first-hand. For some individuals, families and tribal members in Massachusetts, recreational shellfish harvest opportunities serve a more vital function and are viewed as a critical source of high-quality nutritious food they rely on as a supplemental and traditional source of protein.
The Commonwealth views the recreational harvest of shellfish as a public right. Accordingly, state law requires every city or town that exercises authority over shellfish resources in waters approved for direct harvest set aside an area solely for recreational harvest and make recreational permits available to any inhabitant, regardless of local residency.

While some communities contain naturally occurring shellfish populations at levels sufficient to support robust recreational shellfish fishing opportunities, the majority of communities that participated in the survey (24 out of 38) stated that recreational fisheries in their community are supported by propagation activities such as the planting of hatchery reared seed and contaminated quahog relays (Appendix C). In some communities NGO groups such as BARS, TNC, MOP, Barnstable Clean Water Coalition, Barnstable County Cooperative Extension and others assist the municipality with propagation and other shellfish enhancement efforts to advocate and bolster opportunities for recreational shellfish fishing (Appendix B).

To view the current status and trends for recreational shellfisheries in the state see the reports recreational permit trends under the Status and Trends section of this AC Report (Table 29), but generally a majority of the towns reporting (28 of 30) identified increasing permits (12) or static permit numbers (16) as trends associated with the issuance of recreational permits. Importantly, those towns that indicated a trend of increasing recreational permits (8 of 12) also identified shellfish propagation activity as entirely if not part of the reason for such a trend.

Wild Commercial Harvest

While state law requires that municipalities provide public access for recreational shellfish fishing, they are not required to permit the commercial wild harvest of shellfish. The majority of communities that participated in the survey (33 of 38) indicated the municipality permits and manages a commercial wild harvest shellfish fishery. The number of permits issued annually and municipality specific landings varying widely across the state (Appendix C). In communities where commercial wild harvest is not permitted, it is generally the result of limited access to acreage suitable for direct commercial harvest or a lack of shellfish in numbers suitable to support commercial harvest.

Most communities that allow commercial wild harvest shellfish fishing have adopted local rules and regulations that establish catch limits, seasonal restrictions and other management controls. The content of local regulations varies across municipalities. As local shellfish constables can enforce both local and state rules pertaining to shellfish, many communities have basic regulations addressing eligibility, permit fees, and catch limits, but rely on state regulations and statutes to address considerations such as tagging, transport, and minimum sizes. Other communities adopt more stringent requirements than the state or mirror applicable state regulations in their own local bylaws.

Of the 33 communities that reported permitting and regulating a commercial wild harvest shellfish fishery, all stated that residency was a requirement to obtain a commercial shellfish permit. A majority also reported having waitlists for commercial permits. Seventeen of the communities surveyed indicated that the commercial wild harvest shellfish shellfisheries in

their community are supported by propagation activities such as the planting of hatchery reared seed and contaminated quahog relays (Appendix C).

A number of NGO groups such as CCCFA, Wellfleet Shellfishermen's Association, and SPAT also provide resources to support and advocate for commercial shellfish fishing activities in the Commonwealth (Appendix B).

The current status and trends for commercial shellfisheries are available in Table 9 within the Status and Trends Section of this report. Generally, as an indicator of commercial wild harvest shellfish activity, there has been a slight uptick (1.8% average 2014-2018) in shellfish endorsements issued over the past five years, while the percent active (at least one sale of shellfish in a given year) has remained nearly constant.

Shellfish Planting Activities Overview

A growing portion of the Commonwealth's state and local shellfish management capacity is directed at the oversight of, and support for, shellfish planting activities. The statutes authorizing these activities and their associated requirements are provided in M.G.L. c. 130 and outlined in the DMF Shellfish Planting Guidelines.

Generally speaking, shellfish aquaculture refers to the planting and culture of shellfish at a specific municipally licensed portion of coastal waters resulting in the commercial production of shellfish. Shellfish propagation refers to any planting activities conducted by municipalities for commercial and recreational fisheries enhancement. Shellfish propagation is also inclusive of those shellfish planting activities conducted by municipalities for the purposes of shellfish or ecosystem restoration, mitigation, and/or water quality improvement. This activity is often done in partnership with private citizens and NGOs.

The resources and capacity to support the Commonwealth's aquaculture and propagation management framework primarily consist of state and local regulatory resources directed at ensuring shellfish planting activities are conducted in a manner that protects public health and veterinary health; the public's rights to common resources; and minimizes impacts to coastal wetlands and marine resources. In addition to state and local regulatory capacity, shellfish planting activities are reliant on public, private, and NGO capacity for shellfish seed production, disease testing, gear, and other support necessary to conduct shellfish propagation and aquaculture.

Shellfish Planting Activities Management and Capacity

The Commonwealth's aquaculture and propagation management framework places the Boards of Selectmen or City Councils of coastal municipalities as the primary licensing authority for shellfish aquaculture, as well as the entity authorized to conduct municipal propagation activities. While local municipalities have significant discretion related to the

initiation of shellfish propagation and aquaculture activities, state law provides DMF oversight of the operational permitting of all shellfish planting activities. This includes the approval of the source of shellfish, introduction and transplant of planted shellfish stocks, and the certification of municipal shellfish aquaculture licenses prior to their final approval.

Shellfish propagation and aquaculture activities provide economic benefit to the Commonwealth. Additionally, they provide environmental benefits through the ecosystem services rendered by shellfish. However, if these activities are not properly managed, the planting of shellfish and the placement and management of gear can adversely impact environment and public access to shellfish resources. Of substantial concern is the introduction of veterinary disease and pathogens, and the subsequent impacts to the health of cultured and naturally occurring shellfish stocks. Further, in many circumstances the introduction of shellfish in coastal waters requires increased patrol capacity that must be accounted for when these activities are being planned.

State law, in conjunction with DMF regulations and policies, establish operational guidelines for shellfish aquaculture and propagation activities in the waters under the jurisdiction of the Commonwealth. These regulations outline criteria to be used by DMF to determine if adverse effects to important public interests and natural resources are likely to occur at the proposed site as a result of planting activities. Additionally, there are several other state agencies and executive offices responsible for reviewing or permitting shellfish planting activities that may trigger mandates set forth in state statute or regulation or may adversely affect issues significant to agency's mission. These include:

- The WPA (M.G.L. c. 131, §40) and implementing DEP regulations at 310 CMR 10.00 protect wetlands, floodplains, riverfront areas, and other areas from destruction or alteration.

- The Public Waterfront Act (M.G.L. c. 91) and implementing DEP regulations at 310 CMR 9.00, protect activities in, under, or over publicly owned waterways of the Commonwealth. It also provides protections for Areas of Critical Environmental Concern.

- The Clean Waters Act 401 Water Quality Certification (M.G.L. c. 21, §27) and implementing DEP regulations at 314 CMR 9.00, establish procedures and criteria for the administration of Section 401 of the federal Clean Water Act (33 U.S.C. 1251), for the discharge of dredged or fill material, dredging, and dredged material disposal in waters of the Commonwealth.

- DEP has established surface water quality standard regulations at 314 CMR 4.00. These regulations are critical in protecting shellfish habitat and setting bacteria standards to protect shellfish fishing and are implemented.

- The Massachusetts' Endangered Species Act (M.G.L. c. 131A), and implementing DFW's Natural Heritage and Endangered Species Program regulations at 321 CMR 10.00, protect rare species and their habitats by prohibiting the "take" of any plant of animal species listed as Endangered, Threatened, or Special Concern.

- The Massachusetts Environmental Policy Act (M.G.L. c. 30, §§61-62H) and implementing MEPA office regulations at 301 CMR 11.00, require state agencies study the environmental consequences of their actions.

- The federal Coastal Zone Management Act (16 U.S.C. §§1451–1464) provides CZM with the jurisdiction to review federal projects (including ACOE permits for aquaculture projects) that affect Massachusetts' coast. CZM also has regulatory programs (i.e., the Massachusetts Ocean Management Plan, Municipal Harbor Plans, Designated Port and Harbor Planning, and Massachusetts Environmental Policy Act) under which they ensure coastal activities are consistent with state policies. Relevant CZM regulations may be found at 301 CMR 20.00, 23, 25, 26, 27 and 28.

In the aggregate, these statutes and regulations establish procedures for the public review and permitting of activities that have the potential to cause effects on protected species, sensitive coastal areas, fisheries resources, coastal habitats, aesthetics, and public rights to shellfish fishing and navigation. Accordingly, there numerous state agencies involved with and permitting process for shellfish planting activities.

This contributes to substantial management complexity. A number of shellfish aquaculturists and municipalities have cited this complexity as a limiting factor in the expansion of shellfish planting activities. To address this, DMF – in partnership with other agencies within the EEA and with the oversight from MEPA – initiated the development of the MAPP. This effort was intended to provide clarity and guidance for municipalities, aquaculturists and permitting agencies regarding the state review and permitting process for shellfish planting activities in the Commonwealth.

Private Shellfish Aquaculture

In Massachusetts, private shellfish aquaculture is defined as the planting and culture of shellfish at a specific municipally licensed site resulting in the commercial production of shellfish. The Boards of Selectmen and City Councils of coastal municipalities and DMF are the primary managers of shellfish aquaculture in the Commonwealth. The MAA has - since 1986 - served as the primary advocacy NGO for aquaculture in Massachusetts.

While state law sets basic criteria related to the issuance and operation of shellfish aquaculture licenses, the initiation of private shellfish aquaculture is under the municipality's purview. Municipalities may choose not to issue shellfish aquaculture licenses, or place limitations on aquaculture activities to ensure they are conducted in a manner consistent with the municipality's shellfish resource management objectives and the character of the community.

The challenges associated with the establishment of shellfish aquaculture operations in Massachusetts is reflected by minimal growth of licensed acreage within Massachusetts' DSGAs (about 0.1% of the 1.7 million acres of DSGAs in the state).

The content and requirements of local aquaculture rules and regulations vary widely, and include but are not limited to, eligibility (e.g. residency requirements), the size of and locations where aquaculture sites can be located in the community (e.g. maximum acreage, aquaculture development areas), the type of gear and harvest methods aquaculturists may utilize (e.g. floating cages, bottom gear), how aquaculturists can access sites (e.g. boats, over sand vehicles, on foot), transferability of licenses, minimum productivity or investment requirements, insurance and bonding requirements, and varying application processes. In addition, several local communities have established aquaculture management plans that provide for spatial planning and long-term aquaculture management objectives within the community.

All of the responding communities surveyed, which allow aquaculture, reported having residency and substantial use requirements in local aquaculture regulations. Half of the communities (11/21) stated that they had a wait list for aquaculture licenses ranging from 80 to five people. Ten municipalities stated they have an aquaculture management plan in their community (Appendix C).

State Management of Private Shellfish Aquaculture Activities

Pursuant to M.G.L. c. 130, DMF is responsible for the permitting of aquaculturists and hatcheries to possess, culture, and sell sub-legal shellfish (seed) for transplant and grow-out to legal size. In 2018, DMF reported issuing 391 propagation permits to private shellfish aquaculturists (this does not include propagation permits issued to municipalities). These permits authorized the culture of seven shellfish species on 1,202.7 acres of tidal and sub-tidal lands. The ex-vessel value associated with this commercial shellfish aquaculture activity was over $28.5M. DMF reported oysters as the number one cultured species in the state, followed by quahogs. Other less commonly cultured species include blue mussel, softshell clam, surf clam, razor clam, and blood ark clam. The value of aquaculture reared oysters was only surpassed by lobster and sea scallop as third most valuable species of seafood landed in Massachusetts.

Oysters are the primary shellfish species cultured in the state. Monoculture activity may result in lessened resiliency and may increase the risk of shellfish disease and mortality, as well as market collapse in the event of widespread die-offs. A number of government agencies and NGO groups (including but not limited to SPAT, CCCFA, ARC, RWU, and Barnstable County Cooperative Extension Service) have conducted projects focused on refining production methodology and promoting the culture and marketing of alternative shellfish species in Massachusetts (e.g., surf clams, blood ark clams, razor clams, and bay scallops).

Pursuant to state law and state regulation, the issuance of an aquaculture license by the municipality is contingent on DMF conducting a field inspection of the proposed license site and

a review of the license site application. The purpose of this activity is designed to holistically review the proposed aquaculture operation to ensure that it will have no adverse impacts on shellfish resources, other natural resources, and public health.

Accordingly, the review process is multi-faceted. Water quality is reviewed to determine that the site is located in a growing area that is open to the direct harvest of shellfish. The site location, license application, and public comment are reviewed to determine if the proposed operation will impact important shellfish resources, other fishery resources, habitat, public use of tidelands, and other items related to public access to ensure that areas that can support commercial and recreational fisheries are not removed from public use. There are also criteria related to the minimum distance license sites may be located from submerged aquatic vegetation to protect this important inshore habitat. DMF also has gear and area criteria to ensure the setting of aquaculture gear does not pose a threat to state and federally protected species (e.g., marine mammals and sea turtles). Unlike other review processes mandated by state law and regulation (e.g., MESA, WPA), DMF's review and approval process is free of charge. In short, the establishment of shellfish aquaculture operations is highly regulated at the local and state level.

Municipal Shellfish Propagation

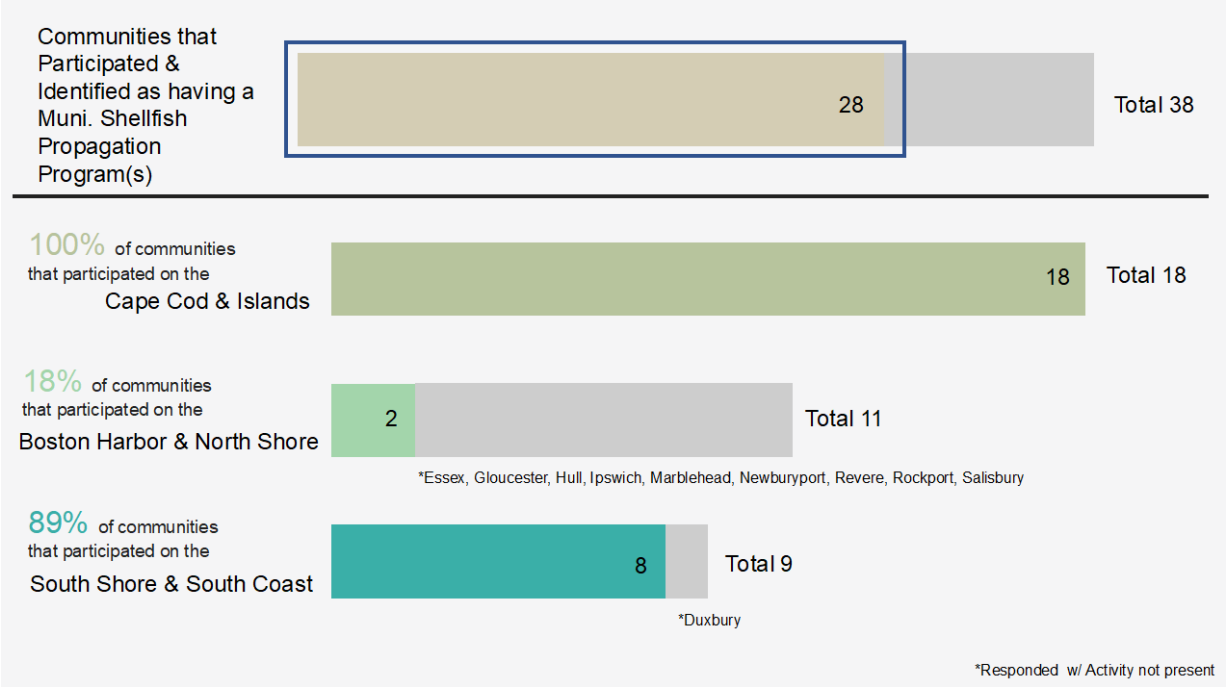
In Massachusetts, municipal shellfish propagation refers to any planting activities conducted by municipalities for the purposes of commercial and recreational fisheries enhancement, ecosystem restoration, the mitigation or restoration of lost or damaged shellfish resources and habitat, or water quality improvement. Propagation activities commonly include the planting of hatchery-reared shellfish, the relay of natural stocks, and the placement of cultch to encourage the recruitment of shellfish and improve shellfish habitat (Figure 4).

Regardless of intent, state law requires that propagation activities be conducted by, or in partnership with, the city or town where the planting is occurring. Propagation activities must be conducted under a DMF permit issued to the coastal municipality where the activity is occurring. In 2018, DMF issued propagation permits to 32 municipalities. Oysters and quahogs are the primary planted species, followed by bay scallops and soft-shell clams. The MSI municipal survey found that most of the communities who responded (25 out of 28) conduct propagation activities principally to enhance their recreational and commercial fisheries. No reason was provided by the other three municipalities.

A number of communities have begun to increase propagation activities to leverage the ecosystem services shellfish can provide. This may allow the municipality to meet state and local objectives related to habitat restoration, nutrient remediation, water quality improvement, and shoreline protection. Most notably, the Cape Cod Commission's Clean Water Act Section 208 Area Wide Water Quality Management Plan Update (Cape Cod Commission, 2015) allowed communities to begin to incorporate shellfish and other non-traditional strategies as a part of their estuarine nutrient pollution mitigation plan. As these plans rely on planted shellfish to realize the nutrient removal potential, municipal propagation

activity provides a benefit to the environment while increasing shellfish fishing opportunities in the community. While all of the communities that have been approved to include shellfish planting into their nutrient mitigation plans are still in the pilot phase, the prospect of wide-scale implementation across the Commonwealth has raised concerns from some industry advocacy groups and municipalities. Of particular interest is that the increased planting by municipalities may have impacts on supply-side commercial shellfish market economics.

Figure 4. Municipal participants identifying as having municipal shellfish propagation programs in their town



A number of communities also conduct shellfish propagation activities as a means of restoring degraded shellfish populations and enhancing the ecosystem services that shellfish can provide. These ecosystem services include wave attenuation, juvenile fish habitat, and improved water clarity. Most of these projects focus on the placement of spat laden shellfish cultch (unconsolidated shell material) as a means of improving historic oyster habitat degraded by the accumulation of organic sediments. Often these activities are conducted in partnership with NGO groups such as MOP, Barnstable Clean Water Coalition, TNC, MVSG, and others. As the placement of unconsolidated materials is considered fill under M.G.L. c. 91 (Public Waterfront Act), municipalities proposing the deployment of cultch for propagation activities are required to obtain a license from DEP. In recent years legislation has been proposed to exempt municipal cultching activities that are conducted as part of an approved comprehensive watershed management plan.

Under state law municipalities may enact temporary spatial closures to protect planted shellfish stocks. These closures are typically limited by law to a period of three years to ensure public access is maintained. In certain cases where communities can demonstrate the continued closure of an area to harvest is in the best interests of resource management, the Board of Selectmen or City Council may petition the DMF Director to close the area for up to 10 years. Once these areas are reopened municipalities may promulgate strict conservation measures for the continued protection of these planted shellfish resources.

Seed Supply and Hatchery Capacity

Municipalities and private growers primarily rely on private hatcheries for shellfish seed to stock shellfish aquaculture license sites and municipal propagation sites. To prevent the spread of veterinary disease and other pathogens, DMF has established requirements that private growers and municipalities obtain seed shellfish only from sources approved by DMF. DMF has a zero-tolerance policy on the introduction or movement of seed and adult shellfish that test positive for shellfish pathogens. DMF maintains a list of approved seed sources, pathology labs and disease testing requirements on its website.

Currently there are four hatcheries permitted in Massachusetts. Two are private hatcheries and are operated by ARC and Island Creek Oyster Company; another is a public hatchery operated by Salem State University; and the last is a hatchery operated by the MVSG. MVSG leases a hatchery facility owned by DMF to support propagation activities on Martha's Vineyard. Municipalities and private growers in Massachusetts also source seed from 10 out-of-state hatcheries located in Maine (3), Rhode Island (3), New Jersey (2), Connecticut (1), and New York (1). There are also 24 operations, in-state, approved to conduct nursery grow out and resell hatchery seed at intermediate (nursery) size.

New sources undergo a review of disease history, brood stock genetics, and biosecurity measures by DMF. Once approved, seed sources must provide DMF with a current disease certification for the stock they wish to sell in the state. Currently there are four pathology laboratories approved by DMF to certify shellfish disease free; each of these approved pathology laboratories are located out the Commonwealth. Sample turnaround varies by laboratory and season but generally ranges from three-days to more than two-weeks.

Additional Capacity for Shellfish Planting Activities

A number of non-regulatory agencies and NGO groups provide support for shellfish planting activities. MDAR has an Aquaculture Specialist on staff that provides technical assistance, education and guidance to the aquaculture sector. MDAR also supports three regional Massachusetts Aquaculture Centers (SEMAC, NEMAC and the Western Massachusetts Center for Sustainable Aquaculture). Originally supported through Environmental Bond Bill funding in 2005, the three regional aquaculture centers provide shellfish aquaculture training courses and

materials; disease monitoring; micro-grants for aquaculturists; applied research and technical assistance; and outreach and guidance directly to the aquaculture industry, municipalities, and the state. SEMAC also supports the collection of water quality data in regionally important aquaculture areas.

In recent years, there has been no direct legislative funding for the three-aquaculture centers and MDAR has provided fiscal support from agency operating funds and trust funds. Funding for the aquaculture centers was identified as a priority for the aquaculture industry by MAA, MSOA, and DMF. Language to fund the centers under both DAR and DMF oversight was included in the 2018 Environmental Bond Bill. However, funding continues to not adequately support the needed services.

DMF, municipalities, and the MAA have identified shellfish disease as a major concern for the state's shellfish resources. Massachusetts has experienced devastating disease related shellfish mortality events impacting both cultured and wild shellfish stocks. Additionally, in Massachusetts there have been considerable impacts from introduced and native shellfish pathogens, some resulting in significant losses to wild and cultured stocks. Most recently, Haemic Neoplasia was implicated in a die-off of softshell clams on the North Shore and quahogs in Wellfleet. In 2010 and 2011 shellfish aquaculturists experienced significant losses to cultured oyster stocks as a result of a spike in MSX, a haplosporidium protozoan that can cause significant mortality in oysters. QPX, a similar haplosporidium organism that impacts quahogs, was associated with a die-off in Wellfleet and Barnstable Harbors in 2005. SEMAC, with support from Barnstable County Cooperative Extension, provides shellfish disease-testing assistance to municipalities and growers in Barnstable and Plymouth Counties, including routine monitoring and event response. This represents the longest running disease dataset for the Commonwealth. Currently DMF, in partnership with SEMAC, and with funding provided from USDA, has expanded disease monitoring to include areas of the north shore and Martha's Vineyard.

A number of academic institutions such as UMass Boston, RWU, URI, and Quincy College offer degree and non-degree courses on aquaculture. The Barnstable County Cooperative Extension's marine program also offers applied shellfish farming courses (Appendix B).

A number of state agencies and NGOs help support opportunities for shellfish constable training (Appendix B). State statute requires shellfish constables to obtain training related to shellfish management. Massachusetts' law does not require a specific training course to be eligible, but includes a reference to constable training provided at the MMA in Bourne, Massachusetts. This constable training has been occurring since the early 1990s. The course is organized by DMF and the MSOA. The course occurs every three years, when there is sufficient interest. The course occurs for 80 hours over two weeks. It provides a comprehensive review of shellfish biology and natural history; *Vp*, biotoxin and other shellfish pathogens; water quality and pollution monitoring; shellfish harvesting methods; and law enforcement, boat handling and first responder measures training. The program is supported by DMF, MSOA, DPH, MEP, WHOI, FDA and other relevant experts. Additionally, the MSOA offers annual in-service training

for shellfish constables and other shellfish professionals to educate them on emerging concerns related to shellfish and public health.

Limiting Factors for Municipal Shellfish Programming

Municipalities identified a number of common factors as potential drivers limiting the opportunities for shellfish programming in their community. This included limited areas under their jurisdiction that support direct harvest, the community's capacity to oversee and support shellfish fishing activities, and local interest and support for shellfish fishing (Appendix C). With regards to limiting the expansion of existing programs, communities identified poor water quality, impediments to public access and limited shore-side infrastructure (e.g., parking lots), and rainfall closures (Appendix C). Additionally, budget resources have a constraining effect on municipal shellfish programs.

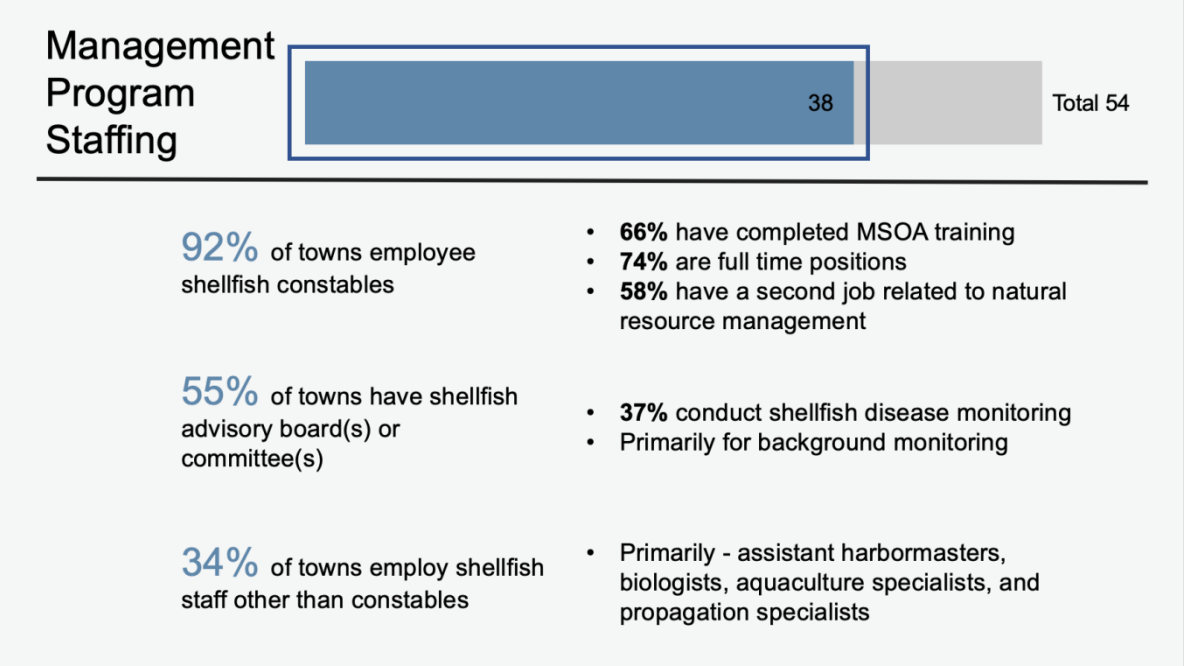
Under state law (M.G.L. c. 130, §98), municipalities that allow shellfish fishing are required to appoint shellfish constables to oversee shellfish fisheries and resources in that community. These constables enforce all state and local shellfish laws and regulations. They are also charged with initiating, promoting and managing shellfisheries in their city or town (Figure 5).

Financial support for shellfish constables and municipal shellfish departments to achieve shellfish management objectives and conduct enforcement, greatly varied between communities. Reported shellfish program budgets ranged from $150,000 to less than $5,000 annually (Figure 6). Current state funding dedicated to municipal shellfish management activities is limited. While some limited legislative funding is provided annually to support propagation activities in select parts of the state, currently funding for local shellfish programming is primarily derived by annual municipal appropriations (Appendix C). Accordingly, in certain communities, shellfish budgets are not sufficient to support the expansion of the local shellfish program because they cannot hire the personnel necessary to patrol shellfish growing areas and provide administrative oversight in conformity with state law and NSSP mandates. Additionally, limited funding may be available to obtain seed for municipal propagation (Appendix C).

The vast majority (35 out of the 38) communities that responded to questions related to municipal shellfish department budget resources stated administration and personnel are the largest annual expenditures. In many communities shellfish constables must also serve in additional roles, such as natural resource officer or harbormaster to ensure adequate year-round funding for the position. Alternatively, a number of municipalities reported employing a full-time constable and other full-time or seasonal staff, including deputy constables, and propagation technicians to assist with enforcement, propagation, and other shellfish management related activities (Appendix C). The majority of responding communities indicated that funding for staffing and equipment to manage shellfish programming is primarily generated from recreational and commercial permit revenues (Figure 7; Appendix C).

A minority number of communities (five out of 28) identified the inability to obtain enough seed as a limiting factor for propagation activities in their community. Those same communities identified the state cap on aquaculture license fees set in 1984 of $25 per acre or part thereof of as insufficient to cover the cost of oversight and patrol and a factor for limiting opportunities for aquaculture growth (Appendix C).

Figure 5. Program staffing levels for towns that participated in the municipal survey[3]



[3] Not all municipalities appoint a shellfish constable, particularly if a community only has areas classified as Prohibited with a status of Closed.

Figure 6. Yearly expenses for communities participating in the municipal survey

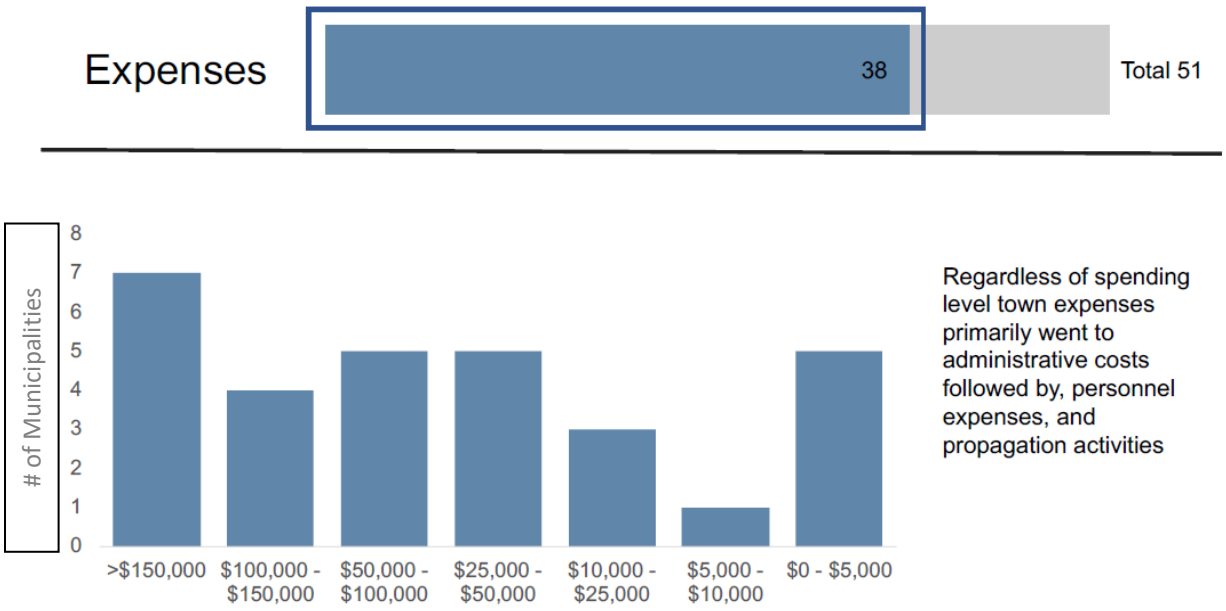
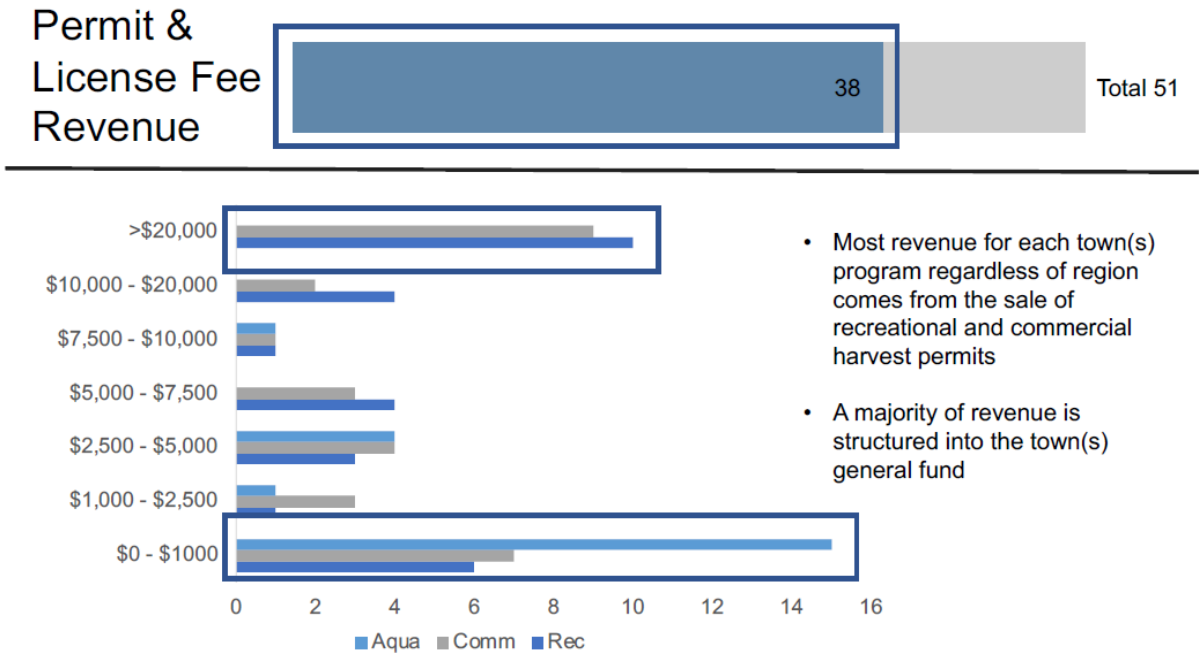


Figure 7. Yearly permit and license fee revenue for towns that participated in the municipal survey



Status and Trends

A component of the AC's charge was to identify the status of shellfish fishing activities and programs in Massachusetts and their associated trends. This includes trends related to the suitability of harvest areas to support recreational and commercial shellfish fishing opportunities, trends in commercial and recreational landings, permitting, and shellfish planting activities. Below we provide selected trends associated with the Commonwealth's shellfish related management objectives and capacity as outlined above. Additional data related these trends are also provided in the attached appendices.

Growing Area Status and Trends

Currently DMF samples and classifies 301 shellfish growing areas covering over 1.7 million acres of state waters to determine their suitability for harvest. Between 2014 and 2018 when viewed statewide there has been very small percentage change in classification acreage, less than .01% overall.[4] 17% (43) more shellfish growing areas were sampled in 2018 compared to 2014 and classification areas were sampled 37% (183) more at the end of the 5-year study period. Water quality sample collection has also increased overall. Between 2014 and 2018, the total number of water quality samples has increased 3% with significantly more pollution sources analyzed (192) and ad-hoc sampling of pollution events increasing over 133% (137) (Table 7 and 8).

Table 7. Percent change from 2014-2018 in statewide growing area classifications

Area Classification	Acreage			Percent
	Jan 1-14	Dec 31-18	Change	Change
Approved	1,475,928	1,475,668	-260	-0.01%
Conditionally Approved	25,088	24,656	-432	-0.02%
Restricted	2,951	3,261	310	0.02%
Conditionally Restricted	4,765	4,377	-388	-0.02%
Prohibited	229,766	230,542	776	0.04%
Total Acreage	1,738,498	1,738,504*		

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

Source: MassGIS/DMF Shellfish Database, 08/31/2019 JK

[4] As stated earlier, classification areas and acreage changes are relatively small when viewed state-wide yet the changes in near-shore productive acreage can be significant and particularly harmful to local fisheries. Simply viewing overall percent change in area classification may obscure actual productive area loss. Unfortunately, no assignment of productive acreage is available.

Table 8. Water quality monitoring

Water Quality Classification Samples	Sampling In			Percent
	2014	2018	Change	Change
Shellfish Growing Areas Sampled	254	297	+43	17%
Classification Areas Sampled	497	680	+183	37%
Total Water Samples	9681	9962	+281	3%
Classification Station Water Samples	*9204*	*9156*	*-48*	*-1%*
Pollution Source Samples	*374*	*566*	*+192*	*51%*
Ad-hoc Samples	*103*	*240*	*+137*	*133%*

Source: DMF Annual Reports

Shellfish Resource Status and Trends

Between 1963 and 1975, DMF conducted extensive estuarine studies and these studies produced 17 reports. These reports documented shellfish standing stock for the period of the study. Subsequently, due the localized nature of shellfish populations, Massachusetts has not routinely conducted standardized standing stock assessments of naturally occurring shellfish resources. In most cases, managers rely on trends in commercial and recreational landings to evaluate local abundance. While there is no standardized municipal commercial or recreational landings reporting, many municipalities conduct surveys at landings sites and via written surveys and reports from local permit holders. DMF requires all individuals harvesting shellfish for commercial purposes to obtain a commercial permit from DMF with a shellfish endorsement and all commercial permit holders must submit trip level reporting monthly to DMF either through the online SAFIS portal or on paper reports. Permit renewals are contingent on meeting reporting requirements.

Permits and Endorsements

Commercial Permits

DMF issues a variety of commercial permits. These permits can be further endorsed for certain regulated fisheries. DMF issues two types of base commercial fishing permits that allow the commercial harvest, landing and sale of shellfish: “Shellfish Rod and Reel” and “Shellfish and Seaworms.” These permits are automatically issued with a shellfish transaction card, which is required to sell shellfish into commerce.

Additionally, other base commercial fishing permits (e.g., Boat Permit or Coastal Lobster Permit) may receive a regulated fishery permit endorsement for shellfish (“Shellfish Endorsement”). Any commercial permit holder with a Shellfish Endorsement will receive a shellfish transaction card, which is necessary for conducting shellfish sales to primary buyers. In

concern, these permitting mechanisms allow the commercial fisherman to harvest, land, and sell shellfish into commerce. (See Appendix A for a complete list and comparison of Shellfish type Endorsements)

Looking at the activity level of Shellfish Endorsements over time gives a good view of high-level trends in commercial shellfish permits issued and activity. Table 9 shows that there has been a slight uptick (1.8%) in Shellfish Endorsements issued over the past five years, while the percent active (at least one sale of shellfish in a given year) has remained nearly constant.

Table 9. Shellfish endorsement issued 2014-2018

Endorsements Issued

ENDORSEMENT	**2014**	**2015**	**2016**	**2017**	**2018**
Shellfish Endorsement	3116	3043	3209	3277	3346
ACTIVE ENDORSEMENT ISSUED					
	2014	**2015**	**2016**	**2017**	**2018**
Shellfish Endorsement	1972	1902	1981	2074	2003
ACTIVE ENDORSEMENTS / ENDORSEMENTS ISSUED					
	2014	**2015**	**2016**	**2017**	**2018**
Shellfish Endorsement	63%	63%	62%	63%	60%
SOURCE: MA PERMITTING DATABASE, SAFIS DEALER DATABASE, 08/05/2019 ED					

DMF issues other endorsements that authorize other specific commercial fishing activities. This includes participation in certain regulated fisheries or the use of certain gears. See Appendix A for a description of DMF permits and endorsements and for the number of endorsements issued. All of these endorsements, except Contaminated Surf Clam and Sea Scallop Diving, are limited entry. In addition to these endorsements, a shellfish endorsement is required to sell the product into commerce.

Special Permits

Special permits include Aquaculture, Shellfish Propagation, Master and Subordinate Digger and Shellfish Contaminated Relay (Appendix A). These permits authorize activities outside those normally associated with commercial wild harvest shellfish permits. Issuance of these special permits vary on an annual basis with no discernible trend and reflect the presence of a variety of influencing factors (e.g., abundance, environmental conditions).

Municipal reported commercial permit trends

Data related to municipal commercial shellfish permits is not standardized across municipalities. The following data was provided by individual municipalities through the AC survey. Only 32 municipalities self-reported the average number of permits issued. Yet 33 municipalities reported having commercial harvest. Of the municipalities who identified as having commercial harvest in their waters, only 31 identified trends in commercial permits and some provided potential factors which may be driving those trends (Figure 8 and Table 10).

Figure 8. Wild harvest commercial permits issued annually by communities that participated in the municipal survey

Average # of Permits	# of Towns	Town
301-400	2	Chatham
		Orleans
101-200	5	Eastham
		Ipswich
		Nantucket
		New Bedford
		Wellfleet
51-100	6	Edgartown
		Essex
		Falmouth
		Gloucester
		Newbury
		Westport
26-50	1	Barnstable
0-25	18	Bourne
		Dennis
		Duxbury
		Fairhaven
		Harwich
		Hingham
		Hull
		Kingston
		Marion
		Mashpee
		Newburyport
		Revere
		Rockport
		Salisbury
		Tisbury
		Wareham
		West Tisbury
		Yarmouth

Table 10. Municipal reported trends in commercial shellfish permits

Annual permit trend	# of towns	town	Factors
Decreased	12	Chatham	Decreased natural recruitment,Other
		Edgartown	Decreased natural recruitment,Increased propagation planting
		Fairhaven	Other
		Gloucester	Other
		Hingham	Disease,Decreased natural recruitment
		Hull	Disease,Decreased natural recruitment,Other
		Marion	Other
		Nantucket	Other
		Revere	Other
		Salisbury	Disease,Decreased natural recruitment
		Wellfleet	Disease,Decreased natural recruitment,Decreased propagation planting
		West Tisbury	Decreased natural recruitment
Increased	4	Eastham	Increased propagation planting,Other
		Newburyport	Other
		Orleans	Increased natural recruitment,Increased propagation planting
		Wareham	Other
Not Changed (Stable)	15	Barnstable	Other
		Bourne	N/A
		Dennis	Increased propagation planting
		Duxbury	N/A
		Essex	Other
		Harwich	Other
		Ipswich	Increased natural recruitment
		Kingston	Decreased natural recruitment
		Mashpee	Decreased natural recruitment,Increased propagation planting
		New Bedford	Increased propagation planting
		Newbury	Increased natural recruitment,Other
		Rockport	N/A
		Tisbury	Other
		Westport	Decreased propagation planting
		Yarmouth	Disease,Decreased natural recruitment

Commercial Permit trends: Species, Landings, and Value

There a numerous shellfish species landed in Massachusetts. However, for the purpose of this report, the AC was instructed to compile and review landings data for the commercial harvest of bay scallops, oysters, quahogs, razor clams, and softshell clams. These species comprise the key nearshore commercial shellfish fisheries. Utilizing SAFIS dealer data as the data source, regional and state-wide overviews of the ex-vessel value for these commercial shellfish fisheries can be provided. Commercial landings include both wild harvest and aquaculture, unless otherwise identified. (All the landings and value data by region can be found in Appendix A). This analysis is to look back over the five-year period from 2014 -2018 (Table 11 and 12). However, since mandatory dealer reporting began in 2005, we have the ability to look back over a 13-yer period (2005-2018) to highlight any relevant trends that may be occurring over a more extensive time-series.

Overall total value of in-shore species has risen 41% from approximately $31.4M in 2014 to $44.2M in 2018. In 2018, commercial oyster landings ranked third for all Massachusetts fisheries landed for value behind sea scallops and lobsters. Softshell clams ranked seventh; quahogs ranked eleventh; razor clams 20th; and bay scallops 26th. Of these five inshore species, commercial oyster landings are dominated by aquaculture reared product, as opposed to wild harvest. This reflects a long-term trend towards the production of cultured oysters, as twenty years ago quahogs were the dominant cultured species, and this trend may be driven by economic factors (e.g., market demand) and species preference of aquaculturists (e.g., ease of culture, disease resistance).

Table 11. Commercial landings by species 2014-2018

	2014	2015	2016	2017	2018
Bay Scallop (Meat Pounds)	176,207	97,088	96,968	170,860	119,462
Oyster (Pieces)	34,455,290	38,506,920	39,290,996	50,569,102	51,133,233
Quahog (Live Pounds)	5,040,504	4,777,370	4,469,958	4,220,300	4,555,101
Razor Clam (Live Pounds)	486,507	336,088	361,078	547,120	728,322
Softshell Clam (Live Pounds)	2,009,057	2,045,058	3,277,268	3,702,887	3,652,841

Table 12. Commercial ex-vessel value by species 2014-2018

	2014	***2015***	***2016***	***2017***	***2018***
Bay Scallop	$ 2,524,330	$ 1,431,364	$ 1,876,959	$ 2,125,376	$ 1,637,595
Oyster	$ 19,420,109	$ 22,637,293	$ 22,508,427	$ 28,333,754	$ 28,310,863
Quahog	$ 3,689,809	$ 4,373,455	$ 4,721,349	$ 4,549,027	$ 4,882,495
Razor Clam	$ 1,821,976	$ 1,437,366	$ 1,471,317	$ 2,410,407	$ 3,226,260
Softshell Clam	$ 3,990,163	$ 4,470,983	$ 6,193,667	$ 6,242,089	$ 6,177,161
Total	*$ 31,448,401*	*$ 34,352,477*	*$ 36,773,735*	*$ 43,662,669*	*$ 44,236,390*

American Oyster

Oysters have the highest ex-vessel value of the five inshore shellfish fisheries being analyzed in the AC Report. During the five-year lookback period, the fishery increased value by about 45% from $19.4M in 2014 to $28.3M in 2018. This 2018 value exceeds the aggregate total annual ex-vessel values for the other four species (bay scallops, quahogs, razor clams and softshell clams). It is notable that this value increased with production during this time-period. This would indicate that markets and value have remained stable despite substantial growth in landings. Looking back to 2005 - when SAFIS dealer reporting became mandatory – we can see substantial growth in both landings and value (Table 13 and Figure 9).

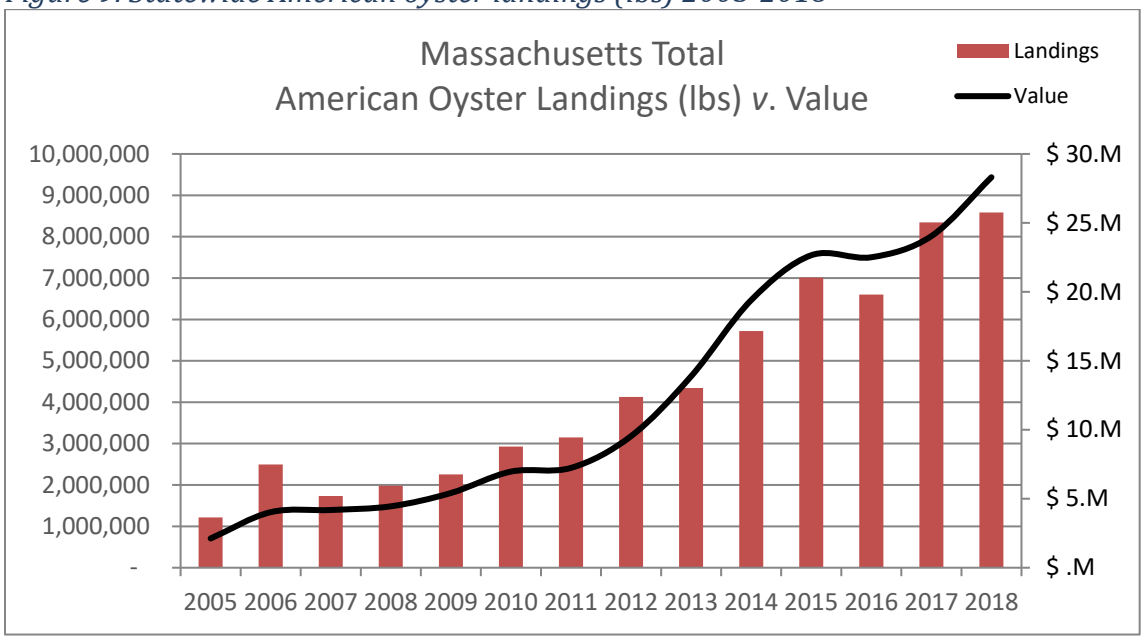
It is noteworthy, that during the period of this analysis, DMF amended its oyster minimum size regulations to accommodate the sale of so-called "petite" aquaculture raised oysters. Specifically, in 2016 for 2017, DMF reduced the minimum size for aquaculture raised oysters from 3" to 2.5". The 3" minimum size for wild harvested oysters remains 3". This likely attributed to an increase in overall landings during the 2017 and 2018 calendar years, by affording aquaculturists the ability to get their product to market earlier. However, the impact is difficult to quantify based on the available SAFIS data.

Table 13. Statewide totals for American Oyster landings in Live lbs and Value. 2005-2018

Statewide Totals

American Oyster (landings in live lbs)							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Landings	1,217 K	2,495 K	1,732 K	1,980 K	2,255 K	2,930 K	3,150 K
Value	$2.12 M	$4.03 M	$4.18 M	$4.45 M	$5.42 M	$6.97 M	$7.24 M
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Landings	4,126 K	4,344 K	5,721 K	7,012 K	6,603 K	8,346 K	8,587 K
Value	$9.54 M	$13.88 M	$19.4 M	$22.66 M	$22.51 M	$24.04 M	$28.31 M

Figure 9. Statewide American oyster landings (lbs) 2005-2018



Of the three geographic regions being analyzed in this report (CC/I; SS/SC; and BH/NS), the CC/I region has the highest reported commercial oyster landings from 2014 through 2018 (Table 14 and 15). Landings from the CC/I region approximately double that of the SS/SC region; the BH/NS region does not support a commercial oyster fishery. DSGA classifications in the Boston Harbor complex prevent the direct harvest of oysters and there are no wild oyster fisheries

along the North Shore. While there is some limited aquaculture in Rowley, no growers are actively rearing oysters. Those landings attributed to the BH/NS region in Tables 14 and 15 are likely miscoded in SAFIS.

From 2014-2018, landings from the CC/I region increased by about 44% from 2014 to 2018 with near commensurate (43%) increase in overall ex-vessel value. The SS/CI saw a larger growth in productivity, with landings increasing by 58%. Similar to the CC/I region, growth in overall e-vessel value was proportional, increasing by 52% over the time period. It is noteworthy that to the CC/I and SS/SC regions the commercial oyster fishery is the most valuable of the five shellfish fisheries being investigated.

Table 14. American Oyster Landings (Pieces) 2014-2018

American Oyster Landings (Pieces)

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	0.05 M	*	0.07 M	0.01 M	*
CAPE COD/ISLANDS	**23.13 M**	**25.54 M**	**25.11 M**	**32.05 M**	**33.31 M**
SOUTH SHORE/SOUTH COAST	11.28 M	12.96 M	14.11 M	18.51 M	17.83 M
TOTAL	34.46 M	38.51 M	39.29 M	50.57 M	51.14 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Table 15. American Oyster Ex-Vessel Value 2014-2018

American Oyster Ex-Vessel Value

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	$.03 M	*	$.04 M	$. M	*
CAPE COD/ISLANDS	**$12.92 M**	**$14.92 M**	**$14.36 M**	**$18.08 M**	**$18.48 M**
SOUTH SHORE/SOUTH COAST	$6.47 M	$7.72 M	$8.11 M	$10.25 M	$9.83 M
TOTAL	$19.42 M	$22.64 M	$22.51 M	$28.34 M	$28.31 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Northern Quahog

There is interannual variability in quahog landings. This can be seen in the data sets for both the 2014 – 2018 study period, as well as the longer look-back period to 2005 (Table 16). This likely reflects the fact that most quahogs are wild harvested and commercial harvest relies on the availability of natural sets. In 2018, aquaculture raised quahog represents approximately ~19% of the total value of state-landed quahogs.

From 2014 – 2018, quahog landings remained relatively stable between 4.2M pounds (2017) and 5M pounds (2014). However, ex-vessel value has been trending upwards with the overall ex-vessel value of the fishery increasing by about 30%, from $3.69M in 2014 to $4.88M in 2018. This occurred despite landings being 9% lower in 2018 as compared to 2014 (Table 16 and Figure 10). Over the longer lookback period, landings and value peaked in 2007 and 2008. During those years, the fishery was valued between $5.4 and 5.5M with landings between 6.9M and 7.2M pounds (Table 16).

It is noteworthy, that during the period of this analysis, DMF amended the minimum size for aquaculture raised quahogs to be sold out-of-state. Specifically, in 2016 for 2017, DMF reduced the minimum size for aquaculture raised quahogs from 1" to 7/8". This 7/8" size limit only applies to aquaculture raised quahogs that are sold out of state; the 1" size limit still applies to all quahogs in commerce in Massachusetts. This was done to accommodate out-of-state "pasta clam" demand. The impact of this rule change is difficult to quantify based on the SAFIS data available. However, qualitatively, its overall impact on landings is likely less substantial than the similar rule change affecting oysters. This is because a much smaller percentage of quahogs are aquaculture raised compared to wild caught, and the minimum size exception applies only to the out-of-state sale of aquaculture raised quahogs.

While quahogs naturally occur across all three geographic regions, commercially viable populations of quahogs only exist south of the BH/NS region. Landings as attributed to BH/NS are likely miscoded in SAFIS. These potentially miscoded landings are insignificant when compared to overall state harvest, accounting for a fraction of a percent of the total state harvest (Table 17).

Over the past five-years, the CC/I region produced a large majority of the state's quahog landings, with their contribution ranging from 77% overall in 2015 to 86% overall in 2018. The remainder of the state's commercial quahog landings are attributable to the SS/SC region. Regional ex-vessel value is similarly proportioned, with CC/I responsible for between 83% and 88% of the average overall annual ex-vessel value, with the SS/SC responsible for the remainder (Table 18). It is notable that in all years, the ex-vessel value of the CC/I fishery was higher than its proportional contribution in poundage. Factors that may be attributing to this region difference in ex-vessel value include local value, local seasonal demand, or grade of product harvested. Of the five shellfish fisheries being investigated, the quahog fishery is the second most valuable to the CC/I and SS/SC regions.

Table 16. Northern quahog landings in live lbs. and Value 2005-2018

Statewide Totals

Northern Quahog (landings in live lbs)							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Landings	3.67 M	6.86 M	7.24 M	6.88 M	6.32 M	6.86 M	6.00 M
Value	$3.24 M	$5.18 M	$5.42 M	$5.48 M	$4.83 M	$4.72 M	$3.96 M
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Landings	4.70 M	5.46 M	5.04 M	4.78 M	4.47 M	4.22 M	4.56 M
Value	$3.67 M	$3.84 M	$3.69 M	$4.37 M	$4.72 M	$4.5 M	$4.88 M

Figure 10. Statewide northern quahog landings (lbs) 2005-2018

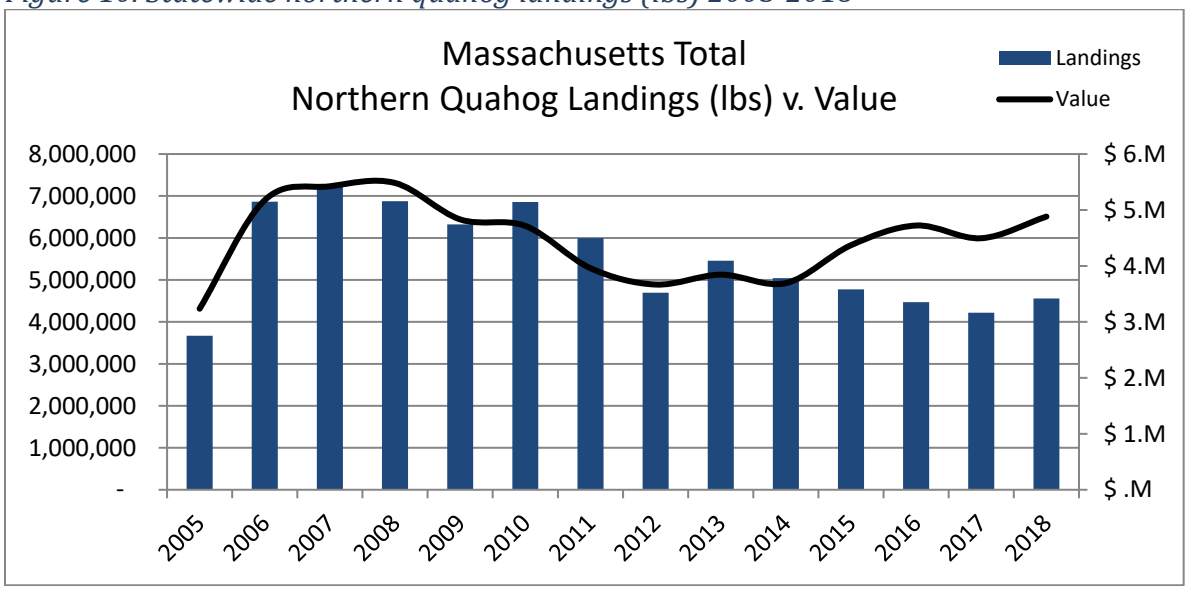


Table 17. Northern Quahog Landings by Region (Live lbs.) 2014-2018

Northern Quahog Landings (Live Pounds)

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	0.01 M	0.01 M	*	0.00 M	*
CAPE COD/ISLANDS	**3.89 M**	**3.79 M**	**3.58 M**	**3.26 M**	**3.90 M**
SOUTH SHORE/SOUTH COAST	1.14 M	0.98 M	0.89 M	0.96 M	0.65 M
TOTAL	5.04 M	4.78 M	4.47 M	4.22 M	4.56 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Table 18. Northern Quahog Ex-Vessel Value by Region 2014-2018

Northern Quahog Ex-Vessel Value

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	$. M	$. M	*	$. M	*
CAPE COD/ISLANDS	**$3.09 M**	**$3.71 M**	**$4.09 M**	**$3.88 M**	**$4.35 M**
SOUTH SHORE/SOUTH COAST	$.6 M	$.66 M	$.64 M	$.67 M	$.53 M
TOTAL	$3.69 M	$4.38 M	$4.72 M	$4.55 M	$4.88 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Softshell Clam

The commercial softshell clam fishery is almost exclusively wild harvest. As such, annual landings are highly influenced by natural recruitment and propagation activities to supplement natural recruitment are not widespread. Moreover, the presence and absence of abundant sets of softshell clams contribute to overall effort in the fishery. These fluctuations are not particularly noticeable in the five-year study period of 2014 – 2018, as landings have generally been on the upswing during this period, from 2M pounds in 2014 to about 3.7M pounds in 2017 and 2018. However, when reviewing the longer 2005 – 2018 lookback period, interannual variability in pounds landed becomes more obvious. This is particularly true of the 2005 – 2014 period, when landings fluctuated between about 2M and 6M pounds (Table 19).

With increasing landings over the course of the study period, we have also seen an increase in overall ex-vessel value. The fishery was valued at $4M in 2014 and then $6.2M in 2018. This positive relationship between productivity and value is discernable throughout the 2005-2018 lookback period, with landings and value both reaching a nadir in 2014 (2M pounds harvested with an ex-vessel value of $4M) and a pinnacle in 2007 (6.28M pounds harvested with an ex-vessel value of $8.28M) (Table 19; Figure 11).
It is notable that despite this general positive relationship between landings and value, it is not proportional. Price per unit is subject to interannual fluctuations. The price per pound went

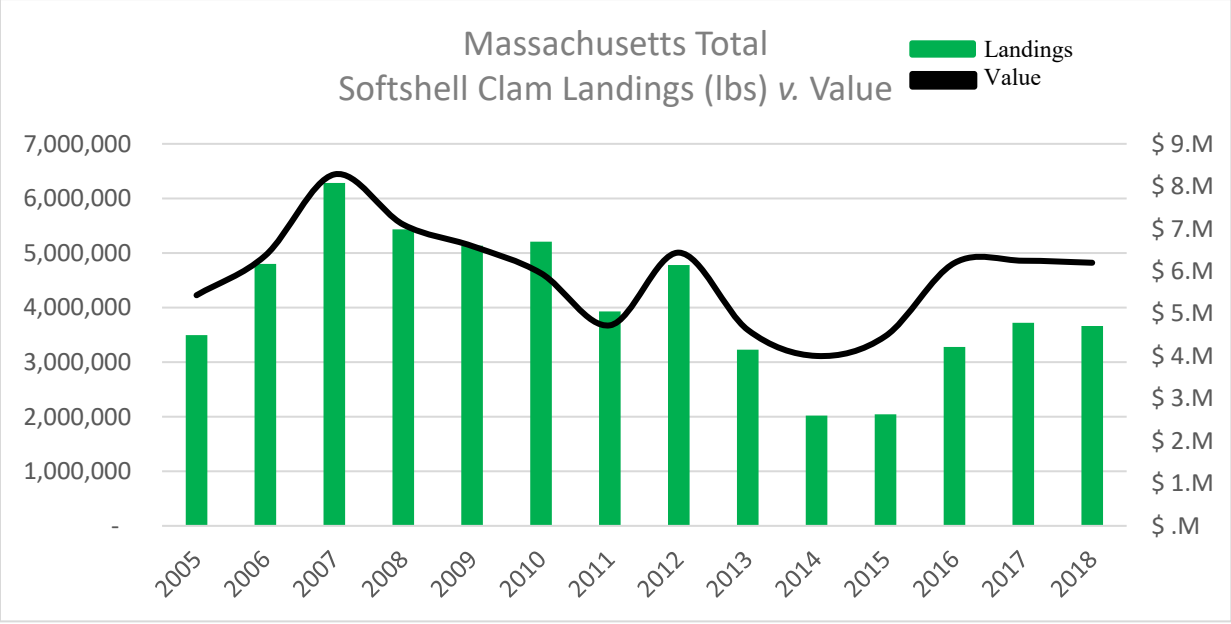
down gradually from 2005 – 2010 (from $1.55/pound to $1.14/pound respectively); it then began to rebound in 2011 ($1.34/pound) before jumping dramatically in 2014 ($2/pound) and reaching its time series peak in 2015 ($2.18/pound); it has since stabilized a bit from 2016-2018 to between $1.68 and $1.88 per pound (Table 19; Figure 11). These price per unit trends may be driven by a number of factors including supply, market demand, product quality, and other larger macro-economic factors.

Table 19. Softshell Clam Statewide Landings (lbs.) and Value 2005-2018

Statewide Totals

Softshell Clam (landings in live lbs)							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Landings	3.50 M	4.80 M	6.28 M	5.43 M	5.13 M	5.21 M	3.93 M
Value	$5.43 M	$6.37 M	$8.28 M	$7.1 M	$6.59 M	$5.95 M	$4.72 M
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Landings	4.78 M	3.23 M	2.02 M	2.05 M	3.28 M	3.72 M	3.66 M
Value	$6.44 M	$4.62 M	$4. M	$4.47 M	$6.19 M	$6.25 M	$6.2 M

Figure 11. Statewide softshell clam landings (lbs) 2005-2018



Softshell clams are found throughout Massachusetts from Westport to Salisbury and occur across all three geographic regions in Massachusetts in commercially viable quantities. Of the five shellfish fisheries being investigated, softshell clams are the most valuable to the BH/NS

region. Depending on the year, it is the fourth or fifth most valuable to the CC/I region, alternating with razor clams. It is only of nominal value to the SS/SC region. While there are municipalities that support commercial softshell clam fisheries in the SS/SC region, they contribute less than a fraction of a percent to annual landings and value Accordingly, the SS/SC fishery is not being analyzed.

During the study period, those communities in the BH/NS region have been responsible for a majority of the state's harvest, but CC/I region (particularly Barnstable and Chatham) have always provided substantial contributions to overall harvest (Table 20). In fact, Chatham was the number one municipal producer of softshell clams for several years.

During the 2014-2018 study period, landings from BH/NS communities have approximately doubled from 1.6 M lbs to 3.3 M lbs. This is likely attributable to an increase in landings from the North Shore, as the softshell clam resource in Boston Harbor has been negatively impacted by neoplasia induced mortality and green crab predation. CC/I landings have fluctuated between 300,000 pounds to over 600,000 pounds during the 2014 to 2018 period. For the time series, CC/I landings peaked in 2016 (680,000 pounds) and saw their nadir in 2018 (320,000 pounds).

As previously stated, this interannual variability within the two major harvest regions is likely attributable to variability in natural resource abundance. However, it should be mentioned that during this study period, DMF implemented a pilot project to encourage the removal of invasive green crabs, a softshell clam predator. This so-called "green crab bounty program" has been funded by the legislature for the communities from Gloucester to Newbury. Whether the increase in North Shore landings is in any part due to this green crab removal program has not been proven.

Regional ex-vessel value trends reflect trends across the state-wide fishery. Accordingly, there is a general positive relationship between landings and value, but price per unit fluctuations annually. Throughout the time series, the ex-vessel value of the fishery in the BH/NS region ranged from $2.77M in 2015 to $5.46M in 2018 and for the CC/I region it ranged from $1.69M in in 2015 to $720,000 in 2018. These were also the peak and nadir years for landings within these regions (Table 21).

There is also a potential relationship between the harvest of softshell clams and the harvest of razor clams. These two fisheries are prosecuted similarly in terms of gear and habitat. Accordingly, the presence or absence of one of these resources may influence commercial fishing effort on the other resource. Trends in the razor clam fishery are examined in the next sub-section of this report.

Table 20. Softshell Clam Landings (live lbs.) by region 2014-2018

Softshell Clam Landings (Live Pounds)

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	1.64 M	1.44 M	2.57 M	3.32 M	3.33 M
CAPE COD/ISLANDS	0.37 M	0.61 M	0.68 M	0.38 M	0.32 M
SOUTH SHORE/SOUTH COAST	*	0.00 M	0.02 M	*	*
TOTAL	2.01 M	2.05 M	3.28 M	3.70 M	3.65 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Table 21. Softshell Clam Ex-Vessel Value by region 2014-2018

Softshell Clam Ex-Vessel Value

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	$3.18 M	$2.77 M	$4.56 M	$5.39 M	$5.46 M
CAPE COD/ISLANDS	$.81 M	$1.69 M	$1.6 M	$.85 M	$.72 M
SOUTH SHORE/SOUTH COAST	*	$. M	$.04 M	*	*
TOTAL	$3.99 M	$4.47 M	$6.2 M	$6.24 M	$6.18 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Atlantic Razor Clam

Similar to the softshell calm fishery, the razor clam fishery is exclusively wild harvest. Accordingly, similar caveats regarding how natural abundance influences effort and landings would apply. During the study period, landings have increased by 50%. However, this increase was not steady, as fishery landings waned in 2015 and 2016 compared to 2014, before increasing substantially in 2017 and again in 2018. This interannual variability is to be expected given fluctuations in natural abundance and is observed throughout the longer 2005 – 2018 lookback period. However, what is striking is the growth of this fishery during this lookback period, as landings have increased by nearly 300% from 191,000 pounds in 2005 to 728,000 pounds in 2018. Much of this growth occurred beginning in 2012, when landings approximately doubled from the prior time series (Table 22). Landings have remained at this elevated level in all years following 2012.

The annual ex-vessel value of this razor clam fishery has seen substantial fluctuations during the study period (and the preceding year of 2013). The ex-vessel value of the fishery was $830,000 in both 2014 and 2018, despite landings in 2018 being 50% higher. However, the fishery was valued at $2.35M in 2015 and 2017 with landings at 336,000 pounds and 547,000 pounds, respectively (Table 22; Figure 12). This indicates that price per pound is volatile and has recently varied greatly from year-to-year independent of landings.

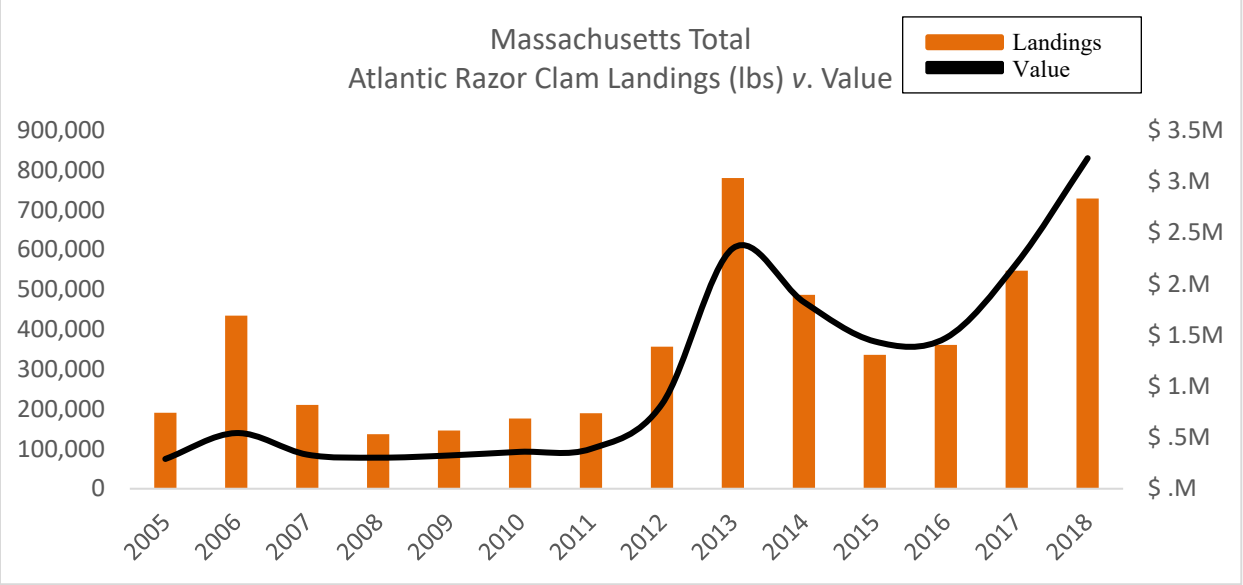
This volatility is not observed at the beginning of the longer lookback period (2005-2012). However, there is a trend towards increasing price per pound. From 2005 – 2007, the price per pound was about $1.30 to just over $1.50. Then from 2008-2012, the price went up to over $2.00 per pound before increasing to over $3.00 per pound in 2013 (Table 22; Figure 12). Anecdotally, these recent trends in razor clam value and landings are in response to the development of new markets.

Table 22. Statewide totals for Value and Landings for the Atlantic Razor Clam 2005-2018

Statewide Totals

Atlantic Razor Clam (landings in live lbs)							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Landings	191 K	435 K	210 K	137 K	146 K	176 K	189 K
Value	$.29 M	$.54 M	$.33 M	$.3 M	$.32 M	$.36 M	$.39 M
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Landings	356 K	780 K	487 K	336 K	361 K	547 K	728 K
Value	$.83 M	$2.35 M	$1.82 M	$1.44 M	$1.47 M	$2.20 M	$3.23 M

Figure 12. Statewide Atlantic razor clam landings (lbs) 2005-2018



The razor clam resources occurs across all geographic regions and there is a commercial fishery in each of the geographic regions (Table 23). Of the five shellfish resources being investigated, razor clams are the second most valuable species harvested in the BH/NS region, fourth or fifth

most valuable species harvested in the CC/I region (alternating with softshell clams) and the fourth most valuable resource to the SS/SC region.

The BH/NS region dominated razor clam landings in 2014 (344,000 pounds) and 2015 (244,000 pounds) accounting for between 60-70% of state-wide harvest. However, by 2016 the region's contribution fell below 50% and continued to decline to 17% in 2018. This change corresponds with BH/NS landings decreasing by 275% over the time-series and four-fold between the time-series peak (2014) and nadir (2017). It also reflects a sharp increase in landings from the CC/I region. The CC/I region went from producing 13% of state-wide landings in 2014 (66,000 pounds) to 72% (525,000 pounds) in 2018.

Landings from the SS/SC region has remained steady over the time with annual landings ranging from 38,000 pounds in 2014 to 91,000 pounds in 2017, with most years around 70,000 pounds, approximating 10-15% of the annual aggregate landings for all regions. Interestingly, during the region's peak year (2017), its contribution to the overall fishery was the lowest (5%) of the time series. This is because of a large increase in landings coming from CC/I region.

This shift in regional landings bears out in ex-vessel value trends (Table 24). NS/BH communities have seen overall ex-vessel value decrease from $1.3M to $593,000, whereas CC/I communities have seen an increase in ex-vessel value from $236,000 to $2.3M. This shows a clear shift in both productivity and value the BH/NS region to the CC/I region. The SS/SC region's value ranges from $130,000 in 2013 to $390,000 in 2017. These years correspond are also the peak and nadir years for the region's landings.

It should be noted harvesters of softshell clams and razor clams are often the same permitted individuals, particularly on the NS. Yet, given the home rule of shellfish fisheries, local regulations often differ across municipalities and region. This may explain some of the trends we are seeing across regional value and productivity. Specifically, certain CC/I municipalities allow the use of a salt spray delivered directly into the razor clam burrow, whereas this technique is prohibited across BH/NS communities. The use of salt spray can greatly improve efficiency and prolong access to the available resource. Razor clams prefer near-intertidal habitat to sub-tidal habitat, and as such, harvesting is generally limited to extreme low tides during the wintertime. In BH/NS communities, this amounts to two or three days of harvesting every other week when the tide is sufficiently low to dig the clams. Whereas, in CC/I communities, where salt spray may be used, harvest is productive over a broader spectrum of tidal conditions and seasons.

Table 23. Atlantic Razor Clam Landings in Live lbs. by region 2014-2018

Atlantic Razor Clam Landings (Live Pounds)

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	344K	244K	166K	85K	125K
CAPE COD/ISLANDS	66K	54K	130K	371K	525K
SOUTH SHORE/SOUTH COAST	76K	38K	65K	91K	78K
TOTAL	489K	338K	363K	549K	730K

Source: SAFIS Dealer Database, 07/17/2019 ED

Table 24. Atlantic Razor Clam Ex-Vessel Value by Region 2014-2018

Atlantic Razor Clam Ex-Vessel Value

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	$1.37 M	$1.09 M	$.79 M	$.39 M	$.59 M
CAPE COD/ISLANDS	$.24 M	$.22 M	$.44 M	$1.63 M	$2.32 M
SOUTH SHORE/SOUTH COAST	$.21 M	$.13 M	$.24 M	$.39 M	$.32 M
TOTAL	$1.82 M	$1.44 M	$1.47 M	$2.41 M	$3.23 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Bay Scallop

Bay scallops are also almost exclusively a wild harvest fishery. Under state law (M.G.L. c. 130, § 71), the commercial harvest of bay scallops may only occur during the fall and winter period. Similar to other wild harvest fisheries, landings demonstrate a high inter-annual variability. During the study period, annual landings have fluctuated between 539,000 pounds and 980,000 pounds with 2014 being the high-water mark and 2018 representing the median. This trend towards annual fluctuations in productivity is also observed over the longer lookback period of 2005 – 2018. During this period, landings fluctuated between 480,000 pounds in 2006 to about 1.4M pounds in 2007 and 2009 (Table 25).

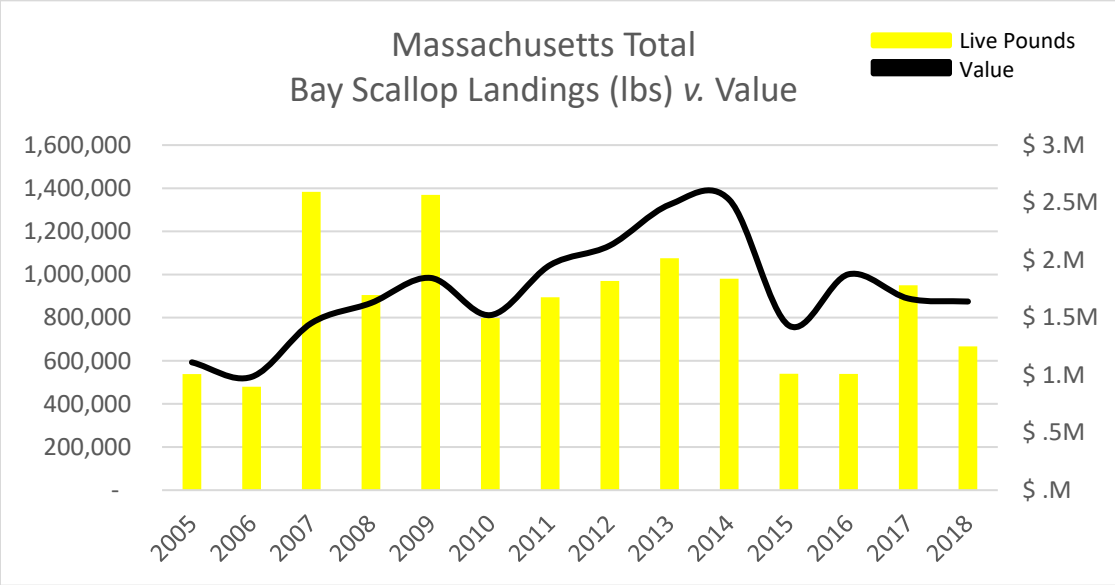
Similarly, ex-vessel value also fluctuates annually. During the study period, the fishery was valued between $2.53M (2014 - high-water mark for landings) and $1.43M (2015). The annualized price per pound also fluctuated during this time series. This price per pound value increased from $2.58 in 2014 to $3.48 in 2016, before dropping to $1.6 in 2017, and bouncing back up to $2.46 in 2018 (Table 25; Figure 13).

Table 25. Bay Scallop Statewide totals for value and landings in live lbs. 2005-2018

Statewide Totals

Bay Scallop (landings in live lbs)							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Landings	538 K	480 K	1,383 K	905 K	1,369 K	798 K	894 K
Value	$1.11 M	$.98 M	$1.45 M	$1.63 M	$1.85 M	$1.52 M	$1.96 M
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Landings	970 K	1,075 K	980 K	540 K	539 K	950 K	667 K
Value	$2.13 M	$2.48 M	$2.53 M	$1.43 M	$1.88 M	$1.67 M	$1.64 M

Figure 13. Bay Scallop landings data in live lbs and value 2005-2018



The wild harvest of bay scallops is limited to CC/I and SS/SC and within the SS/SC region harvest only occurs in Buzzards Bay. Of the five shellfish fisheries being investigated, the bay scallop fishery is ranked third in terms of value for the CC/I and SS/SC region.

During the study period, CC/I dominates state landings, though Buzzard Bays communities produced 30% of the state total in 2017. In terms of production and value, 2014 is the peak year in the time-series for CC/I. This is no surprise given that is the high-water mark for the fishery at large. For the SS/SC region, landings and value peaked in 2017, which also corresponds to the year when the SS/SC region contributed the most to overall landings (Tables 26 and 27).

Table 26. Bay Scallop Landings (Meat lbs.) by region 2014-2018

Bay Scallop Landings (Meat Pounds)

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	*				*
CAPE COD/ISLANDS	169K	87K	91K	128K	98K
SOUTH SHORE/SOUTH COAST	7K	10K	6K	43K	21K
TOTAL	178K	99K	99K	173K	121K

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Table 27. Bay Scallop Ex-Vessel Value by region 2014-2018

Bay Scallop Ex-Vessel Value

REGION	2014	2015	2016	2017	2018
BOSTON HARBOR/NORTH SHORE	*				*
CAPE COD/ISLANDS	$2.41 M	$1.25 M	$1.77 M	$1.8 M	$1.48 M
SOUTH SHORE/SOUTH COAST	$.12 M	$.18 M	$.11 M	$.33 M	$.16 M
TOTAL	$2.53 M	$1.43 M	$1.88 M	$2.13 M	$1.64 M

Source: SAFIS Dealer Database, 07/17/2019 ED

*Confidential

Recreational permit trends:

Issuance of recreational permits falls under municipal control. Collection of recreational landings data and permitting is not standardized across municipalities. Therefore, data was compiled through the AC municipal survey (Appendix C) and presented in the context below. Nonetheless, the economic value of recreational shellfisheries is expected to be substantial based on dated analysis that estimated the total value for recreational shellfishing for just Cape Cod to be $7.4 million in 2002[5].

Of the 38 coastal communities in Massachusetts with DSGAs classified as suitable for the direct harvest of shellfish that participated in the MSI municipal survey, 34 stated they offer recreational harvest opportunities in their community. Of these 34 communities, 32 provided information on the average number of annual recreational permits issued. Nine municipalities reported issuing over 1,000 recreational shellfish permits annually and 7 reported issuing between 500-1,000 permits annually. However, a majority of these municipalities issue fewer than 500 permits. The vast majority of respondents with an annual average of over 500 permits were located in the CC/I region, followed by the SS/SC region (Figure 14; Table 28).

[5] University of Massachusetts Amherst Department of Resource Economics Working Paper No. 2004-10 http://www.umass.edu/resec/workingpapers

Information regarding decadal trends in recreational permit sales and potential factors responsible for the observed trends was provided by 31 communities. Of these communities, 16 reported permit issuance as stable over the past decade. Whereas 12 communities reported increases in permit issuance, with eight of these 12 communities identifying enhanced shellfish propagation as the primary factor contributing to this increase. In 24 communities, recreational harvest is supported by municipal shellfish propagation or contaminated relays. There were 20 communities that responded stating they would like to increase recreational opportunities in their community. There were identifiable factors limiting recreational opportunities in 11 communities. Lastly, two communities indicated they were experiencing a decline in the number of recreational permit holders and one of these communities cited shellfish disease, decreases in municipal propagation, and concerns regarding icing product as limiting factors (Table 29).

Figure 14. Recreational Harvest Programs by Region for towns participating in the Municipal Survey

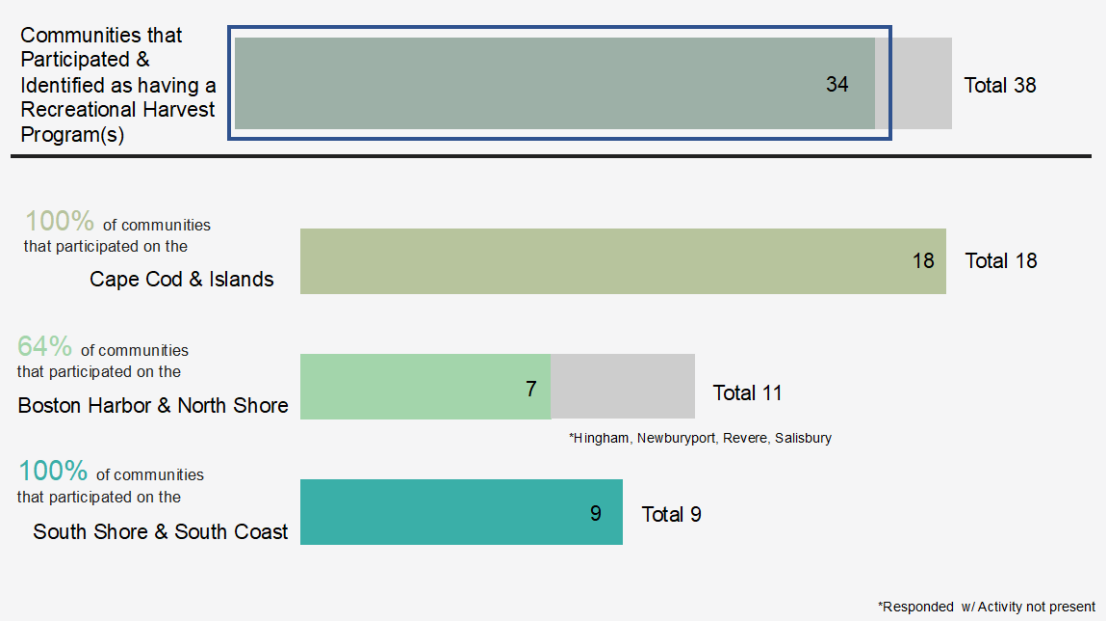


Table 28. Average number of recreational permits issued annually by municipalities

Number of Permits Issued Annually	Number of Towns	Town
>1,001	9	Barnstable
		Bourne
		Chatham
		Duxbury
		Eastham
		Mashpee
		Nantucket
		Orleans
		Wareham
501-1,000	7	Edgartown
		Fairhaven
		Falmouth
		Oak Bluffs
		Wellfleet
		Westport
		Yarmouth
251-500	7	Dennis
		Harwich
		Ipswich
		Marion
		Provincetown
		Tisbury
		Truro
101-250	4	Gloucester
		Kingston
		New Bedford
		Sandwich
51-100	3	Essex
		Marblehead
		Marshfield
0-50	2	Hull
		West Tisbury
Total		**32**

Table 29. Annual trends and factors related to the issuance of recreational permits by towns that participated in the municipal survey

Annual Trend Over the Past Decade	Number of Permits Issued Annually	Number of Towns	Town	Factor(s)
Increased	>1,000	3	Barnstable	Increase Propagation Planting & Decrease of Shellfish Programs in other Towns
			Duxbury	N/A
			Mashpee	Increase Propagation Planting
	500-100	2	Edgartown	Increase Propagation Planting & Population Increase
			Falmouth	Increase Propagation Planting
	250-500	3	Ipswich	Increase Natural Recruitment & Green Crab Trapping
			Provincetow	Increase Propagation Planting & Inclusive Social Attitude
			Truro	Increase Natural Recuritment & Increase Propagation Planting
	100-250	2	Kingston	Increase Natural Recruitment & Increase in Propagation Planting
			Sandwich	Increase Propagation Planting
	50-100	1	Essex	N/A
	0-50	1	West Tisbur	Increase Natural Recruitment & Increase in Population
	Total	**12**		

Annual Trend Over the Past Decade	Number of Permits Issued Annually	Number of Towns	Town	Factor(s)
Not Changed (Stable)	>1,000	6	Bourne	Increase Natural Recuritment, Increase Propagation Planting
			Chatham	Family Permit Holders
			Eastham	N/A
			Nantucket	Fluctuates with Season
			Orleans	N/A
			Wareham	Increase Propagation Planting
	500-100	3	Fairhaven	N/A
			Westport	Increase Natural Recruitment
			Yarmouth	Disease combined with Increase Propgation Planting
	250-500	3	Dennis	Increase Propagation Planting
			Harwich	N/A
			Tisbury	Love of Shellfishing & Education
	100-250	2	Gloucester	Enforcement of Non-Permitted Harvest
			New Bedfor	Increase Propagation Planting
	50-100	2	Marblehead	N/A
			Marshfield	Only Conditionally Approved Areas

Annual Trend Over the Past Decade	Number of Permits Issued Annually	Number of Towns	Town	Factor(s)
Decreased	500-100	1	Wellfleet	Disease, Decreased Propagationg Planting, Ice Impacts
	250-500	1	Marion	N/A
	Total	2		

Aquaculture and Propagation Status and Trends

Annually, DMF typically issues over 350 shellfish propagation permits to private shellfish aquaculture license holders and 25 shellfish propagation permits to municipalities for public propagation activities. These private and public operations occur in 30 coastal municipalities throughout the Commonwealth (Table 30).

Table 30. 2018 Shellfish Propagation Permits

Permit Type	Number of Permits
Private	391
Municipal	32

Private Shellfish Aquaculture Licenses and Permits

The majority of shellfish aquaculture leases in Massachusetts are located in the state's nearshore waters, which includes tidal flats and shallow subtidal waters along estuaries, bays, salt ponds, barrier beaches, and salt marshes. Currently there are 586 lease sites covering 1,202 acres across 30 coastal municipalities in Massachusetts (Figure 15). The average size of a private shellfish aquaculture grant site is 2.6 acres and 89% of permit holders have less than a 5 acre grant site (Figure 16). However, grant site sizes range from small upweller or raft sites of less than a $^{1}/_{10}$ of an acre to a 100-acre open water growout site (Table 31). More than one site can be licensed to the same grower and listed on the same permit, thus accounting for the higher number of grant sites than permit holders.

Private Shellfish Aquaculture Seed purchases and harvest landings and value

Shellfish aquaculture provides opportunities for full and part-time employment in the state (Borges et al., n.d.). A 2015 study evaluating the economic impacts of shellfish aquaculture on Cape Cod found that in 2013 shellfish growers on Cape Cod alone were responsible for 769 direct jobs. This economy also generated an additional 140 jobs through indirect and induced activity, resulting in a total of 909 jobs (Barnes, Nora et al, 2015). Further, it was found that Cape Cod shellfish growers paid $11.9m in direct wages in 2013, and their economic activity generated additional income of $8.2m, for a total of $20.1m in labor income in Massachusetts (Augusto & Holmes, 2015). The report estimated that the output of the shellfish aquaculture industry in Massachusetts was valued at $25.4m in 2013, which in turn generated $45.5m in the Massachusetts economy, or 1.79 times the activity (Barnes, Nora et al, 2015). This may be a conservative estimate of total economic value as many publications routinely use higher values.

Figure 15. Number of private shellfish aquaculture sites by coastal municipalities in 2018.

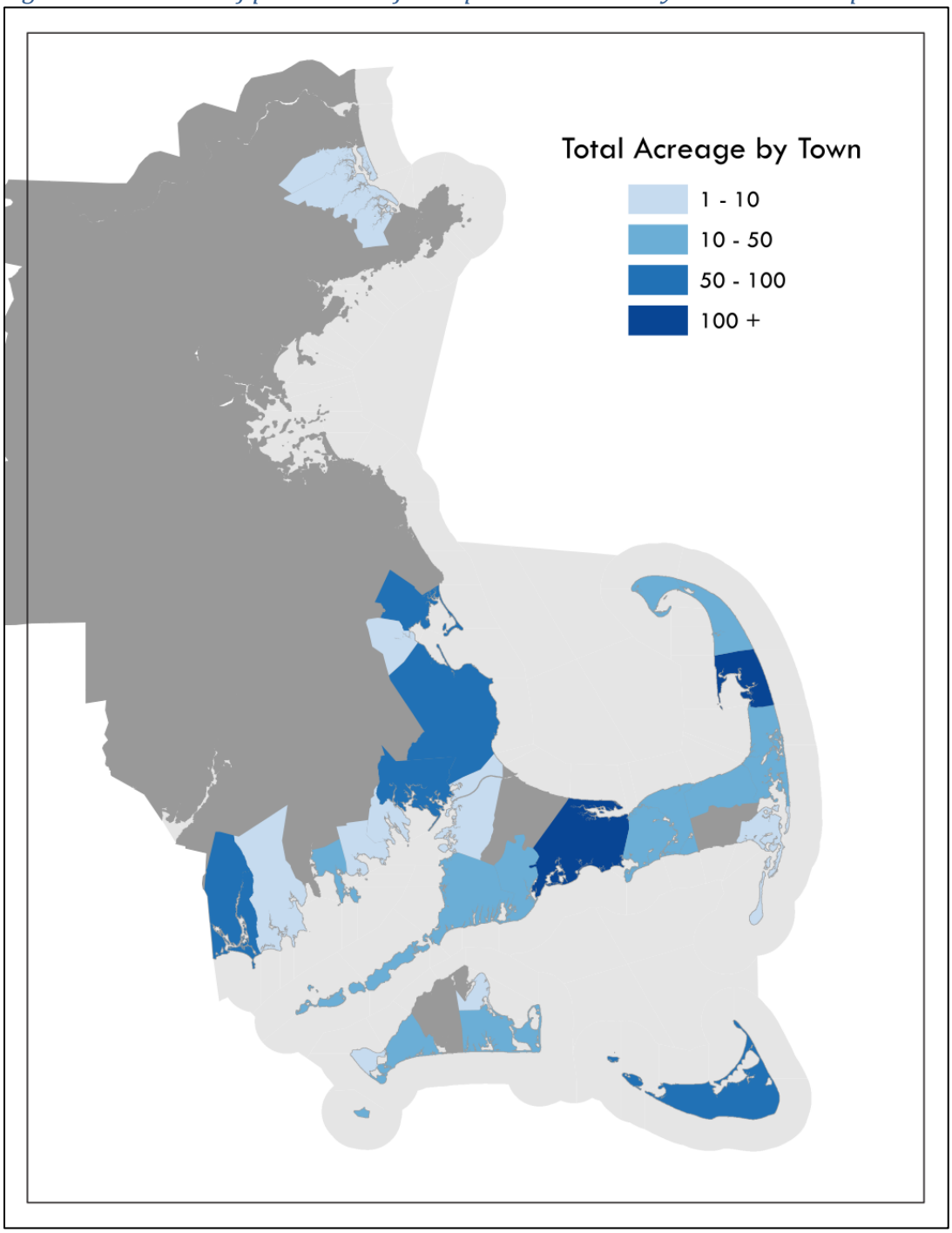
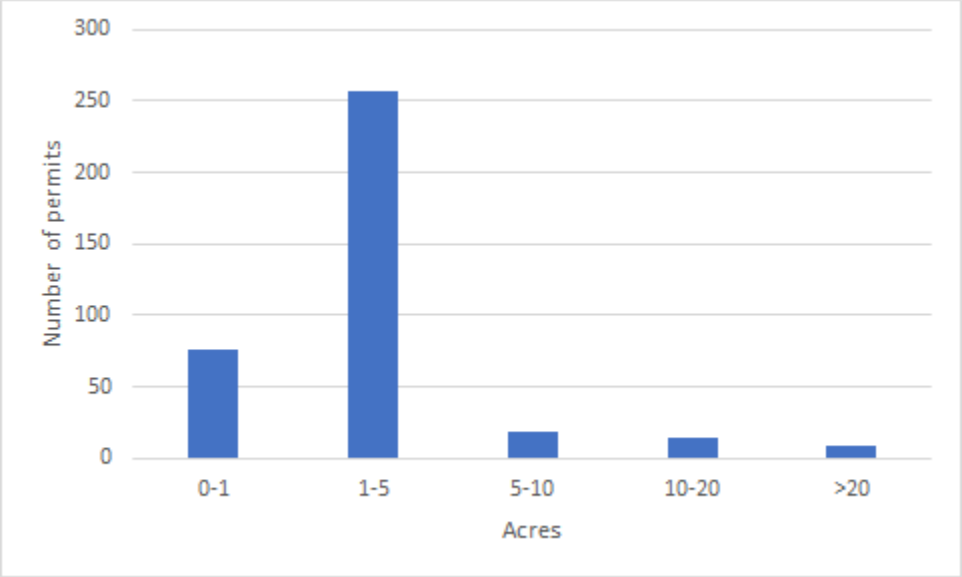


Table 31. 2018 Private Shellfish Propagation Permits and Acreage Under Cultivation, by Municipality

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

Figure 16. Number of private shellfish aquaculture permits by acreage value in 2018



Seed purchases

In 2018, a review of DMF propagation permit renewals showed that private growers in Massachusetts purchase over 200 million oyster seed and 50 million quahog seed. Municipalities purchase over 16 million oyster seed and 20 million quahog seed for propagation activities (Table 32). This resolution of data has not been collected and compiled historically. With continued collection and tabulation, and inclusion of the source hatchery, a better assessment of needs will be possible.

Table 32. 2018 Private Aquaculture and Public Propagation Seed Purchases by Species

Type	Oysters	Quahogs
Private Aquaculture	221M	51M
Public Propagation	16M	20M

Aquaculture landings

Below are 2018 shellfish landings for only the aquaculture sector of the commercial shellfish fishery. These landings and values are derived from SAFIS dealer reports. The SAFIS landings data contained in this report has been aggregated for confidentiality purposes (i.e., "rule of three"). Landings and value data are subject to change due to additions and auditing. Confidentiality of an individual or corporation's data is protected by only displaying summarized values and quantities that could not be used to identify data attributed to a single permitted entity. Units for quantity are converted for reporting purposes using standardized conversion factors developed by the Fisheries Statistics Program. In Table 33, value is calculated from the unit prices reported by dealers with the average unit price used to fill in missing data.

Trends in aquaculture landings have been primarily driven by cultured oyster landings as oysters, on-average, represent more than 95% of all aquaculture raised product in Massachusetts.

Table 33. 2018 Aquaculture Landings:
Pieces and Reported Value by town for Oysters and Quahogs

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

^ Islands means Chilmark, Oak Bluffs, Nantucket, and Gosnold.

^^ South Coast means Westport, Dartmouth, Fairhaven, and Mattapoisett.

^^^ Outer Cape means Provincetown, Truro, and Chatham.

* Summarized due to confidentiality rules.

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

^ Other Areas means Bourne, Chatham, Duxbury Falmouth, Marion, and Yarmouth

** = summarized due to confidentiality rules*

Grand Total of Reported	**$28,594,944**

Acknowledgements

The Massachusetts Shellfish Initiative Assessment Report is the result of concerted effort of the members of the Assessment Committee and dedication of the working group. While the data collection, research, planning, writing and preparation of this report was a coordinated effort in every sense by these individuals. It needs to be acknowledged the extensive time, energy, and thought contributed by Steering Committee with directives from the MSI Task Force.

Certainly, the individual members of these committees and work groups should be recognized, but also the Massachusetts municipalities, NGO's, research institutions and state agencies who permitted and prioritized their staff participation in this process and continue to do so, should be highlighted and thanked.

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Finally, thanks are also extended to all the stakeholders, user groups and individuals attending, participating and actively contributing to in-depth, thoughtful discussion at all Assessment Committee meetings.

Appendix A: DMF Regional Permits and Landings Data

DMF Permit Description(s)

322 CMR 7

7.01(1)

Shellfish means clams, conchs, limpets, mussels, oysters, periwinkles, quahogs, razor clams, bay scallops, sea scallops, surf clams, ocean quahogs and winkles.

7.01(2)

(g) Shellfish and Seaworms. Authorizes only the named individual to harvest, possess and land shellfish and seaworms for commercial purposes, and may be endorsed for the shucking of bay scallops.

(i) Shellfish/Rod and Reel. Authorizes the harvest, possession and landing of shellfish for commercial purposes and/or the harvest, possession or landing of fish by means of a rod and reel for commercial purposes subject to 322 CMR 7.01(10).

(k) Shellfish Transaction Card. Authorizes only the named individual holding a commercial fishermen permit endorsed for shellfish and seaworms to sell shellfish and seaworms, and shall be used in conjunction with either a Massachusetts driver's license or a Registry of Motor Vehicles identification card.

7.01(4) 1.

b. Bay Scallop Shucking. For a named individual to shuck bay scallops onshore for commercial or non-commercial purposes

d. Contaminated Surf Clam. For a named individual and/or vessel to operate a surf clam dredge in shellfish growing area designated by the Division as "PROHIBITED" and to harvest, possess or land surf clams taken from a shellfish growing area designated by the Division "PROHIBITED" for the purpose of being kept or sold as bait.

I. Sea Scallop Diving. For a named individual to commercially fish for sea scallops by hand within the waters under the jurisdiction of the Commonwealth, or to harvest, possess or land sea scallops for commercial purposes that were taken by hand in the Commonwealth.

j. Sea Scallop Shucking. For a named individual and/or vessel to shuck sea scallops at-sea for commercial or non-commercial purposes.

7.01(4) 2.

I. Ocean Quahog and Surf Clam Dredge. For a named individual and/or a vessel to operate an ocean quahog and/or surf clam dredge or to commercially fish for, harvest, possess or land ocean

quahogs or surf clams taken by ocean quahog and/or surf clam dredge gear from the waters under the jurisdiction of the Commonwealth.

j. Quahog Dredge. For a named individual and/or vessel to operate a bay quahog dredge or to commercially fish for, harvest, possess or land bay quahogs taken by bay quahog dredge gear from the waters under the jurisdiction of the Commonwealth seaward of the outer jurisdiction of coastal cities and towns to regulate shellfish pursuant to M.G.L. c. 130, § 52, as appearing on official maps of the Commonwealth prepared pursuant to M.G.L. c. 1 § 3.

7.02(1)

Master Digger means any person authorized by the Director pursuant to 322 CMR 7.02 to engage in the harvest, possession and transportation of moderately contaminated shellfish.

Subordinate Digger means any person authorized by the Director pursuant to 322 CMR 7.02 to harvest and possess moderately contaminated shellfish for sale to a master digger only.

Regional Key for Commercial Landings by Region

BOSTON HARBOR / NORTH SHORE		CAPE COD / ISLANDS		SOUTH SHORE / SOUTH COAST
BOSTON		BARNSTABLE		BOURNE
CAMBRIDGE		BREWSTER		COHASSET
ESSEX		CHATHAM		DARTMOUTH
GLOUCESTER		CHILMARK		DUXBURY
HINGHAM		DENNIS		FAIRHAVEN
HULL		EASTHAM		FALL RIVER
IPSWICH		EDGARTOWN		KINGSTON
NAHANT		FALMOUTH		MARION
NEWBURY		GAY HEAD		MARSHFIELD
NEWBURYPORT		GOSNOLD		MATTAPOISETT
QUINCY		HARWICH PORT		NEW BEDFORD
REVERE		MASHPEE		PLYMOUTH
ROCKPORT		NANTUCKET		SCITUATE
ROWLEY		OAK BLUFFS		SWANSEA
SALISBURY		ORLEANS		WAREHAM
SAUGUS		PROVINCETOWN		WESTPORT
WEYMOUTH		SANDWICH		
WINTHROP		TISBURY		
		TRURO		
		WELLFLEET		
		WEST TISBURY		
		YARMOUTH		

DMF Permits: Issuance, Activity and Landings

Issued and Active Permits

PERMITS ISSUED						
TYPE	**PERMIT TYPE**	**2014**	**2015**	**2016**	**2017**	**2018**
Fisherman	SHELLFISH & ROD & REEL	458	408	414	412	421
Fisherman	SHELLFISH & SEAWORMS	820	735	806	843	879
Special	AQUACULTURE*	49	46	8	2	4
Special	MASTER DIGGER	5	7	9	6	3
Special	SHELLFISH PROPAGATION*	332	295	378	398	415
Special	SHELLFISH RELAY (CONTAMINATED)	17	15	20	17	20
Special	SUBORDINATE DIGGER	51	59	76	37	25

Source: MA Permitting Database, 08/05/2019 ED
* Changes in the number of aquaculture and shellfish propagation permits issued before and after 2014 reflect modifications in how DMF permits these activities.

ACTIVE PERMITS ISSUED						
TYPE	**PERMIT_NAME**	**2014**	**2015**	**2016**	**2017**	**2018**
Fisherman	SHELLFISH & ROD & REEL	360	313	322	336	326
Fisherman	SHELLFISH & SEAWORMS	617	578	637	681	677
Special	AQUACULTURE	*	*	*	*	*
Special	MASTER DIGGER	3	4	4	2	
Special	SHELLFISH PROPAGATION	*	*	*	*	*
Special	SHELLFISH RELAY (CONTAMINATED)	*	*	*	*	*
Special	SUBORDINATE DIGGER	41	47	63	32	23

Source: MA Permitting Database, SAFIS Dealer Database, 08/05/2019 ED
*Commercial shellfish landings are not associated with these permit types.

Percent of Permits with Landings						
TYPE	**PERMIT_NAME**	**2014**	**2015**	**2016**	**2017**	**2018**
Fisherman	SHELLFISH & ROD & REEL	79%	77%	78%	82%	77%
Fisherman	SHELLFISH & SEAWORMS	75%	79%	79%	81%	77%
Special	AQUACULTURE	*	*	*	*	*
Special	MASTER DIGGER	60%	57%	44%	33%	0%
Special	SHELLFISH RELAY (CONTAMIANTED)	*	*	*	*	*
Special	SHELLFISH PROPAGATION	*	*	*	*	*
Special	SUBORDINATE DIGGER	80%	80%	83%	86%	92%

Source: MA Permitting Database, SAFIS Dealer Database, 08/05/2019 ED
*Commercial shellfish landings are not associated with these permit types.

Issued and Active Endorsements

ENDORSEMENTS ISSUED					
ENDORSEMENT	**2014**	**2015**	**2016**	**2017**	**2018**
BAY SCALLOP SHUCKING	43	44	45	42	40
CAP	28	26	26	25	25
CAP-NS MOBIL GEAR	95	93	93	93	92
CAP-SEA SCALLOP DREDGE	11	10	9	9	9
CONTAMINATED SURF CLAM DREDGE	14	14	17	20	25
OCEAN QUAHOG	27	27	27	26	
QUAHOG-DREDGE	48	48	48	48	47
SANCTIONED HARVESTER		108	163	182	237
SC/OQ DREDGE				37	37
SEA SCALLOP DIVING	140	152	156	159	160
SEA SCALLOP SHUCKING	802	800	815	819	835
SHELLFISH CAPTAIN		22	45	53	43
SHELLFISH ENDORSEMENT	3,116	3,043	3,209	3,277	3,346
SURF CLAM	34	34	34	32	
SOURCE: MA Permitting Database, 08/05/2019 ED					

ACTIVE ENDORSEMENT ISSUED					
ENDORSEMENT	**2014**	**2015**	**2016**	**2017**	**2018**
BAY SCALLOP SHUCKING	33	34	32	32	30
CAP	16	14	15	14	13
CAP-NS MOBIL GEAR	58	58	66	58	61
CAP-SEA SCALLOP DREDGE	7	7	6	8	8
CONT. SURF CLAM DREDGE	11	10	10	11	13
OCEAN QUAHOG	18	15	14	17	
QUAHOG-DREDGE	30	36	37	36	32
SANCTIONED HARVESTER		14	40	55	75
SC/OQ DREDGE				23	26
SEA SCALLOP DIVING	82	83	98	100	97
SEA SCALLOP SHUCKING	462	467	472	470	453
SHELLFISH CAPTAIN		2	1	2	3
SHELLFISH ENDORSEMENT	1,972	1,902	1,981	2,074	2,003
SURF CLAM	19	17	18	19	
SOURCE: MA Permitting Database, SAFIS Dealer Database, 08/05/2019 ED					

Percent Active Endorsements Issued					
ENDORSEMENT	**2014**	**2015**	**2016**	**2017**	**2018**
BAY SCALLOP SHUCKING	77%	77%	71%	76%	75%
CAP	57%	54%	58%	56%	52%
CAP-NS MOBIL GEAR	61%	62%	71%	62%	66%
CAP-SEA SCALLOP DREDGE	64%	70%	67%	89%	89%
CONT. SURF CLAM DREDGE	79%	71%	59%	55%	52%
OCEAN QUAHOG	67%	56%	52%	65%	
QUAHOG-DREDGE	63%	75%	77%	75%	68%
SANCTIONED HARVESTER		13%	25%	30%	32%
SC/OQ DREDGE				62%	70%
SEA SCALLOP DIVING	59%	55%	63%	63%	61%
SEA SCALLOP SHUCKING	58%	58%	58%	57%	54%
SHELLFISH CAPTAIN		9%	2%	4%	7%
SHELLFISH ENDORSEMENT	63%	63%	62%	63%	60%
SURF CLAM	56%	50%	53%	59%	
SOURCE: derived from MA Permitting Database, SAFIS Dealer Database, 08/05/2019 ED					

Species Landings and Ex-Vessel Value

Species Landings by Pounds

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
SPECIES	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Clam, Arctic Surf (Stimpson)	*						*					*		*	*
Clam, Blood Arc										34,380	69,873	90,826	61,050	62,345	56,935
Clam, Northern Quahog	3,668,342	6,863,470	7,244,222	6,876,149	6,322,601	6,856,754	5,995,341	4,696,654	5,457,028	5,042,833	4,775,174	4,470,497	4,220,305	4,556,486	2,669,622
Clam, Ocean Quahog		31,525	79,530	16,913	29,865	18,975				141,879			2,157		40,796
Clam, Razor, Atlantic	190,609	434,558	210,481	136,938	146,050	176,126	189,499	356,363	779,835	486,507	336,088	361,043	547,227	728,322	395,959
Clam, Soft	3,496,322	4,799,882	6,283,028	5,434,563	5,134,804	5,207,055	3,929,770	4,779,085	3,228,325	2,019,936	2,045,244	3,277,365	3,722,041	3,663,444	2,019,149
Clam, Stout Tagelus (Stubby Razor/Bamboo)											*		*	*	
Clam, Surf	1,569,727	2,347,812	4,195,476	7,187,622	7,998,332	9,255,488	5,637,849	3,996,924	3,556,906	7,153,085	3,791,529	3,327,565	8,774,688	10,553,610	7,694,358
Mussel, Blue	1,484,158	1,498,990	1,833,646	5,491,949	619,782	757,556	779,952	2,395,364	6,714,709	10,916,681	15,336,216	11,340,841	12,140,357	5,933,393	809,558
Oyster, Eastern	1,216,994	2,495,249	1,731,677	1,980,005	2,254,618	2,929,655	3,150,289	4,125,813	4,343,944	5,720,783	7,012,203	6,602,527	8,346,145	8,586,823	5,025,424
Oyster, European Flat								*	*	*			*		
Scallop, Bay	538,106	479,755	1,383,183	905,027	1,369,452	797,727	894,137	970,364	1,075,300	980,256	539,807	539,141	949,835	666,950	65,825
Scallop, Sea	241,941,972	300,365,218	271,056,321	225,003,980	248,081,357	259,543,652	275,685,549	306,059,483	244,054,575	177,679,457	179,015,565	190,303,366	270,027,082	336,950,880	243,574,582
*CONFIDENTIAL															
Source: MA SAFIS Dealer Database, 08/09/2019 JK															

Species Landings by Ex-Vessel Value

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
SPECIES	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
Clam, Arctic Surf (Stimpson)	*						*					*		*	*
Clam, Blood Arc										$ 70,579	$ 140,102	$ 171,201	$ 80,451	$ 130,323	$ 123,124
Clam, Ocean Quahog		$ 1,632	$ 13,914	$ 710	$ 587	$ 205				$ 3,632			$ 595		$ 8,370
Clam, Razor, Atlantic	$ 290,508	$ 543,435	$ 332,905	$ 303,300	$ 324,570	$ 360,176	$ 389,360	$ 825,647	$ 2,346,524	$ 1,821,975	$ 1,437,362	$ 1,471,163	$ 2,200,900	$ 3,226,251	$ 1,939,934
Clam, Soft	$ 5,433,217	$ 6,370,958	$ 8,280,530	$ 7,099,775	$ 6,592,851	$ 5,951,395	$ 4,724,586	$ 6,437,310	$ 4,617,884	$ 4,003,172	$ 4,471,232	$ 6,193,553	$ 6,246,496	$ 6,198,894	$ 3,516,178
Clam, Stout Tagelus (Stubby Razor/Bamboo)											*		*	*	
Clam, Surf	$ 312,734	$ 341,003	$ 758,999	$ 1,416,143	$ 1,715,633	$ 1,741,777	$ 1,053,295	$ 1,037,677	$ 900,832	$ 1,467,077	$ 840,858	$ 827,797	$ 2,244,324	$ 2,958,219	$ 2,448,902
Mussel, Blue	$ 201,842	$ 249,075	$ 280,759	$ 752,102	$ 267,136	$ 423,315	$ 547,103	$ 588,218	$ 1,474,707	$ 1,434,847	$ 2,069,791	$ 1,786,567	$ 1,111,564	$ 943,456	$ 121,316
Oyster, Eastern	$ 2,120,447	$ 4,027,491	$ 4,184,158	$ 4,451,465	$ 5,416,005	$ 6,969,033	$ 7,238,401	$ 9,538,819	$ 13,878,338	$ 19,402,029	$ 22,655,032	$ 22,508,947	$ 24,040,043	$ 28,309,882	$ 16,498,168
Oyster, European Flat								*	*	*			*		
Scallop, Bay	$ 1,111,508	$ 984,852	$ 1,451,769	$ 1,627,254	$ 1,845,196	$ 1,521,872	$ 1,956,883	$ 2,126,422	$ 2,482,094	$ 2,525,617	$ 1,431,362	$ 1,876,968	$ 1,666,194	$ 1,640,017	$ 224,735
Scallop, Sea	$ 226,790,691	$ 234,542,483	$ 218,251,613	$ 189,891,193	$ 197,172,643	$ 252,229,368	$ 330,410,486	$ 364,622,155	$ 334,044,865	$ 271,292,266	$ 264,690,819	$ 281,220,348	$ 328,832,067	$ 374,489,446	$ 277,595,500
*CONFIDENTIAL															
Source: MA SAFIS Dealer Database, 08/09/2019 JK															

Municipal Landings and Ex-Vessel Value by Species

Oyster Landings (Pieces)

MA Oyster Landings (Pieces)					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	7,641,733	8,681,908	6,374,257	10,255,634	10,931,001
BOSTON	*	*	*	*	
BOURNE	13,137	*	29,400	*	45,564
BREWSTER	206,650	331,394	262,550	389,577	374,900
CHATHAM	1,674,949	2,048,233	2,310,189	2,457,412	1,415,273
CHILMARK	428,284	860,418	861,308	622,241	831,523
DARTMOUTH	*	42,225	*	*	22,800
DENNIS	1,519,145	1,291,997	2,056,157	2,307,379	2,212,138
DUXBURY	8,693,609	10,628,880	10,443,115	12,118,487	11,750,220
EASTHAM	547,412	688,169	568,660	386,597	678,621
EDGARTOWN	1,833,175	2,060,274	2,659,466	2,156,049	2,087,601
FAIRHAVEN	111,122	372,140	288,272	559,151	290,216
FALMOUTH	396,916	298,216	397,848	669,110	840,333
GLOUCESTER	*	*	*	*	*
GOSNOLD	*	*	*	*	*
HARWICH PORT		*			
IPSWICH	*	*	*	*	
KINGSTON	234,635	340,200	279,620	269,315	333,540
MARION	83,729	82,335	78,013	142,563	93,532
MARSHFIELD			*		
MASHPEE	62,385	*	*	83,828	241,420
MATTAPOISETT	*	*	*	*	*
NANTUCKET	108,727	301,289	381,521	371,800	515,461
NEW BEDFORD	*	*	*	*	*
OAK BLUFFS			*	*	*
ORLEANS		1,165,445	863,834	1,061,781	756,900
PLYMOUTH	511,462	850,131	1,661,973	2,633,115	2,291,980
PROVINCETOWN	50,047	689,441	175,089	319,080	100,014
SANDWICH	*	*	*	*	
SCITUATE	*	*			
SWANSEA		*			
TISBURY	*	*	*		
TRURO	*	*		17,000	19,750
WAREHAM	1,698,797	1,800,603	1,471,155	1,564,946	1,533,000
WELLFLEET	7,497,170	9,174,870	7,945,200	10,136,324	11,502,333
WEST TISBURY	*	*	*	*	*
WESTPORT	338,150	576,407	769,761	1,193,463	1,412,520
YARMOUTH	215,789	112,670	129,850	571,004	666,327
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Oyster Ex-Vessel Value

MA Oyster Ex-Vessel Value					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	$4,365,716	$5,217,446	$3,739,688	$5,849,719	$6,050,274
BOSTON	*	*	*	*	
BOURNE	$6,438	*	$15,503	*	$25,260
BREWSTER	$121,025	$190,474	$148,976	$224,196	$214,224
CHATHAM	$993,542	$1,197,477	$1,369,599	$1,464,699	$783,216
CHILMARK	$255,607	$435,337	$398,653	$318,293	$403,507
DARTMOUTH	*	$18,820	*	*	$12,120
DENNIS	$860,600	$744,229	$1,174,811	$1,325,829	$1,254,214
DUXBURY	$4,785,146	$5,418,008	$5,523,868	$6,651,359	$6,514,775
EASTHAM	$300,598	$382,543	$325,201	$216,992	$376,368
EDGARTOWN	$1,098,651	$1,260,997	$1,516,472	$1,351,761	$1,299,558
FAIRHAVEN	$60,513	$205,178	$175,842	$347,128	$168,966
FALMOUTH	$176,344	$133,922	$210,872	$294,119	$403,795
GLOUCESTER	*	*	*	*	*
GOSNOLD	*	*	*	*	*
HARWICH PORT		*			
IPSWICH	*	*	*	*	
KINGSTON	$125,995	$190,625	$155,859	$150,273	$186,278
MARION	$41,580	$43,247	$39,513	$66,304	$42,514
MARSHFIELD			*		
MASHPEE	$35,515	*	*	$43,301	$133,937
MATTAPOISETT	*	*	*	*	*
NANTUCKET	$75,337	$232,927	$265,789	$236,402	$430,931
NEW BEDFORD	*	*	*	*	*
OAK BLUFFS			*	*	*
ORLEANS		$608,211	$508,434	$611,862	$441,251
PLYMOUTH	$281,569	$461,832	$906,071	$1,445,735	$1,222,826
PROVINCETOWN	$28,590	$52,081	$103,646	$190,388	$58,867
SANDWICH	*	*	*	*	
SCITUATE	*	*			
SWANSEA		*			
TISBURY	*	*	*		
TRURO	*	*		$10,100	$11,068
WAREHAM	$957,607	$1,047,793	$848,358	$910,113	$884,388
WELLFLEET	$3,980,865	$4,217,894	$4,329,143	$5,417,571	$6,141,652
WEST TISBURY	*	*	*	*	*
WESTPORT	$188,902	$298,380	$401,065	$628,049	$737,858
YARMOUTH	$111,442	$59,167	$73,771	$323,079	$367,379
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Razor Clam Landings (Live Pounds)

MA Razor Clam Landings (Live Pounds)					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	*	8,361	81,916	244,136	324,919
BOSTON	*		*		
BREWSTER				1,743	11,971
CAMBRIDGE	*				
CHATHAM	47,382	19,824	20,483	57,052	65,036
CHILMARK	*	*	*	*	*
DENNIS	*	*	5,847	1,411	*
DUXBURY	75,195	30,999	25,904	34,151	*
EASTHAM	*	15,436	18,273	24,123	25,909
ESSEX	67,696	22,246	10,485	4,916	*
FALMOUTH	*	*	*	*	3,097
GLOUCESTER	45,964	3,500	2,065	2,423	*
HARWICH PORT			*	*	*
IPSWICH	196,844	196,470	115,263	68,060	108,523
KINGSTON	*	*	36,805	54,356	37,313
MARSHFIELD		*	*		*
NEW BEDFORD					*
NEWBURY	*	12,012	36,429	*	*
NEWBURYPORT		*			
ORLEANS	*	1,463	*	35,006	70,097
PLYMOUTH		*	*	*	*
PROVINCETOWN	*		*		
ROWLEY	*	*	*	*	*
SANDWICH				*	
WAREHAM					*
WELLFLEET	2,276	5,576	*	1,716	7,781
WESTPORT				*	*
YARMOUTH		*		*	14,462
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Razor Clam Ex-Vessel Value

MA Razor Clams Ex-Vessel Value					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	*	$25,246	$251,917	$1,075,799	$1,448,093
BOSTON	*		*		
BREWSTER				$8,172	$56,366
CAMBRIDGE	*				
CHATHAM	$161,022	$85,067	$82,777	$247,631	$278,477
CHILMARK	*	*	*	*	*
DENNIS	*	*	$14,426	$5,867	*
DUXBURY	$210,547	$96,912	$88,415	$139,468	*
EASTHAM	*	$71,073	$78,319	$104,170	$103,634
ESSEX	$268,714	$97,221	$52,199	$21,219	*
FALMOUTH	*	*	*	*	$12,764
GLOUCESTER	$180,818	$16,293	$9,290	$11,099	*
HARWICH PORT			*	*	*
IPSWICH	$785,881	$882,768	$551,958	$316,006	$515,827
KINGSTON	*	*	$142,136	$241,152	$161,432
MARSHFIELD		*	*		*
NEW BEDFORD					*
NEWBURY	*	$56,757	$165,051	*	*
NEWBURYPORT		*			
ORLEANS	*	$6,388	*	$152,560	$309,083
PLYMOUTH		*	*	*	*
PROVINCETOWN	*		*		
ROWLEY	*	*	*	*	*
SANDWICH				*	
WAREHAM					*
WELLFLEET	$8,778	$14,460	*	$6,609	$40,237
WESTPORT				*	*
YARMOUTH		*		*	$63,374
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Bay Scallop Landings (Meat Pounds)

MA Bay Scallop Landings (Meat Pounds)					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE		*	*		*
BOURNE	1,622	1,401	1,258	585	*
CAMBRIDGE	*				
CHATHAM	1,680	*	*	2,954	*
CHILMARK	22,663	11,571	6,803	20,539	14,627
DENNIS	*	*	*	247	*
DUXBURY				*	
EASTHAM	*	*	*	996	2,562
EDGARTOWN	11,141	12,446	19,418	19,310	9,211
FAIRHAVEN	*	*	*	*	
FALMOUTH	1,643	1,778	*	3,499	*
GAY HEAD	5,404		*	*	4,199
GLOUCESTER	*				*
HARWICH PORT			*	*	
KINGSTON			*		
MARION		*			
NAHANT					*
NANTUCKET	109,209	40,220	51,295	62,900	48,780
NEW BEDFORD	342	*	*	6,446	*
OAK BLUFFS	3,613	*	1,995	*	*
ORLEANS	473	*	*	*	6,048
PLYMOUTH	*				
PROVINCETOWN	*	*	76	*	
SANDWICH	*	*	*	*	
SCITUATE			*		
TISBURY	*	1,272	1,150	1,578	*
WAREHAM		*			
WELLFLEET	4,990	16,792	4,593	8,498	6,880
WEST TISBURY	*				
WESTPORT			*	35,649	16,524
YARMOUTH	*	482	*	*	258
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Bay Scallop Ex-Vessel Value

MA Bay Scallop Ex-Vessel Value					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE		*	*		*
BOURNE	$17,310	$27,092	$27,980	$10,805	*
CAMBRIDGE	*				
CHATHAM	$21,702	*	*	$48,619	*
CHILMARK	$358,896	$217,219	$154,497	$321,568	$233,638
DENNIS	*	*	*	$2,898	*
DUXBURY				*	
EASTHAM	*	*	*	$13,558	$44,676
EDGARTOWN	$176,959	$240,936	$418,237	$296,307	$175,850
FAIRHAVEN	*	*	*	*	
FALMOUTH	$16,377	$27,853	*	$50,549	*
GAY HEAD	$90,631		*	*	$67,828
GLOUCESTER	*				*
HARWICH PORT			*	*	
KINGSTON			*		
MARION		*			
NAHANT					*
NANTUCKET	$1,556,276	$641,808	$950,565	$865,730	$747,385
NEW BEDFORD	$5,879	*	*	$51,679	*
OAK BLUFFS	$60,251	*	$47,236	*	*
ORLEANS	$5,503	*	*	*	$66,379
PLYMOUTH	*				
PROVINCETOWN	*	*	$2,042	*	
SANDWICH	*	*	*	*	
SCITUATE			*		
TISBURY	*	$26,729	$24,169	$19,956	*
WAREHAM		*			
WELLFLEET	$38,084	$37,630	$59,648	$59,134	$70,739
WEST TISBURY	*				
WESTPORT			*	$264,301	$125,623
YARMOUTH	*	$7,133	*	*	$2,901
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					

Quahog Landings (Live Pounds)

MA Quahog Landings (Live Pounds)					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	404,368	175,885	139,427	178,942	229,561
BOSTON		*		*	
BOURNE	59,236	68,092	66,425	*	43,940
BREWSTER			*	301	1,684
CAMBRIDGE	*	*	*	*	*
CHATHAM	1,510,889	1,266,570	1,647,743	1,394,926	1,374,362
CHILMARK	98,463	138,296	171,897	109,098	144,755
DARTMOUTH	*	*	57,380	*	*
DENNIS	37,858	87,381	54,737	86,192	104,603
DUXBURY	46,434	46,017	30,993	40,222	24,393
EASTHAM	71,036	93,697	35,946	85,768	228,207
EDGARTOWN	*	5,238	*	*	*
ESSEX				*	*
FAIRHAVEN	158,439	112,705	144,764	110,240	95,781
FALL RIVER	*				
FALMOUTH	330,606	314,316	375,286	527,831	831,818
GLOUCESTER	*	*	*		*
HARWICH PORT	*	*	*	*	
IPSWICH	*	*			*
MARION	35,439	10,062	18,718	17,037	*
MASHPEE	*	*	9,994	5,892	19,713
MASSACHUSETTS*	129				15
MATTAPOISETT		*			
NANTUCKET	*	5,149	950	*	*
NEW BEDFORD	94,803	92,521	60,135	123,390	109,332
OAK BLUFFS	*	*	*	1,281	*
ORLEANS	201,593	117,022	180,400	242,195	336,064
PLYMOUTH		*			
PROVINCETOWN	3,355	43,172	*	*	*
SANDWICH	*	*	*	*	12,837
SWANSEA	285,932	*	120,330	*	*
TISBURY	10,580	17,596	15,293	13,881	11,281
TRURO					*
WAREHAM	173,976	151,690	187,520	170,118	*
WELLFLEET	1,142,042	1,491,807	905,537	570,517	564,810
WEST TISBURY		*			
WESTPORT	179,094	280,940	208,071	264,330	184,798
YARMOUTH	21,789	28,753	20,837	23,582	34,244
SOURCE: SAFIS Dealer Database, 07/03/2019 ED * Not assigned to specific port.					
*CONFIDENTIAL					

Quahog Ex-Vessel Value

MA Quahog Ex-Vessel Value					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	$456,062	$186,836	$155,512	$232,752	$338,860
BOSTON		*		*	
BOURNE	$35,366	$48,063	$40,281	*	$33,628
BREWSTER			*	$236	$1,363
CAMBRIDGE	*	*	*	*	*
CHATHAM	$1,060,194	$1,355,773	$1,806,788	$1,522,243	$1,211,097
CHILMARK	$99,045	$130,613	$180,723	$125,965	$173,003
DARTMOUTH	*	*	$35,229	*	*
DENNIS	$30,468	$45,698	$46,182	$58,664	$80,290
DUXBURY	$28,111	$30,300	$17,195	$24,085	$14,600
EASTHAM	$35,631	$57,282	$37,606	$77,021	$223,501
EDGARTOWN	*	$3,298	*	*	*
ESSEX				*	*
FAIRHAVEN	$82,414	$96,368	$115,895	$90,920	$88,301
FALL RIVER	*				
FALMOUTH	$256,822	$296,144	$400,668	$647,281	$958,982
GLOUCESTER	*	*	*		*
HARWICH PORT	*	*	*	*	
IPSWICH	*	*			*
MARION	$23,863	$7,903	$13,690	$11,001	*
MASHPEE	*	*	$11,241	$5,059	$24,574
MASSACHUSETTS*	$188				$29
MATTAPOISETT		*			
NANTUCKET	*	$3,977	$1,695	*	*
NEW BEDFORD	$50,229	$59,920	$42,828	$70,025	$61,129
OAK BLUFFS	*	*	*	$2,090	*
ORLEANS	$165,533	$110,815	$199,410	$204,582	$356,383
PLYMOUTH		*			
PROVINCETOWN	$4,142	$15,972	*	*	*
SANDWICH	*	*	*	*	$13,284
SWANSEA	$107,290	*	$62,148	*	*
TISBURY	$17,803	$30,016	$25,214	$25,824	$21,485
TRURO					*
WAREHAM	$94,955	$97,320	$118,822	$117,368	*
WELLFLEET	$928,426	$1,441,022	$1,178,902	$933,104	$895,978
WEST TISBURY		*			
WESTPORT	$113,074	$215,974	$189,723	$245,199	$174,618
YARMOUTH	$16,577	$22,942	$24,056	$24,677	$36,290
SOURCE: SAFIS Dealer Database, 07/03/2019 ED * Not assigned to specific port.					
*CONFIDENTIAL					

Softshell Clam Landings Live Pounds

MA Soft Clam Landings (Live Pounds)					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	54,369	39,317	48,828	27,404	26,299
BOSTON	*	*	*	*	
BREWSTER			829	*	*
CAMBRIDGE		*	*	*	*
CHATHAM	244,676	406,996	421,448	264,627	237,527
CHILMARK	12,176	13,193	12,203	10,122	11,099
DENNIS	*	*	46,573	*	6,534
DUXBURY	*	*	*	*	*
EASTHAM	*	*	2,893	*	*
EDGARTOWN	*		*	*	*
ESSEX	341,167	193,912	388,759	1,010,560	1,083,713
FAIRHAVEN			*		
FALMOUTH	15,579	40,339	43,200	12,533	9,662
GLOUCESTER	279,716	178,445	692,123	597,633	489,627
HARWICH PORT		*	*	*	
HINGHAM			*		
HULL	*		*		
IPSWICH	308,034	321,969	813,451	1,300,063	1,378,359
MARION				*	
MASHPEE			*		
NEWBURY	571,493	469,245	529,990	343,023	301,627
NEWBURYPORT	*	*	51,401	*	*
OAK BLUFFS			*	*	*
ORLEANS	10,035	47,977	46,462	9,954	12,979
PROVINCETOWN		*			*
QUINCY	*	*	*		
REVERE	*	*	*		
ROWLEY	9,762	*	*	*	*
SALISBURY	*	*	*	*	*
SANDWICH		*	*		
SWANSEA		*			
TISBURY	5,595	4,478	*	2,313	*
WAREHAM	*	*	*	*	*
WELLFLEET	4,901	5,130	5,342	933	793
WEST TISBURY	*	13,016	15,061	11,714	*
WESTPORT		*			*
YARMOUTH	*	15,266	33,824	33,381	7,553
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Soft-Shell Clam Ex-Vessel Value

MA Soft Clam Ex-Vessel Value					
PORT	**2014**	**2015**	**2016**	**2017**	**2018**
BARNSTABLE	$141,402	$109,499	$112,821	$63,875	$68,801
BOSTON	*	*	*	*	
BREWSTER			$1,988	*	*
CAMBRIDGE		*	*	*	*
CHATHAM	$504,289	$1,156,627	$946,187	$602,704	$495,174
CHILMARK	$32,906	$39,505	$35,808	$30,226	$33,767
DENNIS	*	*	$92,287	*	$10,394
DUXBURY	*	*	*	*	*
EASTHAM	*	*	$5,955	*	*
EDGARTOWN	*		*	*	*
ESSEX	$687,561	$387,187	$717,299	$1,695,774	$1,836,068
FAIRHAVEN			*		
FALMOUTH	$28,108	$86,272	$87,877	$24,234	$20,382
GLOUCESTER	$537,646	$364,303	$1,248,245	$984,004	$827,321
HARWICH PORT		*	*	*	
HINGHAM			*		
HULL	*		*		
IPSWICH	$627,347	$726,416	$1,495,074	$2,084,055	$2,206,132
MARION				*	
MASHPEE			*		
NEWBURY	$1,171,972	$958,505	$914,312	$544,851	$479,008
NEWBURYPORT	*	*	$76,898	*	*
OAK BLUFFS			*	*	*
ORLEANS	$29,717	$152,321	$169,757	$18,767	$40,447
PROVINCETOWN		*			*
QUINCY	*	*	*		
REVERE	*	*	*		
ROWLEY	$21,692	*	*	*	*
SALISBURY	*	*	*	*	*
SANDWICH		*	*		
SWANSEA		*			
TISBURY	$16,243	$12,614	*	$6,607	*
WAREHAM	*	*	*	*	*
WELLFLEET	$2,526	$15,429	$8,920	$2,583	$2,016
WEST TISBURY	*	$38,988	$45,113	$35,155	*
WESTPORT		*			*
YARMOUTH	*	$34,282	$72,155	$52,182	$11,808
SOURCE: SAFIS Dealer Database, 07/03/2019 ED					
*CONFIDENTIAL					

Regional Landings and Ex-Vessel Value by Species

Oyster Landings (Pieces) and Ex-Vessel Value

MA Oyster Landings (Pieces)					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	50,292	*	66,882	5,563	*
CAPE COD/ISLANDS	23,126,142	25,544,654	25,114,852	32,054,995	33,306,960
SOUTH SHORE/SOUTH COAST	11,278,856	12,962,266	14,109,262	18,508,544	17,826,272
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					

MA Oyster Ex-Vessel Value					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	$30,541	*	$41,643	$3,467	*
CAPE COD/ISLANDS	$12,922,534	$14,918,822	$14,358,896	$18,083,931	$18,484,462
SOUTH SHORE/SOUTH COAST	$6,467,034	$7,718,470	$8,107,889	$10,246,355	$9,826,401
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					

Razor Clam Landings (Live Pounds) and Ex-Vessel Value

MA Razor Clam Landings (Live Pounds)					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	344,172	243,540	166,325	85,158	125,449
CAPE COD/ISLANDS	66,454	54,266	129,786	370,905	524,671
SOUTH SHORE/SOUTH COAST	75,881	38,281	64,967	91,057	78,202
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					

MA Razor Clam Ex-Vessel Value					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	$1,372,138	$1,092,573	$788,112	$392,104	$593,844
CAPE COD/ISLANDS	$236,432	$215,156	$442,918	$1,627,204	$2,317,357
SOUTH SHORE/SOUTH COAST	$213,406	$129,637	$240,287	$391,100	$315,059
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					

Bay Scallop Landings (Meat Pounds) and Ex-Vessel Value

MA Bay Scallop Landings (Meat Pounds)					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	*				*
CAPE COD/ISLANDS	168,922	87,174	91,334	128,030	98,174
SOUTH SHORE/SOUTH COAST	7,285	9,914	5,634	42,830	21,288
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					
MA Bay Scallop Ex-Vessel Value					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	*				*
CAPE COD/ISLANDS	$2,405,947	$1,249,356	$1,770,116	$1,795,201	$1,481,917
SOUTH SHORE/SOUTH COAST	$118,383	$182,009	$106,843	$330,174	$155,678
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					

Quahog Landings (Live Pounds) and Ex-Vessel Value

MA Quahog Landings (Live Pounds)					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	14,377	9,084	*	938	*
CAPE COD/ISLANDS	3,888,140	3,792,062	3,575,621	3,261,437	3,901,497
SOUTH SHORE/SOUTH COAST	1,137,988	976,224	894,336	957,925	653,604
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					
MA Quahog Ex-Vessel Value					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	$4,555	$3,016	*	$775	*
CAPE COD/ISLANDS	$3,086,918	$3,709,340	$4,085,537	$3,878,827	$4,347,759
SOUTH SHORE/SOUTH COAST	$598,336	$661,099	$635,812	$669,425	$534,736
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					

Soft-Shell Clam Landings (Live Pounds) and Ex-Vessel Value

MA Soft Clam Landings (Live Pounds)					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	1,642,856	1,436,405	2,569,209	3,319,601	3,328,363
CAPE COD/ISLANDS	366,201	605,566	683,286	383,287	324,478
SOUTH SHORE/SOUTH COAST	*	3,087	24,774	*	*
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					

MA Soft Clam Ex-Vessel Value					
REGION	**2014**	**2015**	**2016**	**2017**	**2018**
BOSTON HARBOR/NORTH SHORE	$3,184,878	$2,774,595	$4,557,369	$5,389,161	$5,461,015
CAPE COD/ISLANDS	$805,285	$1,691,880	$1,601,003	$852,928	$716,146
SOUTH SHORE/SOUTH COAST	*	$4,508	$35,294	*	*
SOURCE: SAFIS Dealer Database, 07/17/2019 ED					
*CONFIDENTIAL					

Appendix B – 2019 Agency, NGO and Academic Questionnaire

Questionnaire Overview/Layout

In 2019, the Assessment Committee identified and contacted 28 NGOs and academic institutions (Table B-1). Each was asked to provide the following information:

- Name
- Overview of shellfish related programming
- Current level of shellfish dedicated staff
- Relevant statutes, regulations, or policies related to shellfish management
- Detailed shellfish programming descriptions
- Emerging trends that may required more resources dedicated to shellfish related programming.

Of the 28 NGOs and academic institutions contacted, 15 responded to the questionnaire. These response are provided in the first segment (p. 116 – 172) of this Appendix B.

In addition to the 15 responsive NGOs and academic institutions, four state agencies also responded to the questionnaire. These agencies include: DMF, MDAR, CZM, and MEPA. These responses are provided in the second segment (p. 173 – 189) of this Appendix B.

Agencies, NGOs, and Academic Institutes Contacted (Table B-1)

Organization	Contact
CCCFA	Melissa Sanderson
TNC	Steve Kirk
MAA	Seth Garfield
SEMAC/WHOI Sea Grant	Abigail Archer
NEMAC	Joe Buttner
SPAT	Michele Insley
MOP	Steve Parkes
UMass Boston	Michael Tlusty
MIT Seagrant	Lindsey Williams
	Rob Vincent
WHOI	Hauke Kite-Powell
NEU - Nahant	Jon Grabowski
Wellfleet Shellfishermen's Association	Ginny Parker
MV Shellfish Group	Emma Green-Beach
Salem Sound Coastwatch	Barbara Warren
NSRWA	Sara Grady
Association to Preserve Cape Cod	Jo Ann Muramoto
MSOA	Paul Bagnall
Eight Towns and the Bay/MVPC	Peter Phippen
UMass Amherst - Gloucester	Katie Kahl
	Lisa Komoroske
	Brian Cheng
GMGI	Andrea Bodnar
NEAQ Anderson Cabot Center	Shellfast Tool
BARS	Bob Parsons
Centers for Coastal Studies	Owen Nichols
Barnstable Clean Water	Zenas Crocker
Cape Cod Cooperative Extension	Josh Reitsma
UMass Dartmouth- SMAST	Steven Lohrenz
Waquoit Bay Research Reserve	Megan Tyrrell
Coonamessett Farm Foundation	Ricky Alexander

BARS

NGO Name & Mission

Barnstable Association for Recreational Shellfishing (BARS)

Mission

- To advocate for good water quality.
- To award scholarships, and grants in support of restoring and sustaining shellfish fishing as a positive asset for the Town of Barnstable.
- To promote and assist shellfish propagation and habitat projects in the Town of Barnstable.
- To encourage the town to reestablish, maintain and increase local “Ways to Water.”
- To educate the membership and the public about the shellfish fishing resources of the town.
- To support enforcement of the shellfish rules and regulations.
- To assist development of sound shellfish regulations for recreational shellfish permit holders.
- To share techniques, resources and shellfish recipes for the enjoyment of our members, associates, friends and supporters.

Overview of Program

We assist Barnstable's DNR with clamming classes, preparation and seeding of clam spat. relocating clams from propagation areas, within Barnstable's waters. We advocate with the town's shellfish committee to preserve clam habitat that would be at risks from new docks. We also support the Barnstable Coalition for Clean Water in their efforts to improve the quality of our waters.

Staffing

Our group is about 127 strong. We provide about 2/3 the voluntary manpower that the DNR uses. I would estimate 40 that would be the definition of "dedicated staff" over the next two years.

Relevant Programs Related to Shellfish Management

Maintaining our mission and adapting to the needs of the DNR shellfish fishing program.

Emerging Trends

External Trends

Using clams, specifically oysters for nitrogen reduction.

Internal Trends

How we raise funds and allocate these funds would be our biggest challenge.

Barnstable Clean Water

NGO Name & Mission

Barnstable Clean Water Coalition (BCWC). Our mission works to restore and preserve clean water in Barnstable.

Overview of Program

In 2018, BCWC, in partnership with the Massachusetts Oyster Project (MOP) and the town of Barnstable (Town), raised approximately 50,000 oysters from spat (1mm) to juvenile-size (25mm) in an upweller tank at Gateway Marina using water pumped from Hyannis Harbor. Once they reached 25mm, the oysters were relocated to Cotuit Bay in the town of Barnstable to mature and benefit the local economy as part of the town's Shellfish Propagation Program. In addition to economics benefits, the oyster upweller is a great outreach tool to educate the general public on the benefits of shellfish for filtering nutrients, sediments and detritus from the water, improving water quality and clarity, and increasing biodiversity. Upweller program was active from June 1, 2018 thru September 11, 2018.

Staffing

For the 2019 upweller season, we have one summer intern dedicated to the upweller. She spends approximately 3-4 hours, 5 days a week at the upweller. She is joined one or two days a week by one of our other summer staffers when oyster grading or extra tank maintenance is needed. In addition, one regular full-time staff is responsible for overseeing the project and coordinating the program with the MOP and Town.

Relevant Programs Related to Shellfish Management

1. Increase oyster propagation in upweller tank in 2019 to two sets of 60,000 oyster spat for a total of 120,000 oysters.
2. Assist in funding of research project to look at the benefits of oyster pseudofeces for nitrogen mitigation in estuarine waters.
3. Assist Town's Department of Natural Resources in implementation of new shell recycling program to provide cultch for town's oyster propagation program.

Emerging Trends

External Trends

As BCWC is interested in the benefits of shellfish to mitigating nitrogen out of locally impaired estuarine waters, we are looking to increase our involvement with shellfish-related projects in town waters.

Internal Trends

Education and outreach on water quality issues to the local community is one of BCWC's primary goals. The use of shellfish for reducing nitrogen and improving water clarity has resulted in an increased investment in shellfish projects by BCWC.

Cape Cod Commercial Fishermen's Alliance (CCCFA)

NGO Name & Mission

Cape Cod Commercial Fishermen's Alliance, Inc. (CCCFA)

Cape Cod Commercial Fishermen's Alliance is fishermen, community members, public officials and scientists working together to build creative strategies, advocate for improved marine policies, protect the ocean ecosystem, and ensure the viability and future of Cape Cod's fisheries.

Overview of Program

Fishermen's Alliance Shellfish Program Vision

Ensure shellfish fishing remains viable long term on the Cape and maintain shellfish's position as the backbone of the Cape's blue water economy.

PHILOSPOPHY/MISSION
By providing best-in-class shellfish programs, we bring together fishermen/growers, scientists and the community to collectively improve Cape Cod's ecosystem and blue economy.

Fishermen's Alliance Shellfish Program Goals

A. Improve communications, facilitate partnerships, and mitigate conflict among commercial shellfish growers, harvesters, scientists, restoration programs, and the community.
B. Empower shellfish stakeholders to advocate and campaign for regulations that improve the fishery and the environment.
C. Increase community support for shellfish activities on public shorelines.

Fishermen's Alliance Goals for Massachusetts Shellfish Initiative

A. Ensure the future of the wild shellfish harvest (commercial & recreational):
    - regulatory changes do not jeopardize existing shellfish fishermen
    - increase support for town propagation programs
    - increase "open area" classification (through water quality improvements and pollution prevention)

B. Increase state and towns capacity to effectively manage shellfish (under status quo and growth scenarios). This includes increased financial resources to support water quality monitoring, constables, research, enforcement, etc.
C. Improve social license for shellfish: increase the public's understanding and appreciation of shellfish: wild and farmed, commercial and recreational.
D. Respect and mitigate shellfish industry impacts when allowing shellfish restoration projects or use of shellfish in wastewater plans.

Staffing

Current level (2019): 30% of one full time employee.
Projected level (2020): 15% of one full time employee.
Projected level (2021): 10% of one full time employee.

Relevant Programs Related to Shellfish Management

Cape Cod Shellfish Education Program

Partners: Monomoy School District, A.R.C. Hatchery, Wellfleet Audubon

Activities: Develop a county-wide, hands-on, elementary age educational experience that will train the next generation to value both the importance of clean water and the role of aquaculture in cleaning and feeding our community. Students will learn about shellfish and clean water through 16 in-classroom lessons, plus a hands-on field trip to the A.R.C. hatchery, where they will tour the facility and learn to dig a clam. They will become ambassadors for shellfish and clean water, laying the foundation for the long-term community support necessary to maintain clean water and a resilient shellfish economy.

Duration: 2018-2020. Curriculum will be freely available long term (past 2020), but there will be minimal Alliance time dedicated to the project after 2020.

Status: Third grade curriculum (19 lessons) was written and pilot tested with Chatham and Harwich Schools in Spring 2019. Revising program based on feedback in summer 2019, with goal to release curriculum Cape-wide in Q4 2019.

Funder: Various private foundations and Massachusetts Environmental Trust

Piloting Surf Clam Aquaculture Techniques to Create Commercial Opportunities

Partners: A.R.C. Hatchery (PI), Cape Cod Cooperative Extension/WH Sea Grant, Roger Williams University

Activities: Demonstrate commercial viability of growing a new aquaculture product: the undersized (1.5-2") surf clam (marketed as “butter clams”):

- Fine tune hatchery production of surf clam seed and demonstrate commercial-scale production capacity.
- Identify appropriate locations for surf clam culture.
- Determine which of three grow out technologies previously demonstrated to be effective for growing surf clams (bottom planting under nets, Florida-style mesh bags, or oyster bags) are the most effective and economical at producing marketable butter clams.
- Document all costs associated with surf clam production to make a preliminary determination as to the feasibility of this clam transitioning to profitable commercial production.
- Initiate formulation of a marketing strategy by soliciting input from shellfish dealers, growers, and chefs.

Waterbodies: Field work occurred in Cape Cod Bay (Wellfleet, Barnstable) and Nantucket Sound (Barnstable and Cotuit).

Duration: March 1, 2017 – February 28, 2020

Status: Hatchery work to grow surf clam seed and field grow out trials are complete. Results have been shared with shellfish community. Remaining work involves providing marketing samples to chefs and surveying them to guide future marketing strategy.

Market Development to Diversify Shellfish Aquaculture Products in Massachusetts

Partners: Cape Cod Cooperative Extension/WH Sea Grant (PI), Wellfleet SPAT

Activities: Address hurdles that are impeding the advancement of aquaculture of three native shellfish species grown in coastal Massachusetts; surf clams (Spisula solidissima), sometimes marketed as butter clams, blood arks (Anadara ovalis) and oysters (Crassostrea virginica). This project examines the economic potential for growers to produce and sell 'alternative' species to oysters, and to market oysters in an alternative form – a shucked product. The key questions being answered are:

1) What are current wholesale values for these species locally and nationally?
2) What is the size or volume of these markets, locally and nationally? Is there unmet demand?
3) Can existing markets for blood arks, butter clams, and shucked oysters be expanded (if needed), and is there potential to develop new markets? If yes, at what price point and what is the competition?
4) Are current wholesale values enough to make alternative culture operations financially viable and if not, at what price would they need to sell the product in order to make a profit?
5) How can regular or closure induced market downturns be better managed by shellfish producers in a supply/demand scenario to sustain market value?
6) How do we build upon the current market-based information to make these alternative species or products a part of the growing shellfish aquaculture industry? What is needed for promotion and future marketing?

Duration: September 1, 2017 – August 31, 2020

Status: Marketing Assessment complete (answer questions 1-4), Marketing Plan for surf clams will be complete by mid-July 2019. Outstanding work: plan/strategy for shucked oysters and managing market impacts of closures.

Massachusetts Shellfish Initiative

Partners: The Nature Conservancy, Mass Aquaculture Association, Mass Division of Marine Fisheries, UMass Boston

Activities: Build capacity for shellfish stakeholders – in fisheries management and in community decision making- through the collaborative and grassroots development of the Massachusetts Shellfish Initiative plan. Over 500 stakeholders will participate in creating goals and guidance for how the state and towns should balance growing and competing demands for shellfish resources, including strategies and tactics

that can be implemented in the first 5 years to maximize the economic, environmental & social benefits of shellfish resources, such as oysters, quahogs, surf clams, mussels, razor clams, steamers and bay scallops.

Duration: September 1, 2017 – May 1, 2020.

Status: The MSI Task Force has been appointed, met twice and set preliminary goals and objectives. Their Assessment Committee has surveyed the Massachusetts Coastal towns re: shellfish programs/capacity and the shellfish NGO community re: priorities and resources; report should be ready in July 2019. The Scoping Committee will start meeting July 2019 to collect public feedback on MSI goals and objectives, which will inform their recommendations to the Task Force on which issues MSI should focus on. The next Task Force meeting is being planned for late October.

Funder: National Fish and Wildlife Foundation with match from MAA, TNC, UMass Boston, Fishermen's Alliance, and DMF.

A.R.C. Hatchery

Partners: n/a

Activities: Investor in A.R.C Hatchery during rebuild of hatchery and transition to "ARC 2.0." Fishermen's Alliance holds two seats on the A.R.C. Board of Directors. Alliance staff focus their board time on A.R.C.'s fiscal health and its plans for education and research.

Duration: 2016 – no expected end date.

Emerging Trends

N/A

Eight Towns and the Bay/MVPC

Institution & Mission

Boston University and Merrimack Valley Planning Commission, MassBays National Estuary Program

The Massachusetts Bays National Estuary Program is dedicated to protecting, restoring, and enhancing the estuarine ecosystems of Ipswich Bay, Massachusetts Bay and Cape Cod Bay. We facilitate partnerships to prompt local, state, and federal action and stewardship, by convening stakeholders on the local and regional level, providing scientific basis for management decisions, and working with decisionmakers to identify problems and solutions.

Overview of Program

Our team has been monitoring green crab for the last five years during spring summer and fall. We have been sexing, measuring carapace width, and noting color of the green crabs. The monitoring has been taking place in the Great Marsh (Essex Bay, 13 sites and lower Plum Island Sound, 11 sites). We have been working with the local communities (Essex, Ipswich and Newbury) and many volunteers to help with this effort. Monitoring activities were suspended in July of 2018.

Staffing

There are no current or projected part or full time staff on this project. The project was performed primarily for research purposes. However, we work closely with Green Crab R&D, a nonprofit that is looking for a beneficial use of green crab.

Relevant Programs Related to Shellfish Management

To publish a research document on the findings of the monitoring of green crab.

Emerging Trends

External Trends

Green Crab R&D is investigating culinary and fertilizer uses of the green crab in hopes that market forces will help control the populations. No real breakthroughs at this point in time.

Internal Trends

The municipal and/or state desire for more information on green crab habits.

GMGI

Institution & Mission

Gloucester Marine Genomics Institute – Our mission is to conduct world-class marine biotechnology research which expands the regional economy.

Overview of Program

Until recently we have worked primarily on shellfish, mainly crustaceans, cultured in other parts of the US, especially pacific white shrimp. Our main project in this area is a partnership with MIT and the University of Arizona to develop disease diagnostics for shrimp. This is funded by the USDA and started June 2019.

We have submitted and are submitting proposals for funding the development of diagnostics for oyster pathogens with collaborators at MIT and Bigelow Labs, a shellfish/norovirus project that involves MADMF, and a population genomic study of Jonah crabs in the western Gulf of Maine. These are contingent on funding success.

Staffing

1 scientist, 1-2 associates, 1 technician

Relevant Programs Related to Shellfish Management

Our existing goal is to secure funding to continue developing our diagnostic and genomic programs for marine bivalves and crustaceans.

Emerging Trends

External Trends

Our level of investment is not changing from expectations. Marine animal production is likely to increase in importance over the next decades and we hope to provide cutting-edge tools powered by genomics that support sustainable and profitable harvest and animal production in Massachusetts and around the US.

Internal Trends

Our level is unchanged from expectations.

Massachusetts Aquaculture Association (MAA)

NGO Name & Mission

Massachusetts Aquaculture Association (MAA)

The Massachusetts Aquaculture Association (MAA) is a non-profit trade association formed in 1986 and is the primary organization representing aquatic farmers and related support businesses and organizations in the Commonwealth.

It is MAA's purpose to promote the aquaculture industry in the Commonwealth of Massachusetts by associating in membership appropriate personnel of firms and companies, which are located in the Commonwealth and are primarily interested in aquaculture business in order to:

- Educate the public and governmental officials as to the needs, benefits, uses, and importance of aquaculture products and to educate such personnel on issues of importance to the industry,
- Increase the pool of potential employees for and employment opportunities in such companies, and to benefit in general the industry, and by doing so,
- Improve the quality of life in the Commonwealth.

Overview of Program

For over 30 years MAA has participated with and/or coordinated research through its membership with a broad range of research initiatives across the Massachusetts coast.

As a result of a recent survey of MAA membership, the following 3 items have been distilled as MAA priorities:

- Enhanced regulatory framework for non-profit and municipal aquaculture projects to prevent siting issues, increased disease pressure, and to eliminate market impact by such projects.
- Recognition and parity among marine uses
- Funding for research and monitoring-shellfish genetics and breeding; animal health/ disease; food safety; water quality.

Staffing

1 part-time consultant, volunteer board of 15 Trustees who are elected by MAA membership.

Relevant Programs Related to Shellfish Management

The following Priority Research Areas (4) and Topics (listed under each area) were prepared and approved by MAA through the MAA Research Guidance Committee. It has been prepared in order to better acquaint researchers with needs articulated by Massachusetts aquaculture industry members so that proposed and executed research may be better aligned with industry needs.

1. Animal Health & Disease

- Broodstock improvements/genomics/improving seed quality
- Boring sponge
- Reliability of seed testing to prevent disease
- Locally developed triploid
- Ocean acidification - Acidification resistance
- Information needed to inform the evaluation of risks/benefits of zone management in MA
- Evaluate public health and water quality impact of contamination by birds
- Deterring birds on gear to reduce WQ issues
- Kelp - biohazard risks
- Bamboo worms in quahogs (clymenella)

2. Tools for Management

- Oyster hatchery research
- Deep water storage vs. pitting
- Best size to broadcast seed for propagation (cost benefit analysis and growth rates and mortality at various starting sizes)
- Predict future winter impacts
- Purge rate studies for FC to determine max-seed size for upwellers in closed waters
- Rainfall closure purge studies
- WTTP malfunction viral purge rates (MSC)
- Understanding entanglement risk - "Turbidity causing aquaculture activities" and impact on seagrass
- Nitrogen credits for industry (with wastewater mgmt. plan #s) (regional approach, RI to ME?)
- Kelp spool source genetics- issue with transplanting or cross breeding
- Deterring birds on gear to reduce water quality issues

3. Marketing

- Alternative species - Kelp, Blood Arc, surf clam, razor clam
- Sea level rise

4. Food Safety

- Product safety: cold chain improvements, risk-mitigating husbandry, Vp, BAH, Noro.
- Health of habor/wastewater (BOH)
- Risk per serving survey to determine Vp closures
- Re-sub and Transplant work to reduce risk and in the event of closures
- Noro - Re-sub and Transplant work in the event of closures
- Kelp - food safety
- Growers: Upwellers for growing and moving seed
- Evaluate public health and water quality impact of contamination by birds

Emerging Trends

External Trends

MAA Research Guidance Committee identified several research priority areas for 2018-2019 attached (Massachusetts Aquaculture Association (MAA) Research Guidance Committee 2018 - 2019 Priority Research Areas and Topics

Internal Trends

Growth in shellfish aquaculture has caused concern for market and environmental impacts. On the market side, particularly in the fall when, lacking winter storage solutions, some growers move large volumes of product into the market and prices have been seen to take significant decreases, in some cases a more than 50% decline. Additionally, the increased volumes of product cultivated and broadcast for recreation, and more concerning, commercial harvest are similarly impacting markets throughout the year. There has been a growing delta between volume and value that is clearly a reflection of supply/demand economics, but has nonetheless been exacerbated by the "fall glut" and municipal propagation.

Shellfish disease, those that impact shellfish as well as those that may impact shellfish consumers, is likewise becoming a growing concern as more shellfish are grown and an increasing number of inexperienced consumers and growers handle shellfish. Related to these disease issues and the significant economic impact that can occur as a result of disease related closures, the industry remains concerned that an adequate level of resources is not dedicated to what is now the third most valuable fishery in Massachusetts.

MIT Sea Grant

NGO/Research Name & Mission

Massachusetts Institute of Technology (MIT) Sea Grant

Our mission is to conduct and support research and develop technology to enable scientific investigation into problems surrounding the ecosystem health and human use of coastal and marine environments. Our education and outreach efforts disseminate the results of our MIT Sea Grant-funded research, and research conducted by our AUV Lab and Advisory staff in collaboration with industry, state and federal partners. These stakeholder engagement, education and outreach efforts are meant to encourage stewardship and implementation of sustainable and useful technologies that help answer management questions in support of public policy and industry through the use of relevant, evidence-based and scientifically sound information.

Overview of Program

Shellfish programming for MIT Sea Grant is focused on research, outreach, and engagement associated with aquaculture.

Staffing

Current level of shellfish dedicated staff: 1 staff member
Projected shellfish dedicated staff for the next two years: 1 staff member

Relevant Programs Related to Shellfish Management

We have been communicating with DMF in an effort to develop a shellfish resource mapping program for siting and permitting purposes, but this effort is still in development.

For the past two years, Carolina Bastidas (MIT Sea Grant Marine Biologist) has worked with the National Park Service, Boston Islands, and City Nature Challenge to survey and identify shellfish species throughout the Boston Harbor area. This activity has taken place during April and May for the past two years (2018 & 2019).

Carolina Bastidas has been working for the past four years with MIT Sea Grant-funded researcher, Justin Ries, focusing on the effects of ocean acidification on commercially relevant shellfish species

Funded shellfish-related projects

Prediction of Hydrodynamic Loads in Mooring Lines for Offshore Aquaculture Systems

- Yuming Liu, MIT

Measuring acid/base chemistry in the extrapallial fluids of New England's commercially important mollusks to explore their differential responses to ocean acidification

- Justin Ries, Northeastern University

Developing a Miniaturized In-situ Sensor Technology for Simultaneous Measurements of Seawater Dissolved Inorganic Carbon and pCO2

- Zhaohui Aleck Wang, WHOI

Sensors for Measuring Carbon Dioxide, Bicarbonate, and pH in the Ocean

- Timothy Swager, MIT

Making Sense of the Variability of Coastal Ocean Acidification: Potential Long-Term Impacts on the Oyster Aquaculture Industry

- Robert Chen, UMass Boston

Emerging Trends

External Trends

- Challenging and competitive external funding environment
- Competition among organizations and individuals, mostly driven by the competitive external funding environment
- Narrow RFP focus areas and limitations by funding organizations
- Funding targeting specific geographic regions and/or species limits opportunities
- Need for specific research focus areas for Massachusetts that address specific stakeholder needs (i.e., industry, resource managers, local communities and municipalities, the research community, the general public)

Internal Trends

- Budget restrictions
- Established multi-year strategic plans that document specific areas and targets that must be met

Massachusetts Shellfish Officer's Association (MSOA)

NGO/Research Name & Mission

Massachusetts Shellfish Officer's Association (MSOA)

The MSOA is a nonprofit educational and professional organization dedicated to promoting and enhancing the welfare of the shellfisheries for the Commonwealth of Massachusetts.

Overview of Program

The MSOA provides a forum for coastal Municipalities' shellfish officers and interested professionals to exchange information about shellfish management, research and the latest advancements in technology and laboratory science regarding the marine environment, aquaculture, water quality and law enforcement issues. We provide insight and develop solutions to the problems within the shellfish industry.

The MSOA began as a loosely organized association of Shellfish Constables in the 1970s. In 2000, the MSOA was officially incorporated with a filing with the Massachusetts Secretary of State and Attorney General. MSOA is headed by an elected Board of Directors (BOD) and includes a President, Vice-President, Treasurer, Secretary and 8 members at large. Officials from DMF serve as advisors. The BOD meets quarterly to discuss relevant issues and develop agendas for full membership quarterly meetings and includes an annual convention and training workshop. Association meetings also provide updates from Federal, State, and local officers on important topics, inviting guest lecturers with demonstrations and discussions on relevant topics. MSOA acts as a conduit for education to Shellfish Constables so they may provide the best management practices to protect and enhance marine resources. Some other educational skills provided deal with law enforcement and public safety. Fields include:

- Aquaculture and Propagation
- Harmful Algae Blooms
- Emerging Diseases
- Protecting the Public Trust Doctrine
- Nitrogen Mitigation
- Public Health

Staffing

No paid staff. All activities accomplished by volunteer member constables.

Relevant Programs Related to Shellfish Management

Constable Certification Course

The MSOA, in collaboration with the Massachusetts Division of Marine Fisheries and the Massachusetts Maritime Academy organizes a certification course for shellfish officers offered every three years. The

80-hour course provides comprehensive lectures and training by federal and state agencies, WHOI Seagrant, NGOs and other scientist on a variety of subjects such as:

- NSSP/ISSC/Model Ordinance
- Laws pertaining to shellfish
- Shellfish biology and disease

MSOA Coastal Resiliency Project

Funded through a Coastal Resiliency Grant, rain gauges have been distributed to participating towns to accurately measure rainfall for determining the proper time to initiate shellfish growing area closures. This data will be used not only by each town but also by DMF as the process continues to verify and allocate the protection of shellfish growing areas. It is anticipated that as climate change continues that the rainfall closures may well become more numerous and / or widespread.

MSOA Scholarship

MSOA members established a financial assistance program for Senior High School students enrolled in a higher education Marine Biology program and that are residents of a city or town that sponsors a representative from MSOA. Scholarships are awarded annually to two students chosen by the Scholarship Committee.

MSI Sub-Committee

Developed to ensure the participation, knowledge and concerns of local shellfish managers are incorporated into the development of all levels of the MSI process.

H746 Sub-Committee

Created in responds to H746: An Act Relative to Shellfish Aquaculture Licenses, a proposed bill to amend MGL Chapter 130, §57 and §58. MSOA opposed the proposed bill in order to protect the Public Trust Doctrine and to maintain local authority over aquaculture grants within the individual community.

MSOA Website

Developed to promote, encourage, and educate the public about responsible shellfish harvesting. The site includes links to coastal communities, their shellfish departments, permitting requirement and local shellfish regulations. http://www.massshellfish.org/coastal-towns.html

NEMAC

NGO/Research Name & Mission

Northeastern Massachusetts Aquaculture Center

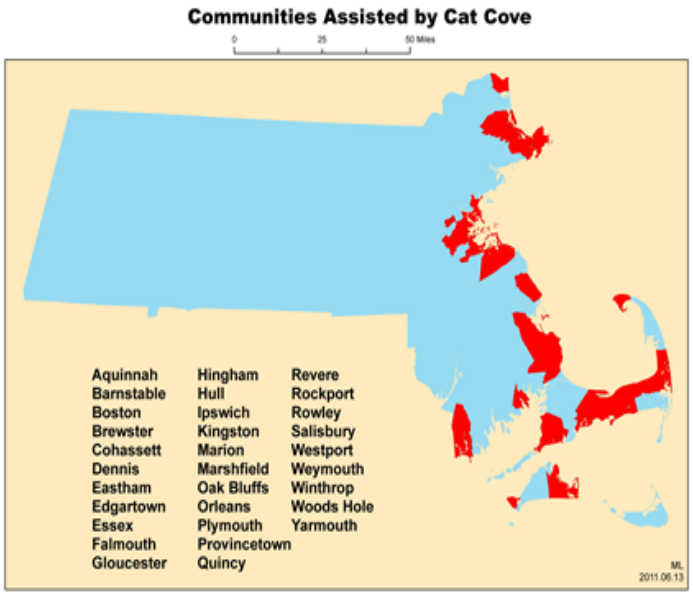
In response to an email from Jeff Kennedy on 5 June, below you will find our feedback to each of the six questions raised. Hopefully, this information will prove adequate and useful. Once you have compiled a synthesis of responses, we would very much appreciate a copy of your finding.

The mission of the Cat Cove Marine Laboratory (CCML) is to develop research and technologies in aquaculture as well as increasing the understanding of marine organisms and ecosystems through research, education, and outreach. Being housed in the Department of Biology at Salem State University, our primary charge is education, broadly defined to include traditional classroom instruction as well as outreach and assistance to the aquaculture industry, regulators, elected officials and the general public.

Overview of Program

Our goal and aspiration is to stay healthy, productive and creative by networking with colleagues, exploring new opportunities/venues such as aquaponics and biological research that utilizes shellfish and/or finfish, and sustaining good relationships with elected officials. We also plan to continue involving students and projects and enlisting alumni, who are distributed throughout the Commonwealth, as ambassadors to garner support broadly for aquaculture and specifically from legislatures in districts distant from Salem State and the Coast.

CCML officially opened in April 1999 and has hosted the Northeastern Massachusetts Aquaculture Center (NEMAC) since the Commonwealth established the three Aquaculture Centers. The other two Centers are located in Barnstable (Southeastern Massachusetts Aquaculture Center) and Amherst (Western Massachusetts Center for Sustainable Aquaculture, WMCSA).



The initial and primary shellfish initiatives pursued by CCML involve serving as a regional source of softshell clams (*Mya arenaria).* The first cohort of 30,000 softshell clams was produced in 2000. Since then, over 42 million juvenile clams have been produced and shared with over three dozen coastal communities in Massachusetts: North Shore, South Shore, Cape and Islands (Figure 1).

Technical assistance and stocking-size clams have been provided to many coastal communities in Massachusetts. Additional towns not illustrated that have recently received softshell clam assistance: Block Island, Bourn, Chilmark, Mattapoisett, Nantucket, North Eastham, Northeastern University (Nahant), Tisbury, Thomson Island, Truro, and Vineyard Haven. Clams have also been distributed outside Massachusetts to Brookhaven, NY; Brown University, RI; Clinton, CT; Groton, CT; Southern Illinois University, IL; and Tiverton, RI.

For over a decade, aquaculture of blue mussels *Mytilus edulis* on longlines has been pursued, initially in coastal waters of Massachusetts, adjacent to Gloucester and Rockport. In January 2015, a 33 acre site located in Federal waters 7 miles off Cape Ann was approved for longline culture of mussels (USACE permit NAE-2012-1598 NEMAC Mussel Culture). The offshore demonstration site is operated collaboratively with support provided by NOAA, S and K, Legal Seafood, and numerous federal agencies. In October 2017, the first spawn of mussels occurred, successful spawning has been replicated multiple times in fall/winter 2017 an 2018.
Concurrently, the first and second harvest of mussel occurred.

Staffing

Staffing includes one Full Time Hatchery manager and three part time professionals that coordinate dive activities, CCML facilities, and aquaculture outreach. Typically, three to five undergraduate students annually assist with daily maintenance and research activities; they work four to eight hours weekly, more in the summer and less during the academic year. No changes in staffing are anticipated for the next two years.

Relevant Programs Related to Shellfish Management

See overview of program

Emerging Trends

External Trends

Growing relevance of aquaculture locally and globally and increased visibility of CCML's efforts have been noticed and appreciated by Salem State University and the Commonwealth. Through energetic, collaborative efforts by all three Centers and the Massachusetts Aquaculture Association, support from the general public, aquaculture community, and elected officials is increasing, albeit with considerable coaxing.

Internal Trends

Fiscal constraints are increasingly a reality at Salem State University and higher education generally. Generation of dollars through production, grants, workshops and other activities is increasingly encouraged, potentially compromising our primary charges of education and outreach.

Northeastern University – Nahant

Institution Name & Mission

Northeastern University, Department of Marine and Environmental Sciences

Most aligned with Northeastern University's mission around sustainability

Overview of Program

Drs. Grabowski, Hughes, and Kimbro have been working on oyster reef habitat and restoration over the past 20 years, first in North Carolina, and then in California (Kimbro), South Carolina through Florida, and Massachusetts and Rhode Island. Dr. Scyphers has also worked on oyster reef habitat and living shorelines over the past decade in Alabama, Florida, North Carolina, and Rhode Island. Dr. Ries has worked on the effects of acidification on bivalves over the past decade. Dr. Bowen is a biogeochemist in our department and has worked on the effects of oyster aquaculture on sediment microbe communities

Staffing

We don't have anyone fully staffed, but students and techs in each of the above faculty's labs are working in part on shellfish-related questions; Northeastern isn't funding anyone directly to work on shellfish

Relevant Programs Related to Shellfish Management

We don't have explicit goals or a plan for shellfish programming.

Emerging Trends

N/A

Salem Sound Coastwatch

NGO/Research Name & Mission

Salem Sound Coastwatch

Our Mission is to protect and improve the environmental quality of Salem Sound and its watershed.

Overview of Program

Salem Sound Coastwatch is a non-profit coastal watershed organization that works with government agencies, businesses, other non-profit organizations and citizens, through municipal partnering, scientific investigation, education, and stewardship.

1. Increasing the public's knowledge and appreciation of the natural resources of the Salem Sound Watershed and the immediate and chronic threats to the ecological health of the watershed.

2. Working with the public and private sectors, as well as other non-profit organizations, to foster responsible and sustainable resource management practices in the Salem Sound Watershed.

3. Conducting and facilitating environmental monitoring and scientific research in the Salem Sound Watershed and sharing the results with the public.

4. Promoting citizens' awareness and understanding of their connection to the Salem Sound Watershed and their role in restoring and protecting its health.

Salem Sound Coastwatch is the regional service provider for the Massachusetts Bays National Estuary Program. We also have conducted numerous research projects with Salem State University Geological Sciences Department. Our current research is on the plankton and nutrients in Salem Harbor.

Multi-faceted monitoring of estuarine turbidity and particulate matter provenance: Case study from Salem Harbor.
Science of the Total Environment (2017), pp. 629-641. Bradford Hubeny, Melanie Kenney, Barbara Warren, Jeremy Louisos. DOI: 10.1016/j.scitotenv.2016.09.081. USA Article reference: STOTEN20907 Final version published online: 14-OCT-2016

Multi-Century Record of Anthropogenic Impacts on an Urbanized Mesotidal Estuary: Salem Sound, MA.
Estuaries and Coasts, Journal of the Coastal and Estuarine Research Federation (March 2018) Volume 41, Issue 2, pp 404–420. J. Bradford Hubeny, Ellen Kristiansen, Andrew Danikas, Jun Zhu, Francine M. G. McCarthy, Mark G. Cantwell, Barbara Warren, Douglas Allen. DOI: 10.1007/s12237-017-0298-y. Published online: 7 August 2017.

Staffing

Zero

Relevant Programs Related to Shellfish Management

We have been working for 30 years to improve the water quality of Salem Sound so recreational shellfish activity can resume.

Emerging Trends

External Trends

We do not work in isolation. Cooperation from state and federal agencies along with an engaged community is crucial for any change from the status quo. We have recently found this in the Town of Manchester-by-the-Sea when residents came to us asking why recreational shellfish fishing was not happening. From there, we helped activate a committee of interested residents, the Manchester Coastal Stream Team (a town committee), and the harbormaster, had meetings with DMF and began preliminary explorations at three beaches. We understand it is a long process, but people are willing to see it though.

Internal Trends

Salem Sound Coastwatch has always been looking for ways to improve the water quality and natural resources. The will is always there but targeted funding and research partners are necessary for sustained engagement.

SEMAC/WHOI SeaGrant/Cape Cod Cooperative

NGO/Research Name & Mission

Barnstable County Cape Cod Cooperative Extension

Mission: To improve the health and well-being of youth, families, and communities, conserve and enhance natural and marine resources, and strengthen agriculture and food systems.

Cape Cod Cooperative Extension Marine Program

Website: https://www.capecodextension.org/marine/

CCCE MP Mission: To establish, develop and carry out education programs in marine resource development, to assist with problems concerning coastal industries and the management of coastal resources, and to transfer technological innovations, educational and informational materials to public officials, educators, and marine users groups.

Woods Hole Sea Grant

Website: https://seagrant.whoi.edu/

WHSG is part of a nationwide network of 33 NOAA-funded Sea Grant college programs. It is based at the Woods Hole Oceanographic Institution. Since 1990, Woods Hole Sea Grant has operated its extension program through a memorandum of understanding with the Cape Cod Cooperative Extension's Marine Program.

The National Sea Grant College Program's legislative charge is to "increase the understanding, assessment, development, utilization, and conservation of the nation's ocean and coastal resources by providing assistance to promote a strong educational base, responsive research and training activities, and broad and prompt dissemination of knowledge and techniques."
WHSG research and extension supports four broad areas of national importance that are referred to as "Focus Areas"
- Healthy coastal ecosystems
- Sustainable fisheries and aquaculture
- Resilient communities and economies
- Environmental literacy and workforce development

Southeastern Massachusetts Aquaculture Center

Website: https://www.capecodextension.org/marine/semac/

SEMAC Program Guide

The mission of the Southeastern Massachusetts Aquaculture Center (SEMAC) is to foster the sustainable development of private/public aquaculture endeavors within the southeastern region and throughout the Commonwealth of Massachusetts by way of a coordinated effort including education, research, technical and economic assistance, best management practices and demonstration projects.

The history of the SouthEastern Massachusetts Aquaculture Center began in 1995 with the publication of the Massachusetts Aquaculture White Paper. Among the recommendations of the paper were the following:

No. 4 – Bond monies should be directed to Strategic Plan priorities.
No. 47 – Fund a research and innovation center
No. 58 – Establish regional aquaculture demonstrations centers.

Within the 1996 Seaport Bond Bill, there was language that called for the establishment of an aquaculture economic development initiative to be located in Barnstable County. A series of meetings were held at the then Cape Cod Economic Development Council Office (CCEDC) and at the County complex with the purpose to structure the initiative. Through these meetings, an aquaculture center concept evolved. Interest in other areas of the region resulted in the center's role extending beyond Barnstable County to include Plymouth, Bristol, Nantucket, and Dukes Counties; and in October of 1996 then Lieutenant Governor Paul Celluci and Senator Henri Raushenback announced that $100,000.00 would be available in the upcoming year to develop the center.

The County Commissioners appointed the original thirteen (13) board members on February 7, 1997, and the first board meeting was held on February 18, 1997. The majority of the board is comprised of industry representatives, five shellfish, one finfish, and the President of the Massachusetts Aquaculture Association (MAA) or his designee. It also includes the Director of Cape Cod Cooperative Extension, the Director of the Economic Development Council, one education representative, one academic/research representative, one environmental representative, and one municipal shellfish officer. SEMAC functions under the auspices of Barnstable County, and the Board meets at least twice a year. The budget is administered through the offices of Cape Cod Cooperative Extension**.** Due to the partnership with WHSG and CCCE and their support of staff salaries - all funding received for SEMAC is spent solely on projects.

Overview of Program

Barnstable County Cape Cod Cooperative Extension has maintained a Marine Program since the 1960s. Woods Hole Sea Grant came into existence in 1971 and began its partnership with Cape Cod Cooperative Extension in 1990. The Southeastern Massachusetts Aquaculture Center began in 1996.

These entities have all been working on shellfish related projects since they began. Listing all projects since then would make for a very long summary – so this summary is focused on the past 15 years up to the present day.

ALL projects described below are considered joint WHSG/CCCE/SEMAC Extension projects.

Geographic area

The three extension staff engage in shellfish related work primarily in Southeastern Massachusetts, including all of the towns in Barnstable, Dukes, Nantucket, Bristol and Plymouth Counties. The staff also collaborate with sister aquaculture centers NEMAC (Northeastern Massachusetts Aquaculture Center at Cat Cove Laboratory at Salem State) and WEMAC (Western Massachusetts Aquaculture Center at Umass Amherst). Staff also regularly collaborate with the network of other Sea Grant programs, especially those in the Northeastern States, and with researchers at Roger Williams University in Rhode Island and Stony Brook University in New York.

Core Programs

Municipal Shellfish Propagation Program

The municipalities of Barnstable County commit financial resources to maintain shellfish resources for both commercial and recreational shellfish fishing, and for water quality and habitat enhancement. The WHSG/CCCE/SEMAC oversees implementation of a Barnstable County-wide, competitive bulk hard clam (quahog) and oyster remote set seed purchase. This bid program allows for reduced costs of hard clam seed from the hatchery, avoids costly and late seed arrival problems, and provides a more streamlined and safe delivery of seed to the municipal shellfish programs. Since 1999, over 220 million quahog seed have been distributed to the 12-15 towns that participate in this program. In 2016 alone, combined funds purchased >16 million quahog seed If 50% of those 2016 quahog seed survived to harvest size, @$.21/ quahog, the potential wholesale value would exceed $1.6 million.

Oyster Restoration

The Atlantic oyster, *Crassostrea virginica*, has long been a favorite of recreational shellfish fishermen in southeastern Massachusetts. In response to the dwindling population of natural oysters due to habitat changes and fishing pressure, WHSG/CCCE/SEMAC has worked with municipalities to restore banks of oysters along the shores and estuaries of Cape Cod through the use of ***oyster remote set bags***. These bags contain juvenile oysters that are spawned in a local hatchery and allowed to attach to pieces of shell (cultch). The bags are then picked up by the 14 partnering towns and transported to grow out areas. Since 2003, over 40,000 bags of remote set oysters have been deployed. In addition to providing a significant catch for more than 17,100 recreational and 1,200 commercial fishermen (2009 CCCE Inventory), these oysters provide a suite of ecosystem services ranging from valuable habitat and structure to water quality improvement and shoreline stabilization. In 2016 alone, combined funds purchased over 5,000 oyster remote set bags. There are approximately 5 million oyster seed in 5,000 remote set bags and if 50% of the 2016 seed oysters survived to harvest, @$.50/oyster, the potential wholesale value would approach $1.25 million.

Farm Network

The Research Farm Network is a collaborative research consortium, bringing together shellfish farmers from different bodies of water to conduct applied research. The aquaculture industry comprises many disparate farming methods and growers are reluctant to adopt new technologies without proven advantages. In response, this program was created in 2003 to address shellfish farming issues relevant to the region through directed research studies. Since 2003, shellfish farmers have responded to an open call to participate in the RFN. Farmers agree to conduct assigned research projects with CCCE/WHSG/SEMAC staff as the technical advisors, which allow them to gain hands-on experience with projects such as growing alternative shellfish species and testing new gear technologies. The goals of the RFN are to 1) provide high quality, relevant data to local shellfish farmers, 2) provide multiple 'platforms' for demonstration and outreach in different communities with each of the participating farms, and 3) increase communication amongst shellfish farmers around the region. This *Research Farm* model has been so successful that a NOAA Sea Grant Aquaculture Extension and Technology Transfer grant was awarded in 2013 to expand similar work throughout New England. Shellfish growers recognize the utility of region-wide experiments and seek active participation in this program.

Research Farm Network projects include:

2016-2017

Over 90% of Massachusetts aquaculture production is oysters grown for the half shell market. This lack of diversity leaves the industry vulnerable to loss. While shellfish farmers have expressed interest in growing new species, they are often reticent to invest resources into such ventures without clear guidance on culture methods and marketing. In response, the RFN has often focused research on 'alternative species' for aquaculture, such as surf clams (*Spisula solidissima*). The surf clam's appeal is the likelihood it could be planted and harvested within a year's time. Clams spawned at the hatchery ARC were distributed to interested farmers within the RFN. Growers were advised on planting while Marine Program staff tended to experimental plots. Growth and survival of surf clam seed were monitored, providing insight into best locations and conditions for this species. Results were used to inform the shellfish aquaculture industry on ways to increase success with these clams. Most importantly, this demonstration project confirmed that this species could be harvested within a year. Subsequently, we became collaborators on a 2016 Saltonstall-Kennedy grant (2017-2019) that will builds on this initial research.

2015-2016:

Growing Seed without an Upweller

Procuring seed is a necessary first step for any shellfish farm or propagation operation and often represents over 16% of total oyster culture expenditures. With demand for oyster seed increasing, especially at larger sizes, improving nursery handling of oyster seed at smaller sizes can alleviate some of this bottleneck. Growers suggested that utilizing small mesh nursery bags and managed stocking densities was a potential alternative to buying large and expensive seed or utilizing a separate energy intensive upwelling system. To better define nursery bag potential staff ran trials in two different seasons with nursery bags compared to traditional upwellers. The results indicate starting with 3-4mm oyster seed in nursery bags seems a viable alternative to upwellers, especially in smaller or beginning farm operations if seed are handled carefully. Both survival and growth were on par with adjacent upwellers if density was managed and did not exceed 2000/bag. In addition, costs would be less than half that of buying larger "field plant" size oyster seed. This project helped demonstrate a viable alternative for nursery culture of oysters capable of producing consistent results at lower costs, with the potential to help alleviate some of the oyster seed bottleneck.

2014-2016

A multi-state (NY, CT, RI, MA, NH, ME) NOAA SG Aquaculture Technology & Transfer grant: Development of a Northeast Aquaculture Research Farm Network (NARF-Net), which was modeled after the successful WHSG/CCCE/SEMAC Research Farm Network. In FY16, the project included tests of a new oyster gear technology – an oyster flip bag for oyster grow-out which yielded promising results for a value-added product. At some locations, the oysters grew faster, produced a deeper cut shell holding more meat, and avoided summertime biofouling, resulting in lower labor costs and a value-added product.

2012-2014

Investigation into the feasibility of alternative species blood arks (*Anadara ovalis*). Five farmers received blood ark (*Anadara ovalis*) seed late in the fall and tried a variety of grow out methods. Staff visited the farms on a regular basis to deliver/exchange gear, monitor procedures and collect data/samples.

Survival and growth was assessed. This pilot study showed growth rates similar to that of quahogs with similar methodology but was not pursued subsequently due to lack of seed and increasing interest in surf clams.

2011-2012

Investigation into the feasibility of alternative species such as razor clams (*Ensis directus*).
Nine growers maintained and monitored razor clam seed which they received in summer 2012. It was previously planned for them to receive razor clam seed in 2011, but in July 2011 all seed perished at the hatchery. This project gave growers an opportunity to experiment with an alternative species with minimal or no risk to their business. Staff visited the farms on a regular basis to deliver/exchange gear, monitor procedures and collect data/samples. Survival and growth was assessed. While market interest was high with razor clams, overall survival was poor in culture conditions tested, so attention was diverted to other species.

Comparison of Bottom and Floating Gear for Growing American Oysters in SE Mass

2008-2010

Effect of Triploidy on Oyster Growth and Survival Seedless Oyster MDAR Final Report_2011

Management of Shellfish Diseases & Outbreak Response: Diseases of oysters and quahogs are one of the most significant ecological deterrents to successful aquaculture in southeastern Massachusetts. In an effort to provide shellfish growers and shellfish resource managers with useful information to optimize their farming efforts, WHSG/CCCE/SEMAC initiated a disease monitoring network (DRN) in 2012 to provide routine testing in representative areas, giving growers, natural resource managers, and shellfish constables an idea of how disease prevalence and/or intensity is changing. Region-wide disease testing of oysters has been conducted yearly since 2012 and WHSG/CCCE/SEMAC also responds to observations of oyster and quahog mortality events reported by the region's shellfish growers through emergency disease testing and site visits with growers to assess these events. This yearly monitoring recently detected an emerging disease trend in hard clams, which led to further WHSG/CCCE/SEMAC research with Roger Williams University and a recently funded $175,366 grant (2017-2019) from NRAC (Northeast Regional Aquaculture Center).

Water Quality Monitoring

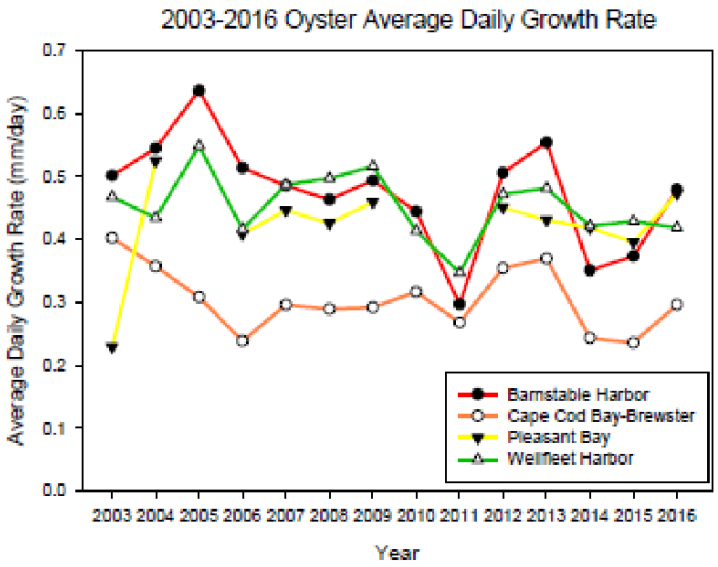
https://www.capecodextension.org/marine/waterquality/

CCCE/WHSG/SEMAC conducts long-term collection and analysis of water quality data from four sites on Cape Cod (Wellfleet Harbor, Cotuit Bay in Barnstable, Barnstable Harbor, Pleasant Bay in Orleans) and one site in Duxbury Bay. Data is collected with YSI multi-parameter sondes and two of the sites provide real-time data relayed to the CCCE website. Sites are in close proximity to large scale aquaculture zones, representing >250 shellfish farmers. The monitoring provides critical information to shellfish growers, as well as all users of the water. Increasing concerns about changing pH and subsequent ocean acidification, as well as rising water temperatures are motivating factors for maintaining long-term

databases on water quality in order to better monitor trends and/or changes. In addition to issues relating to the viability of shellfish aquaculture in coastal waters, state regulatory agencies also express concerns over the relationship between water temperatures and bacterial pathogens in shellfish (e.g., *Vibrio* sp.). The program began in 2001 with the purchase of the multi-parameter sondes. The YSI water temperature data is used by state regulatory agencies to address public health concerns, and the suite of measurements in Wellfleet have been used to help analyze ongoing water quality improvement projects, which includes the establishment of an oyster reef.

Shellfish Habitat Assessment (SHA)

The SHA is a baseline monitoring program, begun in 2003, that assesses the growth and survival of oysters and quahogs annually from July to September using a standardized methodology in four Cape Cod locations. The program was created with recognition that the growth and survival of these commercially important shellfish can be affected by short term events such as extreme weather and harmful algal blooms, long term events such as increasing water temperature, and ecosystem effects such as the cycling of predator populations. In order to detect and learn from these events, this baseline data is collected, analyzed, archived, and made available. In its 15th year of operation, the SHA supports aquaculture operation decision making by providing region wide information about the length of time it could take for product to reach market size. It is also available to support ecosystem-based planning for local estuaries including current efforts to develop nitrogen mitigation plans using shellfish aquaculture. The results are shared with shellfish growers and municipal shellfish programs via reports and newsletters. Data collected since 2003 shows that the average quahog growth rate has ranged from 0.02 mm/day to 0.23 mm/day. For oysters, the average growth rate ranges from 0.23 mm/day to 0.64 mm/day.



Shellfish Habitat Assessment set-up.	Data for oyster average daily growth rate 2003 – 2016

Shellfish Officer Research & Education (ShORE)

This program was developed in response to requests for assistance from town resource managers with municipal aquaculture. In collaboration with the towns, WHSG/CCCE/SEMAC staff develop and implement experiments which help resource managers plan restoration and enhancement efforts. Shellfish monitoring gear is placed in locations where managers have questions about the effects of things like restoration efforts and tidal restrictions. This information is also useful for determining where new propagation areas can be started. The program is built upon the concepts of the Research Farm Network and Shellfish Habitat Assessment programs. It provides a neutral source of information to commonly asked questions, while at the same time increasing communication among shellfish constables within the County and with Extension. Municipal staff select questions they think need answers, the WHSG/CCCE/SEMAC staff design protocols to address those concerns, the participating constables agreed to conduct the experiments, and the WHSG/CCCE/SEMAC staff provide all necessary materials such as shellfish seed, racks, & temperature loggers, and also analyze the data.

Technical Assistance to the Aquaculture Industry

WHSG/CCCE/SEMAC staff provide assistance, one-on-one consultation, and site visits to an industry worth over $23 million in 2016 and includes over 350 licensed shellfish farmers who provide over 1,000 jobs. Every year, staff members provide technical information to local shellfish wardens and harvesters to help them manage the fisheries resources in their communities for continued sustainable production. This work occurs via telephone consultations (avg 4+/week) and through site visits requested by aquaculturists or municipal shellfish managers with questions or concerns. Objective advice is given freely, as a means of transferring current information and conveying best management practices. This assistance has proven invaluable in establishing open lines of communication.

SEMAC Mini Grants

One of the first goals of the SEMAC Board of Directors back in 1996 was to support applied research in the aquaculture industry. In 1998 the, “Mini Grant” program was born and growers were invited to submit proposals for projects that would:

- Encourage industry development and diversification Promote environmentally responsible aquaculture projects Identify and/or develop best management practices Develop alternative aquaculture technologies and species.
- Encourage private/public collaborations. Advance innovative marketing approaches for aquaculture products.

Between 1998 and 2012 a total of 85 people received funding to work on their ideas. 144 projects were completed on a wide variety of topics from predator control to culture of alternative species. Funding has not been available for this program since 2012.

Mini Grant Projects 1998-2012 – Searchable Spreadsheet

This spreadsheet contains the titles of all 144 Mini Grant projects that were funded from 1998-2012, sorted by topic, town, species, and year. If you would like more information about any of these projects, please email Abigail Archer at aarcher@barnstablecounty.org.

Core Education & Public Outreach Activities

Fundamentals of Shellfish Aquaculture Course

Every other year since the early 1990s, WHSG/CCCE/SEMAC staff teach an 8-week course for individuals interested in learning more about shellfish aquaculture. Participants include those just starting out in the industry as well as town natural resources managers, regulators, and interested citizens. Guest speakers include local representatives from the shellfish aquaculture industry and MA Division of Marine Fisheries. Since 2008, 198 students have participated in the class. The course is a mixture of classroom instruction, guest presentations from members of the shellfish culture industry and field trips. It consists of eight modules focusing on best management practices and are presented in two-hour segments. Topics include: Orientation and Introduction to Shellfish Farming; Understanding Seed Supply: Hatcheries and Suppliers; Shellfish Nursery Culture; Oyster Field Planting, Grow-out & Harvest; Clam Field Planting, Grow-out & Harvest; Predators, Pests, Diseases & Other Bad News; the Business of Aquaculture and Permitting.

State Certification Course for Massachusetts Shellfish Officers

Collaborating with the Massachusetts Shellfish Officers Association, the Massachusetts Division of Marine Fisheries and the Massachusetts Maritime Academy, WHSG/CCCE/SEMAC provides lectures for a training program for the state's shellfish officers. In 2016 & 2019 WHSG/CCCE/SEMAC staff developed and taught sections on shellfish disease and management, shellfish pests and predators, shellfish & nitrogen remediation, and propagation without an upweller. To date, this program has awarded over 80 state certifications, promoting science-based decision making by these managers.

MA-ShellfAST, the Massachusetts Shellfish Aquaculture Siting Tool

WHSG/CCCE/SEMAC partnered with Roger Williams University School of Law, Environmental Law Institute, New England Aquarium, and UMass Boston, with grant funds received through the 2015 NOAA Sea Grant Aquaculture Extension and Technology Transfer, developed an online mapping tool to aid in the siting and permitting of shellfish aquaculture in the Massachusetts nearshore coastal zone. This tool is an ArcGIS based mapping tool that helps users understand the specific biological and regulatory factors that may impact upon their decision of where to site a potential shellfish farm. This integrated information provides user-friendly guidance to shellfish growers and local/state agencies. The layers developed for the MA-ShellfAST tool were determined based on discussions with a stakeholder advisory board in addition to directed discussions with MA Division of Marine Fisheries and the Army Corps of Engineers.

Shellfish in the Home

WHSG/CCCE/SEMAC staff were awarded a $50,440 grant from NOAA Sea Grant Aquaculture Extension to develop and produce educational materials on *Vibrio* and safe seafood consumption aimed at shellfish consumers, commercial & recreational harvesters, and retailers. These publications are now distributed every year to supermarkets, fish stores, tourist welcome centers, and town shellfish departments. Publications created and distributed are:

1) "The Harvest: Safe Shellfish for Recreational Harvesters" this tri-fold brochure outlines where and how to get a permit to harvest shellfish, why it is important to follow designated water classification maps, and how best to handle the catch after it is harvested. The brochure content was guided heavily by shellfish officers and the issues they encounter on a regular basis in recreational shellfisheries. 100,000 were printed and about 48,000 were distributed to 55 MA coastal town shellfish authorities in 2014. To date, nearly 68,000 have been sent out and distributions will continue as needed.
2) "*Eating Shellfish as Part of a Healthy Diet*" rack card with complete nutritional profiles of six species of shellfish harvested from MA waters. These shellfish were also screened for potential contaminants: metals, PAH's, PCB's, and pesticides, often of concern to potential seafood consumers on edge about safety of their food. A first print run produced 35,000 of these rack cards, and after distributing almost 30,000 of these in 2015, another 25,000 were printed. These were distributed with the booklet at over 46 seafood retail outlets, and again at natural resource offices, and chambers of commerce.
3) "*Tips for Fresh & Tasty Shellfish*" booklet details what to look for or ask for when buying live shellfish, risks regarding raw shellfish consumption especially for those with compromised immune systems, and best methods to employ when handling and storing shellfish at home. 35,000 were printed and over 12,000 were distributed.

Safe Shellfish at Restaurants

Working with the CCCE Nutrition Education & Food Safety Program, the Marine Program designed and distributed posters to educate restaurant workers on basic food safety practices when handling raw shellfish. There has been growing concern over foodborne illness related to consumption of raw shellfish and the importance of safe handling guidance throughout the supply chain – from farm to plate. Many restaurants, particularly during the summer season, experience a high turnover of kitchen staff, as well as staff who may not be English-speaking. Posters included simple colorful graphics and minimal text in two languages – English and Spanish. Over 200 posters were distributed through more than 12 town health departments for posting in local restaurant kitchens.

Shellfish Restoration & Habitat Focused Projects

Bay Scallop Restoration 2009-2012

As part of bay scallop restoration efforts, two experimental scallop fences were maintained at sites in Falmouth and Yarmouth. The goal was to create scallop spawning sanctuaries and test the feasibility of using these fences for aquaculture. Data was collected on scallop growth, survival, and gonad development to assess when spawning events occurred. 15,000 scallops were stocked in 2009 and monitored through fall 2011 at the Falmouth site, and the site was again stocked with 5,000 mature scallops in June 2011. At the Yarmouth site, several thousand were grown out in floating cages for stock enhancement through 2011, and the underwater fencing was stocked with quahog seed for alternate species evaluation. In addition, quahog seed were planted in Yarmouth's fence to determine feasibility of raising multiple species; one being infaunal and the other epifaunal or free-swimming. Both sites met significant challenges to success despite increased spat production within the waterbody. Anecdotal reports from resource managers of Lewis Bay in Yarmouth say the scallop restoration was a success in helping establish the significant fall fishery that persists to this day.

Examination of Shellfish Harvest for Potential Nitrogen Mitigation

Water quality is of paramount importance to the region and the increase in nitrogen entering some coastal water bodies contributes to their degradation. Municipalities are actively discussing how to manage nitrogen inputs and mitigate deleterious effects in a cost-effective manner. To solve the problem on Cape Cod alone - via centralized wastewater treatment - is estimated to cost between $4.2-6.2 billon, equivalent to ~60-85% of gross regional product (Cape Cod Area Wide Water Quality Management Plan Update June 2015). One alternative mitigation strategy under consideration is utilizing the filter-feeding capacity of bivalve shellfish, which have some potential to contribute toward a portion of the environmental and economic solutions. In 2012, WHSG/CCCE/SEMAC staff initiated a project to quantify the nitrogen present in shell and tissue of locally harvested oysters and hard clams. Results indicate N values to be within the range reported in literature from other areas of the US, though differences by location, time of year, and sometimes method of culture also exist. These data were analyzed and presented in a formal report for towns and others interested in water quality management options that incorporate the use of shellfish. Results were also published in a WHSG Marine Extension Bulletin, Shellfish, Nitrogen, and the Health of our Coastal Waters and in the peer reviewed *Marine Pollution Bulletin* (Reitsma et al., 2017). This information is helping towns accurately calculate region-specific nitrogen removal by harvest-size shellfish for both oysters and quahogs. As the number of municipalities engaged in pilot programs to explore the potential for shellfish harvest to

mitigate nitrogen increases, WHSG/CCCE/SEMAC staff will continue to provide technical assistance to involved officials, consultants, and concerned citizens with the most up to information available.

2009: A one day conference entitled: *Shellfish Restoration and Nitrogen Cycling in Estuarine Environments, What is the science*? was attended by more than eighty (80) people

Evaluation of Stormwater Rain Gardens for Removal of Fecal Coliform & Nitrogen

One of the major regional environmental issues identified by Cape Cod shellfish harvesters, growers, and managers, is the delivery of excess nitrogen to coastal water bodies and its effects on water quality and shellfish habitat. In 2015 the Cape Cod Commission completed an update to the Cape Cod Area-Wide Water Quality Management Plan and included the construction of stormwater rain gardens as a method for reducing nitrogen inputs. WHSG/CCCE/SEMAC received a two-year grant from the EPA Healthy Communities Program to answer the following questions: Are two existing rain gardens in two towns effective in removing nitrogen & fecal coliform from stormwater? How much nitrogen & fecal coliform is found in water exiting these rain gardens, relative to that found in inflows? Samples were collected from 2016-2018. Fecal coliform removal was high and nitrogen removal was highly variable.

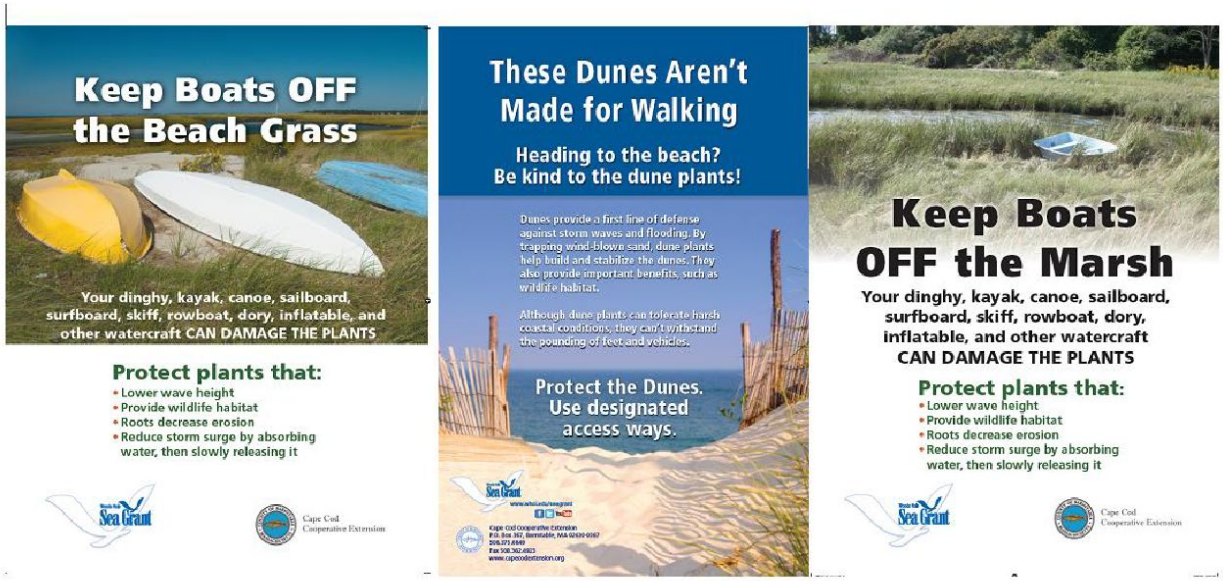
2010 Eelgrass Restoration

Funded through a grant with The Nature Conservancy, staff collected data on eelgrass habitat 'appropriateness' at selected sites around Cape Cod to determine what areas may be suitable for future eelgrass restoration projects. After thorough evaluation of site characteristics, including sediment, water quality, and bioturbator activity, three sites were chosen for eelgrass test plantings in September 2011; Cape Cod Bay in Truro, Town Cove in Orleans, and Phinneys Harbor in Bourne. Test plantings and the nearby eelgrass donor beds were monitored through spring 2012. Survival varied between sites and a number of factors such as light penetration, sediment quality, and predation were evaluated to provide recommendations on potential for large-scale restoration projects.

Final Report:
file:///C:/Users/jreitsma/OneDrive%20%20County%20of%20Barnstable/Josh/Eelgrass/Eelgrass%20TNC%20project/Eelgrass%20Final%20Report%2011-18-11.pdf

2017 Survey for the Southern Surf Clam in MA waters

Surf calm samples from 11 near shore harvest areas around Southeastern MA were analyzed genetically to determine if the Southern surf clam sub species *Spisula solidissima similis* exists in MA waters. It was determined a number of near shore populations of Southern surf clams exist along the southern coast of Cape Cod. This may have management implications and populations need further examination.



A sampling of the series of sturdy coastal signs that have been made available in order to provide some information as to what services valuable coastal resources provide.

Shellfish Aquaculture & Harvest Focused Projects

Surf Clam Grow Out

With help from the Saltonstall-Kennedy Grant Program, seed surf clams were produced in early 2017 and deployed by Woods Hole Sea Grant with cooperating growers. This work continued through 2018, including market evaluation. With partners from Roger Williams University, Aquacultural Research Corporation (ARC), Cape Cod Commercial Fishermen's Alliance, Shellfish Promotion and Tasting (SPAT), and the local aquaculture industry several trials of surf clam grow out were conducted. In addition to evaluating growth and survival of surf clams under a variety of conditions, work was done to evaluate market potential.

Results: With results showing rapid growth of surf clams to a "petite" marketable size as well as market acceptance and demand, shellfish growers are starting to invest in surf clam production. In addition, twoshellfish hatcheries in MA have now produced surf clam seed, with one producing seed consistently for the last several years.

Vibrio parahaemolyticus Research & Outreach

Vibrio species have become increasingly problematic for shellfish farmers throughout the US and in response the Massachusetts Division of Marine Fisheries implemented a set of management regulations to control *Vibrio* risk. While these bacteria are not new and illnesses are still relatively uncommon, requirements to report the resulting gastrointestinal illness suggest an increase in incidence rates resulting in pressure from the FDA to update shellfish handling requirements. As regulatory changes

ensue and *Vibrio*-related illnesses have been reported in local media, shellfish growers are concerned about how best to manage their farming practices to avoid potential illness, and also how to manage public concerns over the safety and quality of Massachusetts grown shellfish. Knowledgeable growers/harvesters, dealers, and consumers are the best way to ensure a continued safe and highly valued product. In response, WHSG/CCCE/SEMAC collaborated with researchers to examine levels of pathogenic and non-pathogenic strains of *Vibrio* sp. in oysters from different growing areas in MA. $190,360 two-year grant from NRAC: *Development of more efficient methods of Vibrio sp. detection and identification of Vibrio sp. abundance in cultured oysters from Northeast U.S. farms and from retail sites post-harvest*.

WHSG/CCCE/SEMAC also explored the relationship between the time oysters are exposed to specific temperature regimes and the level of *Vibrio* sp. at those temperatures. More recently, WHSG/CCCE/SEMAC's collaborative research led to a greater understanding of pathogenic *Vibrio* strains in shellfish harvest areas and data WHSG/CCCE/SEMAC collected was utilized by the State to reduce the shellfish re-submergence standard from 14 to 10 days. This study will continue to potentially reduce the standard to 7 days, based on additional data.

2010: Cape Cooperative Extension and Woods Hole Sea Grant co-sponsored a workshop entitled: *Vibrio Issues When Handling and Harvesting Shellfish* on June 29th which was attended by 32 individuals. The primary presentation was given by Robert Rheault, Executive Director of the East Coast Growers Association. Mike Hickey from the Massachusetts Division of Marine Fisheries and staff from Massachusetts Department of Public Health were also on hand to offer additional information and comments.

Volunteer Community Shellfish Action Program

In 2013 Woods Hole Sea Grant collaborated with retired shellfish warden Sandy McFarlane to create a program which matches willing volunteers with municipal shellfish wardens who need assistance raising shellfish. In 2014 WHSG staff developed and delivered a training workshop for potential volunteers that addressed gear, maintenance, predators, pests and diseases, best maintenance practices, and state regulations. 37 people attended the May 28 workshop and 32 attended on June 3. Participants came from 10 towns on Cape Cod and one on Martha's Vineyard. Of the 30 people who responded to the evaluation survey, 83% reported that they agreed or strongly agreed with the statement, "Shellfish biology is clearer to me". 100% agreed or strongly agreed with the statement, "I understand the importance of following shellfish regulations to ensure public health.", and 90% to the statement "I know what happens when fouling is not controlled adequately".

2013 Climate Change Working Group

WHSG/CCCE/SEMAC staff assisted the Social and Environmental Research Institute (SERI) with the formation of a local working group on climate change impacts to shellfish fishing. This project was funded through NOAA's Climate Program Office. WHSG was an active participant in the working group and provided technical assistance, as well as presentation on Vibrio. The working group identified numerous threats to shellfish fishing from climate change and the role of shellfish in mitigating impacts from climate change and other environmental hazards. Importantly, strategies to increase the town's resilience and its shellfishery in a time of climate change were also identified. The working group also discussed actions for all portions of shellfish production – from growing to harvesting and distribution,

including responses to Vibrio-related illnesses. The group summarized potential management actions and provided these for input into Massachusetts' updated Vibrio Control Plan.

Razor Clam Culture

In 2011-2012 WHSG/CCCE/SEMAC staff collaborated with University of Maine and Roger Williams University on an NRAC funded project: *Optimization of hatchery and culture technology for razor clams*. Staff worked with local hatchery ARC to help spawn and nursery culture razor clams to a size to be deployed by growers. Several nursery trials were also conducted at Mass Maritime Academy.

Disease Resistance: 2012 – Three-year grant: *Genetic marker-assisted selection of Northeastern hard clams for QPX resistance*. Marine Program continued collaboration with Rutgers University investigators on grant: *Evaluation and genetic analysis of hard clam, Mercenaria mercenaria, stocks for QPX-resistance*, by working with co-authors to edit a manuscript which was submitted and published in 2011 in the Journal of Shellfish Review: *Evaluation of three hard clam, Mercenaria mercenaria (Linne), stocks grown in Massachusetts and New Jersey for QPX-resistance*.

2014: Two workshops 1) *Best Management Farm Plan Workshop* and 2) *Gear and Marine Entanglement Risks*; combined attendance exceeded 80 people.

2011: As part of the continued outreach and assistance to shellfish constables, staff organized and led a *Shellfish Upweller Tour* for constables in September. Constables and DNR staff attended visits to Barnstable, Mashpee, and Eastham upwellers.

2010: Cape Cod Cooperative Extension and Woods Hole Sea Grant, in collaboration with SEMAC helped organize and co-sponsor the biennial NACE (Northeast Aquaculture Conference & Exposition) conference in Plymouth, MA in December. This 3-day conference brought together over 220 researchers, regulators, resource managers, and shellfish growers. WHSG/CCCE/SEMAC staff chaired sessions in addition to presenting lectures.

2009: Half-day workshop on upweller nursery systems for raising shellfish seed was provided to a group of 18 shellfish growers and constables.

Cape Cod Shellfish Industry Interviews

Staff increased the accessibility of a collection of shellfish fishing oral history interviews by creating an online collection within the NOAA Voices from the Fisheries Oral History Database titled, "Cape Cod Shellfish Industry Interviews". Shellfish fishing is an important part of Cape Cod's economy and culture. Shellfish aquaculture has been practiced since the 1800s, but the industry experienced rapid growth in the 1970s-1990s. The people who began their involvement with the shellfish industry in those two decades have witnessed a great deal of change in upland land use, water quality, species populations and distribution, and management. Documenting these experiences and observations complements scientific information on these topics. Oral history interviews were conducted in 2007 with 12 individuals involved in aquaculture, wild harvest, and town resource management, but the transcripts were only available in hard copy at the Extension office. In 2013, Woods Hole Sea Grant contacted the interviewees, obtained photos, sought permissions, and worked with NOAA NMFS staff to create a new

online collection called, “Cape Cod Shellfish Industry Interviews” in the NOAA Voices from the Fisheries Oral History Database. http://www.st.nmfs.noaa.gov/voicesfromthefisheries/about_the_project.html This information is now available to resource managers, researchers and interested citizens who can use it to gain perspective on current issues in shellfish management.

Shellfish Economic Impact & Marketing Projects

Market Development to Diversify Shellfish Aquaculture Products in Massachusetts

Funded through the NOAA Sea Grant Aquaculture FFO, staff partnered with Cape Cod Commercial Fishermen’s Alliance and Wellfleet SPAT to explore the potential for ‘alternative’ species of shellfish such as blood clams, butter clams (small surf clams) and shucked oysters. The partners hired a consultant to produce a market assessment for the three species, developed enterprise budgets for growers interested in realistic information about potential profits, held a workshop to present the budgets and advice on growing techniques, and are currently working with a consultant to produce an initial marketing plan for New England Butter Clams.

Wholesale Shellfish Dealer Survey

Due to the keen interest expressed in alternative species from the aquaculture industry, SEMAC contracted with the Center for Marketing Research at UMass, Dartmouth to help develop an Alternative Species Survey. The goal was to gain insight into the marketing opportunities for alternative and under-utilized species such as razor clams and blood arks. Results were formally prepared and shared with 70+ municipal shellfish officers through a professional workshop as well as 80+ aquaculturists through the Massachusetts Aquaculture Association. The results have helped to guide future work to help strengthen and diversify Massachusetts seafood production. Final Report: https://www.capecodextension.org/wp-content/uploads/2015/04/Wholesale-dealer-alternative-species-study-2014.pdf

Survey to Examine the Economic Impact of the Growing Shellfish Aquaculture Industry

Partnering with the UMass Dartmouth Center for Marketing Research, Marine Program staff developed an economic impact survey for the rapidly growing shellfish aquaculture industry. In fall of 2014, the survey was distributed to the 300+ shellfish growers of MA, and responses were analyzed by two UMass graduate students. Survey results were shared among industry stakeholders. https://www.capecodextension.org/wp-content/uploads/2015/04/MA-Aquaculture-Economic-Impact-Study-2015.pdf

Commonwealth Quality Program (CQP)

DAR worked closely with staff to help develop ‘Commonwealth Quality’ standards for the shellfish aquaculture industry. Based on best management practices, this program aimed to elevate industry benefits and encourage farms to operate under the highest practical standards. A similar CQP has been effective for terrestrial agriculture in Massachusetts and this program sought to expand and include aquaculture.

Marketing Assistance 2009-2011

Market competition from other areas of the country prompted SEMAC to provide some marketing assistance to help growers by encouraging their participation at promotional events such as the Boston Seafood Show. This was accomplished by setting aside a small amount of funding to purchase cultured shellfish from growers to serve at these events. It was envisioned that this assistance would help continue earlier marketing initiatives which promoted Massachusetts Bay State Cultured Shellfish, and would also allow growers in these difficult economic times to have greater flexibility in their attendance at marketing venues and events.

WHSG Tri Fold Brochure – Brief Overview
https://seagrant.whoi.edu/wp-content/uploads/sites/106/2019/02/WHSG_tri-fold.pdf
WHSG Program Guide 2018-2020
https://seagrant.whoi.edu/wp-content/uploads/sites/106/2018/05/Program_Guide-2018-FINAL.pdf
WHSG Program Guide 2016-2018
https://web.whoi.edu/seagrant2/wp-content/uploads/sites/106/2019/01/2016-2018-Program-Guide-3-1A.pdf
WHSG Program Guide 2014-2016
https://web.whoi.edu/seagrant2/wp-content/uploads/sites/106/2019/01/2014-2016-Program-Guide.pdf

Woods Hole Sea Grant Research Program

Every other year Woods Hole Sea Grant (WHSG) requests proposals for one- or two-year projects from investigators at academic, research and educational institutions throughout the state of Massachusetts. Funded projects contribute to WHSG and Massachusetts priority information needs and advance knowledge in one of four focus areas: healthy coastal ecosystems; sustainable fisheries and aquaculture; resilient communities and economies; and environmental literacy and workforce development. Proposals must include a plan for how audiences beyond the academic research community can use anticipated results.

Below is a list of WHSG funded research pertaining to shellfish over the past 10 years.

2018-2020

- **Mark Hahn and Chris Reddy, Woods Hole Oceanographic Institution:** *Halogenated Marine Natural Products: A Potential Risk to Human Health?*

  A team of biologists and marine chemists from WHOI led by Mark Hahn and Chris Reddy will examine the potential risk to human health posed by halogenated marine natural products (HNPs) in seafood. Some HNPs have been found to be persistent and bio-accumulative and to occur at similar concentrations as their industrial counterparts such as PCBs. Preliminary research suggests that HNPs could make a substantial contribution to the total "dioxin equivalents" in marine animals, and thus to the total risk of dioxin-like effects from consuming seafood. This research will help inform decisions regarding consumption of seafood by humans, including sensitive subpopulations such as children and pregnant women.

- **Hauke Kite-Powell, Woods Hole Oceanographic Institution:** *Increasing Northeast U.S. Aquaculture Production by Pre-Permitting Federal Ocean Space*

  This project aims to simplify the process and reduce the cost of obtaining permits for aquaculture in U.S. waters. Led by Hauke Kite-Powell, a WHOI research specialist, the two-year project will conduct a range of necessary reviews on selected offshore areas to pre-permit the areas and reduce the regulatory burden for aquaculture growers. With the pre-permitting process completed, aquaculture ventures will have a mechanism to gain access and begin production.

- **Abigail Archer and Diane Murphy, Cape Cod Cooperative Extension, Melissa Sanderson, Cape Cod Commercial Fishermen's Alliance, and Michele Insley, Wellfleet SPAT:** *Market Development to Diversify Shellfish Aquaculture Products in Massachusetts*

  This project will explore the potential to broaden the shellfish aquaculture market in Massachusetts to include two other native clam species, surf clams and blood arks, as well as shucked oysters. Led by WHSG Marine Resource Specialist Abigail Archer, the project will conduct a market analysis of the potential consumer demand for and economic value of culturing alternative species, as well as for shucked oysters. The work will be done in collaboration with Cape Cod Cooperative Extension, the Cape Cod Commercial Fishermen's Alliance, and Wellfleet SPAT (Shellfish Promotion and Tasting).

- **Jefferson Turner, University of Massachusetts-Dartmouth:** *Harmful Phytoplankton Blooms in Buzzards Bay, MA*

  University of Massachusetts Dartmouth biological oceanographer Jefferson Turner will use Sea Grant funding to expand the 30- year data collection record of phytoplankton abundance and community composition in Buzzards Bay (Mass.). The extended program will focus on patterns of appearance and abundance of harmful phytoplankton species in relation to those of other phytoplankton species that may utilize different nutrients and hydrographic niches. The research may provide the state agency responsible for ensuring the safe harvest of shellfish with new management approaches to predicting and dealing with these harmful blooms.

2016-2018

- **Bassem Allam et al.**, **SUNY-Stony Brook:** *Probing Molecular Determinants of Bivalve Resilience to Ocean Acidification (Regional ocean acidification call)*

  This project aimed to identify molecular markers and mechanisms associated with resilience to acidification in some of the most important bivalve species along the east coasts. This research has major implications for basic and applied science. It will determine molecular and physiological mechanisms and pathways involved in bivalve natural resilience to acidification and identify molecular features associated with resilience. This information is greatly needed for the management of wild fisheries and for the development of resilient varieties of aquacultured stocks. Resilient brood stocks will provide the industry with superior germline to face current and projected episodes of acidification in local waters.

- **Michael Brosnahan, Don Anderson, Heidi Sosik, Rob Olson, Woods Hole Oceanographic Institution:** *Enhanced Monitoring and Spatial Mapping of Toxic Algal Blooms: Field Implementation of an Acoustic Cell Concentrator Coupled with Imaging In-Flow Cytometry*

  Harmful algal blooms are common in many coastal areas and early prediction of bloom formation allows resource managers to take action regarding shellfish closures and the protection of human health. Brosnahan et al. modified the design and improved sensing capabilities of the Imaging FlowCytobot by adding an acoustic cell-concentrating module that enabled higher throughput and more sensitive phytoplankton monitoring. Field deployments of the IFCB-HT targeted blooms of the harmful algal bloom species *Alexandrium fundyense*. IFCB-HT yields comparable descriptions of HAB abundance to traditional methods of species abundance and distribution, but with much greater immediacy (2 hours from sampling versus 4 weeks).

- **Scott Lindell, Woods Hole Oceanographic Institution:** *Integrating Mussel and Kelp Longline Culture Structures and Management*

  Mussel and sugar kelp farming have been two of the fastest-growing sectors of marine aquaculture in the Northeastern U.S. over the past ten years. Both crops are typically grown on similar longline structures on private leases in public waters. This project seeks to develop the infrastructure to integrate of these crops to provide better space utilization of limited permitted sites, shared use of the capital costs, better risk management via crop diversification, and lower risk to protected species by fewer vertical lines deployed.

- **Diane Murphy, Cape Cod Cooperative Extension, Read Porter, Roger Williams University, Rebecca Kihslinger, Environmental Law Institute, and Michael Tlusty, New England Aquarium:** *Creating a Spatially Defined Tool for Marine Aquaculture Siting and Permitting*

  Siting and permitting are key barriers to the continued development of the marine shellfish aquaculture industry in New England. When designing projects, growers must select sites that avoid and minimize environmental impacts and conflicts with a wide array of other uses and where they can obtain all required permits. Successful siting therefore requires growers – and the agency staff reviewing applications – to understand and apply complex scientific, practical, and regulatory information. Woods Hole Sea Grant/Cape Cod Cooperative Extension partnered with the Environmental Law Institute, Roger Williams University, and the New England Aquarium to develop a siting tool that integrates data on legal requirements, competing uses, and environmental impacts that would assist growers and agencies successfully and efficiently navigate the siting and permitting process.

- **Dianna Padilla, SUNY-Stony Brook:** *Flexing mussels: Does Mytilus edulis Have the Capacity to Overcome Effects of Ocean Acidification?*

  This project aimed to determine the driving factors that lead to variance in responses seen within species to ocean acidification stress, especially long term, cross-generational studies. This project used cross-generational experiments with the common blue mussel, *Mytilus edulis*, to test for its capacity to display resilience or adapt to different OA conditions. They examined multiple metrics of performance at different life stages, tested for tradeoffs in performance under different OA conditions, and assessed the potential for *Mytilus edulis* to show resilience or adapt to changing environments.

- **Daniel Rogers, Stonehill College, and Virginia Edgcomb, Woods Hole Oceanographic Institution:** *Understanding the Impact of Floating Oyster Aquaculture on the Carbon and Nitrogen Flux to the Sediments using Natural Abundance Isotopic Surveys and Metagenomic Approaches*

  This project sought to determine the fluxes of nitrogen associated with oyster aquaculture operations to determine the net impact of oyster aquaculture on nitrogen (N) inputs or loss. Rodgers and Edgecomb measured water column N removed by export and burial (loss of particulate organic N as a result of oyster activity and the fraction of water column N retained in the oyster tissue. This project also examined microbial metabolic activities in sinking particles and in sediments and how those are both altered by oyster aquaculture.

2014-2016

- **Carl Lamborg, Woods Hole Oceanographic Institution, John Logan, Massachusetts Division of Marine Fisheries, and Ruth Carmichael, Dauphin Island Sea Lab:** *A History of Mercury Impacts to Waquoit Bay Clams*

  This project examined the effect of groundwater sources of mercury (Hg) on small coastal embayments and salt ponds, such as Waquoit Bay (Falmouth/Mashpee, MA). The investigators hypothesize that today's loads are 12 times higher than pre-settlement due to sub-marine groundwater discharge-related fluxes and the three-fold increase in atmospheric deposition world-wide. This project measured natural archives of the history of the Hg and nutrient impact in Waquoit Bay and south shore salt ponds/bays: clam shells and sediment. Analysis of Hg and nitrogen stable isotope composition in the clam shells and sediment allowed the investigators to reconstruct a history of Hg loading to the system (sediments) and biota (clam shells) and thereby determine both the level of disturbance and the biogeochemical connection between Hg and nutrients.

- **Roxanna Smolowitz, Roger Williams University, Hauke Kite-Powell, Woods Hole Oceanographic Institution, and John Brawley, Saquish Scientific:** *Research to Inform Regulatory Decisions on the Management of Vp in MA Shellfish Growing Areas*

  The pathogen, *Vibrio parahaemolyticus* (*Vp*)and *Vibrio vulnificus* (*Vv*), exhibit exponential growth with increased temperature and are naturally occurring in Massachusetts' coastal waters. Mandatory shellfish closures occurred during summer 2013 in several coastal communities in Massachusetts due to an alleged public health threat from *Vp*. This closure event highlighted the need for a better understanding of the behavior and trends of *Vp* and *Vv* populations in Massachusetts' coastal waters. This project aimed to improve understanding the public health risk from *Vp* and *Vv* within the context of oyster cultivation and harvesting practices, and thereby support the improvement of risk management for this pathogen.

- **Jefferson Turner and Brian Howes, University of Massachusetts at Dartmouth:** *"Rust Tides" of the Toxic Dinoflagellate Cochlodinium polykrikoides in Buzzards Bay*

  Over the past decade the toxic dinoflagellate *Cochlodinium polykrikoides* (*C. polykrikoides*) has been increasing in frequency of blooms in Buzzards Bay, MA. It is a fish-killing harmful-algal-bloom species that has been expanding geographically across Asia, North America and Europe over the last two

decades. This species was unrecorded in the only previous study of phytoplankton community composition in Buzzards Bay that covered the years of 1987-1998 (Turner et al., 2009 — Marine Ecology Progress Series 376: 103-122). However, over recent years, *C. polykrikoides* has formed massive blooms with "rust-colored" water discoloration in northern Buzzards Bay during August and September. The Turner laboratory has been conducting system-wide sampling of Buzzards Bay monthly since 1987. This study has produced numerous publications and student theses, a large amount of yet-to-be published data, as well as archived samples for plankton community composition and abundance, and water quality parameters. This project updated the phytoplankton community composition time-series, with particular focus on the initial occurrence of *C. polykrikoides* and the inorganic and organic nutrient conditions associated with the development of recent blooms. If blooms of *C. polykrikoides* are expanding their temporal and spatial presence in Buzzards Bay, and such blooms are implicated in adverse effects on finfish, shellfish, or occurrence of anoxia/hypoxia, then changes in management of nutrients, and/or utilization of recreational fisheries for finfish and/ or shellfish may be prompted.

- **Jeanette Wheeler, Lauren Mullineaux, and Karl Helfrich, Woods Hole Oceanographic Institution:** *Behavioral Responses of Competent Larval Oysters (Crassostrea virginica) to Chemical Settlement Cue in Turbulent Flow*

  This project tested larval oyster swimming behavioral responses to simultaneous hydromechanical and chemical settlement cues mimicking field conditions. Behavioral responses to water column cues may affect larval supply to adult benthic populations, an important consideration in the conservation of wild oyster populations. Larval responses to combined hydromechanical and chemical cues were determined in a flume experiment, in which for the first time the flow surrounding larvae will be actively quantified to decouple effects of turbulence from effects of chemical cues. This project is the first to explore simultaneous effects of turbulent flow and chemical cues to larval behavior, using image analysis methods to isolate larval behavioral responses in flow. Results from this study may help inform management decisions for habitat restoration and conservation.

2012-2014

- **Scott Lindell, Marine Biological Laboratory, and Charles Yarish, University of Connecticut:** *Multi-Cropping Shellfish and Macroalgae for Business and Bio-Extraction*

  Aquaculture of shellfish and seaweed for bio-extraction of nitrogen (N) has gained much attention in recent years. It has been suggested that it may serve as a possible means to mitigate degraded estuarine waters. While oyster aquaculture alone can be beneficial to local waters, there is evidence that co-culture with macroalgae could greatly enhance N removal. Harvesting aquaculture oysters removes more than twice the N per ha/year than the calculated harvest of wild macroalgae; but cultured macroalgae may remove many times more N than oysters, depending on the methods. Oyster and macroalgal co-culture may provide significantly more benefits than single-species culture alone. Lindell and Yarish examined the feasibility of a commercial scale multi-cropping aquaculture project with dual benefits of producing a product and improving water quality.

- **Lauren Mullineaux and Meredith White, Woods Hole Oceanographic Institution:** *Transgenerational Exposure of Bay Scallops to Ocean Acidification*

Mullineaux and White examined the effects of exposure of bay scallops to ocean acidification, and the hypothesis that exposure of a parent population to ocean acidification will mitigate the progeny's negative effects. This study exposed a population of bay scallops to high CO_2 conditions and compared the progeny of scallops raised in ambient conditions to those in high CO_2 conditions to determine if offspring of achieved any adaptive benefits from parental exposure to high CO_2 conditions. This project also explored what life history stage of bay scallops was most sensitive to ocean acidification.

- **Porter Hoagland and Di Jin, Woods Hole Oceanographic Institution:** *Decision-Support for the Economic Analysis of Trade-offs in Coastal and Marine Spatial Planning (CMSP) for the US Northeast Region* (Regional Socioeconomic Project from the Northeast Sea Grant Consortium Competition)

  In this project, Hoagland and Jin adapted and refined a decision-support methodology for the evaluation of socio-economic tradeoffs in coastal and marine spatial planning. A primary objective was to develop an economic methodology based on models of spatially distributed regional economic impacts to characterize tradeoffs among alternative planning policies. They also demonstrated the practical utility of the methodology using ecological and economic data related to the coastal ocean of the US Northeast region. They incorporated information about five economic sectors: commercial fishing, seafood processing, agriculture, manufacturing and an aggregate sector of all other sectors combined.

- **Daniel Ward and Alex Walsh, Ward Aquafarms and ePaint,** *Novel anti-predator coatings for shellfish aquaculture*

  The use of traditional anti-fouling agents is not recommended for aquaculture operations, because metals can leach into the environment and have unintended consequences. This project evaluated several non-toxic, commercially available compounds: ECONEA, capsaicin and menthol. The efficacy of each compound was tested individually, within coating matricies, and in mesocosms. ECONEA was effective at reducing predators but was also toxic to shellfish, Capsaicin and methol were both effective, but more work needed to be done to determine the appropriate concentrations.

2010-2012

- **James Churchill, Woods Hole Oceanographic Institution, and Geoffrey Cowles, University of Massachusetts-Dartmouth**: *Modeling as a Tool to Better Understand Bay Scallop Recruitment and to Manage Bay Scallop Populations*

  In Massachusetts, bay scallops constitute a major resource for the shellfish fishing community and economy, but the harvest value varies significantly from year to year, specifically in local embayments. Those variations have led to efforts to enhance populations in specific areas through seeding – with varying degrees of success. Churchill and Cowles developed and applied a modeling system for examining sources of recruitment variability of bay scallops in the region to help understand the factors that influence juvenile scallop recruitment. They modeled transport and recruitment of juvenile scallops in three critical habitats: Buzzards Bay, Waquoit Bay, and Menemsha Pond. Their goal was to determine the relative extent to which the local population is

self-sustaining through larval retention of locally spawned scallops or nourished through delivery of larvae from remote sources.

- **Anne Cohen and Daniel McCorkle, Woods Hole Oceanographic Institution:** *Ocean Acidification Impacts on Larval Shell Formation by Commercial Shellfish Species of New England: An Experimental Investigation*

  This project investigated the effect of ocean acidification on bivalves. Cohen and McCorkle completed a two-year study with controlled culture experiments to quantify the impact of changes in calcium carbonate saturation state on early shell formation in commercially valuable shellfish. These experiments included bay scallops, quahogs, sea scallops, and eastern oysters.

- **Daniel McCorkle, Woods Hole Oceanographic Institution:** *Controls on Calcification by Shellfish: Carbonate Chemistry of Bays and Estuaries in Southeastern Massachusetts*

  This project monitored the carbonate chemistry of coastal embayments in southeastern Massachusetts to determine if rising atmospheric carbon dioxide concentrations will impact local shellfish. McCorkle collected water quality samples from Barnstable Harbor, Herring River (Harwich) and Waquoit Bay.

Staffing

CCCE/WHSG provide funding for 3 full time Extension staff with the titles of *Fisheries & Aquaculture Specialist*, *Marine Program Specialist*, and *Marine Resource Specialist*. The majority of their time is spent on water quality & shellfish related projects.

At Barnstable County Cape Cod Cooperative Extension, two additional staff persons provide outreach & communications & graphic design assistance to the three extension staff.

At Woods Hole Sea Grant, the additional positions with the titles of Research Coordinator, Education Specialist, and Communications Specialist all work closely with the three extension staff on shellfish related projects.

Woods Hole Sea Grant Staff Profiles: https://seagrant.whoi.edu/about/people/
Cape Cod Cooperative Extension Staff: https://www.capecodextension.org/about/
This level of staffing will remain the same over the next two-years.

Relevant Programs Related to Shellfish Management

See Overview of Program Section.

See pages 5-10 in the WHSG current strategic plan: Woods Hole Sea Grant in the 21st Century – Issues Opportunities & Action for Massachusetts 2018-2021:

https://web.whoi.edu/seagrant2/wp-content/uploads/sites/106/2019/01/Strategic-Plan-2018_2021.pdf

Woods Hole Sea Grant is advised by the Marine Outreach Guidance Group (MOGG) Current MOGG membership: https://seagrant.whoi.edu/about/advisory-board/

Annual Work Plans for the Southeastern Massachusetts Aquaculture Center are determined by the SEMAC Board of Directors. Current SEMAC Membership: https://www.capecodextension.org/marine/semac/aboutus/

CCCE/WHSG Extension maintains the core programs as described in section II, and determines short and long term priorities for new shellfish related projects based on short & long term feedback and input from a variety of sources involved in harvesting, growing, and managing marine resources in the state.

Emerging Trends

External Trends

The National Sea Grant budget is subject to Congressional appropriation. Although support for the National Sea Grant College Program remains strong among Senators & Congresspeople, President Trump has not included the Sea Grant program in his initial national budget for the past two years. Due to support from both branches of the legislature, funding was then reinstated in the House and Senate versions of the budget.

The Southeastern Massachusetts Aquaculture Center budget is subject to State Legislature appropriation and internal Mass Department of Agricultural Resources budget decisions. Since the Aquaculture Centers were developed in 1997 the level of funding has consistently decreased.

Internal Trends

No decrease in level of investment is anticipated.

SPAT

NGO Name & Mission

Wellfleet SPAT, Shellfish Promotion and Tasting, Inc.

Non-profit organization chartered in 2002, after the 1st OysterFest. Mission: Devoted to sustaining our shellfish fishing and aquaculture industries. SPAT promotes knowledge and awareness of the industry by educating the community and promoting the brand. The annual Wellfleet OysterFest is our major promotional activity and fundraising event. We hold many smaller programs and outreach events throughout the year including shellfish farm tours. Proceeds from these activities are given back to the community in the form of high school scholarship program & community grants - $515,000 to date.

Overview of Program

Wellfleet, Massachusetts, has long been considered the home of one of the world's great oyster reefs. In fact, When Samuel Champlain explored Cape Cod's waters in 1605, there were so many oysters in Wellfleet Harbor that he called it "oyster bay." For this reason, shellfish fishing has always been an important subsistence and commercial activity in Wellfleet. In fact, the commercial sale of Wellfleet oysters within North America began in 1645. Currently as estimated 15% of Wellfleet's year-round population of around 3000 people make their living through shellfish fishing. These are small family farms - many which have been shellfish fishing for generations.

SPAT endeavors to support this longstanding tradition and our harvesters in a variety of ways. Our partners and programs include:

- SPAT has an active project funded in part by NOAA, and in collaboration with the Barnstable County Extension Service, Sea Grant and the Cape Cod Commercial Fishermen's Alliance to explore market and production opportunities for alternative shellfish species in an effort to help our shellfish fishermen diversify and expand their markets.
- Town of Wellfleet - SPAT had supported many municipal projects over the years through financial contributions or staff support. These include the Shellfish Department's culching, propagation and most recently enhancement of the recreational fishery. SPAT supports the town's dredging and wastewater efforts to create a healthy marine environment.
- Wellfleet works with our local extension service - the Barnstable County Cooperative Extension - to provide information to shellfish fishermen about their growing environment and communicate with them about pending concerns or threats.
- SPAT invested in and initiated a loan program for shellfish fishermen in collaboration with the Community Development partnership in 2015. This fund is ongoing and available to Wellfleet harvesters.
- SPAT invested in local hatchery and research center ARC in 2015 and works with ARC to help provide the best seed to local growers.
- SPAT supports the local Audubon to provide a coastal ecology program to the 4th and 5th grade in our local elementary school.
- From 2015 - 2016, SPAT hired a scientist to work with shellfish fishermen to explore causes of VP and assess ways they could mitigate the risk of this bacteria affecting their harvest.

Please visit our website to see a full description of community partners and community grant, recipients.

Staffing

Currently, SPAT employs one person on a full-time basis, two people on a part-time basis and has a volunteer board consisting of eight invested individuals. Over the next two-years, we are projected to hire a contract employee or consultant to help us with our new program – that is a marketing campaign for Wellfleet oysters.

Relevant Programs Related to Shellfish Management

SPAT continues to seek relevant and helpful ways to support the shellfish fishing industry and we do so in the following ways:

Education and training

Over the years, we have held education and information sessions with state regulators (DMF) and members of the science community (Barnstable County Cooperative Extension and Sea Grant) to help keep shellfish fishermen up to date on regulations, science and environmental concerns. These sessions are well attended and highly interactive.

This spring, SPAT subsidized and hosted a ServeSafe class for shellfish fishermen. We want shellfish fishermen to be knowledgeable in food safety in the event they choose to operate a raw bar ant one of our events or on their own. The class was attended by 18 individuals and was a big success. We will most likely repeat it.

SPAT also hold shellfish farm tours for the general public. This gives them the experience of being on a working shellfish farm, learning how these farms/grants came into existence, what is involves in oyster and clam culture and what it takes to get fresh shellfish on their plates. The goal is to educate the public about the industry and to instill a greater appreciation for it.

Promotion and Outreach

As mentioned above, SPAT is currently embarking on a campaign to brand Wellfleet oysters. In the last decade, aquaculture specifically oyster production has grown dramatically. As a result, competition for market share has increased. Shellfish fishing is a $6.8 million industry in our town so SPAT has committed to supporting this local economy by reinvigorating marketing efforts. The goal for this campaign is to enhance brand awareness and increase demand for the product and ideally stabilize the price for our harvesters.

We also strive to keep Wellfleet shellfish in the forefront in the minds of consumers, chefs, legislators and regulators. We plan to do so through our aforementioned marketing efforts, tasting events and partnerships. One example of this is SPAT's recent participation in an event sponsored by US Department of Commerce and NOAA Fisheries in Washington DC. This event put SPAT and Wellfleet oysters and clams in front of the Sec. of Commerce Wilber Ross among other legislators.

Sustainability

SPAT values sustainability. We have demonstrated this appreciation at our annual fundraising event, the Wellfleet OysterFest, where we collect the shells from the consumed shellfish. These are then overwintered and given to the Wellfleet Shellfish Department to support their clutching activities. Since we have been collecting the shells, we have put somewhere north of 35 tons of shell back into the harbor. The shell recycling effort also helps us divert trash from the landfill. We plan to expand the recycling efforts this year by eliminating the use of all plastic and the event. SPAT recognized that plastic has been a big contributor to marine pollution, so we are doing our part by elimination plastic at our events to help minimize the impact and keep our harbors clean.

Emerging Trends

External Trends

A. Competition of oysters and other shellfish from other growing areas and the threat of more oysters from municipal projects have recommitted our organization to helping shellfish fishermen be more efficient and better able to compete in the competitive market.
B. Environmental challenges and changes that adversely impact the health of our shellfish fishing industry have prompted our focus on what additional efforts must be implemented to sustain the health of Wellfleet's shellfish fishing industry.
C. Wellfleet Harbor is in dire need of dredging, while plastic pollution, acidification, and other threats continue to pose great harm to our ecosystem.

Internal Trends

Our organization's mission has always resulted in a high level of investment in supporting and sustaining Wellfleet's shellfish fishing and aquaculture industries. It is SPAT's central mission. Our diverse board and immensely committed staff demonstrate sustained effort in honoring this mission. Our board enlists differences of opinion through a culture of inquiry. Our board brings unique areas of expertise and engages in thoughtful questioning and inquiry that cultivates strong collective wisdom. We have members who work in the shellfish fishing industry who provide real-time feedback about the needs of the shellfish fishing industry. Our board consists of tenured and founding members with strong institutional knowledge, newly recruited members with fresh perspectives, and a recent restructuring of our Executive Board.

The Nature Conservancy (TNC)

NGO Name & Mission

The Nature Conservancy (TNC)

The Nature Conservancy (TNC) is an international environmental conservation non-profit organization with a mission to conserve the lands and waters on which all life depends. TNC originated as a land trust to protect biodiversity through the preservation of land. The organization has evolved to address the complex environmental challenges threatening people and nature. The strategic pillars of TNC's suite of conservation priorities include; to effectively protect and manage lands, oceans, freshwater, and forests, build healthy cities, tackle climate change, and ensure sustainable food production.

Coastal and estuarine conservation has been a significant element of TNC's investment over the years, because of the outsized value these habitats hold for people and nature. Estuaries provide valuable services to nature as nursery grounds and habitat for fish, bird, and other species. They filter storm and ground water and provide a buffer from ocean waves and storms. Estuaries are utilized heavily and under increasing pressure from people as places of continued development, commerce, and recreation.

Shellfish play a critical role in the proper functioning of estuaries by providing ecosystem services such as provision of improved water quality, nearshore habitat, shoreline stabilization, and food for marine species and people. Shellfish populations and habitats have been reduced and degraded from historic levels and consequently a reduction in the provision of those valuable ecosystem services. TNC is working to increase shellfish in coastal waters through habitat restoration.

Feeding a global population set to exceed 9 billion by 2050 will have significant environmental implications. Seafood demand is rising, while wild capture fisheries production is flatlining. Aquaculture is the fastest growing food production system globally and landings recently surpassed fisheries production. As a resource efficient means of producing food, providing coastal economic opportunities, and in some cases resulting in positive environmental externalities (shellfish/macroalgae), TNC is working to ensure that aquaculture is developed and practiced sustainably.

Increasing shellfish in coastal waters will result in improved estuarine function, provide increased economic opportunities, and sustainable seafood. With staff and conservation projects in over 70 countries and all 50 states TNC is working toward well managed shellfish resources, properly sited, implemented, and monitored restoration, and sustainable development of restorative aquaculture at the local, state, national and global scales.

Overview of Program

TNC MA Chapter Ocean Food System Vision

Increase the production of sustainable seafood while supporting thriving coastal and ocean ecosystems and the communities that rely on them.

To accomplish this vision, related to shellfish, TNC will continue to work to improve the policy and practice of shellfish restoration, aquaculture, and management. This will include supporting collaborative, natural and social science research meant to inform the aquaculture industry, resource managers and the general public toward sustainable development. Research currently includes:

- Furthering the understanding of aquaculture/marine environment interactions, including quantification of ecosystem services (habitat value to fish and other marine species) from common oyster grow-out gear in MA such as floating and bottom cages compared to control habitats
- Furthering the understanding of public perception of aquaculture including the quantification of the drivers of perceptions related to common aquaculture grow-out methods

TNC will participate in the MSI process to support the development of a statewide holistic shellfish management plan which ideally creates enabling conditions (funds/permitting) for municipal/state directed effective shellfish habitat restoration.

Staffing

Current and expected next two years, in MA: 1 FTE. = $140,000 (a number used by TNC to account for a full-time employee).

In addition, and difficult to quantify, support from regional, national, and international programs in consultation, fundraising, technical support.

Relevant Programs Related to Shellfish Management

Relevant recent TNC shellfish investments

- 2014 – Raised significant funds for land conservation as part of ARC deal
- 2015 – Secured ~$530k NOAA DARRP/NRDA Award: Bouchard B-120 Shellfish Restoration
- 2017 - Matched ~$25k NFWF award for MSI
- 2018 - Raised ~$100k for aquaculture natural and social science research
- Roughly 1.5 M investment in shellfish in MA over the last five years

Nationally, TNC has partnered with the National Oceanic and Atmospheric Administration (NOAA) and in particular the Restoration Center to advance shellfish restoration policy and practice across the U.S.

- A sample of relevant TNC/NOAA shellfish restoration work products include:
    - Mapping Ocean Wealth (website) and accompanying report
        - A Manager's Guide. Setting objectives for oyster habitat restoration using ecosystem services. (link)
    - Design and monitoring of shellfish restoration projects. (link)
- TNC is a founding member of the Shellfish Growers Climate Coalition (link), a partnership between shellfish growers on both the East Coast and the West Coast in collaboration with The Nature Conservancy. The SGCC is utilizing the industry's voice to support progressive climate

change policy. There are at least 100 industry members including at least 12 MA members signed onto the SGCC.
- TNC has been involved in shellfish management, restoration, and/or aquaculture project work in nearly every coastal U.S. state.

The Nature Conservancy's Global Aquaculture Strategy (website) has two primary components. The first is dubbed Smart Growth and will work toward sustainable development through spatial planning, governance reform, and deployment of impact capital. The second is Restorative Aquaculture, harnessing the ecosystem service delivery potential of aquaculture to accelerate ecological recovery.

In Massachusetts The Nature Conservancy

- Supported municipalities via funding and technical support to site, permit, implement, and monitor shellfish restoration projects. Several demonstration scale oyster and bay scallop restoration projects have been conducted in the municipalities of Wellfleet, Tisbury, Fairhaven, Bourne, and Wareham with TNC support.
- Supported the Division of Marine Fisheries (DMF) in the development the Shellfish Planting Guidelines (link), a widely referenced resource that outlines and synthesizes allowable shellfish planting activities.
- Part of the partnership that saved A.R.C. in Dennis by supporting the land conservation efforts around the hatchery and identifying a capital investor.
- Holds a seat on the MA Shellfish Advisory Panel, designed to enhance communication between DMF and members of the shellfish fishing community.
- Instrumental in the formation of the Massachusetts Shellfish Initiative (MSI), holds a seat on the Task Force, member of the Steering Committee, Assessment Committee and will likely designate staff for the Scoping Committee.

Emerging Trends

External Trends

- Lack of a unified statewide plan or guidance for coastal ecosystem restoration
- Limited local data on the role shellfish play in ecosystem
- Limited data on shellfish populations (historic/current/trends)
- Inadequate funding for DMF and municipalities to effectively manage shellfish resources.
- Inadequate funding to execute extensive research needs
- Increased user conflict among shellfish sectors and other coastal user groups
- Interest and expansion of municipal investment in shellfish as waste water management strategy

Internal Trends

- TNC Shared Conservation Agenda
    - Aquaculture Strategy and MA leading/piloting
- Recent MA strategic plan that outlines shellfish investment and priority.

UMass Boston

Institution Name & Mission

The University of Massachusetts Boston (UMass Boston); School for the Environment

Overview of Program

Our School for the Environment is absolutely dedicated to supporting the growth and sustainability of our aquaculture of the marine economy. We've made recent intentional hires of faculty whose work is focused on sustainable seafood and aquaculture specifically.

Recently, the school launched an on-line certificate in basic marine aquaculture. We also dedicated a team of graduate students in the Spring of 2017 to assist in the beginning development of the Massachusetts Shellfish Initiative (MSI). Students participated in stakeholder meetings and distributed surveys in support of the launch of the MSI. In so doing we identified a graduate student whose PhD research leverages the work on the MSI and who is dedicated to the development and implementation of the important state initiative.

Sustainable Marine Aquaculture Certificate (online)

An academic certificate, both credit-bearing and non-credit bearing, that acts as a professional certificate of competency in marine aquaculture. The program is meant to provide a tool to students that are trying to break into the growing and rapidly expanding aquaculture industry, in participating in the aquaculture certificate program could also help students secure an internship working outdoors and on the oceans.

All courses in the Sustainable Marine Aquaculture program are open to the UMass Boston community as well as students from other universities and the public. The goal is to provide a flexible and accessible introduction to this emerging field and so offer a variety of options to suit your individual needs.

The fast-growing aquaculture industry will face many challenges over the next few years to be sustainable. By taking online aquaculture courses from UMass Boston, students will be prepared to successfully address these key issues and meet future growth.

Green Harbors Project

The goal of the Green Harbors Project is to establish green urban harbors—harbors that live within ecological and human limits. The GHP supports coastal ecosystem stewardship through integrated education, outreach, research, and monitoring activities with local communities and harbor users.

The Green Harbors Project (GHP) is an integrated program of research, education and stewardship of harbors, coasts and coastal communities. Furthermore, it is a holistic approach to coastal science and stewardship to make our urban harbors 'green'.

Through the associated LivingLabs, the Green Harbors Project provides unique opportunities to teach and learn by doing hands-on biomimetic projects that address and solve local environmental issues.

Staffing

Currently the School for the Environment has 5 faculty members and 1 graduate student who work directly with and support shellfish related research in the State

Faculty & Staff
Dr. Michael Tlusty (Associate Professor of Food Solutions),
Dr. Jennifer Bender (Research Fellow in Sustainable Marine Aquaculture),
Dr. Bob Chen (Professor of Organic Geochemistry and Marine Organic Chemistry),
Dr. Helen Poynton (Associate Professor of Ecotoxicogenomics),
Dr. Michael Shiaris (Professor of Environmental Microbiology)

Graduate Student(s)
Sean McNally (PhD Candidate, Marine Science & Technology)

Relevant Programs Related to Shellfish Management

Massachusetts Shellfish Initiative (MSI)

In support of the project the School for the Environment at UMass Boston has funded and supported a PhD student, Sean McNally in a supporting role on the MSI team.

We see the MSI as a central role for us to support our marine shellfish industry and our coastal environment. Ultimately, this project will support the long-term goal of abundant shellfish resources for Massachusetts communities through consensus building and prioritization.
Despite the significant opportunities associated with growth in the shellfish industry, there are boundary issues that can limit success and result in varying degrees of efficacy across similar efforts.

Currently, there is little coordination across and within the sectors and little parity in management across municipalities. Often groups attempting to meet similar outcomes end up in competition for the sample limited resources or fail to share valuable information that would lead to improved efficiency or increase opportunities across theirs or all sectors. By organizing a generative network of cross sector partners, it is our hope to provide a stable framework that would ensure the objectives of all sectors are met in the most proficient and effective manner.

Emerging Trends

In Massachusetts, our issues are diverse and the opportunities many. Continuing our legacy in marine fisheries by enhancing opportunities in marine aquaculture and shellfish farming will profoundly impact our ability to meet emerging challenges such as climate but also allow us to contribute important solutions to the global issues of food security by producing high quality protein available to a global market.

As we all know too well there is an immediate economic need to build our capacity in the Commonwealth in shellfish aquaculture. With declining wild caught fisheries and increasing demand for cleanup of our coastal waters combined with the emerging and significant challenges of sea level rise, our Commonwealth is at a tipping point in our marine economy.

We require a state-wide effort to responsibly advance new ways of building upon our historical legacy as a maritime state. Through restoration of oyster reefs and the rebuilding of coastal habitats we will ensure that our communities are protected from the ravages of the rising tide as well as significantly improve coastal water quality and the habitats our wild caught fisheries need to build back and thrive.

Now more than ever there is an economic opportunity tied to an environmental threat that only through a coordinated effort across all sectors can we solve – we need a robust shellfish industry to provide good paying jobs to our fishers, to ensure enable the advance of new technologies and sustainable solutions thereby increasing the economic prosperity of our communities.

UMass Dartmouth – SMAST

Institution Name & Mission

University of Massachusetts Dartmouth
School for Marine Science and Technology
Mission: Education and research in marine science and technology

Overview of Program

Conduct research and education, including training graduate students, in various aspects of shellfish research and application. Expand aquaculture programming and support responsible and sustainable development of offshore wind activities.

Staffing

N/A

Relevant Programs Related to Shellfish Management

Project 1:

i. Oyster aquaculture for seafood and water quality
ii. Funding from EPA, Town of Falmouth, others
iii. Various waters around Cape Cod and South Coast
iv. Dates: ongoing, but do not have specific time frame

Project 2:

i. Scallop grey meat disease research
ii. Funding from NOAA
iii. Laboratory based research
iv. Ongoing work over the past 2-3 years

Project 3:

i. Scallop biomass assessments
ii. Funding from NOAA
iii. Field surveys of scallop abundance and stock sizes on the New England Continental shelf
iv. Various partners
v. Dates: Ongoing over the past 10 years and more

Project 5:

i. Bay scallop larval transport and settlement
ii. Funding from Sea Grant, NSF
iii. Partnership with Woods Hole Oceanographic Institution
iv. Buzzards Bay

v. Dates: 2014-2016

Project 6:

i. Lobster stock assessments
ii. Funding from Vineyard Wind
iii. Field surveys in area of planned offshore wind development
iv. Dates: Currently being conducted this summer

Emerging Trends

External Trends

- Interest in expanding aquaculture research and education
- Growing external interest in aquaculture
- Continued efforts to assess stock sizes of commercially important fisheries
- Requirements for monitoring for offshore wind permitting

Office of Coastal Zone Management (CZM)

Agency Name & Mission

Commonwealth of Massachusetts
Office of Coastal Zone Management (CZM)
Policy and Funding Related to Shellfish

Overview of Program

The role of CZM is to balance human activities with the protection of coastal resources and uses in Massachusetts. CZM's authority arises from the federal Coastal Zone Management Act of 1972 and implementing regulations at 16 U.S. Code Chapter 33 which gives individual states the opportunity to develop CZM programs. The Massachusetts CZM Plan which includes CZM's enforceable policies was first approved by the National Oceanic and Atmospheric Administration in April 1978 and has been updated through subsequent filings. CZM implements this authority through its Program Policies and conducts federal consistency review on federal licenses and permits, federal agency activities, federal assistance to state and local governments, and outer continental shelf plans, in or with the potential to affect Massachusetts coastal resources and uses, to ensure that federal actions do not diverge from the Commonwealth's interests. CZM employs a networked approach where the authorities and expertise of all state agencies, including the DMF, are used as part of an integrated and coordinated approach in reviewing projects. There are many aspects of the CZM program that intersect with bivalve shellfish, their culture and harvest, and the protection of their habitat.

Legal & Regulatory Authority

CZM's authority arises from the federal Coastal Zone Management Act of 1972 and its implementing regulations at 16 U.S. Code Chapter 33. As a networked agency within the state's Executive Office of Energy and Environmental Affairs (EEA), CZM works closely with other state agencies and project proponents during the permitting of coastal projects to ensure that the state's enforceable coastal policies are met.

The CZM Policy Guide and Program Policies can be found at:
https://www.mass.gov/service-details/massachusetts-office-of-coastal-zone-management-czm-policy-guide.

The CZM laws and regulations with bearing upon bivalve shellfish are:

- M.G.L. c. 21A Sections §§ 2 and 4A establish the CZM office within EEA.
- 301 CMR 20.00 "Coastal Zone Management Program" establishes the Coastal Zone Management Program's policies and allows for the analysis and review of projects in the coastal zone.
- 301 CMR 26.00 "Coastal Pollutant Remediation Program" establishes the uniform application, review, award, and disbursement procedures and requirements for municipalities to apply for and receive grant funds to address stormwater and boat sewage pollution.

- 301 CMR 27.00 “Ocean Sanctuaries” is adopted pursuant to M.G.L. c. 21A § 4A and M.G.L. c. 132 §§ 12A through 16K and § 18. This regulation defines prohibited and allowed activities in ocean sanctuaries and requires agencies to protect the ocean sanctuaries from exploitation, development, or activities that would significantly alter or otherwise endanger their ecology or appearance.
- 301 CMR 28.00 “Ocean Management Plan” is adopted pursuant to M.G.L. c. 21A § 4Aand M.G.L. c. 132 §§ 12A through 16K and § 18 to implement, administer, and enforce the Massachusetts ocean management plan. The Activities subject to the plan are governed by siting and performance standards, associated with mapped resources and uses, that direct development away from areas with important and high value resources and water-dependent uses.

Staffing

CZM has three employees working at the Boston office who, as part of their duties, collaborate on the review of shellfish-related projects and help create and implement policies related to protecting shellfish habitat and recreational and commercial shellfish opportunities (usually through the review of construction projects in marine waters). CZM has another two employees in the Boston office that manage grant funds to reduce coastal pollution via stormwater (which may improve shellfish habitat and access). CZM has five employees working in regional offices who, as part of their normal duties, assist in the review of permits and projects related to aquaculture, nitrogen remediation by shellfish, and potential shellfish habitat alteration or improvement.

Relevant Programs Related to Shellfish Management

- CZM was a key partner in helping to develop the 1995 interagency Massachusetts Aquaculture White Paper and Strategic Plan that describes the biology, technology, support systems, water quality, seafood safety, and legal and economic aspects of the aquaculture industry. The Strategic Plan includes 68 recommendations for the state to implement to overcome constraints and take advantage of opportunities in the aquaculture industry.

- CZM is the lead agency in implementing and updating the Massachusetts ocean management plan that provides siting and performance standards for activities in the defined planning area (0.3 nm from shore to the state/federal boundary). During the development of the 2015 ocean plan, the fisheries technical working group recommended that aquaculture projects, an allowed use under the ocean plan, be addressed through siting and performance standards to reduce impacts to water quality, benthic habitat, submerged aquatic vegetation, endangered species, as well as navigation and fishing. CZM is currently working with DMF and MEPA on a Special Review Procedure process for state permitting of ocean aquaculture.

- CZM is the lead agency on implementing the ocean sanctuaries act (OSA). The OSA defines prohibited and allowed activities within the sanctuaries and requires state agencies to protect the Ocean Sanctuaries from exploitation, development, or any activity that would significantly alter or otherwise endanger their ecology or appearance. Under the OSA (301 CMR 27.06(2)(h)), the harvesting and propagation of fish and shellfish in all forms is allowed, so long as CZM and

the Department of Fish and Game are satisfied that the activities are carried on in accordance with sound conservation practices designed to maintain, increase, or restore existing finfish or shellfish stocks.

- CZM performs federal consistency review on all U.S. Army Corps of Engineers permits, including those for aquaculture projects and oyster reefs.

- CZM performs federal consistency review on all EPA NPDES permits. CZM works with the DEP and DMF to ensure that bacteria limits in NPDES permits meet the state's shellfish standards, where appropriate. CZM also ensures, pursuant to the OSA, that new or modified discharges do not adversely affect shellfish beds or shellfish harvesting.

- CZM is an active agency partner in MEPA review of aquaculture projects, oyster reefs, and municipal remediation of nitrogen via bivalve culture.

- CZM administers the Coastal Pollutant Remediation grant program which provides funding to Massachusetts municipalities to assess and treat stormwater pollution from paved surfaces and to design and construct commercial boat waste pump out facilities. One major goal of the program is to improve coastal water quality to allow for increased access to wild shellfish harvest. Since 1996, more than $11 million in CPR grants have been awarded.

- CZM is the host agency for the Buzzards Bay and Massachusetts Bays National Estuary Partnership, both of which have grant programs that aim to improve coastal water quality by reducing bacteria and other pollutants in storm water. MassBays has also recently funded two oyster spat upwellers through its Healthy Estuaries Grants.

- CZM coordinates the Massachusetts Marine Invasive Species Program which tracks the spread of invasive species, some of which are detrimental to shellfish.

- CZM is the lead agency in Massachusetts for boat sewage No Discharge Zone establishment and management, the goal of which is to decrease bacterial impairment of coastal beaches and shellfish beds.

Emerging Trends

N/A

Massachusetts Department of Agricultural Resources

Agency Name & Mission

Massachusetts Department of Agricultural Resources (MDAR)

Overview of Program

MDAR's mission is to help keep the Massachusetts' food supply safe and secure, and to work to keep Massachusetts agriculture economically and environmentally sound. This is accomplished by supporting, regulating and enhancing the rich diversity of the Commonwealth's agriculture, and helping to facilitate agriculture's role in energy conservation and production.

Massachusetts General Law (Ch128,§1A) includes aquaculture within its definition of agriculture: ''Farming'' or ''agriculture'' shall include farming in all of its branches,…growing and harvesting of any agricultural, aquacultural, floricultural or horticultural commodities,…including preparations for market, delivery to storage or to market or to carriers for transportation to market."

Accordingly, and consistent with MDAR regards aquaculture as an extremely diverse, vibrant, specialized sector of the Massachusetts agriculture industry. As a subset of aquaculture, shellfish farming encompasses the largest number of aquaculture farms, and perhaps the most visible aquatic product raised in Massachusetts.

Staffing

N/A

Relevant Programs Related to Shellfish Management

MDAR's Aquaculture Specialist supports the industry by providing technical assistance, education and guidance to the aquaculture sector. MDAR also supports three regional Aquaculture Centers (Southeastern Massachusetts Aquaculture Center, Northeastern Massachusetts Aquaculture Center, and Western Center for Sustainable Aquaculture), which were formed under the 1996 Seaport Bond Bill. These Aquaculture Centers conduct valuable research into culture methods, alternative species culture, disease diagnostics and resistance, and provide technical assistance and guidance directly to the aquaculture industry.

In consideration of the ability of shellfish to extract nutrients from coastal waters of Massachusetts, and estuarine nutrient loading becoming increasingly of concern in the Commonwealth, the Department believes shellfish farming has an important role to play in maintaining the health of our coastal ecosystems. In this respect, prudent shellfish farming has proven itself to be "environmentally sound". MDAR takes a holistic approach to aquaculture, acknowledging it as a legitimate and valuable sector of Massachusetts agriculture, and supports aquatic farmers in many of the same ways terrestrial farmers are assisted, such as eligibility for MDAR grant programs, provision of direct technical assistance, and marketing assistance.

Emerging Trends

N/A

Division of Marine Fisheries (*MarineFisheries)*

Agency Name & Mission

Commonwealth of Massachusetts Division of Marine Fisheries (DMF)

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

Nationally, the harvest and handling of all bivalve molluscan shellfish is regulated by the National Shellfish Sanitation Program (NSSP)[6]. The NSSP was established in 1925 by the United States Public Health Service for the harvest and handling of shellfish in interstate commerce for human consumption. The NSSP "Guide" is developed and administered today by the United States Food and Drug Administration (USFDA) and the Interstate Shellfish Sanitation Conference (ISSC), a federal/state cooperative. The Commonwealth of Massachusetts is a voting member of the ISSC. Compliance with the NSSP MO is mandated in order for Massachusetts' shellfish to enter into interstate commerce.

Shellfish fisheries management is accomplished by direct DMF regulation of the commercial surf clam and ocean quahog dredge boat fisheries. In addition, regulations cover the harvest of contaminated shellfish for depuration and relay, and establish size, trip limit, and season for many shellfish species. DMF also regulates shellfish aquaculture activities, which involves certifying the issuance of aquaculture licenses by municipalities, and the permitting of aquaculturists, towns and hatcheries to obtain, possess and sell sub-legal shellfish (seed) for transplant and grow-out to legal size. Indirectly, DMF manages shellfish resources through a partnership with coastal communities by providing technical assistance to local management authorities in the development of management plans and local regulations for control and conservation.

Legal/Regulatory Authority

State Statute and Regulations: DMF shellfish management and oversight responsibilities are authorized under Massachusetts General Laws (M.G.L) and implemented under 322 of the Code of Massachusetts Regulations (CMR). While there are numerous statues that authorize DMF to develop rules and regulations related shellfish management, and this is not a comprehensive list, the primary statues authorizing shellfish management in Massachusetts are:

M.G.L. c. 130 § 17A authorizes DMF to create rules related to the manner of taking shellfish; the legal size limits shellfish may be taken, and the seasons and hours during which shellfish may be taken. DMF establishes minimum sizes for shellfish and these sizes may be found at 322 CMR 6.00 and 14.00 and are published on

[6] Guide for the Control of Molluscan Shellfish: 2017 Revision
https://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm

DMF's website.

M.G.L. c. 130 § 17B requires that all aquaculture enterprises obtain a permit from DMF. DMF's permit categories and requirements to obtain an aquaculture permit can be found at 322 CMR 7.00 and 15.00.

M.G.L. c. 130 § 20 authorizes DMF to expend funds to assist and co-operate with coastal cities and towns for the purpose of increasing the supply of shellfish and managing shellfish predators. Additionally, M.G.L. c. 130 § 20 authorizes DMF to study methods for the treatment or purification of shellfish taken from areas determined to be contaminated.

M.G.L. c. 130 § 52 authorizes coastal municipalities to regulate or prohibit the taking of shellfish in waters under their jurisdiction, including areas deemed contaminated and under section 74 and 74A and generally under state management if the municipality has a valid contaminated area management plan with DMF. In addition, M.G.L. c. 130 § 52 authorizes municipalities to make any regulations, not contrary to state laws and regulations, in regards to the times, places, methods, purposes, uses, sizes, quantities and any other particulars related to the harvest of shellfish in those waters, and to collect fees and issue permits for the harvest of shellfish. In addition, M.G.L. c. 130 § 52 requires coastal municipalities to set aside areas under their control for recreational harvest. M.G.L. c. 130 § 52 authorizes DMF to temporarily take control over areas that cities and towns neglect or refuse to exercise control over.

M.G.L. c. 130 § 54 outlines the process for municipalities to plant, propagate, and protect shellfish in waters and flats within their borders. This would include shellfish planting conducted solely by cities and towns, or by cities and towns in partnership with private citizens or non-governmental organizations; for propagation, resource enhancement, restoration, mitigation, or water quality improvement. M.G.L. c. 130 § 54 allows coastal cities and towns to conduct shellfish propagation activities in waters under their jurisdiction, provided that such waters and flats are not subject to a private aquaculture license and that any private rights are not impaired. Propagation projects do not require certification by DMF, however, M.G.L. c.130 § 54 limits propagation closures to no more than three years to ensure future public access to such waters and flats by the public. More information can be found DMF's Shellfish Planting Guidelines.

M.G.L. c. 130 § 57 outlines the process for the issuance and review of municipal private shellfish aquaculture licenses by municipalities and DMF. Under M.G.L. c. 130, coastal cities and towns may grant to any person a shellfish aquaculture license for the commercial production of shellfish, subject to a site inspection and certification by DMFs that the license and operation thereunder will not result in substantial adverse effects to the natural resources of the community. Unless conditioned to the contrary by the municipality or by DMF, the license provides the licensee exclusive rights to a specified site to grow and harvest shellfish subject to rules and regulations governing aquaculture promulgated by the local authority and DMF. In addition, licenses issued under M.G.L. c. 130 § 57 must be conditioned by the coastal municipality to allow all compatible public uses of the licensed area. M.G.L. c. 130 § 57 does not provide DMF or coastal municipalities the authority to issue private shellfish aquaculture licenses unilaterally. More information can be found in DMF's Shellfish Planting Guidelines.

M.G.L. c. 130 § 58 outlines the process for the renewal and transfer municipal private shellfish aquaculture licenses.

M.G.L. c. 130 § 59 outlines the requirements of the original application and survey for a municipal

private shellfish aquaculture license.

M.G.L. c. 130 § 60 details the public notice and hearing requirements for a municipal private shellfish aquaculture license.

M.G.L. c. 130 § 61 details the requirements for marking a municipal private shellfish aquaculture license site.

M.G.L. c. 130 § 62 outlines the municipality's requirement to keep on file and for public review copies of all municipal private shellfish aquaculture licenses, renewals and transfers.

M.G.L. c. 130 §§ 63, 66 and 67 details the exclusive rights of municipal private shellfish aquaculture license holders, and allows for the recovery of treble damages in tort by license holders in the event of the unlawful removal of shellfish from the license site and/or removal the marks or bounds of the license site, or damage to gear and shellfish.

M.G.L. c. 130 § 64 caps municipal aquaculture license fees at $25/acre or part there of per year.

M.G.L. c. 130 § 65 outlines the license holders requirement to submit an annual report to the municipality of the amount of shellfish planted, produced, and marketed.

M.G.L. c. 130 § 68 prohibits the removal of shellfish from a municipal private shellfish aquaculture license site at night.

M.G.L. c. 130 § 69 authorizes DMF to issue permits for the taking of seed clams and oysters and establishes a maximum 5% threshold for the incidental possession of seed clams and oysters.

M.G.L. c. 130 §§ 70-73 establishes a framework for the harvest and municipal management of bay scallops including; setting a minimum harvest size, seasonality of harvest and a process for municipalities to petition DMF to make exceptions to these standards.

M.G.L. c. 130 § 74 authorizes DMF to examine shellfish areas for contamination, set boundaries and timeframes of this determination. Further it establishes to who and how this is communicated. In addition, it authorizes personnel in DMF and DPH engaged in this work may pass on or over private property.

DMF along with DPH and DEP may promulgate rules and regulations which establish the criteria for the classification of shellfish areas in compliance with the NSSP. Scallops and conch are exempt from this determination unless specifically included.

M.G.L. c. 130 § 74A authorizes DPH and DMF to declare an emergency closure of a shellfish area and requires the MEP and local authorities be notified. The closure shall remain in effect until after the emergency is over. During a declared emergency the Commissioner of DPH may direct certain DMF employees. Once again scallops and conch are exempt from this determination unless specifically included.

M.G.L. c. 130 § 75 establishes the required mechanisms for a shellfish fishery in contaminated areas, allowing for the purification of shellfish in a plant. It allows for the creation of municipal shellfish management plans in contaminated areas. In addition violation and a fee schedule is specified.

M.G.L. c. 130 §§ 76-77 authorizes the construction and operation of depuration plants for treatment of shellfish determined to be contaminated under §§ 74 and 74A as well as authorizing creation of a fee schedule for plant use.

M.G.L. c. 130 § 82 requires only containers of shellfish bearing a tag be accepted by wholesales or retailers of shellfish.

M.G.L. c. 130 § 98 requires that coastal municipalities appoint a person or persons, qualified by training and experience in the field of shellfishery management, as shellfish constables or deputy shellfish constables. These individuals are authorized and required to enforce all statutes, ordinances, by-laws, rules and regulations relative to shellfish in such city or town. DMF works with the MSOA, DPH and the MEP to provide shellfish constables with training.

Staffing

DMF employs 25 full-time employees in positions directly related to shellfish management.

Relevant Programs Related to Shellfish Management

Shellfish Growing Area Classification

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

To satisfy NSSP requirements, DMF annually collect and analyze 10,000 water samples for fecal coliform bacteria, a human pathogen indicator, from over 300 shellfish growing areas, in 65 cities and towns of the Commonwealth. All samples were tested at either of DMF shellfish laboratories in Gloucester and New Bedford.

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

Notification: A legal notice is required for each classification, or status change per NSSP requirements. These notices reflect the type of opening or closure, date, reason, and other pertinent information. Affected municipalities, as well as required state and federal agencies such as the state MEP, DPH, FDA, as as well as other interested parties are notified by email and via the DMF website[2] . Over 400 notices are generated annually.

Biotoxin Monitoring

Paralytic Shellfish Poisoning Monitoring: A major aspect of the DMF Shellfish Program is monitoring for naturally occurring marine biotoxins produced by microscopic algae that can cause paralytic shellfish poisoning (PSP) or "red tide". Consumption of shellfish containing elevated levels of PSP toxin can cause severe illness and even death. Shellfish Program personnel collect shellfish from primary stations weekly, from March through October. Samples are analyzed at the DMF Gloucester lab where bioassays determine the levels of toxin in shellfish. As toxin is found, both the frequency of sampling and the number of sample sites increase. Shellfish growing areas are closed as toxin levels approach quarantine limits. As indicated by phytoplankton monitoring DMF also collects and analyzes shellfish for Amnesic Shellfish Poisoning (ASP) toxicity.

Phytoplankton Monitoring: Due to emerging harmful algae threats, DMF conducts phytoplankton monitoring to screen for the occurrence and abundance of specific toxic species. As species of concern are documented in significant numbers, shellfish collection and toxicity analysis is initiated.

Contaminated Shellfish Resources

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

Commercial Bait Harvest**:** DMF permits and manages a small contaminated surf clam dredge-boat bait fishery off Nantasket Beach in Hull. Surf clams are harvested for bait purposes only.

Contaminated Relay**:** DMF permits municipalities to relay mildly contaminated shellfish to Approved and Conditionally Approved waters for natural purification and propagation. All activities are conducted under strict NSSP guidelines and are heavily supervised by state and local enforcement authorities. DMF requires shellfish remain in their new growing area through at least one spawning season; contaminated shellfish must remain at the transplant site until at least mid-September if relocated by June 15 or the following September if shellfish are transplanted after June 15. No shellfish can be harvested until bacterial testing has been completed on each lot. Quahogs are the most frequently transplanted species followed by oysters.

Prior to transplant operations, disease monitoring is conducted on shellfish collected from donor sites, which include quahogs from the Taunton River; oysters from the Pocasset River and Bourne's Pond in the Town of Bourne; and Little Harbor and Little Pond in the Town of Falmouth.

Shellfish Purification Plant Depuration

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

Clams are harvested from Conditionally Restricted areas in Boston Harbor, the Pines River in Revere and Saugus, and the Merrimack River in Newbury, Newburyport and Salisbury, then transported by licensed and bonded Master Diggers under strict enforcement to the Purification Plant for depuration treatment. Upon completion, shellfish are returned to the Master Diggers or their Massachusetts wholesale dealer upon payment of a depuration fee. The purified clams are then sold into commerce.

Wet Storage: 2017 marked the fifth year that the Purification Plant has offered wet storage processing to wholesale shellfish dealers. Wet storage processing at Newburyport utilizes the same tanks, seawater, ultraviolet sterilizers, and biological flushing as the depuration process to flush sand, mud, and grit out of

shellfish harvested from NSSP-classified Approved areas. As these shellfish are already at safe bacterial levels, the focus of wet storage is on enhancing them for market and extending shelf-life. While there is no mandatory process time or microbiological testing like for depurated shellfish, wet stored shellfish are also regulated by the NSSP, overseen by DPH and FDA, and must comply with strict controls and standards, for traceability and sanitation.

Shellfish Purification Plant Laboratory**:** The Shellfish Purification Plant laboratory supports depuration and wet storage processing at the facility with both water and shellfish analyzed for bacterial indicators. In addition, viral indicator monitoring is conducted for both water and shellfish in support of classification. Research and assessment of *Vp* in oysters for re-submergence and tidal study projects is conducted annually in season, as well.

Shellfish Restoration and Mitigation

Shellfish Program staff are involved in major shellfish restoration and mitigation activities in Buzzards Bay and previously in Boston Harbor. Shellfish restoration refers to enhancing or augmenting shellfish stocks that have waned or been lost due to any of several possible reasons (e.g., overfishing, poor recruitment, disease, natural predation, and natural change in habitat features). Shellfish mitigation, on the other hand, refers to replacement of shellfish that have been permanently lost due to direct human actions, including shoreline alteration projects, dredging activities, and placement of pipelines and electric cables.

New Bedford Marine Commerce Terminal Quahog Mitigation: The New Bedford Marine Commerce Terminal (NBMCT) was created to develop a multi-purpose marine terminal capable of supporting offshore renewable energy facilities, international shipping, and other industries within New Bedford. Approximately 9.8 million shellfish were lost as a result of filling and dredging activities. In fulfillment of an agreement between the Massachusetts Clean Energy Center (CEC) and DMF , a total of 24.5 million seed quahogs are to be planted within New Bedford waters over a 10 year period.

B-120 Buzzards Bay Shellfish Restoration Project: In April of 2003 the grounding of the B-120 oil barge resulted in an estimated 98,000-gallon oil spill in Buzzards Bay. Federal and state Trustee representatives were tasked, through the Natural Resource Damage Assessment process, with managing and supporting restoration of natural resource and resource use injuries. In partnership with nine Buzzards Bay communities, DMF was selected by the Trustees to implement specified restoration strategies.

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, continues to use portions of this DMF-owned facility to spawn and culture shellfish for eventual transplant to harvestable shellfish beds throughout the waters of Martha's Vineyard. Access to the hatchery greatly expanded MVSG's hatchery and nursery capacity.

Environmental Protection Activities

Environmental Review: Shellfish Program personnel respond to pollution events in coastal waters in order to assess damage to shellfish populations and to determine the need for public health closures. Events include sewage discharges, boat sinkings, extreme rainfall, petrochemical spills, and other discharges of hazardous chemicals. Program personnel contribute to the review of proposed coastal alteration projects for impacts on water quality, shellfish resources, and habitat. Recommendations are provided through DMF's environmental review process to the permitting agencies concerning the effects of proposed structures, filling, and discharge to marine waters.

Pollution Discharge and Contaminant Assessment: DMF provides comments and recommendations regarding EPA NPDES permits. Staff participate in on-going multi-state review of environmental impact statement for desalination plants in Massachusetts. DMF collects/monitors at sentinel stations to support NOAA's nationwide monitoring program for contaminants of emerging concern in blue mussels.

Aquaculture and Propagation Project

The management of marine aquaculture is a major responsibility of DMF. This includes managing the introduction, culture, and harvest of all marine species in the Commonwealth. Currently. the vast majority of marine aquaculture in Massachusetts consists of municipally licensed molluscan shellfish aquaculture (Figure 10). DMF shellfish aquaculture responsibilities involve two major areas of concern: certifying the issuance of aquaculture licenses by municipalities, and the permitting of aquaculturists, towns and hatcheries to obtain, possess and sell sub-legal shellfish (seed) for transplant and grow-out to legal size

Shellfish License Certification: Under state statute, 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 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.

Permitting: DMF issues permits for all marine aquaculture activities in the Commonwealth. Permits require holders to manage their culture activities in a manner that prevents 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. For shellfish, a propagation permit is issued annually to both private growers and municipalities. The permit allows the possession, transplant, and grow-out of seed shellfish from approved sources.

Vibrio Management

Vp Control Plan: A major component of the Shellfish Program's public health protection responsibilities is the implementation of control measures intended to limit the human health risks associated with the exposure of *Vp* bacteria from the consumption of raw oysters. Exposure to *Vp* 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 *Vp* illness to monitor conditions in oyster harvest areas, implement *Vp* control measures, and respond in the event of a *Vp*illness outbreak associated with shellfish consumption. DMF is also responsible for the closure of harvest areas following the notification of a *Vp* outbreak from DPH.

Other Activities

Technical Assistance: In Massachusetts, cities and towns manage the shellfisheries in all waters within their boundaries not closed by DMF for public health reasons. This includes all shellfisheries with the exception of commercial harvest of surf clams and ocean quahogs, which remain under state control. The Shellfish Program assists municipalities on a wide variety of shellfisheries management issues providing technical and regulatory information as well as recommendations on numerous subjects to local shellfish managers. Areas of technical assistance include: shellfish propagation; predator control; survey methods; management openings and

closures; habitat improvement; shellfish management plans; aquaculture development and regulation; water quality; public health and sanitation; and permitting. Shellfish staff provided technical assistance to municipal managers and boards, state and federal agencies, academia and non-governmental research and management organizations, and individuals.

Professional Organizations & Partnerships: Shellfish Program staff participate in numerous professional organizations such as the Interstate Shellfish Sanitation Conference, the Northeast Shellfish Sanitation Association, the Massachusetts Shellfish Officers Association, New England Estuarine Research Society, and the Massachusetts Shellfish Initiative. Up to twice a year DMF convenes a Shellfish Advisory Panel comprising various shellfish industry user groups.

Disease Monitoring: Shellfish Program staff routinely sample shellfish as part of a long-term study of haemic neoplasia in softshell clams to track the prevalence and extent of disease throughout Massachusetts' coastal waters. Neoplasia has been implicated in clam die-offs in Cape Cod, Boston Harbor, and the North Shore as well as other regions of the east coast.

Administration of funds: DMF is often directed in the annual state budget to expend funds on specific Shellfish Program activities and expenditures for municipal and county shellfish programs and research.

Emerging Trends

DMF's Shellfish Program's priorities and actions are influenced by many factors that have evolved over the multi-decadal history of the program. Since the Legislature transferred the shellfish sanitation program from DEP (formerly Department of Environmental Quality Engineering) to DMF in 1988, the top priority has been on meeting the NSSP's MO's requirements to adequately conduct water quality sampling to classify shellfish growing areas to allow commercial and recreational harvesting. Other challenges have been addressed as they arise including outbreaks of toxic algae, disease causing bacteria (*Vp*), oil spills, and vessel sinkings.

The Shellfish Program has been addressing the following ongoing and emerging issues:

Ongoing and Increased US FDA demands to enhance public health protection.

The Commonwealth's Sanitation and Public Health Protection project is under the continuous oversight of FDA and deficiencies due to staffing limitations have been identified. In the future, mandates for increased water quality sampling is expected in risk-prone areas and for the monitoring of new parameters such as male-specific coliphage to better protect public health. In addition, the oversight of aquaculture activities has also increased and will continue to increase. FDA identified deficiencies in patrols, water sampling and the inadequate identification of pollution sources. Also, risk-prone areas may require more intensive sampling, and degrading sanitary infrastructure such as near marinas, mooring areas, and adjacent to sewage treatment plants could escalate the incidence and extent of some closures. FDA is expected to raise standards on lab certifications and equipment and increase DMF's mandate to improve outreach efforts and education of municipal officials and harvesters about shellfish safety.

Increased demand to assist communities in pollution sources identification and accelerate surveys to expand harvest opportunities.

Staff shortages have prevented the agency from dedicated efforts to examine areas for upward reclassification.

Changing Ocean Conditions resulting in changes in shellfish abundance including threats of shellfish diseases.

Changes in climate leading to above average seawater temperatures and lower estuarine salinities associated with increased rainfall are already resulting in changes in species abundance. With the Northwest Atlantic projected to see some of the fastest rates of ocean warming associated with climate change in the near future, the impacts of changing ocean conditions are expected to continue to increase and impact important shellfish resources. Poor recruitment of bay scallops resulted in depleted stocks when compared to landings in the early to mid 20th century; similar trends have been observed in other species. Mussels, which are used as an indicator species for toxin presence, have declined in abundance in many areas making the task of biotoxin monitoring more demanding. Softshell clams have suffered from increases predation by invasive green crabs and disease from *Neoplasia, QPX, MSX, Dermo, and SSO*. There is also evidence of the northward spread of southern surf clams, a subspecies of the common surf clam that would necessitate changes to the management of the state surf clam fishery.

Changing ocean conditions resulting in dynamic threats to public health.

Massachusetts has experienced an increased incidence of illness-causing bacteria such as *Vp*, and toxic algae such as PSP. Closures related to toxin-producing algae have increased in Massachusetts and the Northeast in recent years. Species of toxic algae, more common in southern waters and may become a nuisance in Massachusetts as ocean waters continue to warm. Monitoring for the presence of toxic algae in local waters has been ongoing for decades yet increased attention is warranted. Moreover, there is a critical need to work at the regional and national levels to form national standards for criteria to close – and then re-open areas to harvest based on toxin levels in shellfish.

Coastal development coupled with sea level rise will place nearshore shellfish at risk.

Sea level rise and increased coastal flooding events will result in more frequent closures especially if sanitary infrastructure gets overwhelmed as seen in recent years. Ongoing coastal development will place more strain on sewage treatment plants and storm water infrastructure as well as degraded water quality in areas without sewage collection and waste-water treatment systems.

Increased interest in aquaculture activities.

The workload and challenges facing staff to meet DMF's statuary responsibilities associated with aquaculture and propagation have substantially increased in recent years. Oyster aquaculture production alone increased by 300% from 2007 to 2017. Interest in commercially culturing non-shellfish species such as algae (sugar kelp) and finfish are growing, as is the complexity and scale of municipal shellfish propagation efforts. The Division's aquaculture and propagation management burden is expected to continue to increase as the industry grows and matures. Dedicated and specialized staff will be needed to ensure proper management and foster sustainable growth in the industry.

Competing ocean uses.

Concerns related to growth in marine aquaculture (both shellfish and non-shellfish) reducing access to open waters for traditional wild capture fisheries have increased. There is also a growing concern that the planting of oysters by municipalities for ecological services (water quality improvement) to meet regulatory water quality standards may result in unintended consequences to local fisheries, habitats, and commercial aquaculture operations. Increased industrial development along the coastline such as proliferation of docks and piers, along with a lack of improvements in sanitary infrastructure could put further strain on shellfish resources and habitat**.**

Executive Office of Energy and Environmental Affairs (EEA) & Massachusetts Environmental Policy Act Office (MEPA)

Agency Name & Mission

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs (EEA)
Massachusetts Environmental Policy Act (MEPA) Office

Overview of Program

On behalf of the Secretary of EEA, the MEPA Office conducts reviews of environmental impacts of development projects and other activities that require one or more State Agency Actions. The purpose of MEPA is to provide meaningful opportunities for public review of the potential environmental impacts of Projects for which Agency Action is required, and to assist each Agency in using all feasible means to avoid or minimize and mitigate Damage to the Environment. The MEPA review process provides the mechanism to achieve these goals. It requires public study, review of alternatives, disclosure of potential environmental impacts and avoidance and minimization measures, and development of feasible mitigation measures.

An aquaculture project would require MEPA review if it meets or exceeds a MEPA review threshold and requires a State Agency Action. MEPA review thresholds are identified at Section 11.03 of the MEPA Regulations (301 CMR 11.00). State Agency Actions include public projects proposed or funded by a State Agency and private projects that require a State Agency Permit, include Financial Assistance, or involve a Land Transfer from the State. The Division of Marine Fisheries' (DMF) Certification of a Town issued aquaculture license is an example of a State Agency Action (i.e. a Permit from a State Agency) that could trigger MEPA review. Relevant MEPA review thresholds include, but are not limited to, wetlands/waterways impact and projects located in a designated Area of Critical Environmental Concern (ACEC).

Legal & Regulatory Authority

The MEPA review process is authorized under Massachusetts General Law (M.G.L. c.30, §§61- 62I) and implemented under the Code of Massachusetts Regulations (301 CMR 11.00).

Staffing

MEPA employs eight full-time employees to implement the state-wide environmental review program. None are directly related to shellfish management.

Relevant Programs Related to Shellfish Management

DMF has requested the Secretary establish a Special Review Procedure (SRP) to guide the development and implementation of a state-wide Aquaculture Permitting Plan.

Emerging Trends

N/A

Appendix C – 2019 Municipal Survey Responses

1. General Information

Massachusetts coastal municipalities jointly manage shellfish fisheries and shellfish resources with the Division of Marine Fisheries pursuant to G.L. c. 130. To address the local management of shellfish in Massachusetts, the AC's online Municipal Survey was developed. In late March 2019, the survey was provided to local officials – including shellfish constables, natural resource officers, and clerks - in 65 coastal municipalities.

The survey contained a total of 193 questions and provided municipalities with the opportunity to detail the extent to which there are shellfish management related programs in their community. The questions asked were related to recreational and commercial permitting statistics, landing trends, shellfish propagation and restoration programs, staffing and funding, external assistance, strategic goals, and emerging trends. The municipal survey questions focused on the most recent calendar year (2018), though ten-year retrospective assessment was also requested.

Participation in the Municipal Survey was entirely voluntary. Participating communities were free to not to answer certain questions. Reasons for varying levels of participation were not asked, nor documented. Certain survey questions asked for direct answers, while others questions provided the opportunity for the respondent to comment in detail. The responses to the survey questions are contained herein.

The following 65 coastal municipalities were asked to complete the Municipal Survey: Aquinnah, Barnstable, Beverly, Boston, Bourne, Braintree, Brewster, Chatham, Chilmark, Cohasset, Danvers, Dartmouth, Dennis, Duxbury, Eastham, Edgartown, Essex, Fairhaven, Fall River, Falmouth, Gloucester, Gosnold, Harwich, Hingham, Hull, Ipswich, Kingston, Lynn, Manchester, Marblehead, Marion, Marshfield, Mashpee, Mattapoisett, Nahant, Nantucket, New Bedford, Newbury, Newburyport, Oak Bluffs, Orleans, Peabody, Plymouth, Provincetown, Quincy, Revere, Rockport, Rowley, Salem, Salisbury, Sandwich, Saugus, Scituate, Somerset, Swampscott, Swansea, Tisbury, Truro, Wareham, Wellfleet, West Tisbury, Westport, Weymouth, Winthrop, Yarmouth.

Of the 65 municipalities surveyed, 54 reported having at least one shellfish management related program. The 11 municipalities that do not have a shellfish managed related program include: Beverly, Boston, Braintree, Danvers, Lynn, Manchester, Nahant, Peabody, Salem, Swampscott, Winthrop.

Of the 54 municipalities that do have at least one shellfish managed related program, 13 did not respond to the survey. These 13 municipalities include: Aquinnah, Brewster, Chilmark, Cohassett, Dartmouth, Gosnold, Mattapoisett, Plymouth, Quincy, Rowley, Scituate, Swansea, and Weymouth. Accordingly, a total, 41 coastal municipalities with at least one shellfish management related program participated in this survey.

Table 1. Summary statistics of responses to the MSI Assessment Committee's Municipal Survey by region.

Region	Sample Size		Completed Survey		Response Rate
Total		54		38	70%
Cape Cod & Islands	22	Aquinnah	18	X	82%
		Barnstable		Barnstable	
		Brewster		X	
		Chatham		Chatham	
		Chilmark		X	
		Dennis		Dennis	
		Eastham		Eastham	
		Edgartown		Edgartown	
		Falmouth		Falmouth	
		Gosnold		X	
		Harwich		Harwich	
		Mashpee		Mashpee	
		Nantucket		Nantucket	
		Oak Bluffs		Oak Bluffs	
		Orleans		Orleans	
		Provincetown		Provincetown	
		Sandwich		Sandwich	
		Tisbury		Tisbury	
		Truro		Truro	
		Wellfleet		Wellfleet	
		West Tisbury		West Tisbury	
		Yarmouth		Yarmouth	
South Shore & South Coast	17	Bourne	9	Bourne	53%
		Cohasset		X	
		Dartmouth		X	
		Duxbury		Duxbury	
		Fairhaven		Fairhaven	
		Fall River		X	
		Kingston		Kingston	
		Marion		Marion	
		Marshfield		Marshfield	
		Mattapoisett		X	
		New Bedford		New Bedford	

Region	Sample Size		Completed Survey		Response Rate
		Plymouth		X	
		Scituate		X	
		Somerset		X	
		Swansea		X	
		Wareham		Wareham	
		Westport		Westport	
Boston Harbor & North Shore	15	Essex	11	Essex	73%
		Gloucester		Gloucester	
		Hingham		Hingham	
		Hull		Hull	
		Ipswich		Ipswich	
		Marblehead		Marblehead	
		Newbury		Newbury	
		Newburyport		Newburyport	
		Quincy		X	
		Revere		Revere	
		Rockport		Rockport	
		Rowley		X	
		Salisbury		Salisbury	
		Saugus		X	
		Weymouth		X	

2. Recreational Harvest

Of the 38 municipalities that participated in the survey, 34 have a recreational harvest program in their community. For the purpose of this section, municipalities that identified as not having a recreational harvest program were excluded from the total number of municipalities with recreational harvest programs (n = 34) in the tables below.

Table 2.1. Recreational shellfish harvest programs by municipality that participated in the MSI AC municipal survey[7].

Recreational Harvest Present	Number of Municipalities	Municipality
Yes	33	Barnstable
		Bourne
		Chatham
		Dennis
		Duxbury
		Eastham
		Edgartown
		Essex
		Fairhaven
		Falmouth
		Gloucester
		Harwich
		Ipswich
		Kingston
		Marblehead
		Marion
		Marshfield
		Mashpee
		Nantucket
		New Bedford
		Newbury
		Oak Bluffs
		Orleans
		Provincetown
		Rockport
		Sandwich

[7] The four communities without recreational harvesting only have areas classified as conditionally restricted or prohibited which does not allow for direct and recreational harvesting. These four communities are located in the Boston Harbor region or on the North Shore.

Recreational Harvest Present	Number of Municipalities	Municipality
		Tisbury
		Truro
		Wareham
		Wellfleet
		West Tisbury
		Westport
		Yarmouth
No	5	Newburyport
		Revere
		Salisbury
		Hingham
		Hull

Table 2.2. Average reported number of annual recreational harvester permits issued by municipality; two municipalities did not respond (Newbury and Rockport[8]).

Number of Permits Issued Annually	Number of Municipalities	Municipality
>1,001	9	Barnstable
		Bourne
		Chatham
		Duxbury
		Eastham
		Mashpee
		Nantucket
		Orleans
		Wareham
501-1,000	7	Edgartown
		Fairhaven
		Falmouth
		Oak Bluffs
		Wellfleet
		Westport
		Yarmouth
251-500	7	Dennis
		Harwich
		Ipswich
		Marion
		Provincetown
		Tisbury
		Truro
101-250	4	Gloucester
		Kingston
		New Bedford
		Sandwich
51-100	3	Essex
		Marblehead
		Marshfield
0-50	2	Hull
		West Tisbury

[8] Rockport has areas classified as approved, but these approved areas are located in deep-water offshore and are not typical recreational harvest areas.

Table 2.3. Reported decadal trends in the average number of annually issued municipal recreational harvest permits; three municipalities did not respond (Hull, Newbury and Oak Bluffs).

Annual Trend Over the Past Decade	Average Number of Permits Issued Annually	Number of Municipalities	Municipality	Additional Comments
Increased	>1,000	3	Barnstable	Increase Propagation Planting & Decrease of Shellfish Programs in other Towns
			Duxbury	No Additional Comments
			Mashpee	Increase Propagation Planting
	500-100	2	Edgartown	Increase Propagation Planting & Population Increase
			Falmouth	Increase Propagation Planting
	250-500	3	Ipswich	Increase Natural Recruitment & Green Crab Trapping
			Provincetown	Increase Propagation Planting & Inclusive Social Attitude
			Truro	Increase Natural Recruitment & Increase Propagation Planting
	100-250	2	Kingston	Increase Natural Recruitment & Increase in Propagation Planting
			Sandwich	Increase Propagation Planting
	50-100	1	Essex	No Additional Comments
	0-50	1	West Tisbury	Increase Natural Recruitment & Increase in Population
Decreased	500-100	1	Wellfleet	Disease, Decreased Propagation Planting, Ice Impacts
	250-500	1	Marion	No Additional Comments
Not Changed (Stable)	>1,000	6	Bourne	Increase Natural Recruitment, Increase Propagation Planting
			Chatham	Family Permit Holders
			Eastham	No Additional Comments
			Nantucket	Fluctuates with Season

Annual Trend Over the Past Decade	Average Number of Permits Issued Annually	Number of Municipalities	Municipality	Additional Comments
			Orleans	No Additional Comments
			Wareham	Increase Propagation Planting
Not Changed (Stable)	500-100	3	Fairhaven	No Additional Comments
			Westport	Increase Natural Recruitment
			Yarmouth	Disease combined with Increase Propagation Planting
	250-500	3	Dennis	Increase Propagation Planting
			Harwich	No Additional Comments
			Tisbury	Love of Shellfishing & Education
	100-250	2	Gloucester	Enforcement of Non-Permitted Harvest
			New Bedford	Increase Propagation Planting
	50-100	2	Marblehead	No Additional Comments
			Marshfield	Only Conditionally Approved Areas

Table 2.4. Shellfish species open for recreational harvest by municipality.

Municipality	Species
Barnstable	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Bourne	Bay Scallop, Softshell Clam, Quahog, Oyster
Chatham	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Dennis	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Duxbury	Softshell Clam, Quahog, Razor Clam, Surf Clam, Mussel
Eastham	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Edgartown	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Oyster, Mussel
Essex	Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Fairhaven	Bay Scallop, Softshell Clam, Quahog, Oyster
Falmouth	Bay Scallop, Softshell Clam, Quahog, Oyster, Mussel
Gloucester	Softshell Clam, Razor Clam, Surf Clam, Oyster, Mussel
Harwich	Bay Scallop, Softshell Clam, Quahog, Oyster
Ipswich	Softshell Clam, Razor Clam, Surf Clam, Oyster, Mussel
Kingston	Softshell Clam, Quahog, Razor Clam, Oyster, Mussel
Marblehead	Surf Clam
Marion	Bay Scallop, Softshell Clam, Quahog, Oyster, Mussel
Marshfield	Softshell Clam, Quahog, Razor Clam, Surf Clam, Mussel
Mashpee	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster
Nantucket	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Mussel
New Bedford	Quahog
Newbury	Softshell Clam, Razor Clam, Oyster
Oak Bluffs	No response
Orleans	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Provincetown	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Rockport	Sea Scallop
Sandwich	Softshell Clam, Quahog, Razor Clam, Surf Clam, Mussel
Tisbury	Bay Scallop, Softshell Clam, Quahog
Truro	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Wareham	Bay Scallop, Softshell Clam, Quahog, Oyster, Mussel
Wellfleet	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel, Other
West Tisbury	Softshell Clam, Quahog, Oyster
Westport	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Surf Clam, Oyster, Mussel
Yarmouth	Bay Scallop, Softshell Clam, Quahog, Oyster

Table 2.5. Recreational harvest limits reported by municipalities; four municipalities did not respond (Hull, Newbury, Oak Bluffs, Rockport).

Harvest Limit	Number of Municipalities	Municipality
Daily	7	Edgartown
		Essex
		Fairhaven
		Gloucester
		Ipswich
		Marblehead
		Nantucket
Weekly	23	Barnstable
		Bourne
		Chatham
		Dennis
		Duxbury
		Eastham
		Falmouth
		Harwich
		Kingston
		Marion
		Marshfield
		Mashpee
		New Bedford
		Orleans
		Provincetown
		Sandwich
		Tisbury
		Truro
		Wareham
		Wellfleet
		West Tisbury
		Westport
		Yarmouth

Table 2.6. Designated recreational shellfish areas and acreage[9,10]; two municipalities did not respond (Newbury and Oak Bluffs).

Designated Recreational Shellfish Areas Present	Number of Municipalities	Municipality	Acreage
Yes	28	Barnstable	5.75
		Bourne	None reported
		Chatham	11
		Dennis	2
		Eastham	22
		Edgartown	900
		Essex	None reported
		Fairhaven	None reported
		Falmouth	None reported
		Gloucester	None reported
		Harwich	None reported
		Ipswich	10+
		Marblehead	<1
		Marion	20
		Marshfield	300+
		Mashpee	20+
		Nantucket	None reported
		New Bedford	None reported
		Orleans	None reported
		Provincetown	All approved areas
		Sandwich	15
		Tisbury	79
		Truro	All Approved Areas
		Wareham	193
		Wellfleet	50
		West Tisbury	None reported
		Westport	10
		Yarmouth	100

[9] MGL Ch.130 §52 states in part: "*Every city or town which exercises the authority over such coastal fisheries as provided in this section shall set aside an area or areas not then in private control or under municipal cultivation in which the commercial taking of shellfish shall be prohibited and from which shellfish may be taken, for his own family use, by any inhabitant of the commonwealth holding a permit therefor from such city or town. In any city or town issuing such permits to take shellfish for family use…"*

[10] The Town of Rockport does not have nearshore/intertidal shellfish growing areas classified as Approved. All Approved waters are offshore deep-water only accessible by scuba.

Designated Recreational Shellfish Areas Present	Number of Municipalities	Municipality	Acreage
No	3	Duxbury	
		Kingston	
		Rockport	

Table 2.7. Reported tracking of recreational landings; three municipalities did not respond (New Bedford, Newbury and Oak Bluffs).

Municipality tracks of recreational landings	Number of Municipalities	Municipality
Yes	17	Barnstable
		Bourne
		Chatham
		Dennis
		Duxbury
		Edgartown
		Harwich
		Kingston
		Marshfield
		Orleans
		Provincetown
		Sandwich
		Tisbury
		Truro
		Wellfleet
		Westport
		Yarmouth
No	13	Eastham
		Essex
		Fairhaven
		Falmouth
		Gloucester
		Ipswich
		Marblehead
		Marion
		Mashpee
		Nantucket
		Rockport
		Wareham
		West Tisbury

Table 2.8. Reported municipal decadal trends in recreational harvest by species; 17 municipalities were not able to identify trends at the species level with four municipalities not responding (Nantucket, Newbury, Oak Bluffs, and Orleans).

Town	Bay Scallop	Softshell Clam	Quahog	Razor Clam	Surf Clam	Oyster	Mussel	Additional Comments
Bourne	Down	Down	Stable	Unsure	Unsure	Up	Unsure	Increased Natural Recruitment, More Fishing Effort, Increased Propagation Planting, loss of eelgrass
Eastham	Down	Down	Up	Up	Unsure	Stable	Down	Decreased Natural Recruitment, Increased Propagation Planting
Edgartown	Down	Down	Stable	Unsure	Unsure	Down	Down	Decreased Natural Recruitment, Less Fishing Effort, Increased Propagation Planting
Falmouth	Down	Down	Up	Unsure	Unsure	Up	Stable	Decreased Natural Recruitment, Increased Propagation Planting
Marblehead	N/A	N/A	N/A	N/A	Up	N/A	N/A	No Additional Comments
Marion	Down	Stable	Up	N/A	N/A	Stable	N/A	Increased Natural Recruitment, Less Fishing Effort, Increased Propagation Planting
Mashpee	Down	Down	Up	Unsure	Unsure	Up	Down	Increased Propagation Planting
New Bedford	N/A	N/A	Up	N/A	N/A	N/A	N/A	Increased Propagation Planting
Provincetown	Up	Down	Up	Up	Unsure	Up	Down	Decreased Natural Recruitment, More Fishing Effort, Increased Propagation Planting
Sandwich	Unsure	Down	Up	Unsure	Down	N/A	Down	Decreased Natural Recruitment, Increased Propagation Planting
Tisbury	Down	Down	Down	N/A	N/A	N/A	N/A	Decreased Natural Recruitment, Less Fishing Effort, Other
Truro	Stable	Down	Up	Stable	Down	Up	N/A	Increased Natural Recruitment, Decreased Natural Recruitment, Increased Propagation Planting, Other
Wellfleet	N/A	N/A	Down	N/A	N/A	Up	Stable	Increased Natural Recruitment, Decreased Propagation Planting

Table 2.9. Propagation or contaminated relay support to supplement recreational harvest and percent of each municipality's annual recreational shellfish harvest from either naturally occurring, planted propagation or contaminated relay; two municipalities did not respond (Newbury and Oak Bluffs).

Recreational harvest supplement present	Number of Municipalities	Municipality	% from Naturally Occurring	% from Planted Propagation	% Contaminated Relay Stock
Yes	24	Barnstable	20%	70%	10%
		Bourne	Unsure	Unsure	Unsure
		Chatham	Not Reported	Not Reported	Not Reported
		Dennis	10%	20%	70%
		Eastham	Unsure	Unsure	70%
		Edgartown	20%	70%	10%
		Fairhaven	20%	30%	50%
		Falmouth	N/A	100%	N/A
		Kingston	60%	40%	N/A
		Marblehead	Not Reported	Not Reported	Not Reported
		Marion	30%	30%	30%
		Marshfield	30%	20%	20%
		Mashpee	20%	80%	Unsure
		New Bedford	10%	20%	70%
		Orleans	Not Reported	Not Reported	Not Reported
		Provincetown	30%	30%	40%
		Sandwich	10%	N/A	90%
		Tisbury	Unsure	Unsure	Unsure
		Truro	30%	10%	60%
		Wareham	Unsure	Unsure	Unsure
		Wellfleet	80%	20%	N/A
		West Tisbury	Not Reported	Not Reported	Not Reported

Recreational harvest supplement present	Number of Municipalities	Municipality	% from Naturally Occurring	% from Planted Propagation	% Contaminated Relay Stock
		Westport	60%	20%	20%
		Yarmouth	20%	40%	40%
No	7	Duxbury			
		Essex			
		Gloucester			
		Harwich			
		Ipswich			
		Nantucket			
		Rockport			

Table 2.10. Municipal restrictions on recreational permits specific to out of state applicants; two municipalities did not respond (Newbury and Oak Bluffs).

Restrictions on issuing recreational harvest permits to non-Massachusetts residents	Number of Municipalities	Municipality	Restrictions Cited
Yes	6	Bourne	Restriction not provided
		Harwich	$65 Non-Resident Fee
		Ipswich	One day permit
		Mashpee	Restriction not provided
		New Bedford	Restriction not provided
		Wareham	Restriction not provided
No	25	Barnstable	
		Chatham	
		Dennis	
		Duxbury	
		Eastham	
		Edgartown	
		Essex	
		Fairhaven	
		Falmouth	
		Gloucester	
		Kingston	
		Marblehead	
		Marion	
		Marshfield	
		Nantucket	
		Orleans	
		Provincetown	
		Rockport	
		Sandwich	
		Tisbury	
		Truro	
		Wellfleet	
		West Tisbury	
		Westport	
		Yarmouth	

Table 2.11. Identified factors limiting recreational harvest opportunities by municipality; three municipalities did not respond (Chatham, Newbury and Oak Bluffs).

Factors Identified	Number of Municipalities	Municipality	Factors Cited
Yes	11	Barnstable	Poor Water Quality, Limited Access to Harvest Areas
		Bourne	Poor Water Quality, Limited Access to Harvest Areas
		Eastham	Lack of Standing Stock, Unsure
		Edgartown	Lack of Standing Stock
		Kingston	Conditionally Approved rain closures
		Marion	No response
		Marshfield	Conditionally approved areas, need more water sampling
		Mashpee	Limited Access to Harvest Areas
		Orleans	Poor Water Quality, shoaling
		Sandwich	Poor Water Quality, Limited Access to Harvest Areas
		Yarmouth	Limited Access to Harvest Areas, conditional water body classification, limited propagation funding
No	19	Dennis	
		Duxbury	
		Essex	
		Fairhaven	
		Falmouth	
		Gloucester	
		Harwich	
		Ipswich	
		Marblehead	
		Nantucket	
		New Bedford	
		Provincetown	
		Rockport	
		Tisbury	
		Truro	
		Wareham	
		Wellfleet	
		West Tisbury	
		Westport	

Table 2.12. Educational materials provided to recreational permit holders related to open and closed shell fishing areas, shellfish harvesting, and shellfish sanitation; two municipalities did not respond (Newbury and Oak Bluffs).

Educational Materials	Number of Municipalities	Municipality	Educational Material(s) Cited
Yes	29	Barnstable	Shellfish area maps, shellfish harvest and storage pamphlets, shellfish regulation books, educational learn to shellfish classes, shellfish presentations to schools and non-profits
		Bourne	No response
		Chatham	A number of Pamphlets on safe handling from Cape Cod Cooperative Extension, Video loop at permit office and occasional broadcast on Local Channel 18.
		Dennis	Pamphlets that contain the regulations. Maps that show open areas with dates for each species.
		Duxbury	Pamphlet
		Eastham	The Harvest: Safe Shellfish for Recreational Harvesters, Mass Marine Fisheries information about Red Tide (both are brochures)
		Edgartown	Area map
		Essex	Maps, regulations, public numbers to call
		Falmouth	Annual spring shellfishing education workshop, targeted at Falmouth Newcomers groups; bi-annual fall shellfishing workshop in West Falmouth harbor targeted at the general public
		Gloucester	A packet including management area information, contact information for rain closures etc. Minimal educational material is provided
		Harwich	Hand outs from Cape Cod Cooperative extension -- hard copies
		Ipswich	Maps, flat status numbers.
		Kingston	Pamphlet with license showing a map of shellfish areas
		Marblehead	List of regulations and seminars on-site
		Marion	Maps, guides, signage for shellfish access points
		Marshfield	Maps, regulations, species guide.
		Mashpee	Presentations to the Community, Informational Pamphlets
		Nantucket	No response
		New Bedford	Pamphlet handouts verbal and shellfish education classes
		Orleans	No response
		Provincetown	Regulation, year specific map http://www.provincetown-ma.gov/index.aspx?nid=80
		Sandwich	Tide Charts, Shellfish Regulations Abstract

Educational Materials	Number of Municipalities	Municipality	Educational Material(s) Cited
		Tisbury	Town website with go to information available to the public, updated frequently.
		Truro	Truro web-site and some hand-outs
		Wareham	Regulations booklet, Social media outreach, online shellfish area maps as well as physical maps posted in three public areas
		Wellfleet	Cape Cod Cooperative Extension and Woods Hole Sea Grant brochures
		West Tisbury	Hand out when permit issued
		Westport	A shellfish status hotline. We give a booklet for each license sold.
		Yarmouth	Web site, pamphlets, posters, signs, recorded messages, community talks and public interaction
No	2	Fairhaven	
		Rockport	

3. Commercial Wild Harvest

Of the 38 municipalities that participated in the survey, 33 municipalities identified having a commercial harvest program in their community. The five municipalities that identified as not having a commercial harvest program were excluded from the total number of municipalities with commercial harvest programs in this section of Appendix C (n = 33).

Table 3.1. Existence of Community Commercial Harvest Programs by Municipality.

Commercial Wild Harvest Present	Number of Municipalities	Municipality
Yes	33	Barnstable
		Bourne
		Chatham
		Dennis
		Duxbury
		Eastham
		Edgartown
		Essex
		Fairhaven
		Falmouth
		Gloucester
		Harwich
		Hingham
		Hull
		Ipswich
		Kingston
		Marion
		Mashpee
		Nantucket
		New Bedford
		Newbury
		Newburyport
		Oak Bluffs
		Orleans
		Revere
		Rockport
		Salisbury
		Tisbury
		Wareham
		Wellfleet

Commercial Wild Harvest Present	Number of Municipalities	Municipality
		West Tisbury
		Westport
		Yarmouth
No	5	Marblehead
		Marshfield
		Provincetown
		Sandwich
		Truro

Table 3.2. Total number of commercial permits issued annually by municipality; one municipality did not respond (Oak Bluffs).

Average Number of Commercial Permits	Number of Municipalities	Municipality
301-400	2	Chatham
		Orleans
101-200	5	Eastham
		Ipswich
		Nantucket
		New Bedford
		Wellfleet
51-100	6	Edgartown
		Essex
		Falmouth
		Gloucester
		Newbury
		Westport
26-50	1	Barnstable
0-25	18	Bourne
		Dennis
		Duxbury
		Fairhaven
		Harwich
		Hingham
		Hull
		Kingston
		Marion
		Mashpee
		Newburyport
		Revere
		Rockport
		Salisbury
		Tisbury
		Wareham
		West Tisbury
		Yarmouth

Table 3.3. Municipal cap on commercial permits issued annually; three municipalities did not respond (Falmouth, Oak Bluffs, and Rockport).

Commercial Permit Cap	Number of Municipalities	Municipality	Limit	Year Created
Yes	6	Barnstable	47	1990's
		Duxbury	15	Not Reported
		Essex	94	2011
		Fairhaven	50	Not Reported
		Ipswich	125	2005
		Kingston	7	Not Reported
No	24	Bourne		
		Chatham		
		Dennis		
		Eastham		
		Edgartown		
		Gloucester		
		Harwich		
		Hingham		
		Hull		
		Marion		
		Mashpee		
		Nantucket		
		New Bedford		
		Newbury		
		Newburyport		
		Orleans		
		Revere		
		Salisbury		
		Tisbury		
		Wareham		
		Wellfleet		
		West Tisbury		
		Westport		
		Yarmouth		

Table 3.4. Waiting list on commercial permits by municipality; three municipalities did not respond (Edgartown, Falmouth, and Oak Bluffs).

Commercial Harvest Waiting List	Number of Municipalities	Municipality	Number on the List	Year Created
Yes	3	Barnstable	26	Lottery Drawing
		Duxbury	32	1983
		Kingston	0	Not Reported
No	27	Bourne		
		Chatham		
		Dennis		
		Eastham		
		Essex		
		Fairhaven		
		Gloucester		
		Harwich		
		Hingham		
		Hull		
		Ipswich		
		Marion		
		Mashpee		
		Nantucket		
		New Bedford		
		Newbury		
		Newburyport		
		Orleans		
		Revere		
		Rockport		
		Salisbury		
		Tisbury		
		Wareham		
		Wellfleet		
		West Tisbury		
		Westport		
		Yarmouth		

Table 3.5. Reported decadal trends in commercial permits issued annually by municipality; two municipalities did not respond (Falmouth and Oak Bluffs)

Annual Permit Trend	Number of Municipalities	Municipalities	Additional Comments
Increased	4	Eastham	Increased propagation planting, Other
		Newburyport	Other
		Orleans	Increased natural recruitment, Increased propagation planting
		Wareham	Other
Not Changed (Stable)	15	Barnstable	Other
		Bourne	No additional comments
		Dennis	Increased propagation planting
		Duxbury	No additional comments
		Essex	Other
		Harwich	Other
		Ipswich	Increased natural recruitment
		Kingston	Decreased natural recruitment
		Mashpee	Decreased natural recruitment, Increased propagation planting
		New Bedford	Increased propagation planting
		Newbury	Increased natural recruitment, Other
		Rockport	No additional comments
		Tisbury	Other
		Westport	Decreased propagation planting
		Yarmouth	Disease, Decreased natural recruitment
Decreased	12	Chatham	Decreased natural recruitment, Other
		Edgartown	Decreased natural recruitment, Increased propagation planting
		Fairhaven	Other
		Gloucester	Other

Annual Permit Trend	Number of Municipalities	Municipalities	Additional Comments
		Hingham	Disease, Decreased natural recruitment
		Hull	Disease, Decreased natural recruitment, Other
		Marion	Other
		Nantucket	Other
		Revere	Other
		Salisbury	Disease, Decreased natural recruitment
		Wellfleet	Disease, Decreased natural recruitment, Decreased propagation planting
		West Tisbury	Decreased natural recruitment

Table 3.6. Species open for commercial harvest by municipality; two municipalities did not respond (Falmouth and Oak Bluffs).

Municipality	Species
Barnstable	Bay Scallop, Softshell Clam, Surf Clam, Quahog, Razor Clam, Mussels
Bourne	Bay Scallop, Softshell Clam, Quahog, Other
Chatham	Bay Scallop, Softshell Clam, Surf Clam, Quahog, Razor Clam, Mussels
Dennis	Bay Scallop, Softshell Clam, Surf Clam, Quahog, Razor Clam, Mussels
Duxbury	Softshell Clam, Quahog, Razor Clam, Mussels
Eastham	Bay Scallop, Softshell Clam, Surf Clam, Quahog, Razor Clam, Mussels
Edgartown	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Oyster
Essex	Softshell Clam, Razor Clam, Mussels
Fairhaven	Quahog
Falmouth	Not Reported
Gloucester	Softshell Clam, Razor Clam
Harwich	Bay Scallop, Quahog
Hingham	Softshell Clam
Hull	Softshell Clam
Ipswich	Softshell Clam, Razor Clam
Kingston	Razor Clam
Marion	Bay Scallop, Surf Clam, Quahog, Razor Clam, Oyster, Mussels
Mashpee	Bay Scallop, Softshell Clam, Surf Clam, Quahog, Razor Clam, Mussels
Nantucket	Bay Scallop, Quahog, Oyster, Mussels
New Bedford	Quahog
Newbury	Softshell Clam, Razor Clam, Oyster
Newburyport	Softshell Clam
Oak Bluffs	Not Reported
Orleans	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Mussels
Revere	Softshell Clam
Rockport	Sea Scallop
Salisbury	Softshell Clam
Tisbury	Bay Scallop, Softshell Clam, Quahog
Wareham	Bay Scallop, Softshell Clam, Quahog
Wellfleet	Bay Scallop, Softshell Clam, Quahog, Razor Clam, Oyster, Mussels, Other
West Tisbury	Softshell Clam, Oyster
Westport	Bay Scallop, Softshell Clam, Surf Clam, Quahog, Razor Clam, Oyster, Mussels
Yarmouth	Bay Scallop, Softshell Clam, Quahog

Table 3.7. Harvest limits and harvest methods allowed by municipality; two municipalities did not respond (Falmouth and Oak Bluffs).

Municipality	Harvest Limit	Method(s)
Barnstable	Daily	Mechanical Dragging, Hand Rake, Hand Picking, Bull Raking, Salting, Hydraulic Pumping
Bourne	Daily	Not Reported
Chatham	-	Tonging, Hand Rake, Hand Picking, Bull Raking, Salting, Hydraulic Pumping, Other
Dennis	Daily	Hand Rake, Bull Raking
Duxbury	Weekly	Hand Rake, Hand Picking, Bull Raking, Salting
Eastham	Daily	Mechanical Dragging, Tonging, Hand Rake, Hand Picking, Bull Raking, Salting
Edgartown	Daily	Mechanical Dragging, Tonging, Hand Rake, Hand Picking, Bull Raking, Salting
Essex	Daily	Hand Rake
Fairhaven	Daily	Mechanical Dragging, Tonging, Hand Rake, Hand Picking, Bull Raking, Other
Falmouth	No response	Not Reported
Gloucester	Daily	Hand Rake
Harwich	Daily	Hand Rake, Bull Raking
Hingham	Daily	Hand Rake
Hull	-	Hand Rake
Ipswich	Daily	Hand Rake
Kingston	-	Salting
Marion	Daily	Tonging, Hand Rake, Bull Raking
Mashpee	Daily	Hand Rake, Hand Picking, Bull Raking
Nantucket	Daily	Mechanical Dragging, Tonging, Hand Rake, Hand Picking, Bull Raking
New Bedford	Daily	Tonging, Hand Rake, Bull Raking, Hydraulic Pumping
Newbury	Daily	Hand Rake
Newburyport	Weekly	Hand Rake, Hand Picking
Oak Bluffs	No response	Not Reported
Orleans	Daily	Mechanical Dragging, Tonging, Hand Rake, Hand Picking, Bull Raking, Salting
Revere	Daily	Hand Rake
Rockport	-	Mechanical Dragging
Salisbury	Daily	Hand Rake
Tisbury	Daily	Mechanical Dragging, Hand Rake, Hand Picking, Bull Raking
Wareham	Daily	Hand Rake, Hand Picking, Bull Raking
Wellfleet	Daily	Mechanical Dragging, Hand Rake, Hand Picking, Salting, Other
West Tisbury	Daily	Mechanical Dragging, Hydraulic Pumping

Municipality	Harvest Limit	Method(s)
Westport	Daily	Tonging, Hand Rake, Hand Picking, Bull Raking
Yarmouth	Daily	Mechanical Dragging, Hand Rake, Hand Picking, Bull Raking, Hydraulic Pumping

Table 3.8. Reported decadal trends in commercial shellfish landings by municipality and species; 18 municipalities reported that they could not identify any specific trends in landings.

Municipality	Bay Scallop	Softshell Clam	Quahog	Razor Clam	Surf Clam	Oyster	Mussel	Additional Comments
Chatham	Down	Down	Stable	Up	N/A	Down	N/A	Dynamic environment if the outer beach/access to productive flats
Eastham	Stable	Down	Up	Up	N/A	Down	N/A	Decreased Natural Recruitment, More Fishing Effort, Increased Propagation Planting
Edgartown	Down	Down	Stable	Unsure	Up	Down	N/A	Decreased Natural Recruitment
Essex	N/A	Up	N/A	Up	N/A	N/A	N/A	Predation
Harwich	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Disease, Water Quality
Hingham	N/A	Down	N/A	N/A	N/A	N/A	N/A	Disease, Decreased Natural Recruitment, Decreased Propagation Planting
Hull	N/A	Down	N/A	N/A	N/A	N/A	N/A	Disease, Decreased Natural Recruitment
Marion	Down	N/A	Down	N/A	Down	N/A	N/A	Less Fishing Effort
Mashpee	Down	Down	Up	Stable	N/A	Down	N/A	Decreased Natural Recruitment, Increased Propagation Planting, Temp die offs
Newburyport	N/A	Stable	N/A	N/A	N/A	N/A	N/A	Less Fishing Effort
Wellfleet	Down	Down	Down	Down	Up	Unsure	Up	Disease, Predation, Decreased Natural Recruitment, Decreased Propagation Planting, Ice Impacts
West Tisbury	N/A	Down	N/A	N/A	Down	N/A	N/A	Disease, Less Fishing Effort, Increased Propagation Planting

Table 3.9. Limiting factors in commercial shellfish harvest by municipality; three towns did not respond (Bourne, Falmouth and Oak Bluffs).

Identified Limiting Factor(s)	Number of Municipalities	Municipality	Limiting Factor(s) Cited
Yes	23	Barnstable	Limited access to harvest areas
		Chatham	Limited access to harvest areas
		Dennis	Lack of standing stock, Limited areas open for harvest
		Eastham	Lack of standing stock
		Edgartown	Lack of standing stock
		Essex	Rain
		Gloucester	Lack of standing stock, Limited areas open for harvest, Limited access to harvest areas, Inadequate staff to supervise harvest
		Harwich	Lack of standing stock, Limited areas open for harvest, Limited access to harvest areas
		Hingham	Lack of standing stock
		Hull	Loss of Diggers
		Ipswich	Lack of standing stock
		Kingston	Limited areas open for harvest
		Mashpee	Limited access to harvest areas
		Nantucket	Not reported
		New Bedford	Limited areas open for harvest, Limited access to harvest areas
		Newburyport	Limited areas open for harvest
		Orleans	Lack of standing stock
		Revere	Limited areas open for harvest
		Rockport	Lack of standing stock, Limited areas open for harvest, Limited access to harvest areas
		Wareham	Lack of standing stock
		Wellfleet	Lack of standing stock, ice impacts, decreased propagation efforts, natural cycles
		Westport	Lack of relay quahogs

Identified Limiting Factor(s)	Number of Municipalities	Municipality	Limiting Factor(s) Cited
		Yarmouth	Limited areas open for harvest, Limited access to harvest areas
No	7	Duxbury	
		Fairhaven	
		Marion	
		Newbury	
		Salisbury	
		Tisbury	
		West Tisbury	

Table 3.10. Educational materials provided by municipality to commercial shellfish harvesters; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Presence of Education Materials	Number of Municipalities	Municipality	Educational Resource(s) Cited
Yes	24	Barnstable	Shellfish regulation book, shellfish area maps
		Chatham	Municipal Website
		Dennis	Municipal Website
		Duxbury	Handout
		Eastham	Not reported
		Edgartown	Vp control
		Gloucester	Commercial Shellfishermen's information packet.
		Harwich	Cape Cod Cooperative Extension materials - hard copy
		Ipswich	Municipal Website
		Kingston	Rain closures in CA areas
		Marion	Maps, guides
		Mashpee	Presentations given to the Commercial Harvesters, Shellfish Commission
		Nantucket	Not reported
		New Bedford	All commercial fisherman must meet with the shellfish warden before fishing
		Newbury	Not reported
		Newburyport	Not reported
		Orleans	Not reported
		Salisbury	Maps, along with town regs
		Tisbury	We try to provide as much current information to people as we can
		Wareham	Same as recreational
		Wellfleet	Municipal Website
		West Tisbury	Signage at pond, brochure when permit issued
		Westport	Shellfish hotline, booklets for each license sold

Presence of Education Materials	Number of Municipalities	Municipality	Educational Resource(s) Cited
		Yarmouth	web site, signage, mailings, personal contact and education
No	6	Essex	
		Fairhaven	
		Hingham	
		Hull	
		Revere	
		Rockport	

Table 3.11. Select municipal enforcement issues in the last five years; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Enforcement Issues	Number of Municipalities	Municipalities	Enforcement Issue(s) Cited
Yes	14	Barnstable	Harvesting over the limit, Harvesting from a closed area, harvest between sunset and half hour before sunrise
		Chatham	Harvesting from a closed area, seed (primary enforcement issue)
		Duxbury	Harvesting from a closed area, harvesting on prohibited days
		Edgartown	Failure for individuals to obtain a permit, Harvesting over the limit, Harvesting from a closed area, Seed
		Gloucester	Failure for individuals to obtain a permit, Harvesting over the limit, Harvesting from a closed area, untagged shellfish, harvest from prohibited areas
		Marion	Harvesting over the limit
		Mashpee	Harvesting over the limit, commercial oyster harvest occurring even though it is not allowed within the town
		Nantucket	Failure for individuals to obtain a permit, Harvesting over the limit, Other
		New Bedford	Other
		Orleans	Harvesting over the limit
		Tisbury	Harvesting over the limit, Harvesting from a closed area, time of day restrictions, general ignorance of rules
		Wellfleet	Harvesting over the limit, taking of seed, failure to display, shellfishing on aquaculture grants
		West Tisbury	Harvesting over the limit, size limit violation, fishing on closed days
		Westport	Harvesting over the limit, Harvesting from a closed area
No	16	Dennis	
		Eastham	
		Essex	
		Fairhaven	
		Harwich	

Enforcement Issues	Number of Municipalities	Municipalities	Enforcement Issue(s) Cited
		Hingham	
		Hull	
		Ipswich	
		Kingston	
		Newbury	
		Newburyport	
		Revere	
		Rockport	
		Salisbury	
		Wareham	
		Yarmouth	

Table 3.12. Propagation or contaminated relay to supplement commercial harvest by municipality; four municipalities did not respond (Bourne, Essex, Falmouth, and Oak Bluffs)

Propagation or Contaminated Relays to Support Harvest	Number of Municipalities	Municipality	Naturally Occurring	Planted Propagation	Contaminated Relay
Yes	16	Barnstable	70%	20%	10%
		Chatham	N/A	N/A	N/A
		Eastham	Unsure	Unsure	50%
		Edgartown	70%	20%	10%
		Marion	50%	50%	N/A
		Mashpee	50%	50%	N/A
		New Bedford	10%	40%	50%
		Newbury	100%	N/A	N/A
		Newburyport	100%	N/A	100%
		Orleans	N/A	N/A	N/A
		Tisbury	Unsure	Unsure	Unsure
		Wareham	Unsure	Unsure	Unsure
		Wellfleet	90%	10%	Unsure
		West Tisbury	N/A	N/A	N/A
		Westport	20%	10%	70%
		Yarmouth	70%	30%	N/A
No	13	Dennis			
		Duxbury			
		Fairhaven			
		Gloucester			
		Harwich			
		Hingham			
		Hull			

Propagation or Contaminated Relays to Support Harvest	Number of Municipalities	Municipality	Naturally Occurring	Planted Propagation	Contaminated Relay
		Ipswich			
		Kingston			
		Nantucket			
		Revere			
		Rockport			
		Salisbury			

Table 3.13. Specific concern to state or federal policy, regulation, or legislation related to commercial shellfish harvest; four municipalities did not respond (Bourne, Falmouth, Nantucket, and Oak Bluffs)

Concern Present	Number of Municipalities	Municipality	Concern(s) Cited
Yes	4	Barnstable	Chapter 91
		Edgartown	None reported
		Wellfleet	Potential privatization of aquaculture grants; license per acre fee for aquaculture grants too low for services required; importance of boat shellfishery to local economy
		Yarmouth	Additional fees on contaminated relays
No	25	Chatham	
		Dennis	
		Duxbury	
		Eastham	
		Essex	
		Fairhaven	
		Gloucester	
		Harwich	
		Hingham	
		Hull	
		Ipswich	
		Kingston	
		Marion	
		Mashpee	
		New Bedford	
		Newbury	
		Newburyport	
		Orleans	

Concern Present	Number of Municipalities	Municipality	Concern(s) Cited
		Revere	
		Rockport	
		Salisbury	
		Tisbury	
		Wareham	
		West Tisbury	
		Westport	

4. Shellfish Aquaculture

Of the 38 municipalities that participated in the survey, 21 municipalities have some form of shellfish management program for shellfish aquaculture. Municipalities that identified as not having a shellfish aquaculture program were excluded from the total number of towns with aquaculture programs in the tables below (n = 21).

Table 4.1. Existence of Shellfish Aquaculture Programs by Municipality.

Shellfish Aquaculture Program Present	Number of Municipalities	Municipality
Yes	21	Barnstable
		Bourne
		Chatham
		Dennis
		Duxbury
		Eastham
		Edgartown
		Fairhaven
		Falmouth
		Kingston
		Marion
		Mashpee
		Nantucket
		Oak Bluffs
		Orleans
		Provincetown
		Truro
		Wareham
		Wellfleet
		Westport
		Yarmouth
No	17	Essex
		Gloucester
		Harwich
		Hingham
		Hull
		Ipswich
		Marblehead

Shellfish Aquaculture Program Present	Number of Municipalities	Municipality
		Marshfield
		New Bedford
		Newbury
		Newburyport
		Revere
		Rockport
		Salisbury
		Sandwich
		Tisbury
		West Tisbury

Table 4.2. Current number of shellfish aquaculture licenses and total acreage by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Municipality	Total Acres	Number of Permit Holders	Number of Licenses
Barnstable	156	59	72
Chatham	4	2	1
Dennis	50	25	28
Duxbury	83	32	32
Eastham	29	31	26
Edgartown	32	12	12
Fairhaven	47	2	3
Kingston	10	3	3
Marion	2	4	4
Mashpee	20	4	6
Nantucket	10	8	8
Orleans	26	14	14
Provincetown	38	29	27
Truro	27	5	7
Wareham	71	8	8
Wellfleet	240	134	154
Westport	81	9	9
Yarmouth	30	5	5

Table 4.3. Cap on shellfish aquaculture licenses by municipalities; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Municipality	Cap Present	Number Capped	Year Created
Barnstable	Yes	72	1990's
Chatham	Yes	Not Reported	1990
Dennis	Yes	28	2002
Duxbury	Yes	32	2005
Eastham	No	N/A	N/A
Edgartown	Yes	22	2016
Fairhaven	Yes	5	2016
Kingston	No	N/A	N/A
Marion	No	N/A	N/A
Mashpee	No	N/A	N/A
Nantucket	Yes	8	Not Reported
Orleans	Yes	31	2000
Provincetown	No	N/A	N/A
Truro	No	N/A	N/A
Wareham	Yes	Not Reported	2018
Wellfleet	No	N/A	N/A
Westport	Yes	9	2018
Yarmouth	Yes	Not Reported	Not Reported

Table 4.4. Residency requirements for shellfish aquaculture licenses by municipality.

Municipality	Residency Requirement
Barnstable	Yes
Bourne	Yes
Chatham	Yes
Dennis	Yes
Duxbury	Yes
Eastham	Yes
Edgartown	Yes
Fairhaven	Yes
Falmouth	No
Kingston	Yes
Marion	Yes
Mashpee	Yes
Nantucket	Yes
Oak Bluffs	Yes
Orleans	Yes
Provincetown	Yes
Truro	Yes
Wareham	Yes
Wellfleet	Yes
Westport	Yes
Yarmouth	Yes

Table 4.7. Reported decadal trends in shellfish aquaculture licenses by municipality; three municipalities did not respond (Bourne, Falmouth, Oak Bluffs).

License Trend	Number of Municipalities	Municipality
Increased	8	Dennis
		Eastham
		Edgartown
		Fairhaven
		Marion
		Mashpee
		Provincetown
		Westport
Not Changed (Stable)	9	Barnstable
		Chatham
		Duxbury
		Kingston
		Nantucket
		Orleans
		Truro
		Wellfleet
		Yarmouth
Decreased	1	Wareham

Table 4.8. Reported decadal trends in shellfish aquaculture landings by municipality; four municipalities did not respond (Bourne, Falmouth, Kingston, and Oak Bluffs).

Landing Trend	Number of Municipalities	Municipality
Increased	14	Barnstable
		Dennis
		Duxbury
		Eastham
		Edgartown
		Fairhaven
		Marion
		Mashpee
		Orleans
		Provincetown
		Wareham
		Wellfleet
		Westport
		Yarmouth
Not changed (Stable)	3	Chatham
		Nantucket
		Truro
Decreased	0	

Table 4.9. Decadal trends in shellfish aquaculture acreage by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Acreage Trend	Number of Municipalities	Municipality
Increased	11	Barnstable
		Dennis
		Duxbury
		Eastham
		Edgartown
		Fairhaven
		Marion
		Mashpee
		Provincetown
		Westport
		Yarmouth
Not changed (Stable)	6	Chatham
		Kingston
		Nantucket
		Orleans
		Truro
		Wellfleet
Decreased	1	Wareham

Table 4.10. Municipalities that have official moratorium in place for shellfish aquaculture licenses and the year created; five municipalities did not respond (Bourne, Falmouth, Nantucket, Oak Bluffs, and Orleans).

Moratorium	Number of Municipalities	Municipality	Year Created
Yes	4	Chatham	1990
		Duxbury	2005
		Fairhaven	2016
		Wareham	2018
No	12	Barnstable	
		Dennis	
		Eastham	
		Edgartown	
		Kingston	
		Marion	
		Mashpee	
		Provincetown	
		Truro	
		Wellfleet	
		Westport	
		Yarmouth	

Table 4.11. Number of municipalities with a waiting list for shellfish aquaculture licenses including the number currently on the list and the year the list was created; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Waiting List	Number of Municipalities	Municipality	Number of People on the List	Year Created
Yes	11	Barnstable	33	90's
		Dennis	80	2002
		Duxbury	Not Reported	Not Reported
		Eastham	23	2014
		Edgartown	8	2016
		Kingston	10	2009
		Nantucket	Not Reported	Not Reported
		Orleans	30	1996
		Truro	0	2014
		Westport	5	2012
		Yarmouth	Not Reported	2001
No	7	Chatham		
		Fairhaven		
		Marion		
		Mashpee		
		Provincetown		
		Wareham		
		Wellfleet		

Table 4.12. Aquaculture development areas (ADA) by municipality with availability; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

ADA	Number of Municipalities	Municipality	Max Capacity (Acreage)
Yes	9	Barnstable	No
		Dennis	Yes
		Eastham	No
		Edgartown	Yes
		Marion	Yes
		Nantucket	Yes
		Orleans	Yes
		Provincetown	No
		Truro	Yes
No	9	Chatham	
		Duxbury	
		Fairhaven	
		Kingston	
		Mashpee	
		Wareham	
		Wellfleet	
		Westport	
		Yarmouth	

Table 4.13. Shellfish aquaculture grant use requirements by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Substantial Use Requirement?	Number of Municipalities	Municipality	Requirement
Yes	17	Barnstable	Minimum Production Requirement
		Dennis	Minimum Investment Requirement
		Duxbury	Minimum Investment Requirement
		Eastham	Minimum Investment Requirement
		Edgartown	Other
		Fairhaven	Not Reported
		Kingston	Minimum Production Requirement
		Marion	Other
		Mashpee	Minimum Production Requirement
		Nantucket	Minimum Production Requirement
		Orleans	Minimum Investment Requirement
		Provincetown	Other
		Truro	Other
		Wareham	Minimum Production Requirement
		Wellfleet	Minimum Production Requirement
		Westport	Other
		Yarmouth	Minimum Production Requirement
No	1	Chatham	

Table 4.14. Shellfish aquaculture license fee(s) per acre by municipality; four municipalities did not respond (Bourne, Falmouth, Nantucket, and Oak Bluffs).

Municipality	Annual License Fee per Acre	Other Fees
Barnstable	$25	No
Bourne	Not Reported	Not Reported
Chatham	$25	No
Dennis	$100	Yes
Duxbury	$25	Yes
Eastham	$5	Yes
Edgartown	$5	Yes
Fairhaven	$100	No
Falmouth	Not Reported	Not Reported
Kingston	$25	No
Marion	$12.50	No
Mashpee	$25	No
Nantucket	Not Reported	Not Reported
Oak Bluffs	Not Reported	Not Reported
Orleans	$25	No
Provincetown	$25	No
Truro	$25	No
Wareham	$25	Yes
Wellfleet	$25	No
Westport	$25	Yes
Yarmouth	$25	No

Table 4.15. Experience or education requirements to obtain a license by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Experience or Education Requirements	Number of Municipalities	Municipality	Requirements
Yes	7	Fairhaven	Experience working on a shellfish lease, fisheries experience in general
		Kingston	Experience working on a shellfish lease, fisheries experience in general
		Mashpee	A combination of experience working on a shellfish lease, fisheries experience in general, and course work
		Nantucket	A combination of experience working on a shellfish lease, fisheries experience in general, and course work
		Wareham	A combination of experience working on a shellfish lease, fisheries experience in general, and course work
		Wellfleet	Experience working on a shellfish lease, commercial shellfish experience
		Yarmouth	A combination of experience working on a shellfish lease, fisheries experience in general, and course work
No	11	Barnstable	
		Chatham	
		Dennis	
		Duxbury	
		Eastham	
		Edgartown	
		Marion	
		Orleans	
		Provincetown	
		Truro	
		Westport	

Table 4.16. Enforcement issues associated with shellfish aquaculture in the past 5 years by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Enforcement Issues	Number of Municipalities	Municipality	Enforcement Issue Cited
Yes	10	Barnstable	Gear washing off site, Improper or lack of markings, Gear moved slightly off site to unlicensed grounds
		Dennis	Theft, Gear washing off site, Improper or lack of markings
		Duxbury	Theft, Gear washing off site, Improper or lack of markings, Daylight restrictions
		Edgartown	Theft, Gear washing off site, Improper or lack of markings
		Marion	Gear washing off site, Improper or lack of markings
		Mashpee	Theft, Gear washing off site, Improper or lack of markings
		Nantucket	Gear washing off site, Improper or lack of markings, Other
		Orleans	Improper or lack of markings
		Provincetown	Theft
		Wellfleet	Theft, Gear washing off site, Improper or lack of markings, Minimum productivity requirements
No	8	Chatham	
		Eastham	
		Fairhaven	
		Kingston	
		Truro	
		Wareham	
		Westport	
		Yarmouth	

Table 4.17. Specific concerns or issues pertaining to state or federal policy, regulation, or legislation related to shellfish aquaculture as identified by communities; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs)

Specific Concerns to Policy	Number of Municipalities	Municipality	Policy Cited
Yes	5	Barnstable	$25/acre needs to be increased across the state
		Duxbury	New vibrio requirements. Aquaculture fee. Mooring/ Marina designation
		Edgartown	Not reported
		Provincetown	MEPA Offices and NHEPS not on same page as DMF, Town and ACOE. They require a NOI without segmentation VS everyone else requires individual grant approval. Town and ConCom wants to develop 150 additional acres but NHESP has us stopped with a cost to date of $5800. Towns that are successful seem to go the route of RDA or administrative review. We want to do it the right way and are bogged down. All aquaculture should go through same process
		Wellfleet	Potential privatization of aquaculture bottom; license fees do not cover the amount of mandated services the town is required to oversee aquaculture
No	13	Chatham	
		Dennis	
		Eastham	
		Fairhaven	
		Kingston	
		Marion	
		Mashpee	
		Nantucket	
		Orleans	
		Truro	
		Wareham	
		Westport	
		Yarmouth	

5. Municipal Shellfish Propagation

Of the 38 municipalities that participated in the survey, 28 municipalities identified as having municipal shellfish propagation in their community. Municipalities that identified as not having a municipal shellfish propagation were excluded from the total number of towns with a program in the tables below (n = 28).

Table 5.1. Primary reason for conducting shellfish propagation by community, three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs). Options in survey included supplement recreational harvest, supplement commercial harvest, or both.

Municipality	**Reason for Shellfish Propagation**
Barnstable	Both
Chatham	Both
Dennis	Recreational harvest
Eastham	Both
Edgartown	Recreational harvest
Fairhaven	Recreational harvest
Harwich	Both
Hingham	Commercial harvest
Kingston	Recreational harvest
Marion	Both
Marshfield	Recreational harvest
Mashpee	Both
Nantucket	Both
New Bedford	Both
Newbury	Both
Orleans	Both
Provincetown	Recreational harvest
Sandwich	Recreational harvest
Tisbury	Both
Truro	Recreational harvest
Wareham	Both
Wellfleet	Both
West Tisbury	Both
Westport	Both
Yarmouth	Both

Table 5.2. Primary species and method of propagation by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs). Options in survey included purchase of hatchery reared seed for out planting, relay, upweller facility, or combination.

Municipality	Primary Species Propagated	Method of Propagation
Barnstable	Bay Scallop, Soft Shell Clam, Quahog, Oyster	Combination
Chatham	Bay Scallop, Quahog, Oyster	Purchase of hatchery reared seed for out planting
Dennis	Soft Shell Clam, Quahog, Oyster	Combination
Eastham	Quahog, Oyster	Purchase of hatchery reared seed for out planting
Edgartown	Bay Scallop, Soft Shell Clam, Quahog, Oyster	Combination
Fairhaven	Quahog, Oyster	Purchase of hatchery reared seed for out planting
Harwich	Quahog, Oyster	Upweller Facility
Hingham	Soft Shell Clam	Purchase of hatchery reared seed for out planting
Kingston	Soft Shell Clam, Quahog	Purchase of hatchery reared seed for out planting
Marion	Bay Scallop, Soft Shell Clam, Quahog, Oyster	Purchase of hatchery reared seed for out planting
Marshfield	Soft Shell Clam, Quahog	Purchase of hatchery reared seed for out planting
Mashpee	Bay Scallop, Quahog, Oyster	Combination
Nantucket	Bay Scallop, Quahog, Oyster	Combination
New Bedford	Quahog	Other
Newbury	Soft Shell Clam, Razor Clam, Oyster	Not Reported
Orleans	Quahog	Purchase of hatchery reared seed for out planting
Provincetown	Quahog, Oyster	Relay
Sandwich	Quahog, Oyster	Purchase of hatchery reared seed for out planting
Tisbury	Bay Scallop, Soft Shell Clam, Quahog	Combination
Truro	Soft Shell Clam, Quahog, Oyster	Combination
Wareham	Quahog, Oyster	Combination
Wellfleet	Quahog, Oyster	Combination
West Tisbury	Oyster	Combination
Westport	Bay Scallop, Quahog, Oyster	Combination
Yarmouth	Bay Scallop, Quahog, Oyster	Combination

Table 5.4. Municipality's ability to purchase seed to meet planting and propagation objectives; four municipalities did not respond (Bourne, Falmouth, Nantucket and Oak Bluffs).

Access to Seed	Number of Municipalities	Municipality	Seed Purchases Needed to Meet Planting and Propagation Objectives
Yes	17	Chatham	
		Dennis	
		Eastham	
		Edgartown	
		Fairhaven	
		Harwich	
		Hingham	
		Kingston	
		Marion	
		Marshfield	
		New Bedford	
		Newbury	
		Provincetown	
		Tisbury	
		Truro	
		Wareham	
		West Tisbury	
No	7	Barnstable	Varies from year to year, larger quahogs need about 250,000 and sometimes shortage on oysters
		Mashpee	50,000 Bay Scallops
		Orleans	Not reported
		Sandwich	500,000-1,000,000
		Wellfleet	We would like to get to 1M each of quahogs and oysters
		Westport	Enough to fill our orders
		Yarmouth	25-50%

Table 5.5. Occurrence of exchange and trade of shellfish with other municipalities; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs)

Exchange via Trade or Barter	Number of Municipalities	Municipality
Yes	4	Barnstable
		Mashpee
		Orleans
		West Tisbury
No	21	Chatham
		Dennis
		Eastham
		Edgartown
		Fairhaven
		Harwich
		Hingham
		Kingston
		Marion
		Marshfield
		Nantucket
		New Bedford
		Newbury
		Provincetown
		Sandwich
		Tisbury
		Truro
		Wareham
		Wellfleet
		Westport
		Yarmouth

Table 5.6. Need to augment municipal shellfish propagation with outside sources of funding to meet objectives[11]; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Need for Outside Funding	Number of Municipalities	Municipality
Yes	13	Chatham
		Edgartown
		Harwich
		Marion
		Nantucket
		Orleans
		Sandwich
		Tisbury
		Truro
		Wellfleet
		West Tisbury
		Westport
		Yarmouth
No	12	Barnstable
		Dennis
		Eastham
		Fairhaven
		Hingham
		Kingston
		Marshfield
		Mashpee
		New Bedford
		Newbury
		Provincetown
		Wareham

[11] Certain communities in Barnstable County and Dukes County may use funds provided through earmarks in DMF's annual operating budget.

Table 5.7. Use of state or county-based funds for municipal shellfish propagation programs; four municipalities did not respond (Bourne, Falmouth, Nantucket, and Oak Bluffs)[12].

Use of County or State Funds	Number of Municipalities	Municipality
Yes	14	Barnstable
		Chatham
		Dennis
		Eastham
		Harwich
		Mashpee
		Orleans
		Provincetown
		Sandwich
		Tisbury
		Truro
		Wareham
		Wellfleet
		Yarmouth
No	10	Edgartown
		Fairhaven
		Hingham
		Kingston
		Marion
		Marshfield
		New Bedford
		Newbury
		West Tisbury
		Westport

[12] Certain communities in Barnstable County and Dukes County may use funds provided through earmarks in DMF's annual operating budget.

Table 5.8. Factors limiting success of municipal shellfish propagation programs; four municipalities did not respond (Bourne, Falmouth, Nantucket, and Oak Bluffs).

Identified Factors	Number of Municipalities	Municipalities	Additional Comments
Yes	15	Barnstable	Inability to obtain seed, NIMBY, and Politics
		Chatham	Budget Shortfalls, Needed upgrades in upweller facility
		Edgartown	Budget Shortfalls
		Harwich	Budget Shortfalls, Water Quality
		Marion	Less fishing pressure
		Marshfield	Budget Shortfalls, Staff Limitations
		Mashpee	Budget Shortfalls, Theft, Staff Limitations
		Orleans	Inability to obtain seed
		Provincetown	Asian shore crab
		Sandwich	Budget Shortfalls, Staff Limitations
		Wareham	Increased costs to operate
		Wellfleet	Inability to obtain seed, Budget Shortfalls, Disease, Need for dredging
		West Tisbury	Disease
		Westport	Inability to obtain seed
		Yarmouth	Inability to obtain seed, Budget Shortfalls, Staff Limitations
No	9	Dennis	
		Eastham	
		Fairhaven	
		Hingham	
		Kingston	
		New Bedford	
		Newbury	
		Tisbury	

Table 5.9. Identified concerns pertaining to state or federal policy, regulation, or legislation related to municipal shellfish propagation; four municipalities did not respond (Bourne, Falmouth, Nantucket, and Oak Bluffs).

Identified Concerns	Number of Municipalities	Municipality	Policy Cited
Yes	5	Barnstable	$25/acre/yr is too little to properly manage the aquaculture industry
		Edgartown	Not reported
		Provincetown	Cultching restrictions
		Sandwich	New $1. per bag fee for contaminated relay stock.
		Wareham	Fee increases to shellfish contaminated relay
No	19	Chatham	
		Dennis	
		Eastham	
		Fairhaven	
		Harwich	
		Hingham	
		Kingston	
		Marion	
		Marshfield	
		Mashpee	
		New Bedford	
		Newbury	
		Orleans	
		Tisbury	
		Truro	
		Wellfleet	
		West Tisbury	
		Westport	
		Yarmouth	

Table 5.10. Use of upwellers and/or nursery growout systems for municipal shellfish propagation by community; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Use of Upwellers or Nursery Growout	Number of Municipalities	Municipality
Yes	17	Barnstable
		Chatham
		Dennis
		Eastham
		Edgartown
		Fairhaven
		Harwich
		Marion
		Mashpee
		Nantucket
		Orleans
		Provincetown
		Sandwich
		Wareham
		Wellfleet
		Westport
		Yarmouth
No	8	Hingham
		Kingston
		Marshfield
		New Bedford
		Newbury
		Tisbury
		Truro
		West Tisbury

Table 5.12. Other entities conducting work under municipal propagation permits by community[13]; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs). Description of assisting entities were not provided in survey.

Entities Conducting Propagation Under a Municipal Permit	Number of Municipalities	Municipality
Yes	12	Barnstable
		Chatham
		Edgartown
		Fairhaven
		Hingham
		Marion
		Marshfield
		Mashpee
		Orleans
		Truro
		West Tisbury
		Westport
No	13	Dennis
		Eastham
		Harwich
		Kingston
		Nantucket
		New Bedford
		Newbury
		Provincetown
		Sandwich
		Tisbury
		Wareham
		Wellfleet
		Yarmouth

[13] Though not specified here, entities include NGO's or researchers.

6. Shellfish Program Capacity

All towns that participated in the survey with at least one shellfish management program were asked a set of questions pertaining to their shellfish program capacity (n=38/38).

Table 6.1. Presence or absence of Massachusetts Shellfish Officer Association (MSOA) shellfish constable training by community; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Municipality	MSOA Training Requirement
Barnstable	Yes
Chatham	Yes
Dennis	No
Duxbury	Yes
Eastham	No
Edgartown	Yes
Essex	No
Fairhaven	Yes
Gloucester	No
Harwich	Yes
Hingham	Yes
Hull	Yes
Ipswich	No
Kingston	Yes
Marblehead	No
Marion	Yes
Marshfield	No
Mashpee	Yes
Nantucket	Yes
New Bedford	Yes

Municipality	MSOA Training Requirement
Newbury	Yes
Newburyport	Yes
Orleans	Yes
Provincetown	Yes
Revere	No
Rockport	No
Salisbury	Yes
Sandwich	Yes
Tisbury	Yes
Truro	Yes
Wareham	Yes
Wellfleet	Yes
West Tisbury	No
Westport	Yes
Yarmouth	Yes

Table 6.2. Constable position description by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Position	Number of Municipalities	Municipality
Full Time	28	Barnstable
		Chatham
		Dennis
		Duxbury
		Eastham
		Edgartown
		Essex
		Fairhaven
		Gloucester
		Harwich
		Hingham
		Hull
		Ipswich
		Marion
		Mashpee
		Nantucket
		New Bedford
		Newbury
		Newburyport
		Orleans
		Provincetown
		Revere
		Tisbury
		Truro
		Wareham
		Wellfleet
		Westport
		Yarmouth

Position	Number of Municipalities	Municipality
Part Time	7	Kingston
		Marblehead
		Marshfield
		Rockport
		Salisbury
		Sandwich
		West Tisbury

Table 6.3. Constable positions that carry secondary resource management roles by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Other Job Related Roles	Number of Municipalities	Municipality	Position
Yes	22	Barnstable	Natural resource officer
		Dennis	Assistant Natural Resource Officer
		Duxbury	Harbormaster
		Eastham	Assistant Harbor Master/Assistant Conservation Agent/Natural Resource Officer
		Fairhaven	Harbormaster
		Gloucester	Assistant Harbormaster
		Harwich	Herring Warden, Shellfish Constable, Asst. Harbormaster
		Hingham	Harbormaster
		Hull	Not reported
		Marion	Deputy Harbormaster / Shellfish Officer
		Marshfield	Harbormaster
		Mashpee	Water Quality Tech
		Nantucket	Not reported
		Newburyport	Harbormaster
		Orleans	Harbormaster/Natural Resources Manager
		Revere	ISD
		Rockport	Harbormaster
		Salisbury	Harbormaster
		Sandwich	Director of Natural Resources Dept.
		Truro	Not reported
		Wareham	Director of Natural Resources
		Westport	Not reported
No	13	Chatham	
		Edgartown	
		Essex	

Other Job Related Roles	Number of Municipalities	Municipality	Position
		Ipswich	
		Kingston	
		Marblehead	
		New Bedford	
		Newbury	
		Provincetown	
		Tisbury	
		Wellfleet	
		West Tisbury	
		Yarmouth	

Table 6.4. Municipalities that employ deputy shellfish constable(s); three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Employee Deputy Constable	Number of Municipalities	Municipality	Number of Deputy Constables Employed	Position	Season
Yes	28	Barnstable	5	Full time	Seasonal
		Chatham	1 full time/18 seasonal	Full time	Year round
		Dennis	3	Full time	Year round
		Duxbury	1 Full time & 15 part time	Part time	Seasonal
		Eastham	3	Full time	Year round
		Edgartown	3	Full time	Year round
		Essex	3	Part time	Year round
		Fairhaven	5	Part time	Year round
		Gloucester	1	Part time	Year round
		Ipswich	1	Part time	Year round
		Kingston	1	Part time	Year round
		Marblehead	8 unpaid volunteers	Part time	Seasonal
		Marion	2	Full time	Year round
		Marshfield	3	Part time	Seasonal
		Mashpee	2	Part time	Year round
		Nantucket	1	Part time	Seasonal
		New Bedford	2	Part time	Seasonal
		Newburyport	12	Part time	Seasonal
		Orleans	2	Full time	Year round
		Rockport	2	Part time	Seasonal
		Sandwich	5	Part time	Seasonal
		Tisbury	1	Part time	Seasonal
		Truro	2	Part time	Seasonal
		Wareham	3 full time and up to 7 part time seasonal	Full time	Year round
		Wellfleet	2	Full time	Year round
		West Tisbury	1	Part time	Seasonal

Employee Deputy Constable	Number of Municipalities	Municipality	Number of Deputy Constables Employed	Position	Season
		Westport	9	Part time	Seasonal
		Yarmouth	5	Part time	Year round
No	7	Harwich			
		Hingham			
		Hull			
		Newbury			
		Provincetown			
		Revere			
		Salisbury			

Table 6.5. Other shellfish staff employed by municipalities (e.g. biologist, aquaculture specialist, propagation specialist, other); three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Other Employed Staff	Number of Municipalities	Municipality	Biologist	Aquaculture Specialist	Propagation Specialist	Other
Yes	13	Chatham	-	-	3	-
		Gloucester	-	-	-	3 Assistant Harbormasters
		Harwich	-	-	-	4 High School Interns
		Hingham	-	-	-	9 Assistant Harbormasters
		Marion	-	-	-	1 Assistant
		Mashpee	1	1	1	-
		Nantucket	2	2	2	-
		New Bedford	-	-	-	2 Shellfish Monitors
		Tisbury	-	-	-	1 Shellfish Assistant
		Truro	-	-	-	1
		Wareham	-	1	1	-
		Wellfleet	-	-	-	1 seasonal constable
		West Tisbury	-	-	-	1 Fisherman
No	22	Barnstable				
		Dennis				
		Duxbury				
		Eastham				
		Edgartown				
		Essex				
		Fairhaven				
		Hull				
		Ipswich				
		Kingston				
		Marblehead				
		Marshfield				

Other Employed Staff	Number of Municipalities	Municipality	Biologist	Aquaculture Specialist	Propagation Specialist	Other
		Newbury				
		Newburyport				
		Orleans				
		Provincetown				
		Revere				
		Rockport				
		Salisbury				
		Sandwich				
		Westport				
		Yarmouth				

Table 6.6. Presence or absence of shellfish advisory board or shellfish committee by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs).

Shellfish Advisory Board	Number of Municipalities	Municipality
Yes	21	Barnstable
		Chatham
		Dennis
		Duxbury
		Edgartown
		Essex
		Fairhaven
		Gloucester
		Ipswich
		Marion
		Mashpee
		Nantucket
		Newbury
		Orleans
		Provincetown
		Tisbury
		Truro
		Wellfleet
		West Tisbury
		Westport
		Yarmouth
No	14	Eastham
		Harwich
		Hingham
		Hull
		Kingston
		Marblehead
		Marshfield
		New Bedford
		Newburyport
		Revere
		Rockport
		Salisbury
		Sandwich
		Wareham

Table 6.7. Disease monitoring and purpose by municipality; laboratory used for disease monitoring four municipalities did not respond (Bourne, Falmouth, Nantucket, and Oak Bluffs). In table "both" refers to background monitoring and transplant between propagation sites.

Monitor for Disease	Number of Municipalities	Municipality	Purpose	Laboratory
Yes	14	Barnstable	Both	Kennebec River, Biosciences, and Rutgers
		Chatham	Both	Kennebec River, Biosciences, and Roger Williams
		Edgartown	Background Monitoring	Roger Williams
		Essex	Background Monitoring	DMF
		Harwich	Background Monitoring	Kennebec River, Biosciences
		Ipswich	Background Monitoring	Rutgers
		Mashpee	Both	Barnstable County Cooperative Extension
		New Bedford	Transplant between propagation sites	Kennebec River, Biosciences
		Newburyport	Background Monitoring	Plum Island Plant
		Orleans	Transplant between propagation sites	VIMS
		Provincetown	Transplant between propagation sites	Rutgers
		West Tisbury	Both	MV Shellfish Group
		Westport	Both	Not reported
		Yarmouth	Both	Roger Williams
No	20	Dennis		
		Duxbury		
		Eastham		
		Fairhaven		
		Gloucester		
		Hingham		
		Hull		
		Kingston		
		Marblehead		
		Marion		
		Marshfield		
		Newbury		
		Revere		
		Rockport		

Monitor for Disease	Number of Municipalities	Municipality	Purpose	Laboratory
		Salisbury		
		Sandwich		
		Tisbury		
		Truro		
		Wareham		
		Wellfleet		

Table 6.8. Annual expenditures on shellfish management by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs). Annual expenditure ranges of $0 - $5,000; $5,001 - $10,000; $10,001 - $25,000; $25,001 - $50,000; $50,001 - $150,000; and >$150,000 provided in survey.

Municipality	Total Budget	Personnel	Administration	Propagation
Barnstable	>$150,001	$25,001-50,000	>$150,001	$10,001-25,000
Chatham	>$150,001	$10,001-25,000	$50,001-100,000	N/A
Dennis	>$150,001	N/A	$5,001-10,000	$0-5,000
Duxbury	$25,001-50,000	$25,001-50,000	$0-5,000	$0-5,000
Eastham	>$150,001	$0-5,000	$10,001-25,000	$0-5,000
Edgartown	>$150,001	$25,001-50,000	$100,001-150,000	$50,001-100,000
Essex	$50,001-100,000	N/A	N/A	$10,001-25,000
Fairhaven	$100,001-150,000	$25,001-50,000	$10,001-25,000	$0-5,000
Gloucester	$50,001-100,000	$0-5,000	$0-5,000	$0-5,000
Harwich	$50,001-100,000	$10,001-25,000	$10,001-25,000	$10,001-25,000
Hingham	$0-5,000	$0-5,000	$0-5,000	$0-5,000
Hull	$10,001-25,000	N/A	N/A	N/A
Ipswich	$50,001-100,000	N/A	N/A	$0-5,000
Kingston	$5,001-10,000	N/A	$5,001-10,000	$0-5,000
Marshfield	$0-5,000	N/A	N/A	N/A
Mashpee	>$150,001	$0-5,000	$100,001-150,000	N/A
New Bedford	$50,001-100,000	$0-5,000	$0-5,000	$10,001-25,000
Newbury	$25,001-50,000	N/A	N/A	N/A
Newburyport	$0-5,000	N/A	N/A	N/A
Orleans	$100,001-150,000	$25,001-50,000	$10,001-25,000	$0-5,000
Provincetown	$25,001-50,000	N/A	$5,001-10,000	$5,001-10,000
Rockport	$0-5,000	N/A	N/A	N/A
Salisbury	$0-5,000	N/A	N/A	$0-5,000
Sandwich	$0-5,000	$0-5,000	$5,001-10,000	$0-5,000
Tisbury	$100,001-150,000	N/A	$25,001-50,000	$25,001-50,000
Truro	$25,001-50,000	$0-5,000	$0-5,000	$0-5,000
Wareham	$10,001-25,000	$10,001-25,000	$10,001-25,000	$0-5,000
Wellfleet	>$150,001	$10,001-25,000	$25,001-50,000	N/A
West Tisbury	$10,001-25,000	N/A	$25,001-50,000	$5,001-10,000
Westport	$25,001-50,000	$5,001-10,000	$100,001-150,000	$5,001-10,000
Yarmouth	$100,001-150,000	$25,001-50,000	$25,001-50,000	$5,001-10,000

Table 6.9. Annual Revenue from shellfish permit and license fees by municipality; three municipalities did not respond (Bourne, Falmouth, and Oak Bluffs). Annual revenue ranges of $0 - $1,000; $1,001 - $2,500, $2,501 - $5,000, $5,001 - $7,500; $7,501 - $10,000, $10,001 - $20,000; and >$20,000 provided in survey.

Municipality	Recreational Permits	Commercial Permits	Aquaculture License Fee	Other
Barnstable	>$20,001	>$20,001	$2,501-5,000	$0-1,000
Chatham	>$20,001	>$20,001	$0-1,000	N/A
Dennis	$0-1,000	$2,501-5,000	$2,501-5,000	N/A
Duxbury	>$20,001	$5,001-7,500	$0-1,000	N/A
Eastham	>$20,001	>$20,001	$0-1,000	N/A
Edgartown	>$20,001	$10,001-20,000	$1,001-2,500	N/A
Essex	$2,501-5,000	>$20,001	N/A	N/A
Fairhaven	$10,001-20,000	$2,501-5,000	$2,501-5,000	N/A
Gloucester	$2,501-5,000	>$20,001	$0-1,000	$0-1,000
Harwich	$7,501-10,000	$0-1,000	N/A	N/A
Hingham	N/A	$0-1,000	N/A	N/A
Hull	N/A	$2,501-5,000	N/A	N/A
Ipswich	>$20,001	>$20,001	N/A	N/A
Kingston	$5,001-7,500	$2,501-5,000	$0-1,000	N/A
Marblehead	$0-1,000	N/A	N/A	N/A
Marion	$10,001-20,000	$0-1,000	$0-1,000	$1,001-2,500
Marshfield	$1,001-2,500	N/A	N/A	N/A
Mashpee	$10,001-20,000	$1,001-2,500	$0-1,000	N/A
Nantucket	N/A	N/A	N/A	N/A
New Bedford	$0-1,000	$1,001-2,500	$0-1,000	$0-1,000
Newbury	$0-1,000	$10,001-20,000	N/A	N/A
Newburyport	N/A	$0-1,000	N/A	$0-1,000
Orleans	>$20,001	>$20,001	$0-1,000	N/A
Provincetown	$5,001-7,500	N/A	$0-1,000	N/A
Revere	N/A	N/A	N/A	N/A
Rockport	$0-1,000	$0-1,000	$0-1,000	$0-1,000
Salisbury	$0-1,000	$1,001-2,500	N/A	N/A
Sandwich	$2,501-5,000	$0-1,000	$0-1,000	N/A
Tisbury	$10,001-20,000	$7,501-10,000	N/A	N/A
Truro	$5,001-7,500	$0-1,000	$0-1,000	N/A
Wareham	>$20,001	$5,001-7,500	$0-1,000	N/A
Wellfleet	>$20,001	>$20,001	$7,501-10,000	N/A
West Tisbury	N/A	N/A	N/A	N/A
Westport	$5,001-7,500	>$20,001	$2,501-5,000	N/A
Yarmouth	>$20,001	$5,001-7,500	$0-1,000	N/A

Table 6.10. Permit fee revenue use by the municipality (i.e. general budget or dedicated shellfish fund); six municipalities did not respond (Bourne, Falmouth, Hull, Nantucket, Oak Bluffs, and Rockport).

Municipality	Fund
Barnstable	Retained revenue account
Chatham	75% of commercial and 25% of recreational into a dedicated shellfish revolving fund
Dennis	General fund
Duxbury	General fund
Eastham	General fund
Edgartown	General fund
Essex	General fund
Fairhaven	General fund
Gloucester	General fund
Harwich	General fund
Hingham	General fund
Ipswich	General fund
Kingston	Retained revenue account
Marblehead	General fund
Marion	General fund
Marshfield	General fund
Mashpee	Dedicated Account Shellfish Propagation
New Bedford	General fund
Newbury	General fund
Newburyport	Retained revenue account
Orleans	General fund
Provincetown	Retained revenue account
Revere	General fund
Salisbury	General fund
Sandwich	Retained revenue account
Tisbury	Retained revenue account
Truro	General fund
Wareham	100% of all commercial permit revenue goes to our propagation account; 20% of recreational licenses goes to propagation account; 80 % of recreational goes to general fund, Shellfish Grant Revenue goes to General Fund
Wellfleet	General fund
West Tisbury	General fund
Westport	General fund
Yarmouth	General fund

7. Other

All towns that participated in the survey with at least one shellfish management program were asked a set of questions pertaining to their shellfish program capacity (n=38/38).

Table 7.1. Presence or absence of a comprehensive wastewater management plan (WWMP) and related/relevant shellfish program; seven municipalities did not respond (Bourne, Falmouth, Kingston, Marion, Newbury, Oak Bluffs, and Truro).

WWMP	Number of Municipalities	Municipality	Applicable shellfish related activities
Yes	20	Chatham	Not reported
		Dennis	Municipal Shellfish Propagation
		Essex	Recreational landings, Commercial Wild Harvest
		Fairhaven	Recreational landings, Commercial Wild Harvest, Aquaculture, Municipal Shellfish Propagation
		Gloucester	Recreational landings, Commercial Wild Harvest
		Harwich	Recreational landings, Commercial Wild Harvest, Aquaculture, Municipal Shellfish Propagation
		Hingham	Not reported
		Hull	Commercial Wild Harvest
		Ipswich	Recreational landings, Commercial Wild Harvest, Aquaculture
		Marblehead	Recreational landings
		Mashpee	Recreational landings, Commercial Wild Harvest, Aquaculture, Municipal Shellfish Propagation
		Nantucket	Not reported
		New Bedford	Municipal Shellfish Propagation
		Newburyport	Commercial Wild Harvest
		Orleans	Aquaculture
		Provincetown	Not reported
		Salisbury	Commercial Wild Harvest
		Sandwich	Recreational landings, Aquaculture, Municipal Shellfish Propagation
		Wareham	Recreational landings, Commercial Wild Harvest, Aquaculture, Municipal Shellfish Propagation
		Westport	Recreational landings, Commercial Wild Harvest, Aquaculture, Municipal Shellfish Propagation

WWMP	Number of Municipalities	Municipality	Applicable shellfish related activities
No	11	Barnstable	
		Duxbury	
		Eastham	
		Edgartown	
		Marshfield	
		Revere	
		Rockport	
		Tisbury	
		Wellfleet	
		West Tisbury	
		Yarmouth	

Table 7.2. Presence or absence of a municipal shellfish management plan jointly developed with DMF to manage shellfish resources in contaminated waters; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Truro).

Shellfish Management Plan	Number of Municipalities	Municipality	Recent Update
Yes	22	Barnstable	Recently
		Dennis	2001
		Edgartown	2015
		Essex	Unsure
		Fairhaven	2008
		Gloucester	In the process
		Harwich	Unsure
		Hingham	2017
		Hull	30 years ago
		Ipswich	2018
		Kingston	Unsure
		Marshfield	Not reported
		Mashpee	2019
		Nantucket	Not reported
		New Bedford	2017
		Newbury	2018
		Newburyport	2015
		Revere	Not reported
		Salisbury	2006
		Tisbury	Unsure
		West Tisbury	Not reported
		Westport	Not reported
No	12	Chatham	
		Duxbury	
		Eastham	
		Marblehead	
		Marion	
		Orleans	
		Provincetown	
		Rockport	
		Sandwich	
		Wareham	
		Wellfleet	
		Yarmouth	

Table 7.3. Presence or absence of a local shellfish resource management plan with year the plan was updated; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Westport).

Resource Management Plan	Number of Municipalities	Municipality	Last Year Updated
Yes	17	Barnstable	2018
		Edgartown	2015
		Essex	Unknown
		Fairhaven	2016
		Gloucester	In the process
		Ipswich	2010
		Kingston	2009
		Mashpee	2019
		Nantucket	Not reported
		New Bedford	Contaminated relays
		Newbury	2018
		Newburyport	2015
		Tisbury	Unwritten
		Truro	2010
		Wellfleet	2007
		West Tisbury	2018
		Yarmouth	2010
No	17	Chatham	
		Dennis	
		Duxbury	
		Eastham	
		Harwich	
		Hingham	
		Hull	
		Marblehead	
		Marion	
		Marshfield	
		Orleans	
		Provincetown	
		Revere	
		Rockport	
		Salisbury	
		Sandwich	
		Wareham	

Table 7.4. Presence or absence of a local aquaculture management plan with the year the plan was updated; four municipality did not respond (Bourne, Falmouth, Oak Bluffs, and Westport).

Local Aquaculture Plan	Number of Municipalities	Municipality	Last Year Updated
Yes	18	Barnstable	2018
		Duxbury	2017
		Eastham	2019
		Edgartown	2017
		Essex	Not reported
		Fairhaven	2016
		Ipswich	2011
		Kingston	2009
		Marion	1996
		Nantucket	2016
		New Bedford	Not reported
		Orleans	2000
		Provincetown	2018
		Tisbury	Not reported
		Truro	Not reported
		Wareham	Not reported
		Wellfleet	Not reported
		Yarmouth	Not reported
No	16	Chatham	
		Dennis	
		Gloucester	
		Harwich	
		Hingham	
		Hull	
		Marblehead	
		Marshfield	
		Mashpee	
		Newbury	
		Newburyport	
		Revere	
		Rockport	
		Salisbury	
		Sandwich	
		West Tisbury	

Table 7.5. Presence or absence of a local harbor plan with the year the plan was updated; seven municipalities did not respond (Bourne, Essex, Falmouth, Hull, Oak Bluffs, Orleans, and Truro).

Local Harbor Plan	Number of Municipalities	Municipality	Last Year Updated
Yes	15	Chatham	2005 and 2018
		Duxbury	Not reported
		Eastham	2019
		Edgartown	2017
		Fairhaven	Not reported
		Harwich	2019
		Marshfield	2016
		Mashpee	1990
		Nantucket	Not reported
		New Bedford	2017
		Newbury	Not reported
		Newburyport	2015
		Provincetown	2018
		Wareham	1995
		Westport	Not reported
No	16	Barnstable	
		Dennis	
		Gloucester	
		Hingham	
		Ipswich	
		Kingston	
		Marblehead	
		Marion	
		Revere	
		Rockport	
		Salisbury	
		Sandwich	
		Tisbury	
		Wellfleet	
		West Tisbury	
		Yarmouth	

Table 7.6. Interests and resources needed to expand shellfish activity; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Westport). Resource needed options in survey included technical assistance, financial support, both, or other. Expansion interest area options in survey included recreational, commercial, or aquaculture.

Interest in Expanding Shellfish Activity	Number of Municipalities	Municipality	Expansion Interest Area	Resource Needed
Yes	22	Barnstable	Recreational, Commercial, Aquaculture	Both
		Chatham	Recreational, Commercial	Both
		Dennis	Recreational, Aquaculture	Both
		Eastham	Recreational, Commercial, Aquaculture	Both
		Edgartown	Recreational, Commercial, Aquaculture	Both
		Harwich	Recreational, Commercial, Aquaculture	Both
		Hull	Recreational, Aquaculture	Other
		Kingston	Recreational, Aquaculture	Technical Assistance
		Marblehead	Recreational	Other
		Nantucket	Recreational, Commercial, Aquaculture	Both
		New Bedford	Commercial, Aquaculture	Other
		Newburyport	Commercial	Both
		Orleans	Recreational, Commercial	Financial Support
		Provincetown	Recreational, Aquaculture	Other
		Salisbury	Recreational, Commercial, Aquaculture	Both
		Sandwich	Recreational	Both
		Tisbury	Recreational, Aquaculture	Other
		Wareham	Recreational, Aquaculture	Both
		Wellfleet	Recreational, Commercial	Both
		West Tisbury	Recreational, Commercial, Aquaculture	Both
		Westport	Recreational, Commercial, Aquaculture	Both
		Yarmouth	Recreational, Aquaculture	Both
No	12	Duxbury		
		Essex		
		Fairhaven		
		Gloucester		
		Hingham		
		Ipswich		

Interest in Expanding Shellfish Activity	Number of Municipalities	Municipality	Expansion Interest Area	Resource Needed
		Marion		
		Marshfield		
		Mashpee		
		Newbury		
		Revere		
		Rockport		

Table 7.7. Receipt of state funds to directly support shellfish management[14]; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Truro).

State Fund Support	Number of Municipalities	Municipality
Yes	7	Eastham
		Edgartown
		Harwich
		Mashpee
		Nantucket
		Orleans
		Sandwich
No	27	Barnstable
		Chatham
		Dennis
		Duxbury
		Essex
		Fairhaven
		Gloucester
		Hingham
		Hull
		Ipswich
		Kingston
		Marblehead
		Marion
		Marshfield
		New Bedford
		Newbury
		Newburyport
		Provincetown
		Revere
		Rockport
		Salisbury
		Tisbury
		Wareham
		Wellfleet
		West Tisbury
		Westport
		Yarmouth

[14] Certain communities in Barnstable County and Dukes County may use funds provided through earmarks in DMF's annual operating budget.

Table 7.8. Adequate state resources to support shellfish management needs; seven municipalities did not respond (Bourne, Chatham, Falmouth, Nantucket, Oak Bluffs, Rockport, and Truro).

State Resources are Adequate	Number of Municipalities	Municipality
Yes	19	Dennis
		Eastham
		Essex
		Fairhaven
		Hingham
		Hull
		Ipswich
		Kingston
		Marblehead
		Marion
		Mashpee
		New Bedford
		Newbury
		Newburyport
		Orleans
		Provincetown
		West Tisbury
		Westport
		Yarmouth
No	12	Barnstable
		Duxbury
		Edgartown
		Gloucester
		Harwich
		Marshfield
		Revere
		Salisbury
		Sandwich
		Tisbury
		Wareham
		Wellfleet

Table 7.9. Education materials distributed by the municipality to the general public surrounding shellfish information; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Truro).

Distribution of Education Materials	Number of Municipalities	Municipality
Yes	24	Barnstable
		Chatham
		Eastham
		Edgartown
		Harwich
		Ipswich
		Marblehead
		Marion
		Marshfield
		Mashpee
		Nantucket
		New Bedford
		Newbury
		Newburyport
		Orleans
		Provincetown
		Salisbury
		Sandwich
		Tisbury
		Wareham
		Wellfleet
		West Tisbury
		Westport
		Yarmouth
No	10	Dennis
		Duxbury
		Essex
		Fairhaven
		Gloucester
		Hingham
		Hull
		Kingston
		Revere
		Rockport

Table 7.10. Presence or Absence of shellfish restoration projects and future plans by municipality; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Truro).

Active Restoration Project(s)	Number of Municipalities	Municipality	Plan for Future Project(s)
Yes	14	Edgartown	
		Essex	
		Fairhaven	
		Harwich	
		Kingston	
		Marblehead	
		Mashpee	
		Nantucket	
		New Bedford	
		Tisbury	
		Wareham	
		West Tisbury	
		Westport	
		Yarmouth	
No	20	Barnstable	No
		Chatham	No
		Dennis	No
		Duxbury	No
		Eastham	No
		Gloucester	Yes
		Hingham	No
		Hull	No
		Ipswich	No
		Marion	No
		Marshfield	Yes
		Newbury	No
		Newburyport	No
		Orleans	No
		Provincetown	No
		Revere	No
		Rockport	No
		Salisbury	No
		Sandwich	Yes
		Wellfleet	Yes

Table 7.11. Infrastructure factors limiting opportunities for shellfishing by municipality; six municipalities did not respond (Bourne, Falmouth, Nantucket, Oak Bluffs, Truro, and Westport).

Limitation Cited	Number of Municipalities	Municipality	Additional Comments
Yes	15	Barnstable	Lack of boat ramps, Lack of parking
		Chatham	Lack of boat ramps, Lack of parking, Dredging needs, new/rehab/expanded upweller facility
		Dennis	Lack of parking, Lack of shellfish department boats
		Duxbury	Lack of parking
		Eastham	Lack of parking, poor water quality/limited access to shellfishing areas
		Gloucester	Lack of parking, Lack of shellfish department boats, Lack of manpower
		Harwich	area available
		Kingston	Lack of shellfish department boats
		Mashpee	Lack of parking, Lack of shellfish department boats, Dredging needs
		New Bedford	to work with DMF getting more areas open
		Rockport	Lack of shellfish flats
		Salisbury	Revenues to support growth
		Sandwich	Lack of boat ramps, Dredging needs
		Wellfleet	Dredging needs, budget for equipment
		Yarmouth	Lack of boat ramps, Lack of parking, Dredging needs
No	17	Edgartown	
		Essex	
		Fairhaven	
		Hingham	
		Hull	
		Ipswich	
		Marblehead	
		Marion	
		Marshfield	
		Newbury	
		Newburyport	
		Orleans	
		Provincetown	
		Revere	
		Tisbury	
		Wareham	
		West Tisbury	

Table 7.12. Methods of communicating shellfish growing area harvest status; four municipalities did not respond (Bourne, Falmouth, Oak Bluffs, and Rockport).

Municipality	Means of Communication
Barnstable	Phone Calls, Text Messages, Website, Signs, Social Media
Chatham	Text Messages, Website, Signs
Dennis	Website, Signs
Duxbury	Website, Signs
Eastham	Website, Signs, Social Media, Other
Edgartown	Phone Calls, Text Messages, Signs
Essex	Phone Calls, Signs, Other
Fairhaven	Website, Signs, Social Media
Gloucester	Phone Calls, Shellfish Hotline, Text Messages, Signs
Harwich	Website, Signs
Hingham	Other
Hull	Phone Calls
Ipswich	Shellfish Hotline, Signs
Kingston	Shellfish Hotline, Website, Signs
Marblehead	Signs, Social Media
Marion	Phone Calls, Website, Signs, Social Media
Marshfield	Website, Signs, Social Media
Mashpee	Phone Calls, Text Messages, Website, Signs
Nantucket	Phone Calls, Website, Signs, Social Media, Other
New Bedford	Phone Calls, Shellfish Hotline, Text Messages, Signs
Newbury	Shellfish Hotline, Website, Signs
Newburyport	Phone Calls
Orleans	Phone Calls, Text Messages, Website, Signs, Social Media
Provincetown	Phone Calls, Text Messages, Website, Signs
Revere	Shellfish Hotline
Salisbury	Phone Calls, Signs
Sandwich	Website, Signs, Social Media
Tisbury	Phone Calls, Text Messages, Website, Signs
Truro	Phone Calls
Wareham	Shellfish Hotline, Website, Signs, Social Media
Wellfleet	Phone Calls, Text Messages, Website, Signs, Social Media, Other
West Tisbury	Phone Calls, Text Messages, Signs
Westport	Shellfish Hotline, Signs
Yarmouth	Website, Signs, Social Media