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Nantucket Shellfish Management Plan

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Nantucket Shellfish Management Plan

OCTOBER 2012



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Cover Images (left to right): Bay scallops being grown out at the Brant Point facility; Bay scallop boat tied up at the dock; Sign outside the Summer Shack restaurant in Hingham, MA

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EXECUTIVE SUMMARY

Nantucket's shellfisheries are significant both locally and nationally. Locally, commercial and recreational shellfishing are critical to the Island's history, culture, and economy. Nationally, the Island's largest commercial shellfishery—the Nantucket bay scallop fishery—is one of the last wild-harvest bay scallop fisheries in the country, but there is growing concern over the health of the overall population and the sustainability of the fishery. Given the importance of the shellfisheries on Nantucket and the drastic decline of bay scallop populations elsewhere along the Atlantic coast, there is a compelling interest in ensuring that the Town's shellfish are managed to sustain both the shellfishing industry and the resources.

This is the first official management plan for commercially and recreationally harvested shellfish in Nantucket waters. The Plan addresses bay scallops, quahogs, oysters, mussels, soft-shell clams, and conchs.

A Shellfish Management Plan Committee, consisting of researchers, managers, and fishermen, met regularly for more than a year to discuss issues, research, management strategies, and recommendations. They focused on ensuring that this Plan would be developed by and for stakeholders, with specific attention paid to (1) the biology of the shellfish resources, (2) the interactions within the surrounding ecosystem, (3) the needs and interests of the shellfishing industry, and (4) the cultural and economic attributes of the Island. Together the Committee identified the following goals for this Plan:

The shellfish resources of Nantucket should be managed to support a viable and continuing shellfishery for both economic and traditional purposes by:

- *Maintaining or improving the habitat associated with a healthy shellfish fishery, and*
- *Maintaining or enhancing the populations and health of scallops, quahogs, soft shell clams, mussels, conchs, and any other shellfish of commercial and/or recreational importance in Nantucket waters.*

The breadth of this Plan is reflective of the variety of issues affecting the resources and, as a first iteration of a living document, the Plan is designed to (1) provide a solid foundation of background information relevant to shellfish management on Nantucket, (2) provide a means for updating and adapting its content on both an as-needed and a regular, three-year basis, and (3) capture a broad range of issues and consider a wide range of needs and possibilities.

Sections 1–9 of the Plan provide background information about Nantucket's marine habitat, shellfish, and the fisheries they support. Section 10 contains goals, objectives, and recommendations for improved management. Section 11 describes the process to adapt the Plan as needed. Section 12 outlines a Research Plan to support better management. When taken together, Sections 10–12 comprise the actions to be taken to achieve the Plan's goals for the shellfisheries.

The goals, objectives, and recommendations contained in this Plan are numerous and diverse, covering topics such as habitat management, shellfish resources, regulations, management implementation, education, harvest documentation, support of the commercial fishery, and plan adaptation. Accompanying each recommendation is a list of organizations charged with implementing the recommendation, along with a lead organization. Examples of some of the goals found in this Plan include:

- Maintain and improve the habitat associated with sustainable commercial and recreational shellfish fisheries
- Conduct predator management activities
- Ensure adaptive management of shellfish resources
- Increase public education/outreach efforts to create a better understanding of how human activities affect important shellfish resources

Given the significant need for more scientific information about the Island's shellfish resources and associated habitats and fisheries, the Plan's management and research recommendations are comprehensive and long-term. As was done with the Nantucket Harbors Action Plan, the committee charged with implementation of the Shellfish Management Plan will prioritize the actions based on importance, available resources, feasibility, and other criteria as deemed appropriate. (Preliminary prioritization was conducted by members of the Shellfish Management Plan Committee and is noted in Appendix A). The implementation committee should also give thought as to how they will evaluate the progress of implementation for each recommendation. The matrix of recommendations in Appendix A is designed to help the Implementation Committee refine the list of priority actions and track the status of implementation.

Readers will note that many of the recommendations in Section 10 also appear in the Research Plan (Section 12). The Research Plan provides context for the research-related recommendations, articulates the management implications of the research, identifies opportunities for fishermen to participate in research activities, and promotes collaboration and data sharing among research both off and on-Island. Some examples of research topics to be addressed include:

- Understanding and reducing nutrient inputs from anthropogenic sources, both in Nantucket waters and in Nantucket Sound
- Obtaining data about the growth rates and movement of conchs to inform harvesting guidelines
- Conducting stock assessments to define the resource available for harvest in any given year
- Investigating the relationship between bay scallop spat recruitment and post-set spat survival as it relates to harvestable populations
- Conducting studies on the impacts of propagation and seed management activities in order to guide future efforts
- Understanding the causes and impacts of eelgrass stress/loss in order to reduce those stressors effectively
- Monitoring and predicting the impacts of climate change and ocean acidification to clarify ways to minimize impacts to the resources and the fisheries
- Evaluating the economics of shellfishing to Nantucket in order to identify ways to maximize financial benefits and to understand the overall significance to the Nantucket economy
- Understanding the spawning cycle of bay scallops and their significance to the overall bay scallop population
- Utilizing research findings to educate fishermen and the general public about human impacts on the shellfish resources and to guide future research efforts

As new information becomes available and/or conditions change, some recommendations and research topics will need to be modified or eliminated, and others may need to be added. The Plan addresses this reality and outlines strategies both for a three-year updating process and an as-needed updating process. Through the public process of modifications to management, the intent is to ensure the advancement of measures to achieve a sustainable shellfishery in light of changing conditions.

Implementing the Shellfish Management Plan will require the time and dedication of people and organizations as well as financial resources. While some action items can be advanced through the dedication of time and energy (e.g., the meetings of the Shellfish Management Plan Implementation Committee and the Research Collaborative), other recommendations will rely on funding and in-kind contributions (e.g., enhancement of propagation and management activities conducted by the Marine and Coastal Resources Department). Stakeholders should work together to identify and pursue funding opportunities to carry forward the priority recommendations of this Plan.

Note to Readers: Please refer to the Amendments of this plan for any changes made subsequent to its initial publication on October 23, 2012. Changes will not be made to the original document.

SECTION 1: INTRODUCTION

Located approximately 30 miles from the south coast of Cape Cod, Nantucket has a long history of harvesting shellfish for human consumption and for bait. Over the years, fishermen have seen many changes in species abundance and habitat conditions. Some fishermen claim that eelgrass used to be incredibly thick and as high as a man's chest in certain places; and that bay scallops were so plentiful in the mid-1900s that you had no way to avoid stepping on them when you entered the water. Today, in comparison, bay scallop populations fluctuate and are not nearly as abundant, and eelgrass beds are patchy.

Despite these changes, Nantucket's shellfish fisheries continue today. As a highly seasonal economy with few sources of year-round employment, shellfish provide a way for residents to diversify and supplement their income. The bay scallop fishery, in particular, is locally important. It is not only the Island's highest value fishery, but it is also important because it is a winter fishery and provides income when the summer economy has subsided.

Furthermore, the bay scallop fishery is nationally, as well as locally, significant. Bay scallops were once abundant in coastal waters of the eastern United States from North Carolina to Maine. Today, most populations have been severely depleted, if not extirpated outright. As a result, bay scallop fisheries in most other locales are gone as well, or at best emerge briefly when the few remaining spawners produce a fortuitous set. Nantucket's bay scallop fishery, on the other hand, is a predictable and productive component of the Island economy, albeit less predictable and productive than it once was.

The ghosts of those other fisheries should not escape our attention. Indeed, the causes of the decline of other fisheries could very well come to haunt Nantucket if the community is not attentive and diligent. Nantucket is fortunate in its offshore location, more distant from the terrestrial impacts that have affected other coastal waters. Population density and development have been lower, and slower to increase, on Nantucket than in most other coastal areas. But the threats of shoreside contaminants as well as environmental changes such as climate change and invasive species continue to grow in Nantucket waters, risking the future of bay scallops as well as mussels, clams, oysters and other shellfish. Although people continue to make a living harvesting shellfish from Nantucket waters, many do so with concern for the future of the resources and the habitats that support them. This Shellfish Management Plan provides an historical description of shellfishing on Nantucket, addresses some of the existing pressures on shellfish resources and their habitats, outlines a strategy to fill data gaps that will potentially affect management decisions, and makes recommendations to promote sustainable commercial and recreational shellfisheries on Nantucket, now and into the future. For the purposes of this Plan, "sustainable" refers to (1) maintaining a viable fishery for (at a minimum) the current number of people actively harvesting shellfish; and (2) maintaining/improving habitats and other factors that lead to a healthy shellfish population.

In order to most effectively address the needs of the fishery and preserve our local and national heritage, the Shellfish Management Plan aims to meet three guiding principles, namely management that is:

- *Community-based*, involving decision-making by, addressing the needs of, and spreading responsibility among as many local stakeholders as possible.
- *Ecosystem-based*, accounting for the interconnectedness of multiple physical, chemical and biological factors, and addressing all relevant impacts alongside harvest.

- *Adaptive*, designed to learn from the outcomes of previous management actions and to respond and evolve quickly and purposefully.

SECTION 2: PURPOSE, SCOPE, PLANNING PROCESS, AND LARGER CONTEXT

Nantucket initiated this shellfish management planning process as part of its efforts to implement the 2009 Nantucket and Madaket Harbors Action Plan, which recommended (in Section 3.7, objective one, recommendation one) that the Town, “Develop and implement a shellfish management plan ... to protect and enhance the island’s shellfish resources, employing either community-based management or co-management” (Harbors Plan Recommendations, 2009). This idea of community-based management is found throughout the Shellfish Management Plan (the “Plan”), as is the idea that this Plan be able to adapt to changing conditions within the shellfisheries.

While this is the Island’s first “official” Shellfish Management Plan, the idea of shellfish management is not new to Nantucket. Over the past several decades, many have worked to restore, protect, study, and/or enhance shellfish resources, shellfish habitats, and the recreational and commercial traditions of shellfishing. This Plan draws upon past and ongoing efforts and creates a coordinated approach to management whereby select existing management practices are formalized; new management options are identified; an approach for conducting research to fill in knowledge gaps is articulated; and implementation methods are outlined.

This planning process was guided by a dedicated committee consisting of fishermen, scientists, and resource managers. The committee met regularly from October 2010 through July 2012. Members included: Matthew Herr (Chair, Fisherman); Tara Riley (Secretary, Department of Marine and Coastal Resources); Frank Dutra (Vice Chair, Nantucket Shellfish Association); Sarah Oktay (University of Massachusetts Boston Field Station); Peter Boyce (Maria Mitchell Association, Harbor and Shellfish Advisory Board); Doug Smith (Harbor and Shellfish Advisory Board); Carl Sjolund (Nantucket Shellfish Association); Jake Kritzer (Environmental Defense Fund); Cormac Collier (Nantucket Land Council); and Dave Fronzuto (Department of Marine and Coastal Resources). Members of the public were invited to attend committee meetings, and offered significant contributions to the recommendations section of the Plan.

While no official “planning area” was defined for this Plan, shellfishing is generally concentrated within the vicinity of Nantucket and Madaket Harbors, as indicated in Figure 1. The Town, however, has jurisdiction over fisheries issues within all Town waters; therefore this Plan’s recommendations extend out to that boundary, as appropriate.

The Massachusetts Division of Marine Fisheries (DMF) has a role in managing shellfish in Nantucket waters, and to that end, will be reviewing this Plan to ensure that it does not over-step the Town’s authority to manage its shellfish resources.

Additionally, this Plan only addresses molluscan species of commercial or recreational interest (conch, mussels, quahogs, oysters, bay scallops, and soft-shell clams). Lobsters are not considered “shellfish” for the purposes of this Plan.

The Committee developed the following overall goals for this Shellfish Management Plan:

The shellfish resources of Nantucket should be managed to support a viable and continuing shellfishery for both economic and traditional purposes by:

- *Maintaining or improving the habitat associated with a healthy shellfish fishery, and*

- *Maintaining or enhancing the populations and health of scallops, quahogs, soft shell clams, mussels, conchs, and any other shellfish of commercial and/or recreational importance in Nantucket waters.*

The recommendations contained in this Plan are consistent with the Committee's goals and are based on a review of both the current and historical states of the resource, habitat, and management strategies. A reading of this Shellfish Management Plan will show few major changes to existing shellfish management practices on Nantucket. As an initial version of a living document, this Plan is designed to establish the groundwork to build the research and collaboration needed to further advance shellfish management on Nantucket.

Information for this Plan was gathered through document reviews (Appendix B), interviews (Appendix C), committee meetings (Appendix D), and public meetings (Appendix D).

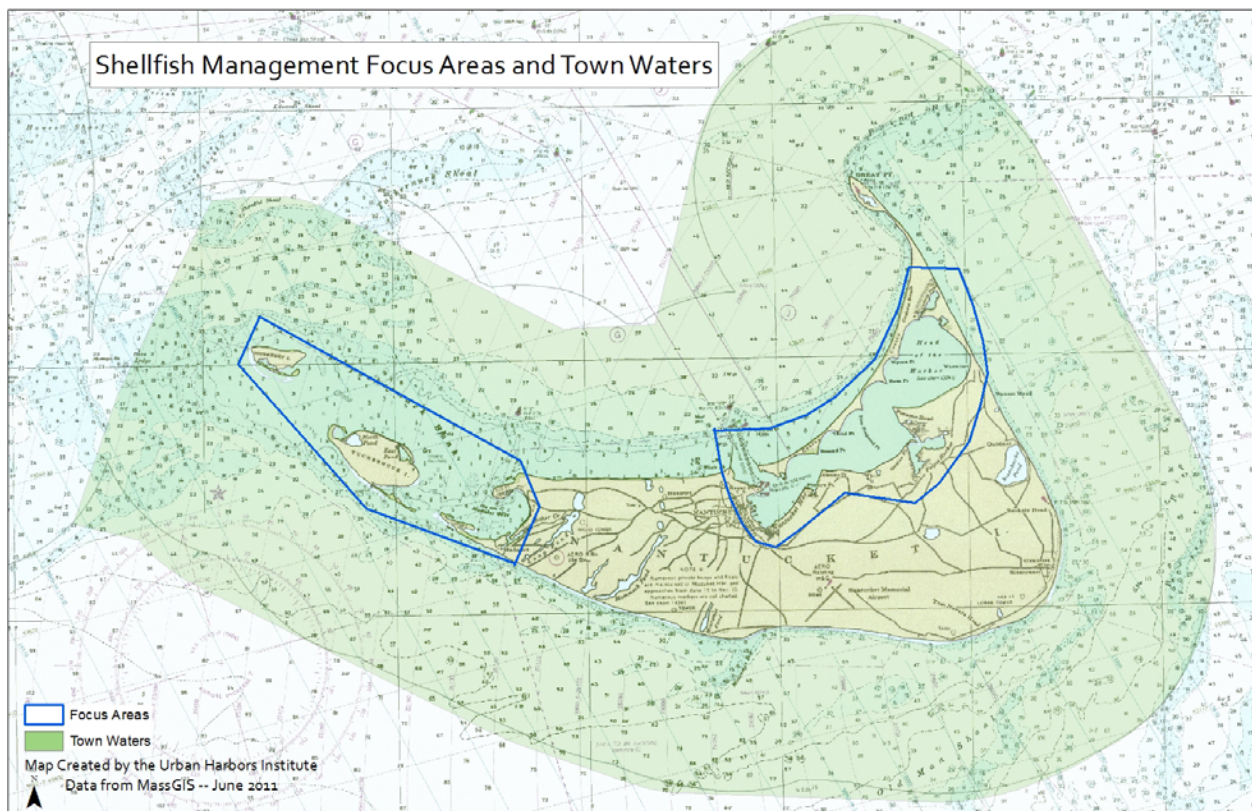


Figure 1: This Shellfish Management Plan addresses issues in all Town waters (in green), with emphasis on the focus areas (outlined in blue) where most of Nantucket's shellfishing occurs.

The structure of this Plan is such that the background sections describe the history and current state of knowledge pertaining to shellfish management issues. Those background sections provide the information necessary to better understand the recommendations and the Research Plan.

While this Plan is aimed specifically at maintaining and enhancing the shellfish in Nantucket waters, it is only one action, among many, that the Town of Nantucket is taking to preserve its water quality and marine habitat. The primary step has been the Nantucket and Madaket Harbors Action Plan, which was adopted in May of 2007 and approved by the Commonwealth of Massachusetts in December of 2009. This comprehensive document makes over 150 recommendations to preserve and protect Nantucket's waters, among which is the preparation of a Shellfish Management Plan (this document). The Harbor

Plan has a number of other recommended actions which are currently in the process of implementation, such as curbing and treating runoff from the roads and streets, reducing fertilizer leaching, and developing educational materials for the general public about how to improve water quality. Implementation of the Harbor Plan is being overseen by a representative committee which provides continuing impetus to follow through with enacting the Harbor Plan recommendations. The presence of an active implementation committee is the crucial difference between a plan which sits on the shelf and an action plan.

In addition to implementing recommendations from the Harbor Plan, several other steps have been taken that relate to shellfish habitat. For example, the current Nantucket sewer system has undergone extensive reworking to reduce leakage and to ensure that storm water sewers are kept separate from the sanitary sewers. The storm sewers are being renovated and treatment basins are being installed as rapidly as funding can be procured. Significant progress has already been made along the waterfront in the Town and several mitigation projects are under way around Nantucket Harbor to remove sources of excess nutrients in various marshes and springs which drain into the Harbor.

Another effort includes appointment of a citizen's committee (by the Board of Selectmen) to look at ways to better manage the use fertilizers. This Committee has produced a regulation which is currently being adopted by the Board of Health requiring that landscapers be licensed and educated about how much fertilizer to use and when to apply it. The Committee has also, over the last two years, produced a 150-page manual of best practices (BMP) based on the latest turf science. The BMP is aimed at educating landscapers and the public about the latest information on the use of fertilizer on Nantucket's sandy soils, especially when and how to apply both organic and inorganic fertilizers and compost. As the garden and turf community becomes more educated, it is expected that by applying no more fertilizer than the plants can use, the runoff of nutrients due to the use of excess fertilizer will be greatly reduced, thus contributing to an improvement in water quality in the Harbors and Ponds. An extensive public education program about proper fertilizer use is being fashioned as this Plan is going to press.

As a Massachusetts Community on the water's edge, Nantucket is also subject to the Massachusetts Estuaries Project which is mandating that the runoff of nitrogen and phosphorous be reduced to specific levels (Total Maximum Daily Loads or TMDLs). This has caused the Town to inspect every septic system on the Island—and to force replacement of every failed system. At the same time, Nantucket has extended sewer lines in the Nantucket Harbor watershed, and is contemplating extending the sewers even farther, both in the Nantucket Harbor watershed and in Madaket. Considerable pressure is being exerted to require the installation of advanced septic systems.

In addition to other education initiatives, the Harbor Plan Implementation Committee is in the midst of producing a comprehensive booklet about things to do to protect the waters around Nantucket. Modeled after the Martha's Vineyard "Blue Pages," the Nantucket version will feature scallops as the signature species to be protected. The booklet is expected to be ready by the end of 2012.

In summary, this Plan is but one of a set of actions, and should be read with this in mind.

SECTION 3: GENERAL CHARACTERIZATION OF NANTUCKET AND ITS SHELLFISHING RESOURCES

The introduction to the 2000 Nantucket Comprehensive Community Plan uses the scallop fishery as a metaphor for issues facing the Island as a whole. For both, conditions have clearly changed over time, cherished parts of the Island's heritage have been diminished, and the steps necessary to ensure a sustainable future are neither simple nor easy.

People are drawn to Nantucket in large part because of the community's successes in preserving its natural resources and the historic character of its built environment. More than 40% of the Island's barrier beaches and dunes, ponds and bogs, salt marshes, scrub oak and pitch pine barrens, coastal heathlands, sandplain grasslands, and hardwood forests are protected open space which provides habitat for a diversity of species and, importantly, contributes to maintaining surface and groundwater quality.

For the past three decades, Nantucket's economy has been dominated by tourism. The Island's current year-round population of 10,172 grows to as many as 50,000 during peak summer months (Bixby, 2005). The three largest sectors of the economy—service, wholesale/retail and construction—are all influenced by the influx of seasonal visitors and summer residents. Nantucket has the highest percent of seasonal homes, approximately 60%, in Massachusetts (Martha's Vineyard Data Report, 2006).

Between 1980 and 2000, the Island's year-round population grew by 87%, and the number of housing units grew by 92.5% (Census Bureau, 2000).

The Island's two main harbors, Nantucket and Madaket, accommodate a range of human uses dependent on marine resources. These include, along with commercial and recreational shellfishing and fishing, the commercial transport of people and goods, swimming, and recreational boating. The latter use has grown over the years so that now about 3,000 boats are moored and berthed in Nantucket waters (Fronzuto, 2011).

The largest commercial fishery on Nantucket is that of the bay scallop. In addition to its historic and cultural value to the Island, the commercial bay scallop fishery provides an important source of income for year-round residents living in the largely seasonal, tourism-based economy, and helps to buffer people from the impacts of a downturned economy.

Shellfishermen have a variety of options when it comes to purchasing a license. They can purchase (1) a recreational license which allows them to harvest for their own personal consumption (options are available for annual and weekly licenses for residents and non-residents); (2) a commercial license which allows them to harvest for the purpose of selling their catch, or (3) a 30-day delayed entry commercial license which allows fishermen a means to enter the fishery late. These options make the resource very accessible, but not everyone uses his/her license to its full capacity, making it difficult to predict the fleet size and overall shellfishing effort during any given year.

To complicate matters further, from year to year, the number of bushels of bay scallops harvested by Nantucket fishermen and the dollar value per pound fluctuates greatly and, over the long term, total landings have been decreasing. For example, from 1980–2000, the number of bushels of scallops landed went from about 100,000 to 12,600 bushels, a decline of 87%. Statistics for two recent seasons report

13,800 bushels landed for a total value of \$721,000 (2008–2009) and 7,000 bushels landed for a total value of \$644,000 (2009–2010). This population variability reflects fluctuations in recruitment, magnified by the fact that scallops are short-lived and populations largely rely on the successful spawn and recruitment of a single year class.

The reasons for the decline and annual fluctuations are not entirely clear, but it is likely that stressors on the environment associated with natural phenomena (e.g., storms) and human uses of the landscape (e.g., landscaping practices, increases in impervious surfaces, etc.) are contributing factors.

Other commercial shellfisheries include quahogs, mussels, and conch. Recreational shellfishing is also popular given the Island's productive habitat, strong tradition of family scalloping, and large seasonal influx of tourists. Recreational shellfishers harvest bay scallops, soft shell clams, quahogs, oysters, and mussels.

In addition to shellfish, other fishery resources harvested by Nantucket fishermen include lobsters, summer flounder, striped bass, bluefish, eels, black sea bass, tuna, sharks, cod, haddock and other groundfish. Although this plan is specific to molluscan shellfish, a broader and longer-range vision for Nantucket might look for ways to build a more diverse set of target species for local fishermen.

The Town, with partners, has been engaged for years in the propagation of scallops, soft shell clams, quahogs and oysters to enhance natural populations. Historically, bay scallop (and other shellfish) abundance and productivity has varied by location in Nantucket waters, with some seasons being best in Madaket Harbor or off Tuckernuck Island while other years saw peak harvests in Nantucket Harbor. This is likely due to changing water quality and habitat conditions related to natural coastal processes and anthropogenic influences, as well as spawning and recruitment success.

SECTION 4: CHARACTERIZATION OF THE HARBORS' ENVIRONMENTS AND HABITATS

The physical features of Madaket and Nantucket Harbors are significant to their abilities to support shellfish and shellfish habitat. Additionally, locations for commercial and recreational shellfishing are largely determined by the bathymetry of the Harbors, with recreational fishing dominating in the shallower waters, and commercial fishing dominating in deeper areas.

The following section describes the physical features of both harbors as well as the habitats found within the Harbors and the surrounding areas.

Nantucket Harbor – General Description

The area of Nantucket Harbor, including Coskata Pond, Haulover Pond, the Pocomo Marshes, and Polpis Harbor is about 4,830 acres (Howes, 2006). The length of Nantucket Harbor from Nantucket Town to Coskata is approximately six miles, and the width of the Harbor varies from almost 2 miles in the Head of the Harbor to just below .5 miles at First Point. Mean tide range in the Harbor is 3.06 feet. A detailed marine survey of several thousand depth measurements within the Harbor was conducted in 1991 to determine the bathymetry of the Harbor, and all bathymetric data was tide-corrected and referenced to the North American Vertical Datum (NAVD) of 1988 (Howes, 2006). The deepest parts of the Harbor are the channels nearest Brant Point (-33.9 ft) and First Point, which are probably maintained by tidal scouring. Other deep regions of the Harbor include the basin off Polpis Harbor (maximum depth of -28.0 feet), and the Head of the Harbor (maximum depth of -25.2 feet and an average depth of -9.8 feet). The maximum depth of Polpis Harbor is -10.6 feet; and its average depth is -5.0 feet. The average depth of all of Nantucket Harbor is -8.5 feet (Howes, 2006, 5).

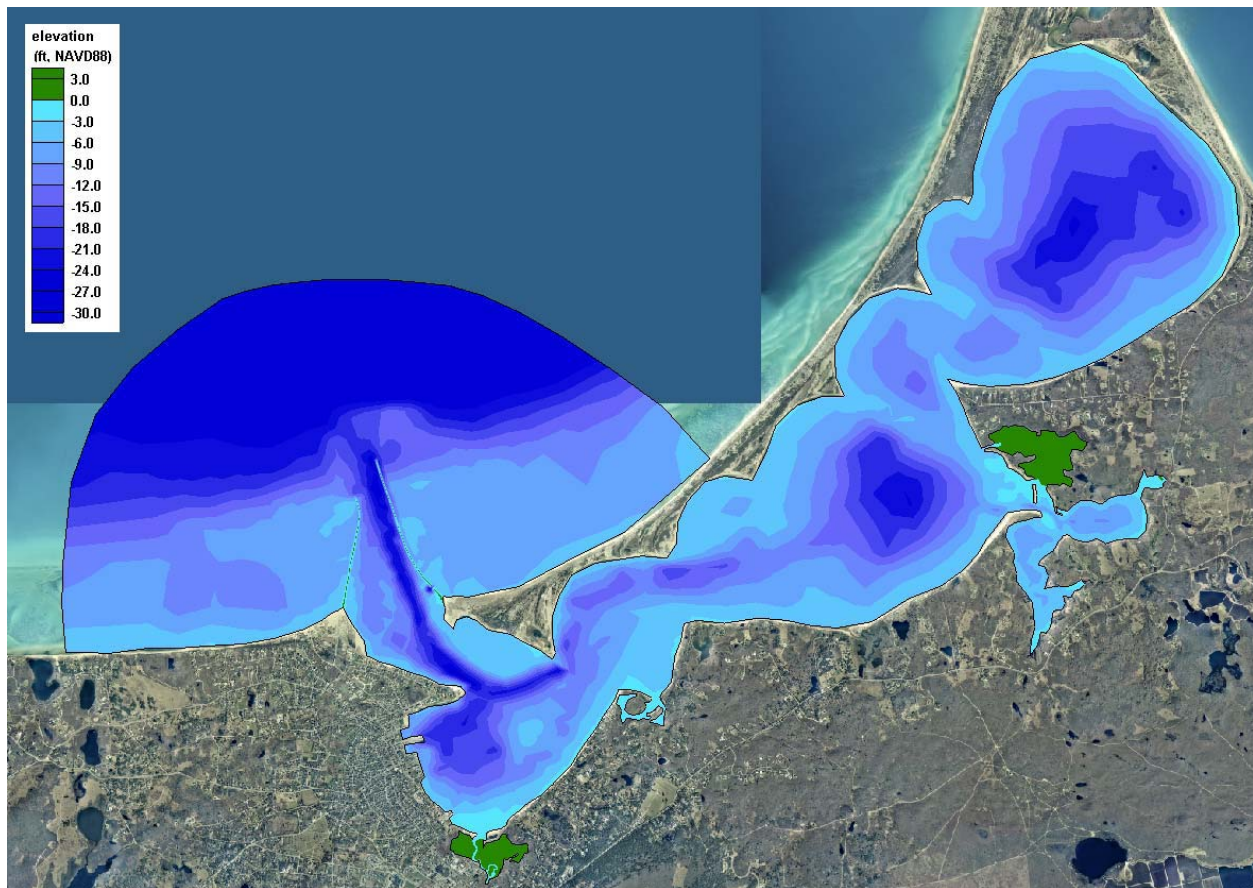


Figure 2: This map, taken directly from Howes (2006), shows interpolated finite-element grid bathymetry of the Nantucket Harbor system, superimposed on aerial photos of the system from 2003. Bathymetric contours are shown at three-foot intervals (Howes, 2006, Figure V-6).

Madaket Harbor – General Description

Madaket Harbor and Long Pond make up a unique ecosystem encompassing approximately nine square miles. These two systems are hydrologically connected via Hither Creek and the Madaket Ditch, as well as a culvert running under Madaket Road. Long Pond is somewhat isolated from the whole system, and may be evaluated as having separate water quality issues. It is relatively narrow and winding with depths of -4–6 feet and no deep basins.

The system is also connected through groundwater and is impacted by the highly permeable nature of the watershed soils. For example, very little surface water flows into Long Pond, and groundwater is the primary discharge pathway. (Howes, 2010).

As described in the introduction to the Massachusetts Estuaries Project for Madaket Harbor,

“The western boundary of the Madaket Harbor system is generally open to Nantucket Sound and Atlantic Ocean waters but [is] somewhat restricted by [a] very dynamic network of sand shoals. Madaket Harbor has a northern shore (Eel Point) bounded by Eel Point Marsh along the Madaket Harbor shore line and sand dunes on the northern side of Eel Point adjacent to Nantucket Sound.... The southern boundary of Madaket Harbor is defined by a long sand spit that periodically is breached—as was the case in 2007 when an

energetic coastal storm breached the spit and created a second opening to Madaket Harbor” (Howes, 2010).

The shape of Madaket Harbor and the surrounding bathymetry allow for efficient flushing of much of the system (exceptions being Long Pond and Hither Creek, whose structural features create limits for flushing and circulation) (Howes, 2010).

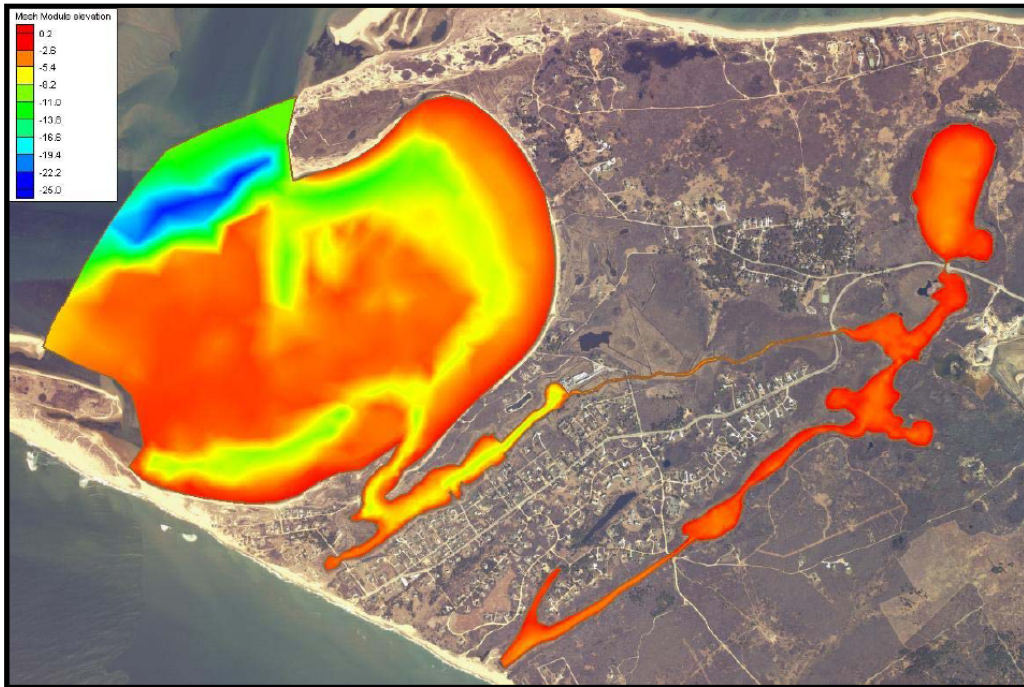


Figure 3: Depth Contours of Madaket Harbor, as mapped in Howes (2010) show a fairly shallow harbor system, much of which is less than eight feet deep.

Water Quality in Nantucket Waters

Shellfish sustainability relies on high quality habitat and clean water, which are closely related. Best management practices for the fisheries, shellfish reseeding and recruitment programs, and protection of eelgrass habitat will only succeed if water quality is adequate.

Water quality in Nantucket and Madaket Harbors is affected through multiple input pathways (sources) such as runoff and groundwater, and by various stressors. Background levels of nitrogen, phosphate, or other nutrients can be augmented and increased by man-made (anthropogenic) sources. The biggest addressable threats for the Harbors come from septic systems, fertilizers, runoff, and “on the water” boat use artifacts (cleaning products, waste discharge from boats with no heads, etc.). These excess nutrients serve as fertilizer, feeding algal blooms. The algal blooms increase turbidity and shading of the sea floor, depriving plants (such as eelgrass) of the light needed to photosynthesize. Additionally, the decomposition of algae creates conditions of low dissolved oxygen (hypoxia), which can lead to the death of fish and other marine organisms.

Scientists have conducted experiments comparing the effects of nitrogen concentrations in the water column and in the sediment under various water circulation scenarios (Burkholder et al., 1992) and have found that, even when not associated directly with higher chlorophyll or algal counts, excess nitrate can affect the ability of eelgrass to process nutrients internally. In addition, when

Nitrogen:Phosphorus (N:P) ratios vary from normal, different types of nuisance algae, both suspended and attached, can overtake a system. For Madaket Harbor, Hither Creek and Long Pond, the latter two were determined by the Massachusetts Estuaries Program Report (2010) to be impaired by nitrogen enrichment while Madaket Harbor exhibited a relatively healthy water and benthic profile.

Of concern especially in other parts of the Commonwealth, and appearing in 2007 in Nantucket Harbor, are incidents of “red tide,” considered a “harmful algal bloom (HAB)” normally caused by a species of dinoflagellate known as *Alexandrium fundyense* found in water bodies with connections to the Gulf of Maine in the Northeast. Blooms of these dinoflagellates cause severe disruptions in fisheries as the toxins in these organisms cause filter-feeding shellfish in affected waters to become poisonous for human consumption due to elevated levels of the chemical saxitoxin—a neurotoxin.

While some HABs can be poisonous to humans, there are a variety of organisms associated with the poisoning of shellfish (summarized in Baier, 2000). Over the past few years, warm sunny summer weather has occurred after significant spring rainstorms that contribute large peaks in storm water runoff and groundwater inputs. This confluence of events has led to the appearance of the so-called “rust tide” caused by the dinoflagellate (small unarmored 1-8 cell organism with flagellas or little whip-like tails) called *Cochlodinium polykrikoides*. The filter-feeding scallops ingest the dinoflagellate in the water column which, in high concentrations, will kill all small seed scallops (Gobler et al., 2008) and some larger scallops (Boyce, Personal Communication, 2012). Even in instances where an adult scallop is not killed, the dinoflagellate may cause decreased body mass. Rust tide is different from the brown tide organism (*Aureococcus anophagefferens*) which almost completely decimated the bay scallop population in Peconic Bay (Long Island) in 1985. The Nantucket Marine and Coastal Resources Department is now monitoring for specific algal species each year with assistance from the UMass Boston Nantucket Field Station. Nuisance algal species such as *Lyngbya* have been linked to excess concentration of nutrients and are also theorized to be negatively impacting eelgrass in Nantucket Harbor (Paerl et al., undated).

Pollutants from cleaning products, petroleum-based chemicals (plastics, fuel oil, volatile organic compounds), pesticides and herbicides, and pharmaceuticals and consumer product pollution (referred to by the EPA as “Pharmaceuticals and Personal Care Products as Pollutants” (PPCPs))—even in small quantities—have been shown to impact shellfish in shallow embayments similar to Nantucket and Madaket Harbors. Additionally, bacterial (fecal and, to a lesser extent, non-fecal) coliforms from animal and human sources can shut down fishing in shellfish beds for species where the entire animal is consumed (e.g., mussels, quahogs, and oysters). For the past several years, parts of Polpis Harbor, Nantucket Harbor, and Madaket Harbor have been placed under shellfish quarantine during warmer months.

Pollution inputs have been well documented in the scientific literature, and the Town of Nantucket and various other State and local agencies have conducted studies over the past 30 years to evaluate the concentrations of potential pollutants in Nantucket’s Harbors. Most of these studies have been “snap shot” type reports that measure contaminant level at specific times (as opposed to long-term data collection). The Massachusetts Estuaries Project reports (including “Nantucket Harbor Embayment System Total Maximum Daily Loads For Total Nitrogen”) (Commonwealth of Massachusetts, 2009) organized some of the Town’s ongoing monitoring and developed a model for calculating TMDLs of Nitrogen. These TMDLs were developed to identify the amount of nitrogen that could be tolerated before adverse impacts (e.g., algal blooms and eelgrass loss) occurred. Importantly, a TMDL is an average over the course of a year. The concentrations of nutrients are usually significantly higher during the summer, and may have a significant negative impact during the shellfish growing season.

The Executive Summary distills the report's conclusions, which include a finding of "impaired" water quality (a 303(d) listing status of a Category 5 state) in some locations of Nantucket Harbor and Polpis Harbor. (Such a listing indicates that waters are too polluted/degraded to meet state water quality standards, and requires the development of TMDLs. The listing is required under Section 303(d) of the federal Clean Water Act.)

The control measures recommended to address Nantucket Harbor's water quality issues include installing sewer lines, better managing storm water, using impoundments and wetlands to attenuate water runoff, and developing fertilizer use by-laws (Commonwealth of Massachusetts, 2009).

In summary:

"The N loadings (the quantity of nitrogen) to this embayment system, from all sources, ranges from 24.09 kg/day at Head of the Harbor, to 66.15 kg/day at Town Basin, with an overall nitrogen load of 149.51 kg/day to the Nantucket Harbor System from all sources. The amount of nitrogen entering the system from the surrounding watersheds (runoff, fertilizers, septic systems, and atmospheric deposition to natural surfaces) is 19.72 kg/day. The N concentrations in the harbor system range from 0.30 to 0.41 mg/L (milligrams per liter of nitrogen).

"In order to restore and protect this system, N loadings, and subsequently the concentrations of N in the water, must be reduced to levels below the threshold concentrations that cause the observed environmental impacts.... The Massachusetts Estuaries Project (MEP) has determined that, for this embayment system, N concentrations of 0.35 mg/L in Head of the Harbor and an N concentration of 0.36 mg/L in Polpis Harbor will allow the restoration of the habitat. The mechanism for achieving these target threshold N concentrations is to reduce the N loadings to the embayments. The Massachusetts Estuaries Project (MEP) has determined that the Total Maximum Daily Loads (TMDL) of N that will meet the target thresholds range from 23 to 64 kg/day."

A separate report was generated for Madaket Harbor, coupled with Long Pond (Howes et al., 2010) and for two of the major ponds located on Island (Sesachacha and Hummock Pond). It is important to remember that pollutants traveling in the groundwater are a significant part of the non-point source pollution entering both Harbors.

Many human uses can contribute to declining water quality. According to the "Update to the Madaket and Nantucket Harbors Action Plan" (2009), Marine Department Water quality reports from 2004–2010, and the Massachusetts Estuaries Program Report for Nantucket and Madaket Harbors, sources for contaminants into Nantucket include:

- Impermeable surfaces
- Development activities
- Landscape activities
- Atmospheric deposition
- Automobiles and boats
- Fertilizers
- Animal waste

- Septic systems and septic system failures

Significant fluctuations in shellfish populations, coupled with noticeable algal blooms in Nantucket Harbor and in some of the fresh and brackish ponds on Nantucket, have resulted in the Town of Nantucket launching the “Water Quality Initiative.” The vision of this Initiative is, “To preserve and improve water quality within and surrounding Nantucket Island.” Several links to reports and recent research can now be found at the Town of Nantucket Water Quality Initiative webpage and at the Marine and Coastal Resources website (www.nantucket-ma.gov/Pages/NantucketMA_Marine/waterquality).

The Town of Nantucket’s Marine Water Quality Policy is, “To maintain, improve or protect water quality levels within all harbors, embayments, estuaries, wetlands, ponds and beaches within and surrounding the island of Nantucket in accordance with local and state standards and to safeguard all Nantucket municipal and private sources of potable water; and, to regularly inform Nantucket’s citizens about the Town’s water quality measurement efforts and results.”

Of critical importance for predicting adverse impacts and tolerance to various water-quality stressors is monitoring, recording, and reviewing the following:

- Water and air temperature;
- Photosynthetically active radiation (PAR). (PAR is a way to evaluate the depth to which light can penetrate in a body of water and, by inference, how much excess algal growth other pollution like silt or oil that blocks sunlight may be in the water);
- Rainfall rates; and
- Water circulation within the Harbors

Nantucket and Madaket Harbors Watersheds

The watersheds of Nantucket Island were delineated by the Massachusetts Estuaries Project team. In geologic areas such as Nantucket, made up of transmissive sand and gravel deposits, watershed boundaries are generally better defined by groundwater elevation and its direction of flow, rather than by land surface topography (Howes et al., 2006, p. 36). Groundwater elevation was used to complete watershed delineations for both Nantucket Harbor and Madaket Harbor—delineations that were adopted by the Town as the Nantucket Harbor and Madaket Harbor Watershed Protection Districts respectively.

The drainage basin for Nantucket Harbor is about 5,340 acres.

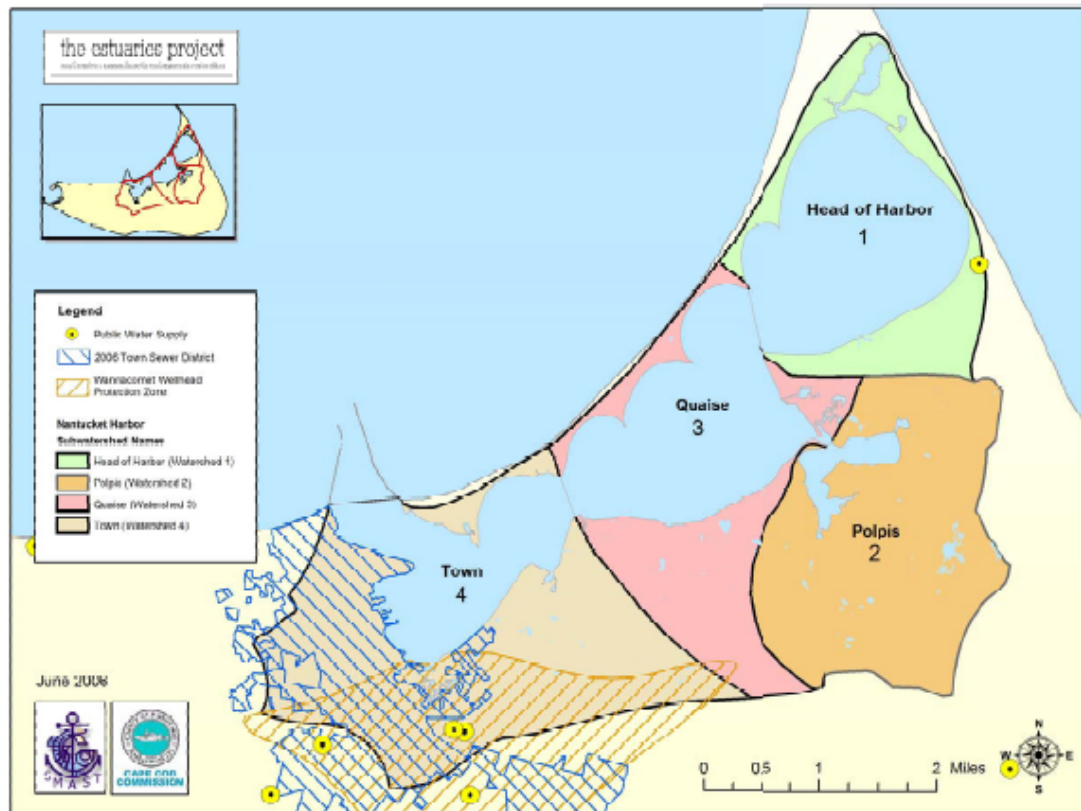
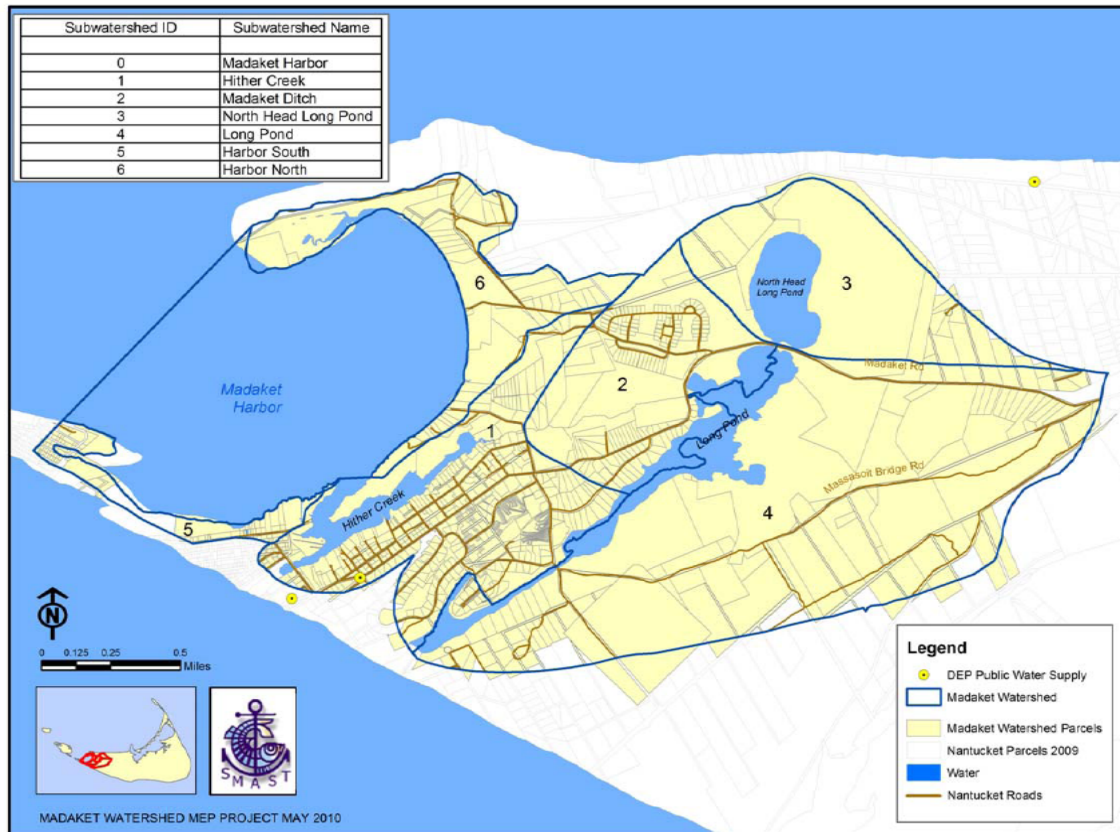


Figure 4: The Massachusetts Estuaries Project identified four watersheds for Nantucket Harbor (Figure taken from Howes, 2006).



Harbor (Figure taken from Howes, 2010).

Eelgrass

General description

Eelgrass (*Zostera marina*) is a type of seagrass that grows in the shallow coastal waters with low nutrient inputs. It is the most common seagrass present on the Massachusetts coastline. The ecosystem value of eelgrass is well documented and include its ability to stabilize sediments, buffer wave energy, and provide habitat for juvenile fish and shellfish (Stauffer, 1937; Orth et al., 1984; Heck et al., 1989; Hughes et al., 2002; Lazarri and Tupper, 2002, as cited in Leschen, 2007).

In Nantucket Harbor, eelgrass is able to grow in water as deep as eight feet, except at the Head of the Harbor where reduced water quality only allows eelgrass to grow to a depth of about 6 feet (Curley, 2002). The seagrass, both alive and dead, is an important and valuable part of the coastal ecosystem. As a live plant, eelgrass provides a sheltered habitat for many organisms, including the bay scallop which attaches itself to the eelgrass blades; however, its value as habitat also attracts predators. Eelgrass also stabilizes sediments in the Harbor which helps to improve water clarity. When eelgrass dies, it washes to shore and accumulates along the tide line. Here, the mass of dead eelgrass provides a nursery for the seeds of beach plants that will eventually help to form new dunes and stabilize existing ones. Shorebirds feed on insects and small crustaceans that are found in the mass of dead eelgrass (Nantucket Conservation Foundation, Inc., 2005).

The health of eelgrass beds is also an indicator of water quality. Eelgrass is able to store nitrogen in its blades and stems; a trait that allows the plant to grow well in areas with low nutrient levels. However, as nutrient concentrations increase, algae are able to grow more successfully. Ultimately, the algae out-

compete eelgrass and may reduce sunlight penetration. Algal shading may occur in two forms; algae in the water column or attached to the bottom may reduce light levels or epiphytic algae may grow directly on the eelgrass plants, thereby reducing the light that can reach the eelgrass blades. The loss that Nantucket Harbor has seen in the size and density of its eelgrass beds over the last decade is likely due to this nutrient loading/shading process (Curley, 2002); however, since eelgrass is still present in the harbor, nutrient loading into the harbor is only moderately high (Curley as cited in Valiela et al., 2002).

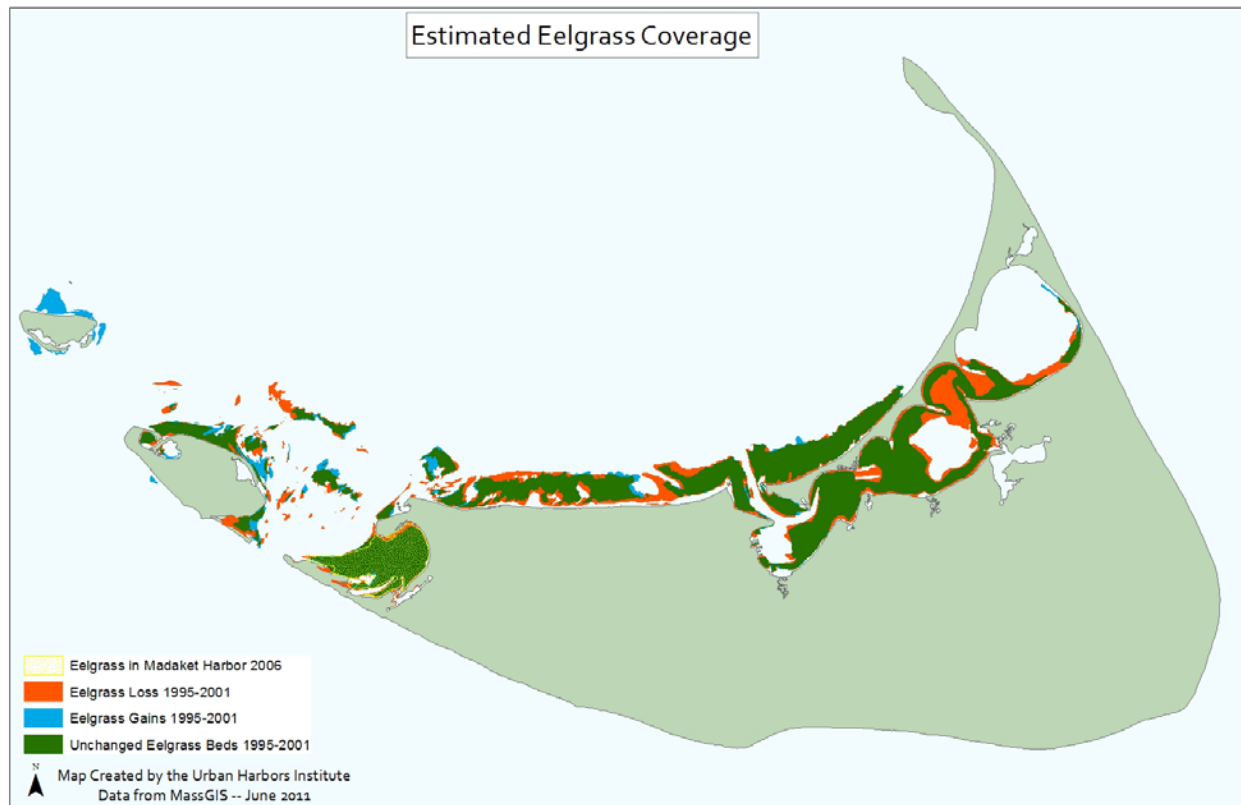


Figure 6: The Massachusetts Department of Environmental Protection compared eelgrass coverage from 1995 to 2001; and estimated coverage again in 2006. Clear losses were seen between 1995 and 2001 west of the mouth of Nantucket Harbor and near Third Bend and Fourth Bend. 2006 data for Nantucket Harbor are not yet available, and residents of Nantucket suggest that present extent is not wholly represented by these data.

The Massachusetts Department of Environmental Protection (DEP) carried out eelgrass mapping in 2006 and 2007 using digital imagery, and re-mapped 33 of the original 46 embayments mapped in 1995 and 2001. The 2006-2007 mapping exercise included Madaket Harbor, but not Nantucket Harbor. Some gains in eelgrass coverage were observed, primarily near Tuckernuck and Muskeget Islands. The research also showed some losses in eelgrass coverage, including near 3rd and 4th Bends and the southeastern portion of the Head of the Harbor. For most mapped areas, however, research showed unchanged eelgrass beds for the majority of the sites. These data are used to evaluate the impacts of a proposed project but, given the variability of eelgrass beds in Nantucket waters, this information can also be viewed as a tool to identify historical eelgrass beds for restoration projects.

Eelgrass spreads both vegetatively (rhizome expansion) and non-vegetatively (seeds). Vegetative spreading is limited to adjacent areas, so the natural spread of eelgrass to new areas must be accomplished by the dispersal of seeds. Eelgrass seeds are negatively buoyant and do not travel far within the water column once released from a vegetative shoot (Orth et al., 1994). Detached

reproductive eelgrass shoots containing seeds can float long distances, and thus can start new meadows far from the bed of origin (Harwell and Orth, 2002).

While eelgrass has the ability to spread from healthy environments to adjacent sediments, the loss of eelgrass can result in significant changes in physical and biological characteristics at a site, which may also prevent natural recolonization. Transplantation can expedite the recolonization process, but the removal of wastewater inputs, heavy organic loads, and siltation is very important to successful eelgrass restoration efforts (Leschen et al., 2007).

Threats

A range of natural and anthropogenic factors may affect the health of eelgrass, including natural cycles, storm events, disease, physical disturbance, sedimentation, and nutrient enrichment (including from septic systems).

Natural causes of eelgrass loss, which can be seen in the variability of eelgrass in Madaket Harbor, include changes in sediment type (due to factors such as changes in water circulation patterns) and the extraction of eelgrass from the sediment during storm events.

There is a clear relationship between eutrophication (the increase nutrient levels which can lead to growth of phytoplankton blooms and/or submerged aquatic vegetation (SAV)) and eelgrass loss (Kemp et al., 1983; Valiela et al., 1992; Short et al., 1996; Hauxwell et al., 2001, 2003; Cardoso et al., 2004). Nutrient enrichment, primarily from fertilizers from agriculture and lawns, wastewater, and acid rain, stimulates excessive growth of phytoplankton and reduces light penetration. Nutrients may also stimulate the growth of epiphytic algae (meaning algae that grow on other plants) which directly shades the plant. Without proper sunlight, eelgrass cannot grow. This loss of eelgrass removes a vital part of shellfish habitat.

Herbicides uses in agriculture may also impact eelgrass extent and health, causing impacts such as impaired photosynthesis and growth (NYS Seagrass Taskforce, 2009).

Coastal development, dredging projects, fishing activity, boating activity, and other water-based activities may degrade water quality through increased turbidity which reduces essential light. Dredging projects for navigation and other harbor-related purposes may have a direct impact by removing the plant and by potentially increasing water depth to an extent that eelgrass will not recolonize because of insufficient light penetration. The impact of dredging used to harvest shellfish is largely unclear. Some argue that the act of dredging during harvesting helps to “groom” eelgrass, removing epiphytes. Others believe that dredges used for harvest may actually dig up eelgrass (Colarusso, 2011).

Estimates suggest that 90% of eelgrass died-off in the 1930s due to an outbreak of wasting disease (Tutin, 1942 as cited in Leschen, 2009). While wasting disease continues to occur sporadically (Short et al., 1986, 1987), natural re-population has been thwarted by degraded water quality from coastal development, which limits the light essential for eelgrass growth (Batuiik et al., 2000). This problem is compounded by the limited ability of eelgrass to disperse to suitable areas over long distances (Leschen et al., 2007).

Boat moorings in Nantucket waters have both direct and indirect impacts on eelgrass. As the wind and currents cause a moored boat to swing around the mooring, the bottom chain of a traditional mooring scours a circle in the sediment, often removing any eelgrass within that circle. In Nantucket, most moored boats are secured with a mushroom anchor; however efforts are underway to understand the implications of converting to conservation moorings. A conservation mooring is a type of mooring that replaces the chain and rope with a length of elastic polyurethane (or similar material) attached to a

bottom anchor and a mooring float. The float reduces slack and keeps the elastic from scouring the sediment, thereby minimizing the impact to nearby seagrass.



Figure 7: Mooring scars in eelgrass off of Cathcart Road, Nantucket Harbor. (Image from Google Earth, 2012).

While eelgrass (*Zostera marina*) appears to be the preferred habitat for larval scallops in Nantucket, the decline in areas of this seagrass has led to a search for alternatives. A short-term research project at the UMass Field Station in 2006 looked at whether scallops would attach to *Codium fragile*, an invasive green algal form that has become common in Nantucket Harbor, in the same way they do with eelgrass. The Field Station evaluation used several small tanks stocked with eelgrass, *Codium*, neither, or both substrates. Findings suggest that scallops would, indeed, use *Codium* if eelgrass was not present—and would sometimes use it even if both species were in the tank. To be more definitive, this sort of experiment should be repeated in significantly larger tanks and over greater time periods.

Scientists working in other geographic locations have found similar results to the research done on Nantucket. Working with scallops planted in the wild over a two-year period, Stephen Tettelbach and his students found that, in Peconic Bay and Shinnecock Bay on Long Island, NY, under some conditions, *Codium* acted as a potential habitat. Additionally, they found similar densities of natural recruits of scallops on the two substrates. This research led to the conclusion that substrates other than eelgrass may serve as important habitats for bay scallops (Tettelbach, 2011).

Sediment/Substrate

In addition to eelgrass, marine and estuarine sediments are another critical environmental factor for shellfish survival. Many, if not most, marine organisms, both plants and animals, have become adapted to grow best in areas with particular grain sizes. Sediment grain size influences the settling of young shellfish and the growth of adults as well as the distribution and abundance of bottom-dwelling organisms and plant life that provide a food source and shelter.

Sediments are typically characterized by size using the Udden–Wentworth scheme as shown in the chart below:

Table 1: Sediment can be characterized by grain size.

Wentworth Size Class		Max Particle Diameter
Gravel	Boulder	256–4096 mm
	Cobble	64–256 mm
	Pebble	4–64 mm
	Granule	2–4 mm
Sand	Very coarse sand	1–2 mm
	Coarse sand	0.5–1 mm
	Medium sand	0.25–0.5 mm 250–500 microns
	Fine sand	0.125–0.25 mm 125–250 microns
	Very fine sand	0.625–0.125 mm
Silt	Coarse silt	31–63 microns
	Medium silt	15.6–31 microns
	Fine silt	7.8–15.6 microns
	Very fine silt	3.9–7.8 microns
Mud	Clay	0.06–3.9 microns

Sediment size and types have several effects on shellfish populations. The young generally have specific grain size requirements for burrowing. Consequently, the success of adults of the species is dependent on the availability of the grain sizes needed by the young. The texture and size of the sediment particles are important to the settling of larval stages and they will not settle if the conditions are not right. Finally, the oxygen levels in the interstices between sediment particles affect the ability of larvae to “breathe” and, by extension, their mortality rate; though dissolved oxygen levels in the water column will exert a greater effect on larval survival than interstitial oxygen levels. These levels of oxygen are affected by particle size and type.

Sediments also become a repository for chemical contaminants ranging from nutrients to heavy metals to petro-chemicals, with finer-grained substrates typically showing higher levels of contamination than areas with more coarse sediments. Understanding which, if any, contaminants are being sequestered in the sediments and how they might be released by either human or natural processes can be important to understanding impacts on shellfish life cycles and human health.

A secondary aspect of the role of sediments is that they provide a site for a wide range of bio-geo-chemical processes that affect overall nutrient levels and flux within the embayment.

In general, the distribution of sediment types is controlled by the hydrodynamic setting, estuarine circulation, and sediment supply to the estuary. Sands are found most frequently in the intertidal zone and along shorelines exposed to wave energy. Fine-grained or muddy sediments are found in more quiescent areas, such as Head of the Harbor, and in areas of high sediment runoff from land.

Sediments in Nantucket Harbor

From 2006–2008, the US Environmental Protection Agency (EPA) Atlantic Ecology Division sampled sediment in Nantucket Harbor as part of a research effort to understand habitat characteristics of bay scallops (Weissberger & Chintala, Personal communication, 2012). Their data showed that, in 2008, the dominant sediment sizes were medium to coarse on the Wentworth Scale (41.55% in the .5-1mm range, and 28% in the .25-.50mm range), with smaller-sized sediments located in Town, the Head of the

Harbor, and the deeper waters west of Pocomo. Their data also indicates slight variations grain size at sampling sites between 2006 and 2007 (2008 data are not yet mapped, and may show additional changes). The primary differences between 2006 and 2007 were found in the vicinity of 1st, 2nd, 3rd, and 4th Bends. (Their report is forthcoming.)

The EPA's data provides an update to the sediment survey conducted in 1956 by Louis Lidz. Lidz's survey found that the Harbor sediments consisted of gravel, sand, silt, clay, and shell debris with the mean diameter of most of the bays sediments being less than 500 microns (medium sand on the Wentworth scale). Some areas with coarser sediments (greater than 1,000 microns—very coarse sand and larger) are found in areas with significant wave energy (beaches) or tidal currents (along channels). Fine sediments (diameters between 8–16 microns) were typically found in areas such as the Head of the Harbor and off of Third Bend, and generally in depths greater than 2 meters.

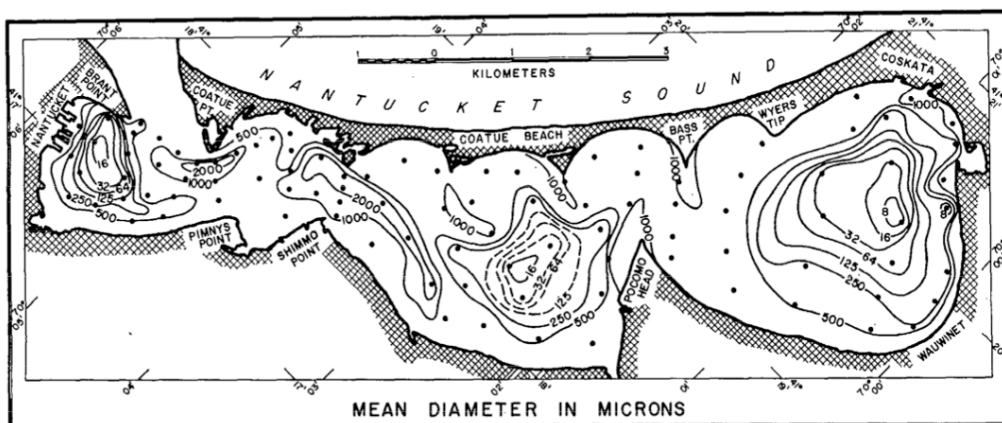


Figure 8: Sediment sizes in Nantucket Harbor as mapped in the 1960s (Lidz, 1965)

Lidz went on to characterize four unique traits related to sediments within Nantucket Harbor:

1. "A distinct mineral composition, almost pure quartz, which serves to distinguish the bay sediments mineralogically from bays and coastal water bodies of other geological settings.
2. "Current energy and depth of water control grain size distribution and sorting of sediments. Where tidal flow has the greatest velocity, gravels with pebble-to-cobble-size sediment are found.
3. "Organic content is highest in areas that have a water depth of at least 4 m and sediment mean diameters of less than 62 microns. These values, which are greater than 15% organic carbon, reflect protection from oxidation afforded by the impermeability of the sediment type. Historically sewage dumped from boats and ships and emptied into the bay from outlets of the town of Nantucket may cause organic content to be increased.
4. "Shoreline physiography and bathymetry remain relatively stable. During long periods of intense storms, however, major changes have occurred, such as those found in the record of Haulover Break."

Sediment sizes and types can be modified either by human intervention (e.g., creating or modifying the breakwaters at the mouth of Nantucket Harbor or dredging channels within the Harbor for navigation or to increase flushing) or from natural phenomena (e.g., the storms that breached the barrier at the eastern end of the Harbor in the early portion of the 20th century).

Sediment types can also be modified by the addition of “artificial substrate” such as solid structures or the shells that may serve as a settling place for shellfish larvae, or to modify the chemical balance of the waters.

The Massachusetts Estuaries Report for Nantucket Harbor (Howes et al., 2006) addresses the additional need to evaluate the organic content of the sediments as “their extent and relative concentration represent a reserve of reduced organic material and nutrients which through the process of sediment respiration constantly recycle nutrients to and withdraw dissolved oxygen from the overlying water.” A survey by the Massachusetts Estuary Program (MEP) found a general correlation between sediment size and organic content with fine sediments having a greater percentage of organic matter than larger particles. Further the MEP report for Nantucket Harbor reported that, “with the exception of tidal current scoured channels, there is a strong positive relationship between water depth and the percentage [of] organic material in the sediment.” This correlates with the EPA’s and Lidz’ findings of finer-grained material in deeper waters.

Sediments in Madaket Harbor

Significant mapping of sediments in Madaket Harbor is not presently available. Howes et al. (2010) characterize sediment there as “generally composed of fine sands with silt and some areas of consolidated mud.... Hither Creek is an artificially deepened basin that is depositional with typical sediments consisting of very soft organic rich mud.”

SECTION 5: DESCRIPTION OF THE RESOURCES HARVESTED AND THEIR HABITATS

In order to identify the management needs for shellfish in Nantucket waters, it is vital to have an understanding of the life cycle, reproductive and feeding strategies, habitat requirements, and likely stressors for each species of interest. The following section describes the biological traits and habitat needs of commercial and recreational harvested species found in Nantucket waters, and describes some of the factors which influence a population's success. In general, as depicted in Figures 9 and 10, suitable habitat exists throughout much of Nantucket waters.

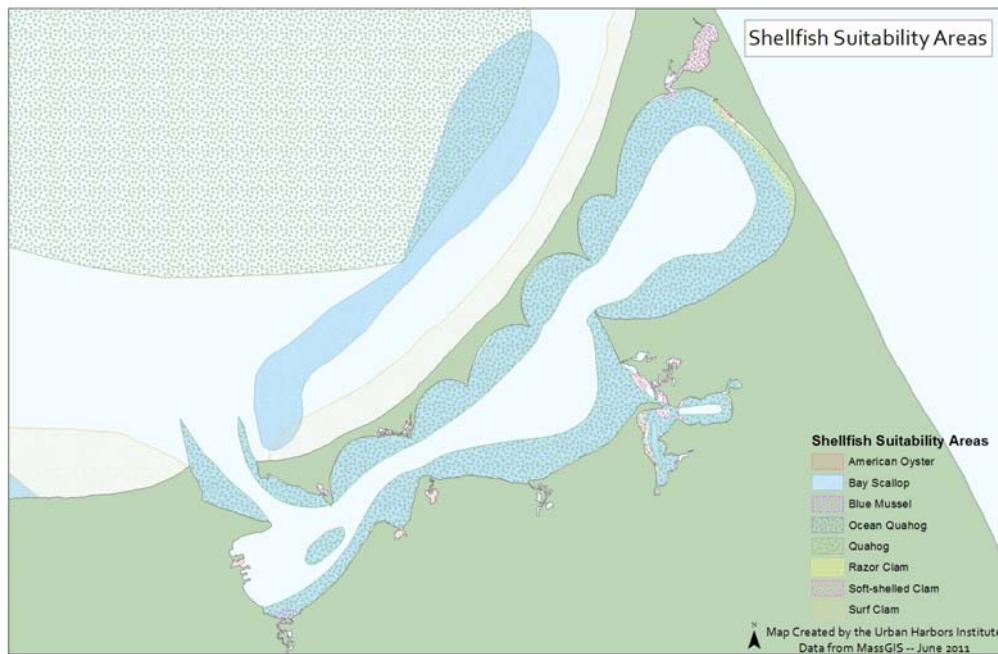


Figure 9: DMF has identified potentially suitable habitat for a variety of shellfish in Nantucket Waters—some of which are harvested, and some of which are not. This map shows the suitable habitats identified by DMF in and around Nantucket Harbor, but does not necessarily indicate the presence of that species. This map also does not (1) show suitable conch habitat, which extends throughout Nantucket Harbor, or (2) reflect seasonal and annual variability in suitable habitats; however this map does provide general information about where shellfish might be found, and is part of the information used in regulatory processes to evaluate the impact of proposed projects.

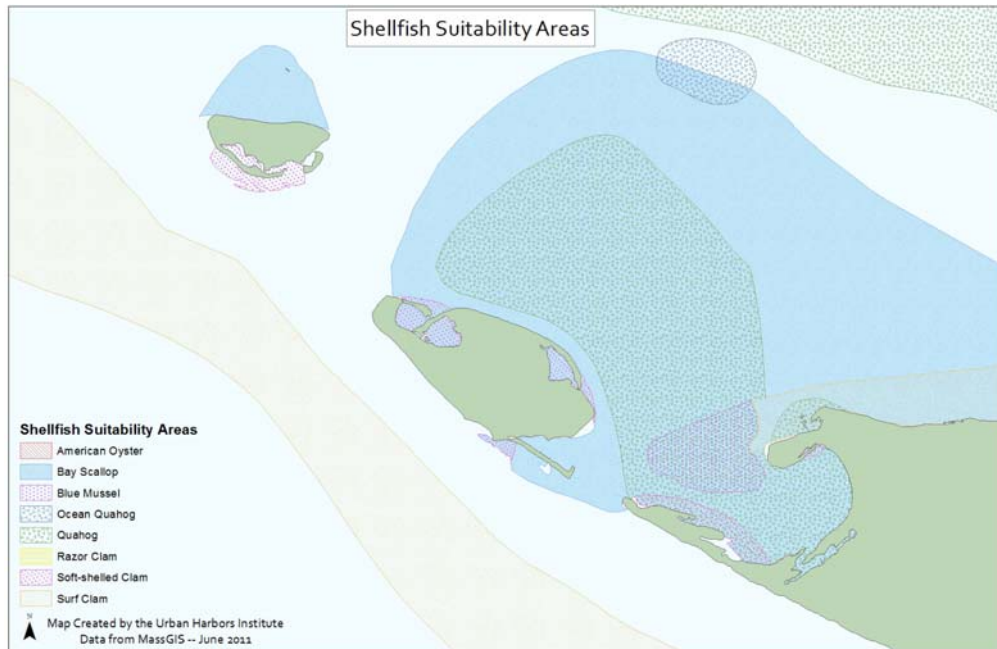


Figure 10: DMF has identified potentially suitable habitat for a variety of shellfish in Nantucket Waters— some of which are harvested, and some of which are not. This map shows the suitable habitats identified by DMF in and around Madaket Harbor, but does not necessarily indicate the presence of that species. This map also does not (1) show suitable conch habitat or (2) reflect seasonal and annual variability in suitable habitats; however this map does provide general information about where shellfish might be found, and is part of the information used in regulatory processes to evaluate the impact of proposed projects.

Bay Scallops

Biological characteristics and environmental requirements of the species

The northern bay scallop (*Argopecten irradians irradians*) is a bivalve distributed along the east coast from Cape Cod to Maryland. It has a nearly symmetrical ribbed shell, a pair of equal-sized ears at the hinge, and a white to dark brown or gray color. Bay scallops are found at varying depths and salinities between 14–32 parts per thousand (ppt). Scallops thrive in areas that have healthy eelgrass and optimal water quality. Bay scallops are filter feeders and their primary food sources are phytoplankton and benthic diatoms.

Bay scallops are relatively short-lived, with an average longevity of 20–26 months (Belding, 1910). Because of the short life span of this species, only two age classes are typically represented in their populations (Fay, 1983). Scallops that do not bear a well-defined annual growth line are defined as seed scallops.

The bay scallop's biology directly influences the commercial fishing industry—specifically in terms of its spawning cycle, life span, development of a growth ring, and population size. Bay scallops (those approximately 12 months in age) typically spawn during the summer months when there is a rapid rise or fall in water temperature to around 20–22.2° C (Conant & Curley, 2005, 2). Scallops from a summer spawn grow through the summer and fall months, reaching a shell height of between 31–51 mm before the water temperature drops and their shell growth slows. Over the winter months, a ridge develops at the shell's edge. This ridge—referred to as a “growth ring”—suggests that the animal has lived through a winter.

Bay scallops are functional hermaphrodites where both gametes mature at the same time. During spawning events, eggs are released and fertilization occurs in the water column. After approximately 10–14 days as larvae drifting in the water column, the animal becomes a juvenile attaching onto a substrate—preferably a blade of eelgrass. They have also been found on alternative substrates such as seaweeds, filamentous algae, stones and debris. After growing to roughly 7.6–30.5 mm, the juvenile drops to the bottom where it will either stay in one place or “swim” by clapping its valves open and closed, which forcibly expels water and propels the animal (Tettlebach, unpublished data).

Some bay scallops may also spawn in the fall, producing scallops that have a shortened growth period before the water temperature drops and shell growth ceases. These shellfish over-winter at 1–20 mm in size (Conant & Curley, 2005, 2), and develop a growth ring between 1–20 mm from the hinge. These scallops are referred to as “nubs” or “ring at hinge” scallops.

In spite of all of the information available about the biology of this species, more research is needed to understand the reproductive capabilities of nubs. Specifically, there is debate as to whether or not an adult nub can over-winter and whether or not it can spawn twice. If it is found that nubs can spawn twice, that information may influence management decisions related to their harvest.

Threats/Stressors

One of the vexing problems of the bay scallop industry on Nantucket is the fluctuation in scallop populations from year to year. Given the short lifespan of these animals, their population levels rely on the successful reproduction of every year class. Successful reproduction depends on two factors—the first of which is a successful spawning that produces the larval supply. The second factor is recruitment, which relates to how many of these larvae survive and “set” as juveniles.

The relationship between spawning and recruitment can lead to a variety of outcomes. For example, a relatively small spawning stock can produce a strong year class when conditions for recruitment are favorable. The opposite can also be true, meaning a large spawning stock can produce a weak year class when unfavorable recruitment conditions exist. Landings data from year to year clearly illustrate this dynamic.

In order to have the best possible outcome for any given year class, environmental conditions must be favorable for both spawning and recruitment.

Though exact numbers are uncertain each year, the boom and bust cycle of the fishing industry shows scallop populations to be vulnerable to environmental changes such as the stress placed on the habitat. While the precise reason(s) for this fluctuation may be unknown, the general downward trend in bay scallop abundance in Nantucket waters (as indicated by annual landing reports) may be linked to a range of stressors including poor water quality, loss of habitat (e.g., decline in coverage and health of eelgrass), the over-harvest of nub scallops, predation by marine species, the loss of larvae on outgoing tides, harmful algal blooms, and various other factors. Ocean acidification is also a threat to bay scallops (Talmage & Gobler, 2010). It is probable that all of the aforementioned stressors individually play a role in the health of the bay scallop population. It is also possible that the cumulative impacts from various combinations of stressors may have additional impacts on populations in Nantucket waters.

Quahogs

(Unless noted otherwise, this section is based upon Stanley & DeWitt (1983).)

Biological characteristics and environmental requirements of the species

Also known as “hard clams” and “little necks,” quahogs (*Mercenaria mercenaria*) are found in sandy and muddy tidal and subtidal areas up to 15 m deep. They prefer sandy bottoms to muddy bottoms, and salinities ranging from about 10–35 ppt; but juveniles and adults can tolerate freshwater for up to a few weeks at a time. Optimum temperature ranges are uncertain—estimates range from 10–31°C for various activities including spawning, burrowing, and feeding. Of critical importance is water circulation adequate for transport of eggs, larvae, food, and waste.

Quahogs have hard, thick, white shells showing several concentric lines spaced most closely toward the perimeter of the shell. The interior of shells are often white with violet borders. Adult shells typically measure 60–70 mm in height. Quahogs are also known for their short siphons which are yellow, brown, or orange toward the end.

Spawning events often begin in July among animals 2–3 years of age and older. Size, not age, determines sexual maturity. Unlike some other shellfish that can spawn all at once, a female hard clam may require up to 2.5 months to complete the spawning process. Most spawning activity takes place during the beginning of the season, with more intense spawning during neap tides (likely because of warmer waters during that period). Studies in New Jersey showed that the majority of spawning activity occurred while water temperatures were in the range of 22°–30°C.

The size of quahogs differs geographically with animals seeming to grow faster in warmer water. In Florida, it takes approximately three years for a quahog to reach 51 mm, whereas in Maine, it takes about five years to reach the same size. Growth is faster for animals living in sandy substrates, as opposed to muddy bottoms and is influenced by tidal currents—currents that are too slow do not bring enough food, and currents that are too fast can scour the bottom, reducing suitable habitat.

Threats/Stressors

Predation—by humans, birds, and marine organisms—is the primary threat to quahogs. Crabs are the most serious predator, having the capability to dig quahogs out of sediment or dig themselves into the sediment to crush the shell. Oyster drills, moon snails, conchs, and horseshoe crabs are other significant predators.

Human harvest also has the ability to affect quahog populations. Andrews (1990) describes quahogs as being harvested in the late 1800s between the beach at Smith’s Point and the south side of Tuckernuck as well as on the flats on the north side of that island. Fishermen built fifteen or twenty shacks on Muskeget and the Gravelly Islands in order to spend the summer there digging (Andrews, 1990). By the 2005–2006 season, however, only one commercial license was issued for quahogs and the fleet has been similarly small in size for several years.

Changes in habitat is another factor that can have an impact on quahog populations. In 1890, the beach of Smith’s Point and Tuckernuck and Muskeget began to break up and the sand pushed through these breaks produced new sand bars that provided habitat for great numbers of quahogs. However, if sand bars are too exposed during the winter, quahogs may freeze to death.

Dredging can also disturb stocks—though the long-term impacts of dredging activities seem to vary from project to project.

Other stressors include turbidity (which can reduce the growth of clams because of the additional energy expended to process the extra suspended material as they filter feed) and exposure to hypoxic conditions and pesticides which can ultimately cause death.

American Oysters

(Unless otherwise noted, this section is based on Stanley & Sellers (1986).)

Biological characteristics and environmental requirements of the species

The American oyster (*Crassostrea virginica*) is most commonly found on mudflats and offshore bars in well-mixed, shallow estuaries, lagoons, and bays, as well as on the sheltered side of barrier islands. These animals can tolerate tremendous fluctuations in environmental conditions such as water temperature (ideal temperature for adults is between 20–30 °C), salinity (they are most successful in brackish waters where there are fewer predators), and the concentration of suspended solids (pumping rates decrease as concentrations increase).

The shape of an oyster's shell depends, in part, on the environment. Where there is hard bottom, oysters' "beaks," (the pointy ends) are usually curved, whereas oysters on reefs and in silty environments are straighter. Single oysters from hard-bottom areas also have a thicker, more ornate shell with radial ridges than those found on soft sediments and reefs. The inside of all oyster shells have a purple scar from the adductor muscle, a feature that distinguishes it from similar species. The shell continues to grow throughout the animal's life, and is typically 10–15 cm in length when the oyster is 3–5 years old.

Oysters spawn when stimulated by a change in water temperature, though the specific triggering temperature differs among populations. In the northeast, spawning usually takes place during July and August. Males typically spawn first, stimulating females to release their eggs (23–86 million eggs per female per spawning event) when they detect the sperm and pheromones in the water column.

Oysters live in the water column for 2–3 weeks after they hatch. Their swimming behavior during this period often prevents them from being flushed out of a harbor. Only a minority of larvae survive the 2–3 week period in the water column. The surviving larvae, stimulated at least in part by the higher water temperature over tidal flats, begin to look for a solid substrate (ideally shells) upon which to attach through the secretion of a cement-like liquid. At this point, the oysters are considered to be juveniles.

Growth in oysters is fastest during an animal's first three months of life. Water temperature significantly influences the rate of growth, with oysters growing faster in warmer water than cold. In the winter in Nantucket waters, oyster growth stops. Other factors such as change in salinity, exposure to air, turbidity, and access to food also affect growth rates.

Threats/Stressors

In Long Island Sound, studies showed a downward trend in oyster landings starting around 1920. The decline was partially related to the increase in the sale of oysters "in the shell" which removed an important settling substrate from the environment. Empty shells on the bottom are also habitat for other animals, such as slipper shells and barnacles; and oysters often have to compete against these (as well as against other oysters) for space to settle. (There is no scientific information specific to the impacts of shell removal on oysters in Nantucket waters.)

Oyster population numbers are also adversely affected by bacteria such as *Vibrio* and *Pseudomonas*; parasites such as *Haplosporidium nelson*, which causes a disease referred to as MSX (Multinucleated Sphere Unknown); and predators such as flatworms, oyster drills, sea stars, and crabs.

Additionally, extreme warming of the water (in the vicinity of 35 °C) that lasts an entire tidal cycle can cause adult oyster mortality. Similarly, prolonged exposure to low salinities (around 6 ppt) can halt reproduction, and may cause death.

Blue Mussels

(Unless otherwise noted, this section is based on Newell (1989).)

Biological characteristics and environmental requirements of the species

Mytilus edulis, commonly known as the blue mussel, is found in the tidal and subtidal zones (<99m), in a variety of settings including flat intertidal areas as well as rocky vertical areas such as the jetties. Estuarine littoral environments provide some of the most challenging conditions for blue mussels (including daily variations in temperature, salinity, exposure to air, and access to food).

The exterior of the shell is often a shiny dark blue, with many fine concentric lines. As the shiny layer, or “periostracum,” wears away, a white inner layer is exposed. The interior of the shell often has a dark blue or violet border with a pearly white center.

One of the primary requirements for a population of blue mussels is the presence of a hard surface to which they can attach. Blue mussels anchor to a secure substrate (which may include other mussels) using byssus threads which are secreted from the animal’s foot. Through the adjustment of the length of existing threads and the secretion of new ones, a mussel has the capacity for limited mobility, allowing it to reposition to avoid smothering by sediment, to move to the outside of a mussel bed, or reposition itself in water currents.

Blue mussels typically spawn at approximately one year of age, though some environmental conditions (such as prolonged exposure to air) can slow the animal’s rate of growth and delay sexual maturity until sometime in the second year. Males typically spawn first, triggering the spawning of females. Animals may release all of their eggs or sperm at once, or they may slowly release them over an extended period of time. Spawning events are influenced by many factors (water temperature, salinity, air exposure, hormonal cycle, and genotype) but are dominated by the availability of food. Mussels that are stressed by environmental factors experience reduced spawning capacity.

The larval stage of a blue mussel may last between 15–35 days, depending on environmental conditions. Temperatures of 15–20 °C and salinities of 15–35 ppt were shown to be ideal for “normal” development in larval mussels studied in Connecticut; however studies from elsewhere indicate that salinity and temperature requirements for “normal” development vary depending on the population being studied, and, in particular, the environmental conditions in the vicinity of the spawning adults.

Once the larvae develop feet, they use byssus threads to attach to substrates such as algae, and metamorphosize into juveniles. A juvenile will stay attached to this substrate until it is about 1–1.5 mm, at which point it releases its hold and re-enters the water column. When the juvenile makes contact with an adult, the juvenile produces new byssus threads and attaches to another mussel or to the adjacent substrate.

As the animals grow, they become more tolerant of environmental variations, and can live up to twenty years.

Spawning activity has not been monitored in Nantucket waters to determine if it occurs with regularity from year to year or if it varies; whether or not environmental stressors have reduced the spawning capacity in Nantucket waters; and what the ideal temperatures and salinities are for “normal” development.

Threats/Stressors

Predation by humans, birds (eider ducks in particular), and marine organisms is one of the main threats to blue mussels. Pressure from marine organisms is highest during the animals’ three-week stage as planktonic larvae. Predation is also higher among those animals with soft shells. As mussels grow and

their shells harden, they become prey for large predators such as gulls and oyster catchers, lobster, crabs, sea stars, conch, and a variety of fish. Mussels also must compete for settlement space, both with other species and with other blue mussels. As filter feeders, mussels in dense groupings can reduce the amount of available food in the water column. This can result in slowed growth and the migration of mussels to the outer edges of the beds to have access to more food.

Within mussel beds the attachment to each other can result in weak attachments to secure a substrate, which, in turn, can lead to entire beds being washed away during a significant storm event.

Water quality issues such as anoxia, or the lack of sufficient dissolved oxygen in the water, can harm mussels, depriving them of the oxygen needed to function. Blue mussels do have the ability to increase their efficiency of extracting oxygen, but if there isn't enough oxygen available to them (below 60% saturation), the increase in efficiency is not beneficial.

This species is used as a sentinel for red tide and other contaminants. Blue mussels are quite resilient to contamination—studies show that a 50% mortality rate in a mussel population would likely only happen in rare contamination events. However, while contamination may not kill the animals, it may affect some aspects of their physiology, such as their ability to spawn. One of the specific concerns related to the human consumption of mussels is Paralytic Shellfish Poisoning (PSP), a poisoning that results from the bioaccumulation of toxins produced by dinoflagellate algae during warm-water blooms. While PSP can affect all bivalves in Nantucket waters, mussels are specifically monitored to inform shellfish bed closures because, “they have the capacity to uptake and release toxins of ambient dinoflagellates in close temporal relationship to the actual duration of ... blooms” (DMF Shellfish Sanitation and Management, undated).

Human harvest may also put stress on the resource. When mussels are present, there is a significant recreational fishery. Given the variability in mussel populations, however, the fishery is not consistent.

Soft-shell Clams

(Unless otherwise noted, this section is based on Abraham & Dillon (1986).)

Biological characteristics and environmental requirements of the species

Mya arenaria have a thin and brittle chalky-white/grey egg-shaped shell. The average shell length is 75–100 mm, but can reach up to 150 mm. Due to the influences of water temperature on growth (colder water results in slower growth than warmer water), northern soft-shell clams, including those found in Nantucket waters, are often smaller than those found in warmer waters.

Ideal conditions for adult survival and growth are generally found in intertidal and subtidal areas with water depths of no more than 3–4 feet, temperatures less than 28 °C, salinities greater than 5 ppt, and “stiff” sands and muds that will not collapse against the shell valves when the shell is closed. Given a relatively limited tidal range, the Island does not support extensive clam flats except within narrow stretches along Nantucket Harbor and around the edge of some ponds (Kelley, 1986).

Spawning events are triggered by water temperature, with water temperatures affecting gonadal development and the release of gametes. Spawning usually happens once in the spring and again in the fall. Soft-shell clams begin to spawn around the age of five years. Larvae live in the water column for roughly 2–6 weeks, eventually settling to the substrate as a juvenile, anchoring to the ground via a byssus. The animals soon shed their byssus and burrow into the sediment, becoming sedentary adults. While adult soft-shell clams burrow into the sediment (up to 30 cm deep), juveniles move about the

substrate, and only burrow 1–2 cm, exposing themselves to wave action, resulting in the animal's common "clumped" distribution.

Growth of adult soft-shell clams is related to:

- Availability of phytoplankton
- Sediment type and bottom topography (growing best in sediments that can be easily penetrated),
- Density of clams (growing best when density is less than 25 clams/sq. ft.)
- Water temperature
- Size of clam (as clams get larger, their growth slows)
- Spawning activity (clams grow at greater rates when not spawning)

Threats/Stressors

In the early 1900s, soft-shell clams supported a small commercial fishery on Nantucket, but harvesting pressure, along with changing environmental conditions, is believed to have depleted the stock. As a result, harvesting is currently limited to recreational harvesting (Kelly, 1986). In addition to human pressures, soft-shell clams on Nantucket are also at risk of predation by moon snails, horseshoe crabs, green crabs, lady crabs, blue claw crabs, mud crabs, grass shrimp, flounder, and Canada geese (Kelley, 1986).

Issues related to water quality may also impact soft-shell clams by altering the biota so that soft-shell clams have more competition for space.

Because adults are sedentary and live in shallow and intertidal areas, they are often affected by coastal pollution resulting in closures to harvesting.

Conchs

Biological characteristics and environmental requirements of the species

Conchs include the channeled whelk (*Busycotypus canaliculatus*) and the knobbed whelk (*Busycon carica*), both of which are found in Nantucket waters. Most channeled whelk are brown or orange/yellow. The outside of their shells is often a yellow-ish white and is covered by minute hairs (Smithsonian Marine Station at Fort Pierce, undated). Their pear-shaped shell is spiraled with a series of small bumps and a deep channel along the top of the spiral. The channeled whelk can grow up to 8 inches in length (Marine Biological Laboratory, Undated).

The knobbed whelk's shell grows up to about 10 inches in length and has a ring of projections, or "knobs," along the top of the spiral (Marine Biological Laboratory, undated). The shell is usually tan to grey on the outside, although some have dark brown streaks on the outside. The inside of the shell ranges from dark red to orange to pale yellow.

Conchs live on most bottom types in subtidal bays, moving about with their strong foot. The foot lays a layer of "slime" which acts as a road upon which the conch can pull its body. It is believed that, during winter months, conchs move to more shallow areas, and then migrate to deeper water (up to 40–50 m deep) during the summer months.

These carnivorous animals are known to feed on bivalves, including burrowing clams, which they dig out of the sand and then pry apart.

Conchs reproduce by laying disk-like egg capsules which are joined together by a shared “spine.” One end of this string of egg capsules is buried in the sand, and within each capsule are approximately one hundred embryos including a mix of fertile and infertile eggs—the young resulting from fertile ones may feed upon the infertile ones. When the animals are approximately 3.175 mm in size, they crawl out of the capsules (Marine Biological Laboratory, undated).

Given the increasing importance of the conch fishery, as well as its invasive species status on the west coast (Cohen, 2011), more research is underway to better understand the movement, reproductive habits, and life cycle of the species and to manage the fishery accordingly.

Threats/Stressors

The largest threat to conchs seems to be from fishing pressure. Once thought of as a nuisance species, conchs are now caught and sold commercially—though some communities do still consider conch a threat to bay scallops and remove the egg cases from certain ponds (Edmundson, 2012). While the exact cause is not known, the Maria Mitchell Association has conducted surveys of Nantucket Harbor which show a decrease in the number of conchs since 2006 (Boyce, 2012).

SECTION 6: HISTORY AND DESCRIPTION OF NANTUCKET SHELLFISHING

Historical Significance of Shellfish

Shellfish resources on Nantucket have played an important role in shaping the Island's history, character, and economy; however the significance of the different species has changed over time. Human population growth, economic fluctuations, environmental alterations, and advances in science and technology have all influenced shifts in the abundance, distribution, and economic/social significance of Nantucket's shellfish.

The bay scallop fishery is currently the Island's largest commercial shellfishery in terms of the number of people employed and its economic significance; however this is a departure from the bay scallop's value among early European settlers who believed that the bay scallop was poisonous. Though they were eventually harvested in the early 1800s for bait, bay scallops were not commercially harvested for human consumption until the late 1800s (Andrews, 1980). Archeological explorations into the Native American diet on Nantucket also suggest that bay scallops were not consumed by Native Americans to the same extent as other local shellfish. The scallop shell, however, has long been used for decorative and religious purposes on Nantucket (Patrick, 2002).

Quahogs were a very important commercial shellfishery in the early 1800s, in part for their use as codfish bait for dory fishermen.

Conchs, on the other hand, were not valued for their commercial significance until relatively recently. Up through the 1960s, this predatory shellfish was seen as a nuisance, and fishermen who caught conchs as by-catch were encouraged to leave the conchs on culling boards to die. In the 1970s however, conchs became marketable. While the fishery has never been large two fishermen from Nantucket fish for conch today—mostly in Nantucket Sound.

In the mid-1800s, sea clams (which early European settlers also believed to be poisonous to humans) and soft-shell clams were harvested in great numbers for bait. Soft-shelled clams were also the principal shellfish consumed by locals in the mid 1800s, but they are no longer abundant in Nantucket waters.

Recreational shellfishing has also played an important role in shaping Nantucket's economic and cultural history. On average, approximately 1,700 family permits have been issued each year for the past ten years. Recreational fishermen turn out each fall to uphold a long-held family tradition. Their visits help bolster the Island's shoulder season economy through the purchases of rakes, buckets, gear, and lodging.

Presently, the only wild shellfish commercially harvested are conch, quahog, mussels, and bay scallops. In addition, oysters are also harvested through aquaculture. Recreationally harvested species include bay scallops, mussels, quahogs, soft-shell clams, and oysters.

The following sections focus on management topics for those types of shellfish currently commercially and recreationally harvested.

Past and Present Shellfish Management

Previous attempts at developing a management plan for Nantucket's shellfish resources have been written, and have been implemented to varying degrees (Kelly, 1981 and 1986; Norton, 2000; Starbuck,

undated). While no plan has ever formally been adopted, shellfish are currently managed through the application of a number of federal, state and local regulations and administrative practices. These management activities include the assessment of and protection against risks to human health, control of entry into the fishery, fishing effort, specification of fishing technologies, and fishery area management. The following sections describe available information about both past and current shellfish management on Nantucket, including: who shellfishes; when, where, and how people shellfish; catch limits; size regulations; aquaculture activities; and the shucking and selling processes.

Shellfish Licenses

Since the late 1800s/early 1900s (MacKenzie, 2008, Andrews, 1990) commercial shellfish harvesters have needed licenses in order to gather shellfish. The first commercial municipal shellfish licenses were issued to people having a legal residence on Nantucket for at least 12 months. The residency requirement was instituted as a way to prevent Cape Cod fishermen from taking bay scallops from Nantucket waters (Andrews, 1990). In more recent times, the license requirement has been expanded to include both commercial and recreational harvests and continues to distinguish between Nantucket residents and non-residents. The original state conch regulations of 1992 required a license to fish; and shortly thereafter it became a limited-entry fishery open only to people previously licensed to harvest conch. Originally, conch licenses were non-transferable, but they became transferrable in the late 1990s and remained so for approximately 10 years. Recently though, the licenses became non-transferrable again—in part to minimize demand for the fishery’s primary bait source, the horseshoe crab.

Licenses are obtained through application to the appropriate state or local agency and the payment of a license fee. The Town fee for a commercial shellfish license is \$150/species; the fee for a commercial bay scalloping license is \$250; the fees for annual non-commercial shellfish license are \$25 for residents, and \$100 for non-residents, and; the fees for weekly non-resident recreational licenses is \$50. (The original shellfish license fees were a dollar.) A commercial shellfish license (an individual commercial permit endorsed for shellfish) is obtained from the DMF and is required for an individual to land and sell shellfish to a licensed shellfish dealer. In addition, the harvester must have a DMF-issued Shellfish Transaction Card for identification purposes.

A license to allow an individual to harvest shellfish within the waters of Nantucket (up to 3 miles offshore) can be obtained from the Nantucket Department of Marine and Coastal Resources and is awarded as either a commercial or a recreational license. A commercial license is awarded for general shellfish or for bay scallop, and allows the holder to harvest, land and sell his/her catch to a licensed dealer. Obtaining a commercial license is restricted to residents of Nantucket and, in some cases, may require additional conditions (e.g., a designated apprenticeship period in the case of a bay scallop commercial license).

Residency as a license requirement for the Town’s Commercial and Resident Recreational Shellfish Licenses states that “The applicant must...live in the Town of Nantucket for at least one year, and maintain a domicile on Nantucket” (Town Code, §122-2). Additionally, licensees must now be at least 14 years of age (Town Code, §122-2). A Town shellfish license is only good for one year, and applications for bay scallop licenses need to be filed between January 1 and March 31 (Town Code, §122-2).

A recreational shellfish harvest license can be purchased by any individual who applies, and allows the holder to catch a limited harvest for personal consumption only.

There is no fee for people over 60 years of age who wish to obtain a senior citizen permit (Town Shellfish Regulations, §230-3). This free license is good for the rest of the fisherman’s life, and entitles him/her to harvest up to 2 bushels/day with commercial gear. However, the animals caught under this

license may not be sold. If a fisherman is 60 years or older and wishes to harvest in order to sell his/her catch, he/she must obtain a commercial license and pay the full fee. The 2012 Annual Town Meeting will address whether or not this senior citizen permit should be restricted to Town residents.

Regulations do not limit the number of commercial shellfishing licenses sold each year; however in the early 1980s, a survey of commercial scallopers showed that most (78%) were in favor of some type of limit on licenses. The majority of those surveyed (73.6%) also felt special allowances should be in place to assure that “native Nantucketers” could get a license (Kelley, 1986). At the time of the survey, the fishery seemed to be stable and doing well, and a management strategy report (which was never implemented) suggested not only that the number of licenses be capped at 400, but also that there be an effort requirement whereby a certain percent of a person’s income had to be obtained via shellfishing (Kelley, 1986). In 1983 the Town voted on and defeated an article to set a limit on the number of commercial licenses sold (Kelley, 1986), and the number of commercial licenses has never been capped.

Even without a cap, the number of people commercially fishing for shellfish on Nantucket has fluctuated over time and is associated with factors such as the economic and cultural significance of the resource, abundance of shellfish, start-up and operating costs, and economic conditions—with more people entering the fishery during difficult economic times and/or times of plentiful shellfish. The following plot (Figure 11) shows the different numbers of shellfishing licenses issued by the Town of Nantucket, as reported to and recorded by the DMF. Records are kept for different categories of licensees. It is worth noting that the non-residential licenses are only recreational, but are *not* included in the numbers listed as “recreational.” In looking at the data, specific trends can be noted, particularly the gradual increase in recreational licenses over the forty-year interval and a general decline in the number of commercial licenses since the early 1980s. Since 1997, the number of licenses in all categories appears to have stabilized at approximately 160 commercial licenses, 1,700 resident recreational licenses, and less than 100 non-resident recreational licenses. (The way that recreational license data are tracked will change now that the Town is offering a weekly recreational license.) ,

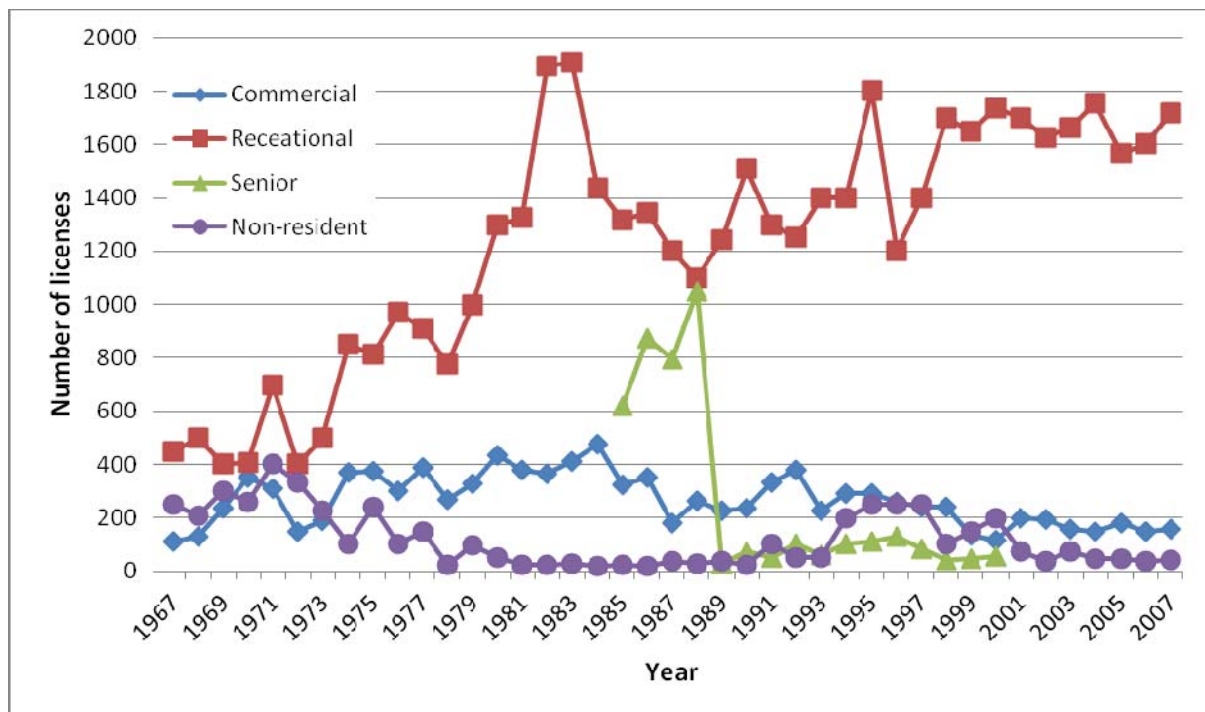


Figure 11: A plot of the total numbers of shellfish licenses sold between 1967–2007, as recorded by the DMF. The non-resident licenses are not included in the “recreational” license numbers listed, though they are both considered recreational. The Senior Citizen licenses (age 60 and older) were added to the recreational license numbers from 2001–2007. It is uncertain as to what caused the drop in Senior licenses in 1989. Updated commercial license numbers from the Town report the following totals: 153 (2008); 156 (2009); 164 (2010); and 160 (2011).

Shellfish Seasons

Times during which one can legally land shellfish are limited primarily by regulation, although natural conditions can influence harvest times as well. By dictating active harvest times, shellfish managers can protect populations during times of reproductive activity, allow juvenile members of the population to grow into a marketable size, and control the total landed amount to prevent an overfishing situation. The following harvest seasons have been established on Nantucket through regulations developed either at the state or town level (Table 2).

Table 2: A summary of the seasonal limits for landing shellfish species in the waters of Nantucket.

Species	Fishery	Season	Days/Week	Time of day
Bay Scallop	Commercial	November 1– March 31	Monday–Friday	6:30 am–4:30 pm
	Recreational	October 1– March 31	Wednesday– Sunday	Dawn–dusk
Quahog	Recreational	April 1–March 31	No restrictions	Dawn–dusk
	Commercial	April 1–March 31	No restrictions	Dawn–dusk
Oyster	Recreational	September 1– April 30	No restrictions	Dawn–dusk
Mussel	Commercial	April 1–March 31	No restrictions	Dawn–dusk
	Recreational	April 1–March 31	No restrictions	Dawn–dusk
Soft-shell Clam	Recreational	September 16– June 14	Sundays (all season); Saturdays (limited to December 15– March 31)	Dawn–dusk
Conch	Commercial	April 15– December 15	No restrictions	Dawn–dusk

The development of these seasons is influenced primarily by the need/desire to limit fishing effort, give the shellfish more time to grow, and improve safety conditions. For example, in 1992, in an effort to protect Massachusetts conchs from being overfished, the DMF issued size and catch limit regulations and regulations to establish a season and daylight restrictions for conch fishing.

While the history of the development of seasons for most shellfish species is not well-documented, much has been written about the limits placed on the commercial bay scallop fishery season. Those

limits, described below (and shown in Table 2 above), have been affected by changes in the demand for the bay scallop, changes in technology, weather conditions, and shellfish abundance.

The commercial season for bay scallops was first restricted statewide in 1885, when it was set at September 1–April 15. In 1896, it was further restricted to October 1–March 31 (Mackenzie, 2008). In 1910, the current commercial season (November 1–March 31 (Nantucket Town Code §122-12A)) was established; however people were allowed to harvest from April 1 until May 15 for the sole purpose of harvesting scallops for bait (Mackenzie, 2008). The restrictions on the start date were established in part to give scallops more time to grow before harvest, thus increasing the meat yield; and to accommodate the fact that people were typically employed through the fall and found it difficult to take time off for scalloping (Mackenzie, 2008).

The bait extension no longer exists, but the season has been extended in the past (pursuant to MGL CH 130 §73) due to abnormally good (e.g., 1968—where people were still bringing in their daily limits when the season ended in mid-April (Patrick, 2002)) and bad seasons (e.g., 2009—when only a handful of fishermen were still fishing) (Fisherman interview, 2010)), and seasons where fishermen lost several days of fishing because of poor weather conditions (e.g., 2004—when fishermen lost over forty days of fishing due to weather and the season was extended into the first week of April) (Town and County of Nantucket, 2004).

In seasons with poor catches, some believe that extending the season is not very useful because the bottom conditions are poor, the product is generally inferior to what it was earlier in the season, and few people are still fishing (Fisherman interview, 2011). In fact, in 1996, due to a poor harvest, the Harbor and Shellfish Advisory Board (SHAB) suggested that the Board of Selectmen *shorten* the season (both commercial and recreational) to make it end on January 1. Their arguments included the fact that most of the legally harvested animals have been caught by then; and shortening the season would protect eelgrass from being dragged over for the sake of catching only a few animals. (Patrick, 2002).

The bay scallop season was again changed in 1977 when a rule was established to restrict hours of harvesting to 6:30 am–4:30 pm. This rule was put in place primarily for safety and enforcement reasons (Patrick, 2008). Previously, commercial bay scallopers could harvest in the dark, making it difficult to perform inspections and rescues. Another reason for limiting the fishing day was the argument that limiting the hours fished each day might actually increase the number of fishermen fishing later into the season (Mackenzie, 2008).

Up through most of the 1950s, fishermen could harvest scallops Monday–Saturday. In the 1980s, scallopers advocated moving to a Monday–Friday work week (Kelley, 1986). The shortened week was enacted to extend fishing later into the season (Mackenzie, 2008) and to reduce the number of “part-timers” in the fishery (Kilburn, 1986). Additionally, fishermen advocated for a shortened harvest week because the catches on Friday and Saturday did not yield the same financial benefits for fishermen as did their catches earlier in the week—scallops caught on Fridays and Saturdays were not sold until Monday, so the product and prices associated with a Friday or Saturday catch were inferior to the products caught and sold earlier in the week.

While fishing is typically limited to Monday–Friday, the regulations still allow for a Monday–Saturday week in order to provide flexibility when holidays, weather, and ice conditions impact fishing during weekdays.

In addition to the aforementioned restrictions on the bay scallop season, natural conditions such as storms, extreme cold, and frozen harbors can keep people from fishing. (Historically, when boats fished under sail, a very calm day could also prevent people from fishing (Mackenzie, 2008)). While extreme

cold can be dangerous to fishermen, it can also cause death to seed exposed to the cold air during harvest. To minimize seed deaths due to exposure, a rule was established in 1983 prohibiting shellfishing if the air temperature fails to rise above 28° Fahrenheit by 10:00 am (Town Shellfish Regulations 230-1F). Extreme cold can also cause the Harbors to freeze over, preventing boats from leaving the docks for weeks at a time as it did in 2003, when Nantucket Harbor froze over twice during the shellfishing season (Town and County of Nantucket, 2003). On average, scallop boats are iced in 5–10 fishing days/season (Fronzuto, personal communication, 2011).

The Marine Superintendent can also close the commercial scalloping season when seed is stranded on the beach (Town Shellfish Regulations 230-1B).

Recreational scalloping, which begins a month before the commercial season, experiences the most activity in October while the weather and water are still warm; however some people do recreationally fish longer into the season.

Size Regulations:

Minimum size limits are frequently placed on a fishery to provide protection for juveniles within the population to allow them to attain an adult size before harvest. This not only ensures the optimal market value for the product but also generally includes an opportunity for an individual to attain reproductive maturity and reproduce at least once in its life cycle, prior to its removal from the population.

Table 3: State and Town regulations specify the legal size for harvested shellfish

Species	Size Rule	Source
Bay Scallop	Must have well-defined raised growth line	230 Nantucket Commercial Shellfish Regulations §1(B)
	Must have well-defined raised annual growth line at least 10 mm from the hinge of the shell. Exception: well-defined raised annual growth line located less than 10 mm from the hinge of the shell if the shell height is at least 63.5 mm (2.5 inches).	322 CMR §6.11
Quahog	≥ 1 inch thick;	322 CMR §6.20-2(a); 230 Nantucket Commercial Shellfish Regulations: §1(F)
Oyster	≥ 3.0 inches in longest diameter	322 CMR §6.20-2(c)
Mussel	≥ 2.0 inches shell length	230 Nantucket Commercial Shellfish Regulations §1(D)
Soft-shell clam	2.0 inches shell at longest diameter	322 CMR §6.20
Conch	2.75 inch shell width	322 CMR §6.21-2

The definition of a legally harvested bay scallop has been the topic of much debate in Massachusetts and on Nantucket over the past several decades. Current State regulations require that, “No person shall land or possess scallops without a well-defined growth line and that growth line shall measure at least 10 millimeters from the hinge of the shell.” The exception to that is when, “Bay Scallops...have a well-defined raised annual growth line located less than 10 millimeters (mm) from the hinge of the shell... [but have a] shell height...at least 63.5 millimeters or 2.5 inches” (322 CMR §6.11(2)). Shell height is measured in “a straight line from the middle of the hinge to the opposing valve margin” (322 CMR §6.11(1b)). Those scallops lacking a well-defined growth line are defined as “seed scallop” (322 CMR §6.11(1c)), and fishermen are prohibited from harvesting them because they have not yet reproduced.

In addition to adult scallops (with a well-defined growth ring at least 10 mm from the hinge) and seed scallops (with no growth ring present), there is a third class of scallop known as the “nub” scallop—a term for an adult-size scallop with a clear growth ring under 10 mm from the hinge. The nub scallops originate from a fall spawning and therefore it is believed that the nubs reach reproductive maturity late during their first summer of their lives. Come harvest time, as a one-year-old bay scallop, the nub scallop has no well-defined growth ring greater than 10mm from the hinge and has an unknown history of reproductive effort. There are two issues regarding the occurrence of nub scallops during the fall harvest:

1. The spawning patterns of a nub are unclear. Some believe that nubs, especially those with thick shells, spawn during their first summer and should be harvested like any adult. Others believe that nubs only spawn in their second summer and should be allowed to live and reproduce even if they die before they can be harvested.
2. Not all growth lines are obvious, making it sometimes difficult to distinguish nubs from large seed (young of the year).

If it is determined that a nub does spawn during its first summer, then it would seem logical to allow these animals to be harvested with normal adult scallops. However, the inability to reliably differentiate between a nub and a seed raises potential for the accidental removal of seed which have not reproduced. A study is currently underway, led by Ms. Valerie Hall, to address the issue of whether nub scallops do reproduce during their first summer and also will measure their survival behavior over the course of their life cycle.

Previously, scallopers were prohibited from harvesting nubs because of the 10 mm requirement. Just prior to the 2008–2009 season however, estimates suggested that 85% of the harvestable scallops were nubs and it was projected that enforcing the 10 mm rule would lead to a disastrous season. The Town of Nantucket and Nantucket fishermen petitioned DMF to review the regulations. Ultimately, the 2.5” shell height exception was added to the regulations as a way to exempt the 10 mm rule while still imposing some limits on the harvesting of nubs. (The shell height exception allowed the harvest of an estimated 43% of the nubs, protecting 57% from being harvested (Town and County of Nantucket, 2009).) Nantucket proposed a 1” shell thickness (shell inflation) rule as a better exception measure than the 2.5” shell height measure but DMF was unwilling to change its decision based on research limited to Nantucket (Town and County of Nantucket, 2009). See Appendix I for more information on this change to harvesting criteria.

One additional concern from fishermen favoring the shell-thickness rule is that the current 10mm rule and the 2.5” shell height measurement prevent the catch of those adult scallops who are believed to

have spawned, but do not meet either of the criteria for harvesting (Dutra, Personal communication, 2012).

Catch Limits

Overharvesting is a common problem in wild harvest fisheries, leaving too few reproductive individuals to sustain the population. One strategy to reduce the risk of overharvesting is to limit the amount of animals that can be harvested in any season. Catch limits are a common management strategy that has proven to be an effective means to control the level of harvest and protect spawning biomass.

Rather than employ true catch limits, Nantucket's shellfisheries manage the catches of each fishermen. The current regulations for catch limits on Nantucket are presented in Table 4.

Table 4: A summary of the catch limits for shellfish harvested in the waters of Nantucket. Where State and Town limits both exist, shellfishermen are held to Town limits while fishing in Town waters.

Species	Fishery	Catch Limit per License	Source
Bay Scallop	Commercial	5 Town-approved boxes/day	230 Town Commercial Shellfish Regulations §1(E)
		10 bushels/day	130 MGL §72
	Recreational	One bushel/week	230 Town Recreational Shellfish Regulations §5(D)
Quahog	Commercial	Up to 10 Town-approved boxes/day	230 Town Commercial Shellfish Regulations §1(F)
	Recreational	Up to one ten-quart bucket/day; up to one-half (.5) bushel/week	230 Town Recreational Shellfish Regulations §5(F)
Oyster	Recreational	One-half (0.5) bushel/week	230 Town Recreational Shellfish Regulations §5(E)
Mussel	Commercial	Up to 10 Town-approved boxes/day	230 Town Commercial Shellfish Regulations §1(G)
	Recreational	One bushel/week	230 Town Recreational Shellfish Regulations §5(F)
Soft-shell Clam	Recreational	One ten-quart bucket only to be taken on Sundays	230 Town Recreational Shellfish Regulations §5(H)
Conch	Commercial	200 pots at any given time (no limit on lbs.)	322 CMR §6.15(2)(b)

Up until the late 1880s, shellfishermen were free to take as many shellfish as they could physically load in their vessel. However, in the late 1890s Massachusetts imposed a 25-bushel/fisherman limit for bay scallops (Mackenzie, 2008). In 1910, the bay scallop limit in Massachusetts was further reduced to 10

bushels per person. In 1944, a Nantucket fisherman's association successfully petitioned the Board of Selectmen to lower the Town's catch limit to 4.5 bushels/person; but that was increased to 6 bushels sometime in the late 1970s (Nantucket Planning and Economic Development Commission, 1980), and then rose to about 12 bushels in the late 1980s (Fisherman interview, 2011). In the early 1990s, a 5-bushel limit was established on Nantucket (Kelley 1986; Patrick, 2002). That 5 bushel limit stands today, with a maximum of two licensed fishermen per boat (i.e., 10 bushels/boat) (122 Nantucket Town Code §12D). The most recent round of catch limit reductions were seen as a way to prevent people from landing too many animals too early in the season, thus flooding the market with product (Mackenzie, 2008). When appropriate (for example, due to an abundance of adult scallops still in the water at the end of the season or the loss of several fishing days due to weather conditions), the Board of Selectmen has temporarily raised the bushel limit. For example, in 2005 they raised the limit to six bushels/license for the last five days of the season.

In addition to the limit modifications, changes were made regarding the containers used to hold scallops. Prior to limits, people often held their scallops in woven coal baskets. From the early 1900s up to the mid 1900s, people used state-issued burlap bags (Mackenzie, 2008). Current regulations require fishermen to use boxes which they purchase from the Town (Town Shellfish Regulations §230-1D).

Bushel limits can be used as a means to penalize or incentivize certain behaviors. For example, if a fisherman is caught with more bushels than is allowed, he/she must take off one day for every extra bushel in his/her possession. Along similar lines, an incentive to encourage fishermen to assist with seed management (strandings and relocation) and research activities (e.g., deploying spat bags and spawning cages) might include allowing the harvest of extra shellfish.

Unlike bay scallops, there is no real limit on the number of conchs that can be harvested. Instead, conch fishermen are limited to fishing no more than 200 pots in the water at any given time, and can take as many conchs as these pots can catch on any given day.

Information about the development of catch limits in other commercial or recreational shellfisheries in Nantucket waters is sparse.

Harvest Documentation

Until recently, most information about commercial bay scallop harvests was obtained through the Town's observations of how many people fished each day, in combination with estimates of total catch per fisherman, and inspections at landing sites. While these numbers were likely decent approximations of harvests, they provided no official record of locations harvested. Until 2010, these numbers were reported to the State, serving as the primary means of obtaining commercial bay scallop data from Nantucket waters. Estimates were also developed at the Town level related to the average price per pound of bay scallop for each season, and the resulting total amount earned from the sale of bay scallops.

While the Town has been the primary source of data for the State for the past several decades, a comparison of Town and State records for bay scallops shows a discrepancy for some years. The causes for the discrepancies are unclear.¹ Furthermore, no specific procedure is required in terms of how the

¹ The data in Table 5 have been changed from their original form. The State's original record of bushels from 1966–1988 was previously listed as being from 1967–1989, but was one year off of the Town's records. This may have been due to the difference in how the State and the Town referred to the seasons (i.e., the State may have referred to the 1978–1979 season as the 1979 season while the Town referred to it as the 1978 season). Efforts

Town acquires its numbers; so while the current system of observation now exists, prior managers may have had different means of obtaining their information—making it difficult to compare data for all years.

This comparison demonstrates the need for more accurate records of bay scallop harvests.

Table 5: The Town's data for commercial shellfish landings illustrates the general downward trend in the number of licensed fishermen, and bushels of scallops harvested, as well as the general increase in the average price/pound. (*Several hundreds of bushels of seed were lost due to major storm events; ** Massive shellfish strandings occurred; ***Average yield was 5.5 pounds instead of the state average of 7.5 pounds.)

were made to clarify the discrepancy, but officials at the State and Town could not explain the apparent shift. (The column showing the differences between Town and State records refers to the differences in the *adjusted* data.) The State also noted that they have not received data from the Town since 2007, so State data since then is what has been reported in the local newspaper. Despite the discrepancies in data, this table shows the general declining trend in catches. The recent implementation of the Standard Atlantic Fisheries Information System (SAFIS) reporting mechanisms will hopefully reduce such issues going forward.

Year	# Licenses	Bushel record (from DMF)	Bushel record (from Town)	Difference between State and Town records
1966	n/a	10,330	n/a	
1967	n/a	37,000	n/a	n/a
1968	n/a	68,000	n/a	n/a
1969	n/a	56,000	n/a	n/a
1970	n/a	60,000	n/a	n/a
1971	n/a	36,000	n/a	n/a
1972	n/a	42,000	n/a	n/a
1973	n/a	44,100	n/a	n/a
1974	n/a	90,000	n/a	n/a
1975	n/a	65,000	n/a	n/a
1976	n/a	56,400	n/a	n/a
1977	n/a	40,000	n/a	n/a
1978	329	59,000	59,000	0
1979	435	96,000	96,000	0
1980	379	117,600	117,000	600
1981	331	77,975	77,900	75
1982	304	50,000	50,000	0
1983	294	48,300	48,300	0
1984	326	36,600	36,600	0
1985	300	38,000	38,000	0
1986	240	12,300	n/a	n/a
1987	260	23,000	23,000	0
1988	280	25,000	25,000	0
1989	252	--	48,000	n/a
1990*	440	44,000	44,000	0
1991*	330	27,024	27,000	24
1992	340	28,907	24,000	4,907
1993	320	12,250	13,000	(750)
1994	260	27,000	28,000	(1,000)
1995	240	1,500	13,391	(11,891)
1996	250	10,000	11,100	(1,100)
1997*	270	4,100	8,000	(3,900)
1998	239	3,333	5,800	(2,467)
1999	137	14,000	14,000	0
2000	117	12,500	15,000	(2,500)
2001	197	14,500	14,500	0
2002	195	13,900	13,900	0
2003	157	15,600	15,600	0
2004	150	32,500	32,500	0
2005	179	5,500	5,500	0
2006	147	3,800	3,800	0
2007**	161	16,800	16,800	0
2008	153	n/a	8,900	n/a
2009***	156	18,116	13,800	4,316
2010	164	6,916	7,000	(84)

As of 2010, however, all shellfishermen working in Nantucket waters are now required to submit reports to the State using the Standard Atlantic Fisheries Information System (SAFIS). These reports are not limited to bay scallops, and will provide more robust information on other commercial species not recorded in detail at the Town level. Information includes species fished, time spent fishing, gear used, total catch harvested, and dealers sold to for each fishing trip. Despite the new SAFIS reporting, Nantucket will continue to collect data about bay scallop harvests through observations, and report this information to the State. The two sources of data, analyzed together, may help paint a more accurate picture of what is being harvested.

It should be noted that there are incentives for fishermen to over report (if an event occurs whereby fishermen are prohibited from fishing, and they are compensated based on previous catches, their compensation will be greater if they have over-reported their catch) and under report (for tax purposes).

Recreational shellfishers are not required to report their catches to anyone; however the Nantucket Marine Department does ask people to provide information about last year's catch (species and quantities caught, and locations fished) when they apply to purchase a license for the following year.

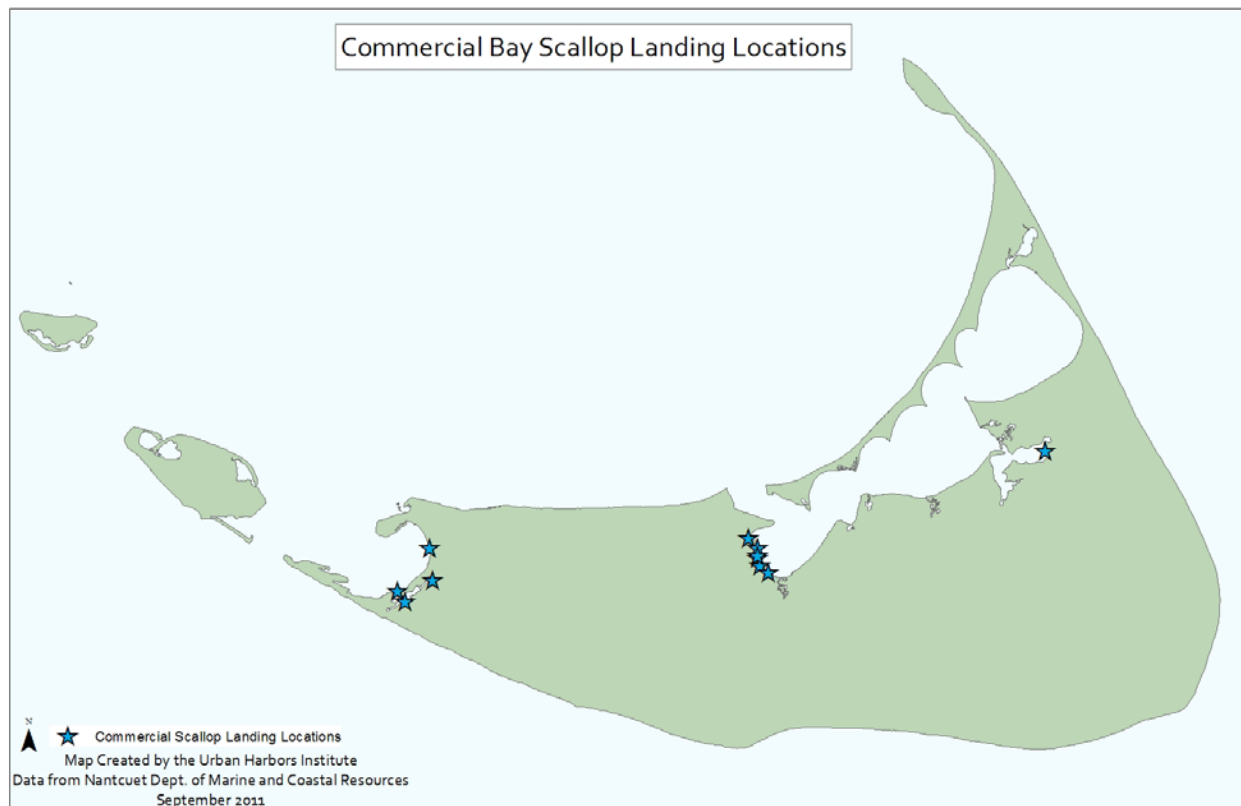


Figure 12: Commercial fishermen typically bring their bay scallop harvests to shore at the locations identified in this figure. The relatively limited landing locations allow for some inspection of harvests. While these inspections are in part meant to ensure that the shellfish are of legal size, the inspections also provide important information about how many bushels are being caught. Other species are also landed at some of these locations

Area Closures:

Area closures prohibit all shellfish harvest activity within a designated area. This strategy is used for a multitude of reasons. First and foremost, area closures are mandated in some areas, based on the risk of shellfish harboring human pathogens, to prevent the outbreak of human illness from the consumption of contaminated shellfish. It is DMF's responsibility to monitor all active shellfish harvest areas, using coliform bacteria as an indicator of potential health risk, and to assume control and closure of areas that exceed federal standards for the presence of pathogenic bacteria areas impacted by harmful algal blooms. The standards for these areal closures are set by the Commonwealth, following guidelines from the Interstate Shellfish Sanitation Conference, and are jointly implemented by DMF and the MA Department of Public Health. One area in particular which experiences seasonal closures from time to time is the area known as "NT2.3." This area extends the existing closure in Nantucket Harbor to the east, and includes the part of the Harbor that is southwest of a line drawn from the lighthouse at Brant Point to the northern end of Boston Avenue.

The bay scallop is not often subject to these water-quality-based closures given that the only part generally consumed by humans is the adductor muscle, which does not typically accumulate pathogens.



Figure 13: Water quality influences where shellfish can be safely harvested, as indicated by the closed areas identified by DMF. Additionally, there are historical seasonal closures in Madaket Harbor every July 1–December 31 due to high fecal coliform counts. Sesachacha Pond is undergoing testing to have it re-classified as restricted.

Local area closures can also be mandated by the Town. The Board of Selectmen or the Marine Superintendent (in consultation with the SHAB) can close an area to harvesting if that area is determined to be predominantly bay scallop seed (230 Town Shellfish Regulations §1G). For example,

Madaket Harbor was closed to bay scallopers most recently in the later part of the 2010–2011 season due to the abundance of seed and almost no legally harvestable adults.

Additionally, areas may be closed to create spawning sanctuaries in which bay scallops are left, undisturbed, to spawn. The Town has only identified spawning sanctuaries on a few occasions in First Bend and Second Bend (most recently in 2007), but the effects of sanctuaries were not monitored, and Town effort has been redirected to focus more on spawning cages and the release of shellfish larvae.

Other reasons for area closures may include habitat protection, protection from overfishing, or for other management strategies.

Shellfishing Methods and Equipment

The methods used to harvest shellfish are highly varied and often species-specific. Therefore, it is impossible to discuss the myriad of fishing technologies that may be in use on Nantucket. The primary fishing methods for each of the commonly fished species are included below.

Bay Scallops & Mussels

Methods for harvesting scallops have changed over time. In the late 1800s, some people commercially harvested scallops using pushers and hand rakes while either standing on the flats or while standing in small drifting boats. Pushers were wooden poles with rectangular iron frames and net bags attached to the bottom (Mackenzie, 2008). They would pile their catches into rowboats or onto horse drawn wagons which came out onto the flats for loading (Andrews, 1990) and would bring them to the shanties for opening.

Those fishing by boat in the late 1800s fished from a wooden oar-propelled rowboat or a flat-bottom boat known as a dory. A dory typically measured approximately 15–17 feet in length and was unstable while dredging. Catboats, which were longer (typically 18–23 feet long) and more stable than the dory due to a center-board or keel, became popular in the late 1800s and were used to dredge for scallops under sail up until the 1920s. Their shape allowed fishermen to tow several dredges at a time. Fiberglass boats entered into the fishery in the 1960s (Mackenzie, 2008).

Sail-powered vessels such as the dory and catboat were difficult to maneuver, especially while towing dredges. The inboard gasoline engines of the early 1900s provided a new form of propulsion (albeit small and sometimes problematic). The outboard motors of the 1930s largely replaced sail-power for shellfishing, and wooden boats, known as skiffs, began to replace catboats. The advent of the outboard motor allowed boats to operate in new locations and were better suited to work in the Harbors when there was ice.

While pushers and hand rakes were initially popular in the industry, dredges, introduced around 1874 (Patrick, 2002), are now the most common means of harvesting scallops commercially. There are different configurations for dredges, but all include some sort of iron bridle, a bag made of twine, and a bottom made of metal rings.

Today, bay scallops are primarily harvested by towing dredges behind a boat. Shellfishermen hand-hauled their dredges until the 1960s, when motor-powered hoists, known as “donkey engines,” became available (Mackenzie, 2008, Patrick & Benchley, 2002). Motor-powered hoists encouraged some fishermen to use heavier dredges, but §203-2 of the Code of Nantucket now limits the weight of dredges to no more than 40 pounds. Power hoisting is allowed, but is limited for use only on dredges no more than “twenty-eight inches wide [and] seven rings deep.” Additionally, the bag on a power-hoisted dredge cannot be more than eighteen mesh long.

In addition to harvesting with dredges and a boat, a few divers use SCUBA equipment to gather bay scallops by hand.

Recreational scallopers are legally allowed to harvest scallops in any manner they choose as long as it does not involve a motor- or sail-powered boat or a dredge. While some people dive for bay scallops, many recreational fishermen use rakes to harvest their shellfish.

Commercially, mussels can also be harvested using a dredge that is very similar to the bay scallop dredge. Recreationally, mussels are generally hand-picked from exposed or shallow areas.

Quahogs

Quahogs were once commercially harvested with hand rakes (MacKenzie, 2008). Tongs were introduced to access hard bottoms that rakes could not break open. By the 1920s, most people used box rakes, described as “rectangular frames with teeth on the bottom, spaced one and one-quarter inches apart according to the size of the clams in the bed, and a basket of iron rods on top.” (Andrews, 1990) Bull rakes, consisting of “large semi-circular teeth attached to a single bar” were used for deeper water and muddy bottoms (Andrews, 1990).

Today, quahogs and other burrowing clams are routinely harvested recreationally with some form of digging implement operated by hand. It conventionally has some form of tines that penetrate into the sediment either to remove the quahogs that lie near the surface or to remove sediment for access to clams, such as steamers, that can dig deeper.

Conchs

Conchs are harvested by deploying pots on the seafloor and pulling them to the surface. Typically a square or rectangular “box,” conch pots measure 8–10 inches in height and 20–22 inches to a side on average. Conch pots are traditionally framed in hardwood with pine lath sides of various widths (1 ½–4 inches). The bottom consists of 35–45 pounds of poured concrete which provides the weight necessary to keep the pots on the seafloor. The top of the conch pot is open, with a wire mesh baffle overhanging the perimeter of the top of the box to prevent the shellfish from escaping. Recently, traps have been produced with wire instead of wood and concrete. These wire traps are weighted with bricks placed inside the pot (Herr, 2011, Personal communication). State regulations limit conch fishermen to no more than 200 pots at any given time (322 CMR 6.15) and limit vessel length to 90 feet or less (322 CMR 8.05).

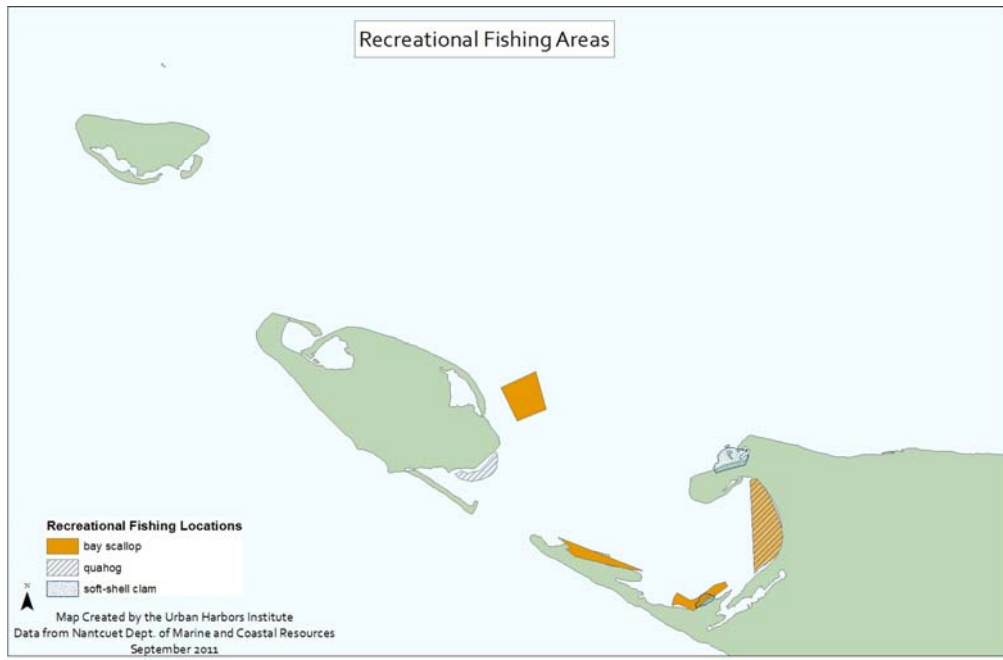


Figure 14: Recreational Fishing Locations in Madaket Harbor. While the locations for commercial shellfish harvesting broadly include those areas with shellfish, many recreational fishermen harvest in shallow waters. Recreational harvesting with SCUBA gear often takes place in deeper water (not shown on this map).

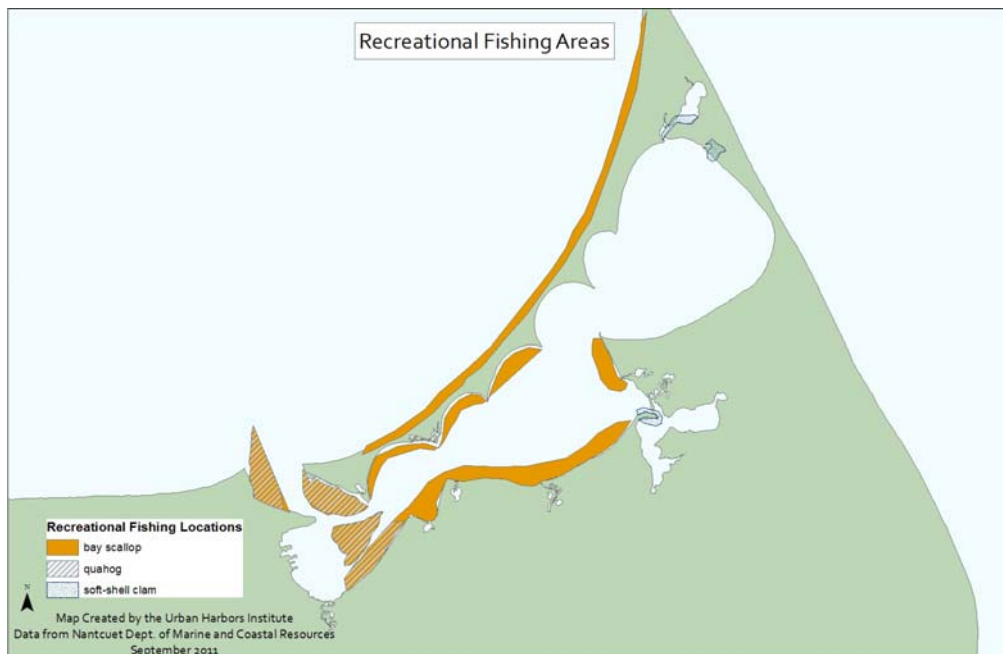


Figure 15: Recreational Fishing Locations in Nantucket Harbor. While the locations for commercial shellfish harvesting include those areas with shellfish, many recreational fishermen harvest in shallow waters. Recreational harvesting with SCUBA gear often takes place in deeper water (not shown on this map).

Shucking & Selling

While there have been many changes in methods and technologies related to harvesting bay scallops, the process of opening bay scallops has remained relatively unchanged. In the late 1800s and early 1900s, scallops were harvested and then brought to land to be opened. Up until the mid- 1980s, shellfishermen used to bring their catches back to shore and open them where it was most convenient, such as in a basement, kitchen, or living room (Patrick, 2002). Opening was sometimes conducted by school children, fishermen, their wives, and other family members (MacKenzie, 2008).

Nantucket Health Department regulations now require that all scallops be opened in a licensed shanty. Licensed shanties include those at fishermen's private residences, those provided by wholesalers in exchange for the exclusive right to buy their catch, and those (not operated by a fisherman or wholesaler) that employ non-fishermen to open the shellfish. Nantucket Board of Health regulations have been developed to supplement those provisions found in federal and state law as they pertain to the "handling, processing, and storage of potentially hazardous food" (Board of Health Regulations 37.00).

Shucking facilities must be enclosed and used solely for the purpose of opening shellfish, and guidelines exist regarding the construction of the facilities so as to minimize contamination or human health risk (Board of Health Regulations §37.01) and safety concerns. The Board of Health also regulates the utensils and equipment used to open shellfish (Board of Health Regulations §37.04-37.05) and the specifications for storing, packing and refrigerating opened shellfish (Board of Health Regulations §37.08-37.10). Additional shanty standards are outlined by the Code of Massachusetts Regulations (105 CMR 533).

Estimated numbers of licensed shanties are as follows (Ray, 2010, Personal communication):

Table 6: The number of licensed shucking facilities on Nantucket has ranged from as high as 38 (1997) to as low as 12 (2007).

Year	# Licensed Facilities
1994	29
1995	26
1996	32
1997	38
1998	34
1999	22
2000	22
2001	23
2002	21
2003	19
2004	18
2005	16
2006	No data
2007	12
2008	18

2009	20
2010	20

Fishermen sell their catch to one of the local buyers such as Sayles Seafood, Glidden's Island Seafood, and Souza's Seafood (which in turn sell to wholesalers or directly to restaurants off-Island), to one of several smaller buyers who have accounts with retail markets or restaurants off-Island, or obtain a license and sell the product themselves. Only about 3,000 pounds of scallops are sold on-Island during the season because most restaurants are closed during the fishing season.

In some cases the fisherman is selling the meats from scallops opened at a licensed shanty owned by the fisherman or by independent openers; in other cases fishermen sell unopened scallops to an independent shanty or to a shanty associated with the buyer. In this latter case, the buyer purchases all of the scallops opened in the shanty. There is a chain of custody that runs from the harvester, through the opener and wholesaler, and to the restaurant or retail market. Scallops are shipped off-Island by airplane or ferry in refrigerated containers.

Marketing

Nantucket bay scallops, widely appreciated for their distinct texture and flavor, often fetch a higher price at market than do other types of scallops. For this reason, it seems that some products marketed and sold as Nantucket bay scallops, are not harvested from Nantucket waters. Competition from falsely marketed product can lower the price of the true Nantucket bay scallop, and can change the perception of the resource's quality.

As scalloping has transitioned from an income supplement to a primary source of off-season income, a desire has grown among fishermen (and wholesalers) to brand the Nantucket bay scallop in such a way as to prevent the sale of other shellfish under the label of Nantucket bay scallops.

One way to brand the bay scallop is to physically modify the appearance of the shell, giving the Nantucket bay scallop a distinguishing mark such as a specific colored line in its shell. This has been done with some success on Martha's Vineyard (Karney, Undated).

Another alternative is to develop a sticker or label that can be placed on all boxes of Nantucket bay scallops. While this may be the easiest way to indicate that a product is indeed from Nantucket, it also does little to prevent people from making counterfeit stickers to place on boxes containing something other than Nantucket bay scallops.

Yet another option is to form a cooperative among shellfishermen, and communicate a collective message about the factors that make the Nantucket bay scallop so unique. The marketing message could include information ranging from descriptions of the product's taste and texture to the fact that this is one of the last bay scallop fisheries in the country and that it supports a long-held tradition of commercial shellfishing for this special island community. In addition to branding the Nantucket bay scallop for marketing purposes, this type of information can also be used to educate people about the importance of the Nantucket bay scallop and the economically and culturally significant industry it supports. While past efforts to form a fishermen's cooperative on Nantucket have not been successful, a cooperative specifically focused on marketing and branding may have more buy-in than those more broad proposals of the past. See Appendix G for more information on cooperatives.

While the primary concerns for shellfish marketing pertain to the bay scallop, the aforementioned approaches to marketing could potentially be applied to other commercial shellfish as well.

Having the ability to prove that a bay scallop originated from Nantucket waters could also help prevent the intrusion of imitation scallops into the market. The University of Massachusetts Boston is conducting research that (1) creates a catalog of scallops from known locations in Nantucket waters, (2) analyzes the geochemistry of the growing edge of the shell to identify chemistry of the particular habitat, and (3) build a classification model that will help identify the geographic origin of a bay scallop (Hannigan, January 4, 2012, Personal communication). Similar work with the scallop meat is in the initial stages of research.

See Appendix H for examples of seafood branding and marketing initiatives.

Town Structure for Managing the Resource

Both the Commonwealth and the Town have a role in managing shellfish resources in Nantucket waters.

Under its Shellfish Project, the DMF designates “shellfish growing areas”—areas of potential shellfish habitat. Growing areas are managed with respect to shellfish harvest for direct human consumption, and comprise at least one or more classification areas. The classification areas are the management units, and they range from being approved to prohibited with respect to shellfish harvest. The six classification types are:

- **Approved**—Open for harvest of shellfish for direct human consumption subject to local rules and State regulations.
- **Conditionally Approved**—During the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and State regulations.
- **Conditionally Restricted**—During the time area is restricted it is only open for the harvest of shellfish with depuration (i.e., purification in through the filtration of clean water, in a State-run facility) subject to local rules and State regulations.
- **Restricted**—Open for harvest of shellfish with depuration subject to local rules and state regulations or for the relay of shellfish.
- **Management Closure**—Closed for harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.
- **Prohibited** -- Closed for harvest of shellfish.

In addition to managing growing areas, DMF also qualifies areas and issues licenses for aquaculture, maintains records on various elements of the fisheries (including catch and effort information for recreational and commercial fisheries), conducts inspections, and sets and enforces regulations such as size and harvest limits and gear specifications.

While the State has jurisdiction to set broad limits on shellfish harvesting, The General Shellfish Act of 1880 gave town selectmen powers to regulate shellfish in their municipal waters. Boards of Selectmen can refine the State’s regulations—as long as they don’t conflict—to fit the needs of the communities and the resources (MacKenzie, 2008).

Management of Nantucket’s shellfish is also partly under the purview of Nantucket’s Marine and Coastal Resources Department (MCRD). The MCRD employs up to four full-time shellfish wardens who are responsible for the day-to-day enforcement of shellfish regulations during the commercial and recreational shellfishing seasons. In addition to the shellfish wardens, the Town also employs a shellfish biologist. The shellfish biologist is responsible for research related to Nantucket shellfish, monitoring of shellfish and shellfish habitat, and working with other research entities to enhance the scientific

understanding of shellfish and shellfish-related topics. Additionally, the shellfish biologist is responsible for coordinating all Town shellfish propagation activities.

The MCRD is also responsible for issuing commercial and recreational shellfishing permits, makes recommendations on aquaculture leases, and works with state and federal entities to ensure proper management of the local shellfish resources.

In addition to the MCRD, the Board of Selectmen is involved in the development and approval of plans related to shellfish, helps define policies and goals for the efficient management of the shellfish and related resources, and issues aquaculture licenses (with input from MCRD and SHAB). For example, at the suggestion of the Town Biologist, the Board of Selectmen can vote to close a seed area to harvesting (230 Nantucket Recreational Shellfish Regulations §5B).

The Board of Selectmen is advised by the Harbors and Shellfish Advisory Board (SHAB), established by Chapter 465 of the Special Acts of 1976. The elected seven-member board makes recommendations to the Board of Selectmen on matters pertaining to shellfish and the waters of Nantucket, including recommendations on appointments of the harbor master and shellfish wardens and their duties. The Mission of SHAB is, "...to advise and make recommendations to the Board of Selectmen about the effective and appropriately balanced management and use of Nantucket's marine resources both now and for the future." (Town of Nantucket, Undated) SHAB's guiding principles focus on ensuring balanced use of Nantucket's waters, minimizing human impacts to Nantucket's waters, ensuring the sustainability of the Island's natural marine resources, promoting biodiversity of marine life, and supporting the implementation of related management plans adopted by the Town.

The Health Department is also involved in managing the resource, once it is harvested, in that it issues licenses for shellfish shucking facilities and enforces the regulations for those facilities.

SECTION 7: AQUACULTURE, PROPAGATION, AND SEED MANAGEMENT ACTIVITIES ON NANTUCKET

Aquaculture

Nantucket has had shellfish aquaculture operations in Town waters since the 1980s. As of 2011, there were six private aquaculture licenses and municipal propagation areas encompassing a total of 46 acres between the Head of the Harbor and Pocomo Meadows. As of October, 2012, individuals have expressed interest in developing aquaculture at all approved areas, with the exception of four acres set aside by the Town. The predominant species grown is the American oyster, although growers have expressed interest in diversifying their crops beyond the single species.

Chapter 130 §57 of Massachusetts General Laws gives cities and towns the authority to issue shellfish aquaculture licenses authorizing licensees, “(1) to plant and grow shellfish, bottom/off bottom culture; (2) to place shellfish in or under protective devices affixed directly to the tidal flats or land under coastal waters, such as boxes, trays, pens, bags, or nets; (3) to harvest and take legal shellfish; (4) to plant cultch for the purpose of catching shellfish seed; and (5) to grow shellfish by means of racks, rafts or floats.”

Those seeking to conduct aquaculture activities in Nantucket waters must first obtain permission from the Board of Selectmen (who are advised by the MCRD and SHAB), and subsequently a license from the Commonwealth. More specifically, the application process includes notification of the Board of Selectmen, a public hearing followed by a preliminary approval by the Selectmen, site inspection by DMF, approval at the federal level, lead by the US Army Corp of Engineers, and final approval by the Selectmen. The applicant must also secure a permit to possess seed shellfish.

In 2011, the Town put together a working group to update its aquaculture licensing guidelines. Of particular interest are:

- Establishing qualification criteria for license holders,
- Requiring a business plan from license applicants,
- Creating guidelines for placing moratoria on new leases,
- Clarifying the rules for transferring a license,
- Defining an appropriate site inspection schedule, and
- Creating a standardized reporting form.

A designation of bottom land for shellfish aquaculture in Nantucket is valid for three years, can be extended for up to ten years, and must be for an area between two and ten acres in size (Nantucket Marine and Coastal Resources Department, 2010). License holders must meet the same residency requirements as those eligible to obtain a commercial shellfish license (i.e., they must be at least 14 years of age, live in the Town of Nantucket for at least one year, and maintain a domicile on Nantucket (122 Code of Nantucket, §2)). The applicant must present a production plan outlining the acreage requested, the method of shellfish cultivation, the equipment to be used, the amount of seed purchased for cultivation (for one year), and a grow-out density plan (Nantucket Marine and Coastal Resources

Department, 2010). In order to issue licensed areas competitively, applicants must also provide a list of qualifications.

Per the draft document titled “Guidelines for Lease of Bottom Land for Aquaculture” (Nantucket Marine and Coastal Resources Department, 2010), once the license is issued, the license holder must:

- *“...Maintain the licensed site in a neat and environmentally responsible manner*
- *...Plainly mark the area in accordance with any stipulations set forth by the Marine & Coastal Resources Department [and Section 61 of MGL Chapter 130]*
- *...Make the site available to the Town, or its designee, for the purpose of determining activity at the site and its impact on the surrounding areas*
- *...Provide the Marine & Coastal Resources Department with quarterly reports of its activities including the number of bushels of each type of shellfish planted, produced, and marketed along with an estimate of the remaining number of shellfish still growing at the site...[and] accounts of predators (species, quantity, size). These reports shall be filed within 30 days of the end of each quarter, beginning on January 1*
- *...Provide visual certification and verification of all seed to be grown on the site. Verification will also be made by the State Division of Marine Fisheries*
- *...Provide the Town with certificates of insurance against environmental damage and general liability in the amount of One Million (\$1,000,000) dollars*

Licenses may be revoked if the licensed area is not “actively worked” (Nantucket Marine and Coastal Resources Department, 2010). Consistent with 130 MGL §57, licenses may also be revoked “for failure to comply with any terms conditions or regulations set forth by these entities” (130 MGL §57) or for failure to pay the license fee of \$25/acre (or less) within six months after the fee is due (130 MGL §64). All money from shellfish aquaculture licenses accrues to the Town’s Shellfish Propagation Fund.

Since 1982, the State has approved seven shellfish aquaculture projects in Town waters (including a license to the Town) (Division of Marine Fisheries, 2011, Personal communication). Six licenses, all for oysters, were in effect in 2011. Interest in aquaculture has grown considerably in 2012, and with the exception of four acres retained by the Town, all approved areas are either licensed or in the process of being licensed for aquaculture activities.

Table 7: Nearly 50 acres were licensed for aquaculture projects in Nantucket waters in 2011.

Location	Acres	Number of Licenses
Coskata Pond	10	1
Pocomo Meadows	6	2
Head of the Harbor	30	4

Nantucket also maintains its own aquaculture operations on 16 acres in Nantucket Harbor (Fronzuto, 2011, Personal communication). Though the Town keeps records about the amount of seed used in aquaculture operations, it is difficult to know what the actual harvest numbers are.

The ability to issue aquaculture licenses is limited, in part, by the number of acres of bottom that the Division of Marine Fisheries deems suitable for aquaculture. The criteria used to determine whether or not an area is suitable are: (1) the overlying waters must be classified as Approved, (2), the area does not contain sustainable populations of naturally occurring shellfish (3), the activity does not “cause substantial adverse effect on the shellfish or other natural resources of the city or town” (130 MGL §57). The Town is working to have additional areas qualified for aquaculture, including areas in Polpis Harbor (which were closed because of issues believed to be related to nearby septic systems) and Sesachacha Pond.

Legal harvest sizes differ between wild-caught and aquacultured shellfish. Unlike wild-caught oysters, which must measure at least three inches in length, oysters raised by aquaculturists only have to be 2 ½ inches in longest diameter at the time of harvest. Aquacultured quahogs must be 7/8 inches in thickness (322 CMR §6.20(3)), as opposed to the 1-inch wild-caught requirement.

Propagation

In addition to the aquaculture activities carried out largely by private individuals, the Town and a small number of other entities have engaged in propagation activities (public aquaculture) as a means to enhance the shellfish populations of Nantucket. Propagation activities have largely centered on growing small shellfish to a size sufficient to increase their likelihood of survival in the wild, and then releasing them into the Harbors. Bay scallop propagation has also involved the use of spawning cages to increase the potential for fertilization during the spawning process. Since 1992, the Town’s propagation activities have focused on oysters, soft-shell clams, quahogs, and bay scallops. With the exception of bay scallops, most other seed is purchased from licensed providers off-Island (although the Town did cultivate a small amount of quahog seed in 2010 and 2011).

The Brant Point Boathouse has been an active propagation facility off and on for more than twenty years. When the US Coast Guard ceased their operations at the Boathouse during the 1980s, the Town received a lease for the land under the building. In 1993, the Coast Guard transferred ownership of the building to the Town, along with a 20-year lease for the land under the building. (That lease has been extended to 2033.) In 1989, the Town, working with Nantucket Shellfish Aquafarm, built the Nantucket Marine Laboratory at the Boathouse, and by 1990 they began to prepare the facility for propagation activities. In 1993, the Town received a \$250,000 federal appropriation to develop aquaculture on the Island, including development at the Boathouse.

Unfortunately, after only a few years in operation, propagation activities at the Brant Point facility slowed, in part due to a withdrawal of federal funding; and from 1997–2006 the facility was used as a small marine research facility on a limited basis. The Town continued to operate a small propagation program during this time.

Recognizing the importance of shellfish propagation in terms of rebuilding and maintaining shellfish stocks, recent efforts have been made to conduct larger-scale propagation activities at the Brant Point facility. In 2006, the Committee to Establish the Nantucket Marine Collaborative drafted a proposal outlining the development of the Nantucket Marine Collaborative (NMC—a 501(c)3 tax-exempt organization. They stated that the NMC would “increase the resources and personnel to conduct research, monitor water quality, enhance native shellfish populations, support shellfish aquaculture, and provide educational programs” (The Committee to Establish the Nantucket Marine Collaborative, 2006). Though the NMC has not yet been established, the current shellfish biologist has been able to use her vast knowledge of aquaculture to set up a limited, but productive propagation facility at the Brant Point Boathouse.

Bay Scallop Propagation

Given the boom and bust cycles of the bay scallop population and the fact that they are no longer abundant in so many historically productive areas along the eastern United States, Nantucket has taken steps to protect and enhance bay scallop numbers in Nantucket waters through propagation—primarily through the use of spawning cages.

The Town has been placing spawning stock in spawning cages prior to anticipated spawning events in order to increase the potential for fertilization. It is believed that placing scallops in close proximity during a spawning event will increase the likelihood that fertilization will take place (Conant, 2005b).



Figure 16: Spawning cages have been placed throughout Nantucket and Madaket Harbors in recent years, and continues to be one of the methods designed to enhance the Nantucket bay scallop population.

Experiments have been conducted to determine appropriate stocking densities and the effects of confinement on growth rates, mortality, and reproduction. Those experiments have concluded that 50 scallops per tray is an ideal density level for Nantucket's spawning cages, and that captivity negatively impacts survival rates and thus reproduction (Conant, 2005b). While the success of spawning cages has not been scientifically measured, anecdotal reports from scallopers suggest large amounts of seed in areas where spawning cages have been deployed (Conant, 2004b).

The use of spawning cages for propagation has also provided opportunities to conduct observations about scallop lifecycles, including during 2004 and 2005, when spawning was observed in 2nd year "classic" adult scallops; and live seed collected from a stranding event were shown to have high mortality rates before they had a chance to spawn (Conant 2004b; Conant, 2005b).

Though spawning cages were the primary means of bay scallop propagation activities, the Town also worked with certified hatcheries which spawn Nantucket bay scallops and send seed back to Nantucket. That seed is grown out at Brant Point and is released in various locations in Nantucket Harbor

(Whillauer, 2008; Town of Nantucket Annual Report, 2008 & 2009). Protocols are in place to prevent the transport of diseases, and efforts are made to ensure the genetic integrity of seed (i.e., no less than 75 animals are spawned at one time, and the egg and sperm are pooled before fertilization) (Riley, 2012, Personal communication).

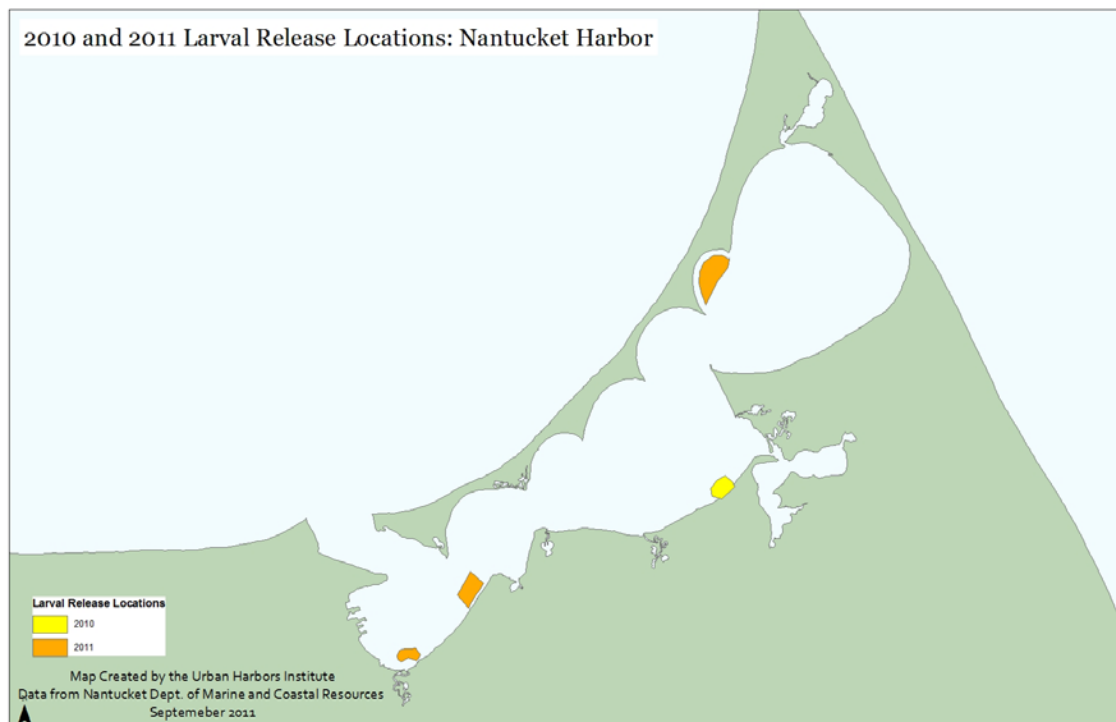


Figure 17: Larvae from the Brant Point Boathouse facility are dispersed throughout Nantucket and Madaket Harbors. In addition to those sites shown on this map, releases also took place in Madaket Harbor off of Warren's Landing and in the middle of Madaket Harbor in 2011.

Bay scallop larvae are also raised in the Town Shellfish Hatchery at Brant Point through the larval stage until they have become competent to metamorphose. At that point, the larvae (in the millions) are released in areas where it is anticipated they will quickly set and establish a propagated year class in the area. Preliminary results suggest that this is a viable strategy for bay scallop propagation and work is continuing to test its effectiveness (Riley & Boyce, 2011, Personal Communication).

Table 8: Much of Nantucket's propagation activities center around the bay scallop. *Spat bags are used primarily to understand the timing of spawning events. **The seed sanctuary (2007) was a very controversial endeavor. *** Unlike the other releases, the release in 2010 was of competent larvae, and not seed.

Year	Grow-Out	# Spat Bags*	Seed Collected	Dispersal Location
1983		90	40,000	Various locations in Nantucket Harbor and off of Tuckernuck
1985	1,541,200			Various locations in Nantucket Harbor
1994	1,055,270			Polpis Harbor, Folgers, Horseshed, Hussey's Shoal, Brant Point, the Jetties, Madaket Harbor
1985	1,062,400			Horseshed, Folgers, various locations in Nantucket Harbor
1996	655,210			1st and 2nd Bend, Pimney's Point to UMass Boston Nantucket Field Station
2000		50	1,600	West side of Pocomo
2000	unknown			16 diverse locations in Madaket and Nantucket Harbors
2001		120	500,000	4 lines-spring collection
2001			100,000	Fall set(released June-02)
2001	60,000			Floating trays in Coskata
2002		75spring/25 fall		Pocomo West
2002	unknown			Various locations in Nantucket and Madaket Harbors
2003			100,000	2nd Bend, 3rd Bend, 4th Bend, 5th Bend, Hussey Shoal, Monomoy, Abram's Point, Middle Ground, UMass Boston Field Station, Quaise Point
2004		100 spring/100 fall	1 spring/2312 fall	Brant Point Boathouse
2005		100spring/25 fall	1,000/16,250	
2006		100 spring/ 20 fall	142/1,000	
2007	60,000			
2007	1,000,000			Seed received from state certified hatchery to create sanctuary at 2nd Bend**
2008	1,500,000			Seed received from Milford Lab and released at 1st Bend
2009	1,000,000			Seed received from state certified hatchery and dispersed at 1st Bend
2010	5,000,000***			Quaise Point

Quahog Propagation

Still harvested recreationally and commercially, the Town is focusing its quahog propagation activities on sustaining the recreational quahog fishery (Conant, 2000c).

Similar to the grow-out procedures used with oysters, quahogs are typically purchased as small (1–2.5 mm on average) seed from an off-Island supplier and are grown out to larger sizes (typically ranging from 3–20 mm) at the Boathouse before being released into Nantucket Harbor in the fall.

Quahogs have historically been purchased and grown out in large numbers (up to one million animals in 2004 and again in 2005) because the smaller animals are less expensive and quahogs grow slowly, requiring less room in the Boathouse upwellers (an upweller is a system used to bring food and oxygen to shellfish in a tank via the pumping of water into and out of the tank).

Table 9: The Town has conducted quahog propagation activities of various sizes over the course of the last decade.

Year	# Quahog purchased	Size	Dispersal Location
2000	10,000	2.5cm	Unknown
2001	60,000	-	Ordered but not received-QPX
2002	150,000	8-10 mm	Monomoy and Coskata Pond
2003	250,000	1.5mm	Horseshed
2004	1,000,000	1.5mm	Horseshed, Quaise, Monomoy, Coskata
2005	1,000,000	1.0mm	Horseshed, Monomoy, Brant Pt.
2006	350,000	4-6mm	Monomoy and Horse Shed, Brant Pt.
2007	500,000	4-6mm	Monomoy and Horse Shed, Brant Pt.

Oyster Propagation

The Town has taken steps to enhance the natural stock of oysters both to increase oyster harvests and to improve water quality through the filtering behavior of the oyster.

Since the early 2000s, the Town has purchased small oysters (approximately 1–2 mm) from an off-Island hatchery, and has grown them out at the Boathouse during the summer months. In the fall, prior to the annual winterization of the Boathouse, the oysters are released into Nantucket Harbor (size range varies but is approximately between 19–30 mm). The timing of this release coincides with the dropping water temperatures responsible for starting the period of relative inactivity for shellfish (Conant, 2006c). Though most of the oysters are released each fall, a small number are held in grow-out cages for the winter and are released the following fall with the new oysters. Oysters typically change sex from male to female after growing and maturing, so releasing animals of different ages at the same time increases the likelihood of having both males and females present for successful fertilization.

In addition to growing out the oysters at the Boathouse, the Town has also filled spat bags with shells and then introduced oyster spat into those bags and placed them in Madaket Harbor. This “remote setting” of oysters allows the animals to grow in the bag, where they are protected from many predators. The bag of shells also prevents the animals from settling into softer sediments where they might suffocate.

Oyster propagation is ongoing—in 2011 the Town purchased 50,000 seed (1.5 mm range) for grow-out experiments—and the 2006 Biologist’s Report noted that natural sets had been observed in Madaket Harbor and Sesachacha Pond.

Soft-Shell Clam Propagation

Once a very important commercial species, the Town is working to ensure a healthy recreational shellfishery for soft-shell clams.

In the spring of 2000, the Nantucket Marine Department conducted an experiment to obtain information about the prospects of soft-shell clam propagation using netted enclosures and soft-shell clams from Nantucket Harbor. Soft-shell clams were harvested from Nantucket Harbor and were placed in cages where they spawned. The number of soft-shell clams per cage was counted to try to determine the reproductive levels and mortality in the different cages. While the results of the study were not definitive, the experience provided a great deal of information about equipment needed and potential areas suitable for soft-shell clam propagation (Conant, 2000b). Though the 2000 experiment had some success, subsequent soft-shell clam propagation activities have not used netted enclosures.

In 2002 and 2003, the Town ordered a total of 160,000 small (approximately 20 mm) soft-shell clams and grew them out until the fall of each year. Seed were (1) physically planted in the harbor by using a finger to make an indentation in the mudflat, and placing the clam in the hole, (2) “scratched in” by raking a mudflat at low tide to remove debris and soften the ground, then broadcasting the shellfish into the area, and (3) scratched in and covered with a net to keep predators out (Conant, 2003). The Town Biologist’s Reports from 2005 and 2006 both noted that abundant supplies of healthy soft-shell clams were present on most mudflats, and that the lower harbor was acting as a spawning sanctuary given that it was closed to harvesting because of high fecal coliform counts (Conant 2005b, Conant 2006c). No additional propagation of soft-shell clams has been conducted, and more research is needed to understand the health of the current soft-shell clam population.

Table 10: The Town conducted soft-shell clam propagation activities for three years.

Year	# Soft shell clams purchased	Animals Collected	Size collected	Dispersal Location
2000		96	3-4"	Various experimental stations
2000	250,000		2 mm	Raked into west side of Pocomo
2002	150,000		grown to 2.0cm	Raked into Pocomo, Coskata, and Cotue
2003	10,000		20mm	Planted and raked into lower and mid harbor, Salt pond Creek

Seed Management

In addition to aquaculture and propagation activities, the Town works with fishermen to relocate seed within the Harbors for both preservation and enhancement reasons.

Significant storm events can wash seed ashore where, stranded, they cannot survive for long periods of time. Anecdotal reports suggest that the conditions of each stranding (how long the shellfish are out of water, the age of the shellfish stranded, the air temperature, whether or not they are buried, etc.) affect whether or not the shellfish will survive and whether or not they will reproduce and/or be harvested after a stranding event. Historical records of seed relocation due to strandings are not complete; but

the biologist's reports from the 1980s show that several thousand bushels were returned to the water after stranding events. From the records that have been kept, it appears that most post-stranding relocation efforts focus on the bay scallop; however, in 1953, oysters were stranded around Sesachacha Pond after the Pond opened, and efforts were made to put many of those oysters back in the water.

Table 11: Seed Stranding Relocations -- While measures are taken to relocate shellfish prior to a potentially harmful event (e.g., a storm or dredging project), steps are also taken to return stranded shellfish to Nantucket waters.

Year	Amount (Bushels)	Species	From	To	Reason
1953	Unknown	Oyster	Sesachacha Pond	Various locations	Pond opening stranded seed
1980	1,500	Scallop	Wauwinet	Unknown	Storm stranding
1980	6	Scallop	Wauwinet	Horseshed	Storm stranding
1980	75	Scallop	Wauwinet	Town Pier, Brant Point	Storm stranding
1981	500	Scallop	East Pocomo Point, Wauwinet	Town Pier, Hussey Shoal, West Pocomo, Pimney's Point	Storm stranding
1982	300	Scallop	East Pocomo Point, Pocomo Point	Horseshed, West Pocomo Point	Storm stranding
1983	2,280*	Scallop	East Pocomo, Wauwinet, West Pocomo, Polpis Inlet	Horseshed, Wyer's Point, Hulburt Ave., Hussy Shoal, 1st Point, Bass Point, East Polpis, West Polpis, Abram's Point, Pimney's Point	Storm stranding
2003	300	Scallop	Wauwinet	1st Bend, 2nd Bend	Storm stranding
2007	Unknown	Scallop	Madaket, Nantucket Harbors	1st Bend, 2nd Bend	Nor' easter Noel (many adults)
2010	5,500	Scallop	Quaise, Wauwinet	Hussey Shoal, Pocomo, Folgers	Storm stranding

*Biologist's report suggests this number might have been as high as 5,000, but records only show 2,280 bushels

While most relocations due to storm events are done *after* shellfish have been stranded, a handful of relocations have been conducted when a storm is coming and shellfish are in locations that make them susceptible to stranding. For example, in 2007, in anticipation of Nor'easter Noel, many bushels of scallop seed were moved throughout Nantucket Harbor to prevent massive strandings.

In addition to moving seed to prevent strandings, seed is also moved in order to improve seed development and spawning success. This seed "relay" is often done at the end of the fishing season, and typically involves engaging fishermen to move seed from thickly seeded beds to other suitable areas in the Harbors. Ideal relocation sites are those with appropriate circulation (for larval retention), water temperatures, and dissolved oxygen levels in approximately 8–10 feet of water with eelgrass coverage of 25% or greater (Conant, 2005b).

The first known seed relays were conducted in May and June of 1981. Eighty bushels of scallops were moved from Bass Point and the Horseshed to West Pocomo Point, Hulburt Ave., and the north side of Tuckernuck Island. While the exact results of the relay are unknown, the thinning of beds at the Horseshed did not seem to have a negative impact. Reports indicate that the harvest at the Horseshed were good the following season (Kelley, 1981).

A protocol has been developed to protect the young seed as it is moved from one location to another—specifically with regard to making sure the shellfish are not crushed, that the shellfish are not exposed to cold temperatures for long periods of time, and that the shellfish are not buried in sediment that might

interfere with their gill structure. The protocol describes measures to be taken under ideal conditions; but it is generally understood that conditions may not always be right to meet all of the following:

1. *“Collection should be limited to one tow per relay.*
2. *Short tows should be made to avoid packing the dredges and collecting sand.*
3. *Scallops should be loosely packed in boxes or left on culling board, no more than 12” in height.*
4. *Scallops should be relayed to a designated area shortly after being collected.*
5. *Scallops should be released while under way, to allow dispersal of grass and, to avoid piling on bottom.*
6. *Number of bushels and area of collection and dispersal should be designated on map, and returned to Marine Dept.”*

(Nantucket Marine and Coastal Resources Department, 2007).

Table 12: Shellfish are moved in order to thin densities for optimal growth and increase the likelihood of spawning success in multiple areas.

Year	Amount (Bushels)	Species	From	To	Reason
1976	Un-known	Scallop	Unknown Nantucket Harbor location(s)	Madaket Harbor	Tidal surge swept scallops away
1981	80	Scallop	Bass Point, Horseshed	West Pocomo Point, Hulburt Avenue, north side of Tuckernuck Island	To reduce mortality and increase spawning
1982	50	Scallop	4th Bend	Hulburt Avenue, north shore of Tuckernuck	To reduce mortality and increase spawning
1983	195	Scallop	2nd Bend, 3rd Bend, 4th Bend, Hither Creek	West Pocomo Point, 4th Point, 1st Bend, 2nd Point, Abram's Point, Pimney's Point, Hulburt Avenue, East Jetty, north shore of Tuckernuck, Esther's Island	To reduce mortality and increase spawning
1984	700	Scallop	Hither Creek	Warren's Landing, Madaket Harbor flats, past Jackson Point, Eel Point Channel, and Esther's Island	Dredging
1999	700	Scallop	Jackson's Point	Deeper water (exact location unknown)	Unknown
2003	20	Scallop	Head of the Harbor	Mid-Harbor	To reduce mortality and increase spawning
2003	20	Scallop	Wyer's Point	4th Bend, 3rd Bend, Quaise Point	To reduce mortality and increase spawning
2004	200	Scallop	2nd Bend	Middle ground from 1st Bend to McGoslin's	To reduce mortality and increase spawning
2005	1000 (adult)	Scallop	4th Bend	Various locations in Nantucket Harbor	To reduce mortality and increase spawning
2010	1,000	Scallop	Folgers	Various locations in Nantucket Harbor	To reduce mortality and increase spawning

In addition to moving seed for its protection, seed-laden areas have also been closed to harvesting in order to protect the shellfish and to allow them to mature and reproduce (Town of Nantucket Annual Report, 2000). The impacts of these “seed sanctuaries” are unknown.

SECTION 8: OTHER MARINE RESOURCE USES

While shellfishing is an important activity in Nantucket waters, it is, by no means, the sole use of the marine environment. The following section describes other activities that take direct advantage of Nantucket's marine resources. Some of these other uses may be fully compatible shellfishing activities and the resources required for sustainable shellfisheries. Some of these other marine uses, however, may conflict to some degree with shellfishing, either by negatively affecting the resource itself or by creating issues related to the action of shellfishing.

Boat Slips, Docks and Piers

Slip rentals in Nantucket Harbor are available at the Town Pier and the Nantucket Boat Basin. Slips are also available to members of the Nantucket Yacht Club and Great Harbor Yacht Club. In Madaket Harbor, slip rentals are available at Madaket Marine.

The Boat Basin has 240 slips. To dock at this marina during the summer, a vessel must be at least 30 feet in length; and may be as long as 230 feet. In the off-season, the Boat Basin offers reduced winter rates, which attract a number of scallop boats. The Boat Basin also offers fuel sales and vessel pumpout.

The Town Pier has 20 slips for boats up to 40 feet long, 55 slips for boats up to 30 feet long, and 25 additional slips that can accommodate boats of various sizes between 13–30 feet. Slips at the Town Pier are allocated based on a lottery system tied to a boat's registration number. Recreational slips at the Town Pier are only allocated for one-year terms. In order to provide some stability for businesses, commercial slip permits at the Town Pier are issued on a one-year, three-year, or five-year basis. When the term of their permits are up, commercial enterprises must once again enter the lottery.

The Nantucket Yacht Club provides launch services to members' boats moored in the inner Harbor and offers a limited number of boat slips at its waterfront. The club has a fleet of sailboats for racing and recreational use by its members. The Great Harbor Yacht Club has 36 slips at its docks and piers.

Chapter 139-22 of the Nantucket Zoning Bylaw contains a prohibition on all new private docks and piers or expansions of existing private docks except certain public or commercial water-dependent docks and piers within the Harbor Overlay District. The prohibition of private docks was developed in part out of concern that the construction of these docks would interfere with and negatively affect commercial and residential shellfishing activities. A proliferation of private docks would make it difficult for shellfisherman to fish in and around these structures, and activities from the construction, footprint, and use of these structures has potential to affect the natural habitat and water quality in the area. Through State approval of the 2009 Nantucket and Madaket Harbors Action Plan, this same prohibition on private docks outside the Harbor Overlay District is now also part of Massachusetts Department of Environmental Protection (DEP) Chapter 91 licensing criteria. Expansion of existing commercial docks and piers and those for governmental and public entity use are allowed within the Harbor Overlay District by both the local bylaw and Chapter 91.

Three public boat ramps are located within Nantucket and Madaket Harbors, and ensure that public boating access is available throughout the Harbor areas. In Madaket Harbor, boaters can launch from Walter S. Barrett Pier or Jackson's Point; and in Nantucket Harbor, boaters can launch from the ramp at Children's Beach.

Mooring areas

Moorings are the traditional vessel berthing arrangement on Nantucket. All moorings must be registered by the MCRD (Section 137-4.B of the Nantucket Town Code). In 2011, approximately 1800 mooring permits were issued within the Town's designated mooring areas, and approximately 220 moorings were off of private waterfront residences. The MCRD has capped the number of mooring permits issued each year at 2200. This policy helps address potential impacts to water quality and to eelgrass, minimizes the potential for new user conflicts, and is compatible with the service and infrastructure capacities of the waterfront. In 2010, during the July and August peak season, there was an average of 2,900 boats in Nantucket waters (Nantucket Annual Report, 2010).

Moorings are located within eleven mooring fields: Hulbert Avenue; Children's Beach; Easy Street; Swain's Wharf; south of Town Pier; Monomoy; between the Piers; the General Anchorage Mooring Field; Polpis Harbor; Hither Creek; and Warren's Landing. Boats of 23 feet or less make up the vast majority of moored boats (approximately 1,360 boats, or more than 80%) and are accommodated in all of the mooring fields except the General Anchorage mooring area which is reserved for vessels of 27 feet or more.

The Town bylaws allow waterfront homeowners to be issued permits for up to two private moorings located offshore of their residence. These private moorings are located primarily in Shimmo, Quaise, Wauwinet, off of Hulbert Avenue, and on both sides of the channel in Hither Creek.

All private moorings are required to be removed from any shellfish areas prior to October 15. If the mooring is a Helix type mooring, it must be outfitted with an approved cap to avoid snagging scallop dredges.

Personal Water Craft (PWC)

Chapter 137(D), (E), and (F) of the Town's bylaws establishes areas where PWCs can and cannot operate. Prohibited areas include the waters of Nantucket Harbor northerly to the end of the east and west jetties and in the established navigation lane between said jetties easterly to the Head of the Harbor, in Polpis Harbor and along any portion of the shoreline of Nantucket Harbor.

Personal watercraft may be launched from the Children's Beach boat ramp and navigate through Nantucket Harbor along the most direct route as marked by buoys, to Nantucket Sound.

PWC cannot operate in the waters bounded by a line drawn from "The Rock" off the "Fortieth Pole" and marked by a hazard buoy, northwesterly to the R-2 lighted bell buoy, northwesterly to the westernmost point of Muskeget Island, southeasterly to the westernmost tip of Smith's Point including the entire shorelines of Muskeget, Tuckernuck and New Smith's Point (Esther Island). PWCs may be launched from the Walter S. Barrett and Jackson Point public access boat ramps and shall navigate at hull speed through Hither Creek along the most direct route as marked by buoys, to the westernmost tip of Eel Point, and then north to Nantucket Sound or south to the Atlantic Ocean.

The 2009 Harbors Plan included the recommendation to exclude personal water craft rentals from the allowable uses in the Harbor Overlay District as part of a strategy to preserve, protect and reduce conflicts with the Island's traditional water-dependent commercial uses located within the district. This prohibition was adopted into Section 137-21 of the Town's bylaws and will be respected in Chapter 91 licensing decisions by DEP.

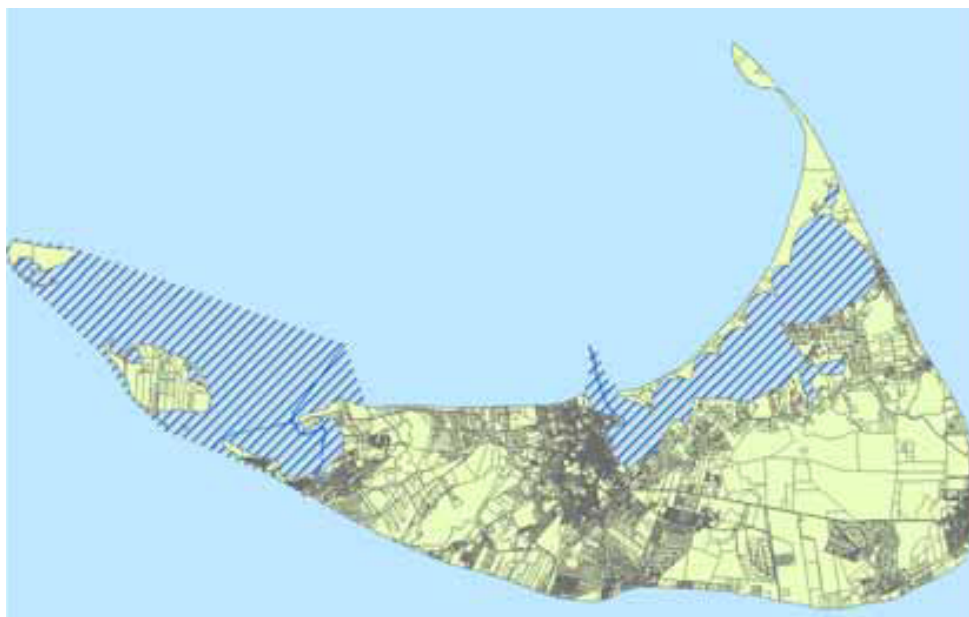


Figure 18: Personal Watercraft use is prohibited throughout most of Nantucket and Madaket Harbors (Image from Urban Harbors Institute, 2009).

Waterskiing

Town Code prohibits waterskiing (which includes motor-propelled surf boards, water bikes, and the towing of any surfboard (or similar device) behind a motor boat) on all waterways of the Town, except outside of navigation channels and swimming and mooring areas on Nantucket Sound, Polpis Harbor and Madaket Harbor. In addition to the above restrictions, waterskiing is prohibited within 400 feet of bathers, divers, piers, wharves, floats, other boats, or of any shore (§ 137-12).

Kiteboarding

In Nantucket Harbor kiteboarding is most popular in the open water of the Head of the Harbor. To minimize potential safety problems with beach goers, kiteboarding is restricted at all life-guarded beaches. At Pocomo Point, an unguarded beach and one of the most popular launching sites, kiteboarding rules allow launching and landing at the end of the point, but two buoys set off of the beach delineate a line shoreward of which kiteboarders are not allowed to ride.

Kiteboarders also ride in Madaket Harbor, launching from Smith's Point.

Kiteboarding is restricted in posted state and federally listed species habitat areas and prohibited within 200 meters of nesting or territorial adult or unfledged juvenile endangered/threatened species (i.e., piping plovers) between April 1 and August 31.

Section 137-23 of the Town of Nantucket Bylaws requires that anyone wishing to rent out kiteboards as part of his/her business must first receive a permit from the Board of Selectmen. No permits have been issued under this section.

No Discharge Zone

The coastal waters of Nantucket from Muskeget Island to Great Point, including Nantucket and Madaket Harbors have been federally-designated a No Discharge Zone (NDZ) under the Clean Water Act since August 1992. The designation prohibits discharge from all vessels of any sewage, whether treated or

not, into the waters of the NDZ. The MCRD has been operating a pump-out boat since 1992; and since the NDZ, has coordinated with the Boat Basin to pump more than 100,000 gallons of sewage annually from vessels in Nantucket waters.

Table 13: Nantucket's Pump-out boat has pumped nearly 80,000 gallons of waste from boats since 2007.

Year	Gallons of Waste Pumped
2007–2008	10,369
2008–2009	20,452
2009–2010	24,376
2010–2011	24,029

No Discharge Areas protect water quality and aquatic life from pathogens, nutrients and chemical products contained in discharged sewage and also reduce the risk of human illness, making it safer to swim, boat, fish and eat shellfish from protected waters. NDZs can also help reduce the growth of harmful algae that occurs due to high nutrient levels in sewage and protect commercial and recreational shellfish areas.

SECTION 9: OTHER PROGRAMS RELATED TO SHELLFISH MANAGEMENT ON NANTUCKET

In past years and continuing into the present, there have been a number of ongoing activities on Nantucket that increase the understanding of shellfish management and protection of shellfish habitat. The following provides a brief description of some of these activities.

Eelgrass Restoration

Eelgrass beds are highly productive communities, and are ecologically important because they act as a nursery, habitat, and feeding ground for many fish, waterfowl, and shellfish.

The Massachusetts DEP has been mapping eelgrass areas and charting changes for decades. The most recent paper on the topic (Costello, 2011) locates eelgrass in Madaket Harbor and reports less than 2% change between 1994–96 and 2000–2002. Changes were not provided for Nantucket Harbor.

The UMass Boston Nantucket Field station has done some underwater verification of density and presence of eelgrass in Nantucket Harbor but does not, as yet, have extensive data over time. The Maria Mitchell Association has conducted surveys every year since 2006 to document blade length, coverage, and fouling.

Both the UMass Boston Field Station and the Maria Mitchell Association monitor eelgrass for epiphyte load and invasive species.

In addition to the eelgrass mapping and verification efforts, there have been two recent experiments in eelgrass restoration in Nantucket Harbor. Both utilized funding from the Great Harbor Yacht Club through the Nantucket Land Council.

The first of these attempted to transplant approximately 10,000 square feet of eelgrass from relatively densely populated donor sites to areas devoid of plants. The transplanted grasses have been in place for only a year so, as of this writing, it is too soon to judge whether this will be a viable option. Both the donor and transplanted areas are being monitored. Transplanting is labor-intensive and attempts in other areas have had mixed results. It remains to be seen whether Nantucket Harbor is a more feasible spot for broad-scale transplants.

The second experiment involves reducing impacts from moorings. Typical moorings in New England waters involve some sort of weight resting on or sunk into the bottom and attached to a boat with a “bottom chain” and rope line. The chain portion sits on the bottom, effectively shortening the overall connection between the boat and the bottom weight. This shortening allows a greater number of moorings to be located in limited areas and provides a “shock absorber” effect in heavy winds and waters. Unfortunately, the chain also drags around the bottom weight as the boat sets with the wind, producing a circular scoured area typically devoid of vegetation. A more recent design for the bottom component consists of a helical screw set into the bottom with no need for a bottom chain. Oftentimes a rubber snubber is included in the line to provide a shock absorbing effect obviating the need for chain that would drag on the bottom. Approximately 30 such moorings have been put in place in Nantucket Harbor replacing traditional moorings. The areas around these moorings will be monitored for regrowth/expansion of eelgrass.

The Maria Mitchell Association is also conducting an informal study to attempt to grow eelgrass in a small plot near the Boat House using seed harvested in Nantucket Harbor.

Harbor Circulation and Flushing

A critical aspect related to water quality in both Nantucket and Madaket Harbors is the circulation of waters (both where the water goes and how fast it moves to get there) and flushing or exchange between Harbor waters and open waters.

The morphology of Nantucket Harbor has remained generally stable over time. Historically, the most significant change was a breach at Haulover beach at the upper end of the Harbor in the early part of the 20th century. At that point waters could enter and leave the Harbor at both ends. The breach closed naturally over the years leaving the Harbor in its current form (there have, however, been suggestions to reopen the breach to improve flushing). Over the years, Nantucket Harbor has developed shoals and required dredging to deepen places where it has become shallow.

There have been historic studies that generally define movements of water within Nantucket Harbor. In recent years the Maria Mitchell Association has conducted preliminary surveys to better track surface water movements. These have consisted of the deployment of tracking buoys over periods of up to two days in various locations within Nantucket Harbor.

During the investigations leading to the publication of the Massachusetts Estuaries Project (MEP) Report on Nantucket Harbor in 2006 (Howes et al., 2006), researchers utilized the RMA-2 model, developed by Resource Management Associates. This is generally described in the Project Report as a “state-of-the-art computer model to evaluate tidal circulation and flushing.” More specifically it is a “two-dimensional, depth-averaged finite element model, capable of simulating transient hydrodynamics.” The use of this model provided estimates for flushing rates/residence times for waters within the Harbor.

When compared to Nantucket Harbor, the configuration of Madaket Harbor has changed dramatically and suddenly several times in recent decades—often as the result of storms. Generally these changes have been related to the opening or closing of breaches in the barrier beach east of Esther’s Island. When there is a sizable opening, flushing—and water quality—is improved. When it closes, water quality declines. Because of the instability of the system, it has been difficult to provide long-term estimates of flushing rates between the Harbor and adjacent open waters.

Two areas of important contribution of nutrients and other possible anthropogenic contaminants to the Harbor are Hither Creek and, via Madaket Ditch, Long Pond. In 2000, DMF produced a study of the hydrography and flushing of Hither Creek and its interactions with Madaket Harbor and waters beyond (Casey and Churchill, 2000).

The Massachusetts Estuaries Program Project Report on Madaket Harbor (Howes et al., 2010) describes the Harbor itself as functioning “as an open marine basin.” As with the above-mentioned MEP investigation of Nantucket Harbor, the researchers utilized the RMA-2 hydrographic model to provide information on flushing and residence times. This investigation also extended to the Hither Creek/Madaket Ditch/Long Pond estuarine system.

Water Quality

Given that Nantucket is an island and much of its economy and lifestyle are related to its waters, there have been many efforts over the years to better understand the current conditions and trends in water quality. However, due to budgetary and staffing limitations, as well as changes in focus on issues related

to water quality, most of these efforts tended to be short-term (or “snap-shot”) samplings. Since these investigations were done by various groups and individuals; differed in techniques, equipment, and parameters measured; and were done for different purposes, many of the data sets cannot be effectively reconciled with others to provide long-term trends. Through the date of this report (Spring, 2012) many of the data have not been reviewed for compatibility or entered into a comprehensive system. The Town has established a Water Quality Initiative Team which plans to hire someone to computerize existing data, review them and assess whether there is sufficient information available from these data to develop trends. Timing for the completion of this process is presently unclear.

One long-term data set provides information on water temperatures within Nantucket Harbor. Since 1998, water temperatures at Brant Point (Coast Guard Dock) have been taken weekly by volunteer Dan Kelliher, a retired Nantucket High School science teacher. Additional temperature data sets include the NOAA temperature station at steamship dock. Six HOBO temperature loggers operated by the Maria Mitchell Association, taking hourly measurements, have been deployed at locations inside and outside of the Harbor and there has been continuous hourly coverage at Pocomo since 2006.

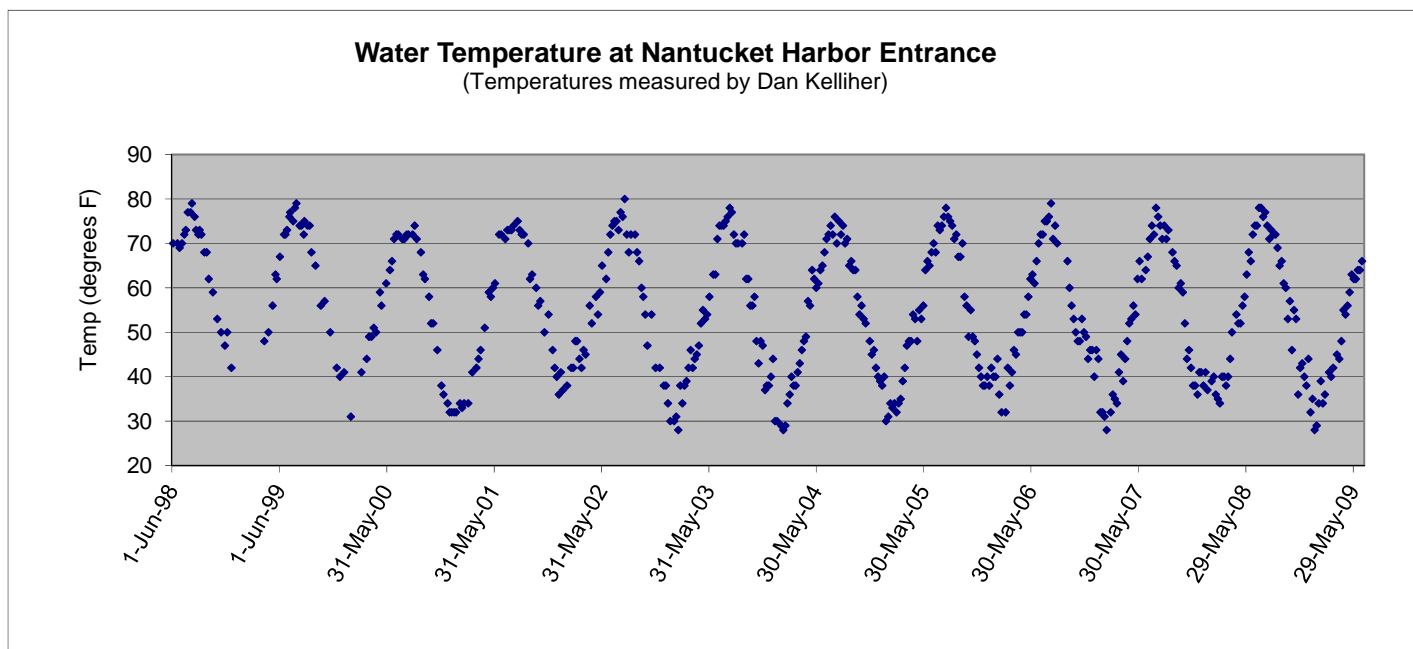


Figure 19: Water temperature data from the entrance to Nantucket Harbor show clear seasonal cycles with lowest temperatures usually recorded in January or February and warmest temperatures recorded generally in July and August.

The MEP investigations of Nantucket and Madaket Harbors have provided data on nutrient levels and offer an extensive bibliography related to nutrient-related research within the water bodies and the drainage areas leading to them.

The Town also conducts water sampling. In addition to the fecal coliform tests conducted during Figawi and the Opera House Cup, the MCRD samples areas of Nantucket Harbor, Sesachacha Pond, Hummock Pond, Madaket Harbor, Long Pond, and eight streams around Polpis Harbor multiple times throughout the year. Data are gathered at the time of sampling pertaining to total depth, water clarity (secchi depth), dissolved oxygen, salinity, conductivity, temperature, pond and estuary state (e.g., wave height), general weather, wind speed and wind direction. The samples are sent to a laboratory for analysis of

salinity, nitrate, nitrite, ammonium, dissolved organic nitrogen, total phosphorus (fresh water only), particulate organic carbon and nitrogen, specific conductivity (fresh water only), pheophytin *a*, chlorophyll *a* and orthophosphate (Riley, 2011).

The University of Massachusetts Boston Nantucket Field Station (Field Station) also conducts water quality research. In 2008 and 2009, they deployed a datalogger to measure water quality parameters including temperature and sunlight (PAR). In 2009 and 2010, they conducted intensive tidally linked, seasonal water quality surveys of the water column for 9—11 different sites located in the boat basin and lower Nantucket Harbor (from Monomoy westward). The survey involved tracking fluctuations in nitrate and phosphate and dissolved oxygen and temperature and salinity parameters every 12 hours over a three- to five-day period during the summer months when boat traffic was highest in Nantucket Harbor. These results show definite inputs from boaters in Nantucket Harbor and neighboring local watershed impacts with substantial and distinct changes in nitrate and phosphate concentrations in the water column on incoming and outgoing tides.

In addition, the Field Station has conducted water quality sampling in various locations in Nantucket Harbor in 2009, 2010, and 2011 including spots at the Head of the Harbor and near Polpis Harbor. This information will be shared with the MCRD and the Maria Mitchell Association, and work will continue in 2012.

In 2012, in collaboration with Sustainable Nantucket, the Field Station surveyed the marsh and near shore closest to Holly Farm where an experimental program in sheep and chicken agrarian care was conducted in 2011.

The Field Station is planning research for 2012 pertaining to understanding fertilizer and pesticide inputs in Nantucket Harbor.

The Maria Mitchell Association has contributed to the water quality monitoring efforts on Nantucket. Between 2006–2008 they took water quality measurements for the US EPA at approximately 50 sites in Nantucket Harbor in July and September, measuring for

- Depth
- Water clarity (secchi depth)
- Dissolved Oxygen (DO) at the bottom and the surface
- Water temperature
- pH
- Salinity
-

The Maria Mitchell Association has continues to gather these data during September, though no longer under contract with the US EPA.

Harmful Algal Blooms

In recent decades, two forms of Harmful Algal Blooms (HABs) have been identified in Nantucket Harbor and adjacent waters. These have been referred to as “red tide” (produced by the dinoflagellate *Alexandrium sp.*) and “rust tide” (produced by the dinoflagellate *Cochlodinium sp.*). Rust tide was initially identified in Nantucket waters during the first week of August 2009. That bloom lasted one week and may have been limited to inside Nantucket Harbor. Starting in August 2010, and continuing into the first week of September, another rust tide occurred within Nantucket Harbor, but it was also observed outside the jetties and near Coatue. A considerably milder bloom was observed in 2011.

Samples of water containing these organisms were taken by the Nantucket Marine and Coastal Resources Department on September 9th and 14th of 2010. The samples were used to obtain species and density information (~40,000 cells/liter and ~ 20,000 cells/liter, respectively). It is unclear as to whether or not rust tide has affected Madaket Harbor, but sampling will be conducted there in 2012.



Figure 20: Rust Tide (*Cochlodium*) in Nantucket Harbor in 2010. Photo: Tara Riley

Massachusetts Estuary Program Investigations in Nantucket and Madaket Harbors

As mentioned previously, the Massachusetts Estuaries Program, administered by the School of Marine Science and Technology located at the University of Massachusetts Dartmouth, has undertaken investigations of both Nantucket Harbor and the Madaket Harbor/Hither Creek/Long Pond complex. The MEP is designed to provide water quality, nutrient loading, and hydrodynamic information for a series of estuaries in Southeastern Massachusetts—including those on Nantucket.

The Nantucket Harbor report was issued in 2006 (Howes et al., 2006) and the report for Madaket Harbor/Long Pond was released in 2010 (Howes et al, 2010). These two reports were designed “to assist the Town with upcoming nitrogen management decisions associated with the Town’s current and future wastewater planning efforts, as well as wetland restoration, anadromous fish runs, shell fishery, open-space, and harbor maintenance programs.” They provide a wealth of information on water quality and shellfish habitat. Copies of the report may be found at the MEP web site at <http://www.oceanscience.net/estuaries/>.

Shellfish Biology

There is a considerable body of scientific research into the biology of the bay scallop throughout its range on the northeast coast of the US. In addition, there have been several efforts in recent years specific to Nantucket. Some of these include:

- Research into the ecological significance of fall spawning in the Nantucket Bay Scallop by Valerie Hall (Hall, 2010). This effort is part of the requirements for a PhD through the School for Marine

Science and Technology at the University of Massachusetts Dartmouth. Publication of the Thesis is expected sometime in 2012–2013.

- Research into the genetics of various populations of Nantucket scallops by Stephen L. Estabrooks of the Nantucket Marine Laboratory. It is unclear when the results of this research will be published.
- Spat bags have been hung in various locations within the Harbors and in waters along the north face of the Island by the Maria Mitchell Association and the MCRD. These are designed to sample timing and densities of scallop spawning. (See Figure 21 below.)
- The Maria Mitchell Association is currently undertaking research on the suitability of artificial substrates.
- From 2009-2011, the Field Station-affiliated researcher from UMass Boston, Bryanna Broadaway, collected juvenile and adult scallops and water column and sediment samples for analysis for rare earth elemental and trace metal signatures in order to establish site traits and area-specific concentrations of these elements. In addition, researchers from the UMass Boston Earth and Environmental Research lab conducted elemental mapping to determine if taurine, glycine and sulfur indicate changes in shell construction as a result of ocean acidification. They further identified potential volatile organic carbon compounds including those produced by combustion engines. Using data on abundance of bay scallops at particular sites, these efforts will help identify key habitat characteristics (e.g., salinity and pH) that can be used to help identify areas that might support future propagation and relay activities. (Publications forthcoming: “Elemental fingerprints used to identify essential habitats: Nantucket Bay Scallop (*Argopecten irradians*);” “Taurine and Glycine as indicators of ocean acidification induced stress in *Argopecten irradians*,” and “Ocean acidification impact on net calcification in adult and juvenile *Argopecten irradians*.”)

Efforts are also underway to better understand the biology of conchs. Shelley Edmundson, currently studying at the University of New Hampshire, is in the initial stages of two related projects. The first is designed to understand the growth rate and movement of the channeled whelk in Nantucket Sound. Working closely with fishermen from Martha’s Vineyard, Ms. Edmundson has tagged whelk, and is gathering location information from fishermen who catch her tagged conchs. This project also involves obtaining data on the general size and quantity of potted conchs, documenting the number of channeled and knobbed whelk in order to gather baseline data that may help identify whether or not knobbed whelk are becoming more prevalent than channeled whelk. The second project is designed to understand hatching rates and possible triggers for hatching (e.g., temperature, etc.). These research projects will help fill important gaps in the understanding of conch biology.

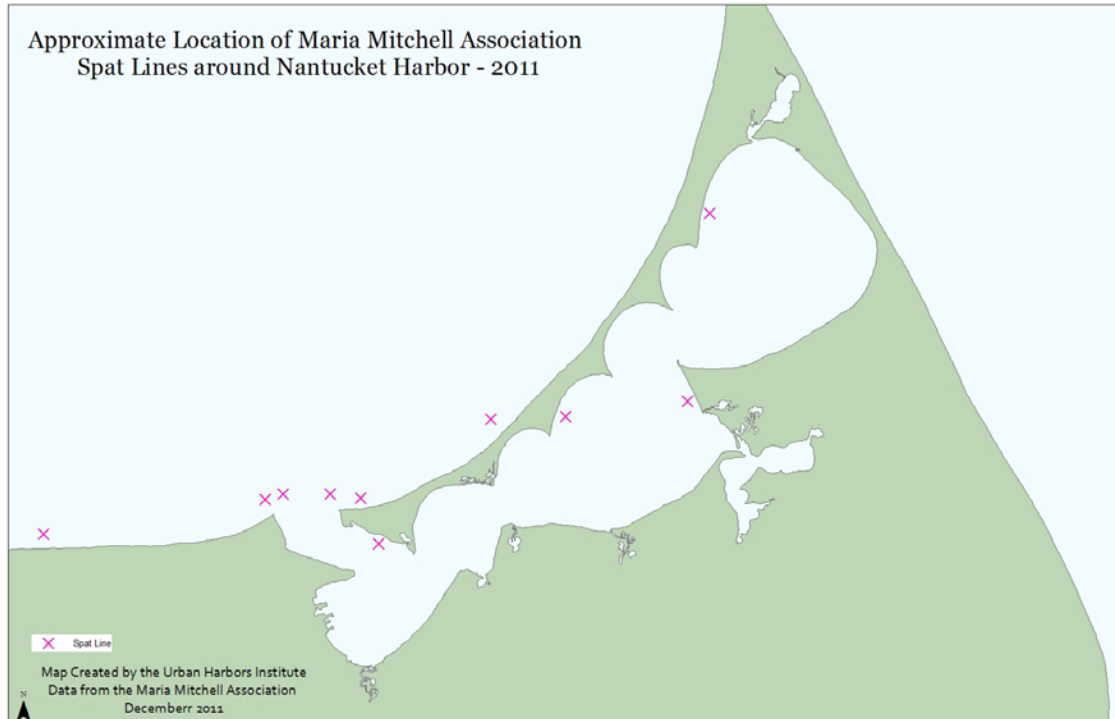


Figure 21: The Maria Mitchell Association uses spat bags to help identify the timing of bay scallop spawning events. In addition to those placed around Nantucket Harbor, the Maria Mitchell Association also placed a spat bag near Esther Island in 2011.

Harbor Plan Implementation Committee

In May of 2009 the Town of Nantucket produced a Harbor Management Plan (ultimately approved by the State in December of 2009). This plan produced more than 150 recommendations for actions to help the Town better manage Nantucket and Madaket Harbors, including the shellfish resources contained therein.

To ensure that this Plan was put into action, the Town appointed the Harbor Plan Implementation Committee (HPIC), whose mission is “to prioritize the Nantucket and Madaket Harbors Plan implementation items in the form of recommendations to the Board of Selectmen, to provide regular updates to the Board as to implementation of the Plan, and to recommend changes to the Plan as needed.” Members of the HPIC include three representatives of Harbor and Shellfish Advisory Board (SHAB) appointed by that Board and five at-large members appointed by the Board of Selectmen. The Committee is scheduled to meet twice a month. This ensures an ongoing effort to relate harbor management efforts to shellfish management. As of December 2011, 63% of the Harbors Plan has been implemented (Oktay, Personal Communication, 2012).

Nantucket Shellfish Association

The Nantucket Shellfish Association, Inc.’s (NSA) mission is to ensure the continued viability of Nantucket’s shellfisheries through education and research, with the goal of using the knowledge gained from its sponsored research to enhance the community’s shellfish management capabilities. To that end, over the years the Association has supported various research and education efforts, as well as the Town’s re-invigorated shellfish propagation program. These activities help underscore the shellfisheries’

importance as a sustainable natural resource, their cultural importance in the island's history and their continuing, significant contribution to the Island's economy.

More specifically, NSA encourages research and education for the conservation and enhancement of the populations of bay scallops, mussels, soft-shell clams, quahogs, oysters, whelk and conch (referred to collectively as "shellfish") in the waters of Nantucket Island and to assure prudent commercial and recreational harvesting of shellfish in support of a diversified economic base for the Nantucket community. The Association promotes that objective through activities including, but not limited to, the following:

- Encouraging research on shellfish and associated organisms, with emphasis on species of economic importance;
- Encouraging shellfish propagation;
- Gathering and disseminating scientific and technical information on shellfish;
- Promoting and advancing shellfisheries research and the application of results to the shellfish industry;
- Promoting—through education—broader understanding and appreciation of the historical heritage of Nantucket derived from the shellfish industry;
- Holding meetings for presentation, exchange, and discussion of information on scientific and professional aspects of shellfish research and management;
- Supporting efforts to ensure understanding of the shellfish industry and its role as a fundamental contributor to the strength of Nantucket's economy; and
- Educating its members and others involved in shell fishing and promoting professionalism.

SECTION 10: RECOMMENDATIONS

The following section presents recommendations to promote sustainable shellfisheries in Nantucket waters in accordance with the Plan's goals. These recommendations include planning-, research-, budgetary-, and management-related actions determined to be appropriate for the current state of the fisheries. Several additional recommendations received attention from the Shellfish Management Plan Committee, but were not included in this Plan for various reasons. While those recommendations were not appropriate for this version of the Plan, they are described in Appendix E, with insight into benefits that might be of value as adaptations are made to this Plan. Also, some of the recommendations list the Nantucket Research Collaborative as an implementing entity. The Nantucket Research Collaborative is described in the "Collaborative Research" section of the Research Plan.

Habitat Management

Although the extent to which various aspects of water quality, eelgrass coverage, predators, and other habitat features affect the health and status of Nantucket shellfish is not entirely clear, there is abundant research to indicate that certain habitat features are significant and in need of protection/restoration. Additional research is needed (see Research Plan) to better understand the specific impacts of habitat degradation and/or alteration on the survival of shellfish. Though some recommendations are made in the absence of perfect science, the belief is that these recommendations are proactive and will not cause new harm. Additionally, it is critical that management and regulations will adapt as new information becomes available.

Goal I: Maintain and improve the habitat associated with sustainable commercial and recreational shellfish fisheries

Objective I: Manage water quality to maintain or improve the habitat associated with sustainable shellfish fisheries

Issues

Sustainable commercial and recreational shellfishing depend on suitable water quality. Direct linkages between water quality, land use, nutrient input, and habitat health have been well established in the scientific literature for areas associated with Cape Cod, the Massachusetts coast, and the Northeast Atlantic Seaboard. Water quality in Nantucket and Madaket Harbors is affected by multiple input pathways (groundwater, atmosphere, sheetflow/overland runoff, direct dumping) and via various sources including stormwater runoff, transport of groundwater containing excess nutrients from fertilizers and septic systems, pollutant plumes from underground storage tanks, contaminated soils near downtown, changes in land use which may accelerate stormwater runoff, etc. To complicate matters, climate change, anthropogenic stressors from the inadvertent encouragement of waterfowl, increased runoff from heavy rainfall, and warmer summer temperatures all create additional stress on harbor and salt marsh systems.

Stormwater and wastewater on the Island can greatly affect water quality by contributing contaminants and nutrients to the Harbors; and their management is critical to maintaining suitable habitat for shellfish. The main water quality concern for many areas on Cape Cod and the Islands is excessive concentrations of nutrients which can lead to eutrophication with resulting algal blooms, reduction in photic depth, excess growth of invasive aquatic algal plant species such as *Codium sp.* and *Lyngbya sp.*, and a subsequent reduction in eelgrass coverage. Despite extensive efforts to slow the eutrophication process, "water quality results, specifically in Nantucket Harbor, indicate that nutrients are increasing;

and being recycled at the Head of the Harbor and Quaise Basin” (Conant, 2006). In addition, certain areas such as “the Creeks,” Folger’s Marsh, Medouie Marsh, Hither Creek, Polpis Harbor, and Coskata Pond are especially susceptible to environmental impacts due to their hydrodynamic characteristics, presence of natural resources, and fragility.

The most recent recommendation from the “Water Quality Monitoring and Assessment of the Nantucket Island-Wide Estuaries and Salt Ponds 2010” (Howes et al., 2010) clearly indicates that constant and long-term monitoring of both Nantucket and Madaket Harbors is important, and will help identify the results of critical nutrient reduction activities.

In the Executive Summary of the Massachusetts Estuaries Project report, it was noted that to maintain or preserve eelgrass bed health, a nitrogen threshold of $0.350 \text{ mg N L}^{-1}$ should not be exceeded. Nitrogen levels in East Polpis Harbor were determined at the time to be $0.361 \text{ mg N L}^{-1}$ and had recently lost most of its eelgrass, suggesting that this threshold is both accurate and critical. Results from the most recent (2010) Harbor monitoring project show that total nitrogen (TN) values have increased over the past few years in Nantucket Harbor. The Town has used the School for Marine Science and Technology at the University of Massachusetts Dartmouth (SMAST) to run computer models for various scenarios to reduce nitrogen levels in Nantucket Harbor—centering around options relating to sewerage and/or raising the jetties. Results suggest that sewerage and raising the jetties together will help reduce nitrogen to appropriate levels (Fronzuto, Personal Communication, 2012).

In addition to water quality, water circulation has an impact on shellfish. Some areas of Nantucket Harbor (e.g., the Head of the Harbor) have low flushing rates, exacerbating the impacts of nutrients and contributing to poor shellfish habitat. Additionally, some areas of Nantucket Harbor experience high rates of flushing, and observations suggest that some amount of spat is flushed out of Nantucket Harbor on outgoing tides.

Recommendations

- 1) *Conduct and/or support research to better understand the hydrodynamics within Nantucket and Madaket Harbors and the impacts of water circulation on shellfish habitat and population dynamics. This research should include a study to determine the effects of raising the jetties. With better information on water circulation and its impacts, options for improving circulation could be considered and implemented as appropriate.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Department of Marine and Coastal Resources or the Town*
- *Outside experts as appropriate*
- *Harbor Plan Implementation Committee*

- 2) *Support research activities, regulatory management changes, public education initiatives, capital improvements, and related fund-raising activities aimed at reducing nutrient inputs from anthropogenic sources, both in Nantucket waters and in Nantucket Sound.*

Nantucket is currently addressing nutrient reduction from anthropogenic sources through a variety of activities, including reviewing the Massachusetts Estuaries Report project and implementing the Best Management Practices guide developed by the Article 68 Work Group. Additionally, the Harbor Plan Implementation Committee, in conjunction with the Town, is currently developing an educational initiative called the “Nantucket Blue Pages” that was

recommended as part of the Harbor Plan. Nantucket is supporting a water quality testing effort to assess the effectiveness of activities to reduce nutrient input into local waters. Researchers are looking into the possibility of using barriers of natural materials (e.g., woodchips) to remove nitrogen from groundwater. A federal No Discharge Area for Nantucket Sound is under development. Stakeholders should support these types of activities by lending their expertise, raising awareness of important information, events and developments, such as meetings or the dissemination of publications; and helping to secure financial resources.

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Board of Selectmen*
- *Board of Health*
- *Marine and Coastal Resources Department or the Town*
- *Conservation Commission*
- *Harbor Plan Implementation Committee*
- *Maria Mitchell Association*
- *University of Massachusetts Boston Nantucket Field Station*
- *Harbor and Shellfish Advisory Board*
- *Nantucket Shellfish Association*
- *Outside experts as appropriate*

- 3) *Conduct and/or support research to better understand the links between shellfish habitats, population dynamics, and anthropogenic activities that introduce chemicals into Nantucket waters. Examples of activities of interest include: the application of fertilizers, herbicides, and pesticides on upland areas (including details about the chemicals being used, the quantities being applied, and the associated impacts); the use of septic systems; the discharge of grey water from vessels (and the related No Discharge Area designation); the discharge of petroleum hydrocarbon; and boat maintenance activities such as boat washing and bottom painting.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Board of Selectmen*
- *Board of Health*
- *Mosquito Working Group*
- *Marine and Coastal Resources Department or the Town*
- *Conservation Commission*
- *Nantucket Land Council*
- *Maria Mitchell Association*
- *University of Massachusetts Boston Nantucket Field Station*

- *Boat yards and marinas*
 - *Outside experts as appropriate*
- 4) *Develop a better understanding of the sources and impacts of HABs on shellfish and their habitat. Support or conduct research to address identifying and tracking potentially harmful blooms in local waters.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
 - *The Marine and Coastal Resources Department*
 - *Nantucket Land Council*
 - *Nantucket Biodiversity Initiative*
 - *Maria Mitchell Association*
 - *University of Massachusetts Boston Nantucket Field Station*
 - *Outside experts as appropriate*
- 5) *Conduct and/or support studies to investigate the role that environmental changes may have in altering shellfish populations on Nantucket, including sea level rise, ocean acidification, and climate change. As part of this, continue, and where appropriate, enhance efforts to record water temperature, changes in pH, and details about when the Harbors freeze over.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
 - *Marine and Coastal Resources Department or the Town*
 - *Maria Mitchell Association*
 - *Outside experts as appropriate*
- 6) *Explore options to reduce the financial cost and temporal delay currently associated with obtaining water quality results. Include a review of on-Island options for “in house” local analysis.*

List of implementing agencies/groups:

- *The Marine and Coastal Resources Department**
- *Nantucket Research Collaborative*
- *Nantucket Waste Water Management group*
- *Maria Mitchell Association*
- *University of Massachusetts Boston Nantucket Field Station*

Objective II: Maintain and, where possible, improve the condition and extent of eelgrass beds in Nantucket waters

Issues

Eelgrass (*Zostera marina*) is a critical habitat for shellfish, especially scallops. When disease ravaged eelgrass beds in the 1930s, scallop populations also crashed and it took 20–30 years for stocks to rebound. *Zostera* health can be affected by a variety of factors, including disease and human activities. Principal among the human activities at the present time are point and non-point nutrient discharges, contaminants from herbicides/pesticides and road runoff, and sedimentation—all of which are directly related to increased landside development. Other detrimental impacts can result from boat moorings, dredging, and changes in currents and flushing rates.

Restoration of existing areas or creation of new eelgrass beds may be possible with careful planning, although historically results have been mixed. Appropriate substrate, light levels, water depth, water motion (currents and flushing), salinity, and nutrient levels are all critical to the success of restoration efforts.

Recommendations

- 1) *Beginning with historical data compiled and maintained by the Massachusetts DEP, encourage continued monitoring of the extent and health of eelgrass in Nantucket waters, and explore the relationships between eelgrass beds and other aquatic vegetation such as epiphytic growth, which can influence eelgrass health. To the extent possible, connect with regional eelgrass mapping exercises.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Massachusetts DEP*
- *US EPA*
- *Outside experts as appropriate*

- 2) *Undertake a review of practices that may directly damage eelgrass beds (e.g., moorings, scallop dredges, propeller damage, excess nutrient inputs from upland sources) to determine the short- and long-term nature and significance of the impacts and explore methods to minimize those impacts.*

As part of this, look at options to modify dredging activity throughout the season (e.g., starting with a 40-pound limit at the beginning of the season, and reducing weight as the season progressed; changing the design of the dredge to reduce impacts to eelgrass; etc.). Specifically evaluate the progress of modifying moorings in Nantucket Harbor to minimize damage to surrounding eelgrass beds. Evaluate the effects of alternative technologies, such as placing floats on mooring chains, replacing chains with flexible bungee-style rope, or placing multiple boats on one chain anchored between two mushroom moorings. Once the effects and capabilities of these technologies are understood, work to implement appropriate mooring strategies to reduce impacts on eelgrass.

Additionally, explore the option of charging an extra fee for people who do not upgrade to more environmentally sensitive mooring technologies and for dedicating those funds to mitigation of damaged resources.

List of implementing agencies/groups:

- *Nantucket Research Collaborative**

- *Nantucket Land Council*
- *Marine and Coastal Resources Department or the Town*
- *Great Harbor Yacht Club*
- *Nantucket Land Council*
- *Conservation Commission*
- *SHAB*

- 3) *Develop and implement a cost-effective strategy to protect/restore eelgrass in locations of significance to shellfish resources—both within and outside Nantucket and Madaket Harbors. This strategy should take into consideration options such as propagating eelgrass, re-seeding areas, and removing stressors (e.g., moorings, excess nutrients) to existing and potential eelgrass habitats.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Nantucket Land Council*
- *Maria Mitchell Association*
- *SHAB*

- 4) *Until a new strategy to protect eelgrass is in place, enforce existing mooring regulations and ensure that moorings are not located in productive shellfish beds. This will require a substantial reduction in the number of permits.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *SHAB*

- 5) *Support research to better understand the relationship between eelgrass health and density and shading from various algal blooms, physical effects on eelgrass growth from overlying macroalgae (for example, observations suggest that *Gracilaria* sp. is covering eelgrass and causing it to lay flat during the spring, but it may also serve as a settlement substrate for bay scallops), and effects to eelgrass from nuisance epiphytes growing directly on eelgrass.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Massachusetts DEP*
- *Outside experts as appropriate*
- *Nantucket Land Council*

- 6) *Conduct research to better understand changes in sediment within the Harbors since the most recent data were gathered.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Maria Mitchell Association*
- *UMass Boston Nantucket Field Station*
- *Outside experts as appropriate*

Objective III: Improve opportunities for shellfish recruitment into the fishery

Issues

Successful recruitment of shellfish is dependent on larval supply, appropriate settlement substrate, and post-settlement survival of the spat. It is generally conceded that larval supply is an important factor in bivalve recruitment and recent work by the Maria Mitchell Association suggests that tidal flushing in Nantucket Harbor may result in exportation of larvae from the Harbor. Improved knowledge of water circulation patterns along with recognizing locations of potential bivalve larval sources can be combined to predict where larval recruitment sinks may occur under varying environmental conditions, and where spat collection efforts would be most appropriate.

Successful larval settlement is contingent on the presence of appropriate settlement substrate. Current knowledge suggests that specific substrate types (e.g., eelgrass for bay scallops and shell cultch for oysters) will enhance settlement and post-settlement survival of newly-recruited bivalve juveniles. Efforts to preserve and enhance appropriate substrate and habitat types to promote bivalve larval settlement and post-settlement survival are critical to the sustained production of shellfish in Nantucket waters.

Shellfish recruitment into the fishery also entails post-metamorphic survival. A host of predators influence post-settlement populations in Nantucket waters. Again, the role of habitat is critical to this stage, as appropriate habitats allow for the natural predator avoidance behaviors of various shellfish species to help protect the population from excessive predation pressure. Therefore, maintenance of suitable habitat in shellfish areas is paramount to protecting a sustainable population.

Recommendations

- 1) *Catalog, map, and ground-truth information about the dominant habitat types (relative to shellfish survival) throughout Nantucket waters. If adequate funding for these activities cannot be secured, explore alternative, less-costly options for obtaining habitat information. Use this information as baseline data and as a basis for prioritizing and protecting shellfish habitat and promoting an awareness of the need for managing habitat as an important element in managing the shellfishery.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *SHAB*
- *UMass Boston Nantucket Field Station*
- *Maria Mitchell Association*

- 2) *Work with the Nantucket Department of Public Works to institute a shell recycling program where most, if not all, shells are returned to the Harbors for pH buffering and settlement substrate purposes (potentially with assistance from fishermen). Ensure that the deposition of shells does not harm existing habitat features (such as eelgrass beds) or create new habitat dominated by predators. Adhere to DMF's Shellfish Planting Guidelines for placing shells in the water: "Oyster, quahog and softshell clam shell used as cultch shall be aged on land for a minimum of one year. Shell from other species of bivalves such as surf clam, ocean quahog, scallops and mussels may be used without limitations. All issues regarding approved shell cultch must be addressed by Marine Fisheries prior to placement into coastal waters." (Hickey et al., 2012). Conduct research to identify the most appropriate locations for returning the shells and monitor the deposition sites to better understand the impacts of such activities.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Department of Public Works*
- *Massachusetts Division of Marine Fisheries*
- *Nantucket Shellfish Association*

- 3) *Continue to monitor dissolved oxygen in benthic areas of the Harbors, and expand monitoring to include monitoring of sediment acidity.*

List of implementing agencies/groups:

- *Maria Mitchell Association**
- *The Marine and Coastal Resources Department or the Town*
- *Conservation Commission*

- 4) *Continue monitoring spat settlement throughout the waters of Nantucket by way of spat collection and enumeration.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Maria Mitchell Association*

- 5) *Conduct collaborative annual surveys of juvenile shellfish stocks to assess the areas of spatfall to aid in management decision-making.*

List of implementing agencies/groups:

- *The Marine and Coastal Resources Department**
- *Maria Mitchell Association*
- *Harbor and Shellfish Advisory Board*
- *Nantucket Shellfish Association*
- *UMass Boston Nantucket Field Station*

Objective IV: Understand the impacts of harvesting-related activities on the habitat and the resources

Issues

Shellfish harvest often entails the application of disruptive forces to the environment. There is conflicting opinion and evidence as to the overall impact of shellfish harvest on the habitats and their ability to sustain shellfish populations. Undoubtedly, the overall impact of shellfish harvesting will depend not only on the method of harvest but also the intensity of the harvest in any given area. Therefore, it is contingent on shellfish managers to monitor and maintain harvest pressure at levels that allow for continued functioning of the habitat to support new shellfish growth. Due to the dearth of good scientific information on overall harvest impacts, historical observations may provide the basis for these management decisions while striving to generate new information on the effects that shellfish harvesting plays on shellfish production and overall environmental quality.

Recommendations

- 1) *Conduct and/or support studies to determine the impacts of recreational and commercial shellfish harvesting (including the impacts of by-catch) on the sustainability of the resource and the habitat.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Nantucket Shellfish Association*
- *Commercial fishermen*
- *SHAB*
- *Outside experts as appropriate*

- 2) *Monitor and assess the overall intensity of shellfish harvest practices (including impacts stemming from by-catch) and manage activities within specific harvest areas to minimize the risk of detrimental impacts from excessive harvest practices.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *The Marine and Coastal Resources Department*
- *Nantucket Shellfish Association*
- *SHAB*

Shellfish Resources

On Nantucket, commercial and recreational harvested shellfish include bay scallops, oysters, soft-shell clams, conch, quahogs, and mussels. While these species differ in terms of life cycles and fishing pressure, they all benefit from some level of management. Management can take the form of limits to accessibility, limits to fishing intensity, and/or strategies to enhance shellfish populations in the field. A mix of these three tools will increase the probability of having sustainable shellfish resources for the citizens of and visitors to Nantucket.

Goal I: Maintain and enhance the populations of scallops, quahogs, soft shell clams, mussels, conch, oysters, and other shellfish of commercial and/or recreational importance in Nantucket waters

Objective I: Enhance shellfish resources through propagation activities

Issues

Shellfish propagation entails the manipulation of shellfish resources to augment naturally occurring populations. Propagation can occur through relays of adult shellfish from restricted areas to approved or conditionally approved areas—followed by an appropriate interval of time to allow for depuration. Another propagation strategy utilizes shellfish juveniles or larvae produced in a shellfish hatchery and reared under controlled conditions until released into the wild. Both strategies allow for the addition of new individuals into existing populations resulting in either a “put-and-take” fishery or propagated individuals that are allowed to grow and reproduce thus seeding natural areas within Nantucket waters. Although the latter type of propagation activities are currently conducted for Nantucket’s bay scallops, quahogs, oysters, and soft-shell clams, propagation has historically fluctuated due to inconsistent funding, man-power, and other resources. Overall, the Island needs to continue to support these activities, as they have been proven to be effective strategies in augmenting “natural” shellfish resources.

Recommendations

- 1) *Develop and implement a strategy to track the effectiveness of propagation activities in terms of supplementing the commercial and recreational harvests. As part of this, identify locations best suited for larval release (e.g., areas with larval retention), examine the timing of larval release in terms of survival, and conduct post-set release and associated monitoring for survivability.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Nantucket Shellfish Association*
- *Commercial fishermen*
- *UMass Boston Nantucket Field Station*
- *Outside experts as appropriate*

- 2) *Continue current propagation efforts such as the larval release program and, based on the results of the study of propagation effectiveness, consider pursuing opportunities to expand propagation activities, including expansion to different species (i.e., oysters).*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Nantucket Shellfish Association*
- *Commercial Fishermen*

Objective II: Enhance shellfish resources through seed management activities

Issues

Often times, wild shellfish seed can be manipulated to enhance the survival and productivity of existing populations. Seed management activities include returning seed to the water if stranded on the shore,

moving seed from one location to another to improve the likelihood of spawning and/or survival, and closing off areas to harvesting so that they may serve as seed sanctuaries. Though seed management on Nantucket has some guidelines, there is no formalized seed management plan.

Recommendations

- 1) *Develop seed management protocols for transplanting seed. Outline criteria for establishing seed sanctuaries and for determining compensation to volunteers who assist with seed management. Review the effects of the protocols and adapt as appropriate.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Harbor and Shellfish Advisory Board*

- 2) *Develop and/or support studies to evaluate the efficacy of seed management activities. Adjust seed programs to improve effectiveness.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*

- 3) *Better understand impacts of wind-driven strandings on the bay scallop population. Topics of interest include survivability of seed returned to the water and the effects on the seed population (i.e., what percent of seed is stranded).*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Maria Mitchell Association*
- *Outside experts as appropriate*

Objective III: Enhance shellfish resources through spawning management

Issues

When shellfish populations decline in the wild, critical densities are required to ensure optimal fertilization success. To ensure that effective fertilization has occurred, threshold densities need to be maintained. If those densities cannot be sustained naturally, then broodstock can be intentionally held at optimal densities through artificial means, e.g., relaying to specific areas or enhancing through propagation.

Nantucket has performed various bay scallop spawning management activities and, while the projects did yield some helpful “lessons learned,” research to understand the impacts of these efforts has not been conducted. Future spawning management efforts can benefit from the past work on Nantucket, as well as advances made off-Island however, it is important to closely monitor the impacts of any new spawning management efforts in Nantucket waters.

Recommendations

- 1) *Continue to develop spawning sanctuaries, through the use of spawning cages, to increase larval supply, and monitor impacts of sanctuaries. Particular focus should be on utilizing areas with high larval retention and evaluating the manipulation of water flow for larval retention.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Harbor and Shellfish Advisory Board*
- *UMass Boston Nantucket Field Station*

- 2) *Institute new steps—and continue existing efforts—to identify spawning events and monitor spat levels in the Harbors such as by the strategic placement of spat bags strategically around the Harbors.*

List of implementing agencies/groups:

- *The Marine and Coastal Resources Department or the Town**
- *Maria Mitchell Association*
- *Harbor and Shellfish Advisory Board*

- 3) *Continue larval release at various locations throughout Nantucket waters and evaluate its effectiveness in terms of localized recruitment of spat. Investigate whether or not the timing of the releases affects their effectiveness at enhancing local populations.*

- *The Marine and Coastal Resources Department**
- *Nantucket Shellfish Association*

Goal II: Conduct predator management activities

Objective I: Better understand the impacts of shellfish predators on the fishery and manage accordingly

Issue

Predation on shellfish resources affects all life stages of the bivalves, from planktonic larvae being consumed by comb jellyfish to adults being attacked by predatory gastropods. Many argue that predation is the primary factor controlling the overall population dynamics of shellfish in the wild. Therefore, any outside means of reducing or excluding predators from consuming shellfish may have a significant positive effect on shellfish resources.

Recommendations

- 1) *Measure and monitor predator abundance in Nantucket waters (in part through a survey of by-catch) and measure impacts on shellfish resources during the various life stages for each species. Understand the impacts of native versus non-native predators and implement a predator management protocol as appropriate, perhaps based on the identification of an “over-abundance” (which would need to be defined) of predators in the ecosystem. As part of the protocol, conduct research to understand the impacts of predator removal—both on the harvested resources and on the biological communities in the Harbors. Specifically look at the impacts of the mud blister worm (Polydora).*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**

- *Marine and Coastal Resources Department or the Town*
- *Shellfishermen*
- *Outside experts as appropriate*

Goal III: Manage shellfish based on scientifically sound understanding of the shellfishes' lifecycles, population dynamics, and other biological traits.

Objective I: Develop a better scientific understanding of Nantucket shellfish

Issues

Life history characteristics of shellfish resources and their interactions with their environment are generally understood but site-specific differences need to be identified. This is particularly true with respect to the uncertainty about when shellfish spawn and, specifically, whether or not a nub scallop will spawn twice. Additionally, it is unclear as to how shellfish move around the Harbors, including those transported during wind-driven events. This uncertainty creates differences in opinion on how to manage shellfish resources; therefore it is important to encourage and support research and use the resultant findings to make science-based decisions regarding shellfish management.

Recommendations

- 1) *Conduct and/or support current and future research to better understand the spawning cycle of scallops, and specifically the spawning cycle of nub scallops.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Maria Mitchell Association*
- *University of Massachusetts*
- *Massachusetts Division of Marine Fisheries*
- *Massachusetts bay scallop fishing communities*
- *Outside experts as appropriate*

- 2) *Better understand and define the biological traits of and stressors to bay scallops, quahogs, conch, oysters, soft-shelled clams, and other harvested shellfish. Use that knowledge to make informed management decisions. Specific topics of interest include (1) the relationship between spat recruitment and post-set spat survival as it relates to the overall abundance of shellfish, and (2) the genetic variability among harvested shellfish.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Maria Mitchell Association*
- *Outside experts as appropriate*

Regulations

The principal approach to shellfish management has historically been through regulations—standards based in law with enforcement and penalties for violations. In the legal structure, the Commonwealth of Massachusetts, through DMF, establishes standards for implementation by either State or local officials. The Town of Nantucket has the authority to implement stricter standards than those of the State but does not have the authority to change, or “weaken,” State standards. The Town may, however, work with DMF to modify State standards to better meet local conditions.

While a great deal of research is still needed on shellfish, their habitats, and the factors that affect shellfish, several regulations should be explored to improve local management.

Goal I: Structure commercial and recreational harvesting effort to protect shellfish resources.

Objective 1: Ensure that commercial and recreational harvesting efforts provide for the sustainable maintenance of the shellfish resources

Issues

There are many regulatory management strategies available to ensure the sustainable harvest of shellfish resources. Based on an understanding of the standing stock available for harvest and recruitment into the fishery, regulations can be established for practices such as the technology applied to fishing effort and overall commercial and recreational effort. Additionally, controls can be established based on the biological characteristics of the shellfish, e.g., minimum size thresholds. These control measures should be based on strong scientific data characterizing the resources wherever possible.

Recommendations

- 1) *Monitor the population characteristics of important shellfish resources across the Island, assessing recruitment into the fishery and the standing stock available for harvest, in order to provide information for management decisions. This monitoring could possibly lead to the development of a predictive population model for Nantucket shellfish. Additionally, this monitoring could be done in a collaborative manner by working with local fishermen.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Maria Mitchell Association*

- 2) *Continue to limit the size and mechanics (power hoisting) of dredges and enforce existing restrictions such as the current 40-pound limit on the weight of the dredge.*

List of implementing agencies/groups:

- *Board of Selectmen**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*

- 3) *Work with other Massachusetts-based shellfishing communities and DMF to identify and conduct research designed to evaluate the definition of a legally harvestable bay scallop. As part of this, consider research to inform the potential use of a thickness gauge to measure harvestable bay scallops.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Board of Selectmen*
- *Harbor and Shellfish Advisory Board*
- *NSA*

- 4) *Increase oversight of recreational shellfishermen and enforcement of recreational regulations more widely. This includes expanding enforcement efforts during the summer, obtaining data on recreational catches throughout the shellfishing seasons, and enforcing the regulation requiring people to wear the pins which prove they have purchased licenses.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**

Goal II: Ensure adaptive management of shellfish resources

Objective I: Regulations need to be adaptive and responsive as new information and management strategies arise

Issues

Regulatory programs cannot be static. Management methods and emphasis must change in response to new environmental conditions, improved understanding of environmental and harvesting impacts, legal and/or budgetary constraints, and other aspects related to management capabilities.

Establishing the capacity for timely changes in regulatory systems allows for a smooth transition in management techniques when conditions or scientific and legal understanding changes. A section of this report has been developed to outline the process by which adaptive management should be conducted. That section should be read in conjunction with these adaptive management recommendations.

Recommendations

- 1) *Implement the steps needed to institute the adaptive management section of this Plan. As a first step, the Town should establish a Shellfish Management Plan Implementation Committee. This Committee should be responsible for developing specific rules about adaptation, including the timing of meetings, whether or not a “traffic light” approach to management is logical/feasible (see Appendix F), etc.*

List of implementing agencies/groups:

- *Board of Selectmen**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*

- NSA

Goal III: Ensure sufficient resources to carry out the recommendations of this plan and management responsibilities under State and municipal laws and regulations

Objective I: To increase the revenue generated for shellfish management

Issues

Managing shellfish habitat and resources to achieve the goals of this Plan requires adequate and consistent funding for staff and facilities. If enforcement is, or is even perceived to be less than fair, equitable and consistent, compliance and acceptance of new management strategies will be more difficult. Additionally, structured propagation and research activities are vital to achieving sustainably managed fisheries. These activities fall largely to the MCRD, which is stretched thin with many diverse responsibilities.

Propagation, research, and water quality monitoring may benefit from being the responsibility of a separate fiscal entity, rather than part of the MCRD. In addition to more fiscal security as an independent entity, separation of these activities from the MCRD might quell any distrust of research conducted by a department also engaged in enforcement.

Funds generated through the sale of shellfish permits are utilized for the Town's shellfish propagation efforts. Annual fees for shellfishing licenses are as follows:

Table 14: Shellfishing licenses have different fees depending on what you are harvesting, whether or not you're a Nantucket resident, and whether or not you are fishing commercially or recreationally.

<u>Category</u>	<u>Shellfish Species</u>	<u>Fee</u>
Commercial	Scallop	\$250
Commercial	Other than scallop	\$150 per species
Recreational; Nantucket Resident	Any species	\$25
Recreational; Non-Resident (annual)	Any species	\$100
Recreational; Non-Resident (weekly)	Any species	\$50

Currently annual income from sales of licenses is approximately \$60,000. Of this, roughly half is from commercial license sales and half is from recreational sales. Three-quarters of this income is used to support the shellfish propagation fund while the rest goes into the Town's General Fund.

Additional revenue could be provided for propagation efforts—while potentially stimulating other sectors of Nantucket's economy—by exploring options for new recreational and commercial fee structures and permit opportunities or by adjusting the percentage of the total license sales that goes to support propagation efforts.

Recommendations

- 1) *Develop alternative commercial and recreational permit fee structures to generate more revenue for Nantucket. Investigate opportunities for changes to permit fees from time to time. Any*

direct revenues should be put toward propagation activities. Follow-up studies should be conducted to determine the economic impacts of any new fees.

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Board of Selectmen*
- *Harbor and Shellfish Advisory Board*
- *NSA*

Management Implementation

Goal I: Administer and enforce the municipal Shellfish Management Plan in an efficient, consistent, equitable, and cost-effective manner

Objective I: Establish a stable independent budget for the Town's shellfish management activities

Issues

Presently, shellfish management (including propagation efforts, enforcement, and research) does not have a stable and predictable source of funding. Some funding comes from the annual budget approved at Town Meeting, while the rest comes from the sale of shellfish licenses. The former is subject to the constraints and competition for financial resources within the overall Town budget. More certainty for consistent funding levels will allow for better allocation of resources and better planning for future propagation and research efforts.

Recommendations

- 1) *Ensure stable funding for sufficient staffing of all management activities including research, water quality testing and analysis, propagation, enforcement and the use of interns and seasonal employees (estimated to cost at least \$150,000). Funding sources should include money for salaries and equipment out of the general fund, money for propagation from fines, and additional income from grants, gifts, and the sale of licenses. One hundred percent of license fees must be used for propagation efforts. Consider various budget scenarios for expanded propagation activities, and the hiring of a second biologist.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Board of Selectmen*

Objective II: Continue to build on collaborative management and research, coordinating the activities and interests of the relevant Town of Nantucket boards and departments, commercial and recreational fishermen and associations, the Division of Marine Fisheries, and nonprofit organizations

Issues

The shellfish fisheries on Nantucket are “managed” by multiple entities, including the Massachusetts Division of Marine Fisheries, the Town Board of Selectmen, the Harbors and Shellfish Advisory Board, the Town Board of Health, and the Marine and Coastal Resources Department.

DMF has overall authority in designating and classifying shellfish growing areas, identifying locations suitable for aquaculture, issuing aquaculture leases, and setting the definition of a legally harvestable shellfish. DMF also keeps records of total catches, numbers of licenses sold, and other statistics.

While DMF has general authority over shellfish, the Town of Nantucket can fine-tune the shellfish regulations (in municipal waters) as long as their regulations are not in conflict with those of the State. Accordingly, the Board of Selectmen, advised by the Harbors and Shellfish Advisory Board, acts to define policies and goals for the shellfishery. The Marine and Coastal Resources Department is responsible for carrying out many of those goals and policies, including the issuance of shellfish licenses and aquaculture leases, ensuring that fishermen comply with regulations, conducting shellfish transplants and relays, as well as propagation and research activities. The Board of Health is also involved through the licensing of shanties where shellfish are shucked.

In addition to the State and Municipal entities tasked with managing the shellfisheries, fishermen are also involved in management, acting through SHAB, the Nantucket Shellfish Association, and Town Meeting to articulate concerns and issues that arise. The fishermen are also responsible for understanding and adhering to the regulations while fishing.

The number of groups presently involved in shellfish management on Nantucket necessitates some level of communication in order to function. While the current approach to communication seems to work to a large extent, additional steps can be taken to improve the efficiency and effectiveness of that communication. For example, training and education opportunities can promote a consistent understanding of the regulations among fishermen and those responsible for enforcement, thus improving enforcement efforts.

Similar to the way that multiple entities are involved in managing the fisheries, several groups, including the Marine and Coastal Resources Department, the Maria Mitchell Association, the UMass Boston Nantucket Field Station, and the Nantucket Land Council, are conducting research on shellfish-related topics. While some collaboration already exists, efforts should be made to reduce redundancies, adopt common data collection methods, apply for joint funding, and take other steps to advance the state of knowledge of Nantucket's shellfish and habitats.

Recommendations

- 1) *All personnel involved in management of shellfish resources and enforcement of shellfish regulations should attend periodic joint-training sessions (facilitated by fishermen and managers together) to ensure consistency of enforcement. These sessions should be open to commercial and recreational shellfishermen in the interest of improving compliance and communication between managers and the regulated community. Continue to include attendance in a training session as part of the penalty for harvesting seed scallops.*

List of implementing agencies/groups:

- *Harbor and Shellfish Advisory Board**
- *Marine and Coastal Resources Department or the Town*
- *Board of Selectmen*
- *NSA*
- *Commercial fishermen*

- 2) *Work with other fishing communities in Massachusetts to identify and make recommendations to DMF in areas where changes might benefit Nantucket shellfisheries, such as with the size of a legally harvestable bay scallop. Prepare and make widely available clear guidance on identifying harvestable scallops.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Board of Selectmen*
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Fishermen*
- *Other fishing communities in Massachusetts*
- *Outside experts as appropriate*

- 3) *Work with the Harbor Plan Implementation Committee to develop the data clearinghouse for Harbors-related topics, including information pertaining to shellfish. Include the resources listed in this Management Plan, and ensure the availability of information pertaining to previous research on Nantucket shellfish.*

List of implementing agencies/groups:

- *Shellfish Management Plan Implementation Committee**
- *Marine and Coastal Resources Department or the Town*
- *Board of Selectmen*
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Maria Mitchell Association*
- *UMass Boston Nantucket Field Station*

- 4) *Nantucket's research entities, along with the Town and fishermen, should work together to further develop and implement the coordinated Research Plan associated with this Shellfish Management Plan, identifying priority research sites, data needs, and a standardized method for data collection, recording and reporting. This research coordination should be overseen by a group of local and outside experts with knowledge of research issues contained in the Research Plan. For purposes of this Plan, that group is referred to as the "Nantucket Research Collaborative."*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Maria Mitchell Association*
- *University of Massachusetts Boston Nantucket Field Station*

- *Department of Health*
- *School for Marine Science and Technology*
- *Massachusetts DEP*
- *Other experts as needed*

Objective III: Increase opportunities for successful commercial shellfish aquaculture in Town waters

Issues

Shellfish aquaculture has proven to be a low-impact method of producing marketable shellfish, and is growing in both the acres farmed and the level of production in the northeast at a very high rate (approximately 10% per year, e.g. see the Rhode Island Annual Aquaculture reports between 1999-2011, at <http://www.crmc.ri.gov/aquaculture.html>). In addition to providing economic benefit to watermen, shellfish aquaculture also provides a variety of ecosystem services that aid in moderating impacts such as nutrient eutrophication in our coastal waters (an oyster can filter about 15 gallons of water a day (Rhode Island Sea Grant, undated)); therefore, shellfish aquaculture should be encouraged more widely in Nantucket waters. Existing shellfish aquaculture in Town waters represents only a fraction of what can be accommodated sustainably and compatibly with other uses. As such, more should be done to encourage and support shellfish aquaculture.

Recommendations

- 1) *Continue to develop and implement an action plan to increase available space and use of space for aquaculture in Town waters. The action plan should address qualifications of bidders; a requirement for a business plan, and; management standards. The action plan should also ensure that shellfishing activities are not impaired as a result of aquaculture, and stress the participation of fishermen in hearings pertaining to aquaculture decisions.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Board of Selectmen*
- *Harbor and Shellfish Advisory Board*
- *NSA*

- 2) *Continue to work with DMF to identify and consider (1) potential aquaculture locations outside of the agency's usual physical siting requirements and (2) approval of a block of sites in advance of the DMF's issuance of a license to an individual.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Board of Selectmen*
- *MA Division of Marine Fisheries*
- *Harbor and Shellfish Advisory Board*
- *NSA*

Objective IV: Manage areas of the Harbors for harvest based on assessments of the resource, habitat conditions, and social demand

Issues

Accessibility to Nantucket shellfish resources should be managed to address the needs of the stakeholders (recreational and commercial) and the sustainability of the resource. Management decisions based on apportioning areas for harvest will be dependent on the social demand modulated by the availability and sustainability of the resource, as assessed by resource monitoring.

Recommendations

- 1) *Identify and make publically available areas for recreational fishing.*

Recreational fishing already dominates those shallow areas of the Harbors most easily accessible to recreational fishermen. Information about those areas should be made available to recreational fishermen, though commercial fishing should not be excluded from those areas.

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Board of Selectmen*
- *Harbor and Shellfish Advisory Board*
- *NSA*

Education

Goal I: Increase public education/outreach efforts to the general public as well as recreational and commercial fishermen to create a better understanding of how human activities affect important shellfish resources

Objective I: Educate the general public about the significance of shellfishing to the Island's economy, culture, and history

Issues

Harvesting shellfish commercially and recreationally has long been important to both the economy and culture of Nantucket. However, many full-time and summer residents do not appreciate the full significance of shellfishing and, all too often, are not aware that their actions on the land and on the water can affect the fisheries. Furthermore, they often fail to appreciate the importance of ensuring a healthy shellfish population. Improving the general public's understanding of shellfish-related issues, including the economic and cultural significance of shellfishing, will allow for more informed decisions on activities ranging from Town budgets and by-laws to the use of private property and public waters. Efforts such as the development of the Blue Pages are already underway to help promote awareness of the Island's marine resources; however, additional efforts are also needed to increase public awareness.

Recommendations

- 1) *Design and implement a study to assess the economic impact of recreational and commercial shellfishing to Nantucket. This study should address topics such as employment rates (including jobs both directly and indirectly impacted by shellfishing), wages, impacts to other sectors of the economy, cash-flow through the Island economy, and economic trends related to shellfishing.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Outside experts as needed*
- *Nantucket Planning and Economic Development Commission*

- 2) *Develop and implement a public outreach strategy to highlight the significance of shellfishing both from a cultural and an economic perspective. This may include components such as a series of articles in local newspapers and magazines; a mail campaign; outreach activities at fairs and festivals; recruitment of recreational shellfishers for the NSA; a “meet the fishermen” event; the development and distribution of the Blue Pages book; and an informational display that can be moved from venue to venue (appearing in such places as the library, Town Hall, ferry terminals, the airport, etc). This strategy should be developed in a way that fosters collaboration with other existing outreach plans so as to not duplicate efforts or send mixed messages to audiences.*

List of implementing agencies/groups:

- *Shellfish Management Plan Implementation Committee**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*

- 3) *Develop an oral history of commercial and recreational shellfishermen and those associated with the industry as part of the historical records of the Island.*

List of implementing agencies/groups:

- *Nantucket Historical Society**
- *NSA*
- *Harbor and Shellfish Advisory Board*

Objective II: Educate the general public about the ways in which their actions affect the shellfishing industry

Issues

Chemicals such as fertilizers, pesticides, boat cleaners, and nutrients from septic systems can result in significant negative impacts on shellfish and their habitat. Activities such as anchoring boats with mushroom moorings and bottom chains can disrupt various features of shellfish habitat and harvesting shellfish without a license and proper training may affect shellfish populations. Providing the public with information about how their activities can affect shellfish, and ways to avoid these impacts through best management practices, will help minimize or alleviate some of the problems. More education may lead to greater voluntary compliance and lessen the need for costly enforcement efforts.

Recommendations

- 1) *Develop and implement an outreach strategy to educate the public about how land and water-based activities can affect shellfish habitat. The outreach strategy should consider opportunities to coordinate with existing education efforts such as those identified in the Harbors Plan.*

This outreach strategy should make every effort to reach landowners, boaters, yacht clubs and their members, students, Maritime Festival audiences, and others, as appropriate. Additionally, electronic communication methods, including social network tools, should be explored. Examples of possible topics include fertilizer applications and their impact on shellfish habitat, and the dangers of dropping anchor in a shellfish bed.

List of implementing agencies/groups:

- *Shellfish Management Plan Implementation Committee**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Harbor Plan Implementation Committee*
- *Marine Science Teacher(s)*
- *Egan Maritime Institute*
- *reMain Nantucket*
- *Nantucket Health Department*
- *Nantucket Department of Public Works*
- *Others as appropriate*

- 2) *Support the Harbor Plan Implementation Committee's work to develop and circulate a Blue Book modeled after those found in many communities on Cape Cod and Martha's Vineyard. Assist with content development and distribution.*

List of implementing agencies/groups:

- *Shellfish Management Plan Implementation Committee **
- *Harbor Plan Implementation Committee*
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*

Objective III: Provide education/outreach to recreational fishermen both as to how to improve their catch (within the limits of the management program) and to minimize impacts on habitat

Issues

Because recreational fishermen spend less time on or in the water harvesting shellfish, and because a failure of the crop does not affect them as greatly as commercial shellfishermen, the recreational community may not clearly recognize changes in the numbers and health of the shellfish. Further, they

may not clearly recognize the impacts that they have on the overall populations and habitat. And in some cases, they may not know how to maximize their catch while minimizing their effort. Educational/outreach materials, tailored to the recreational fishermen, can help improve their harvest (and enjoyment and understanding of shellfishing) while helping to minimize adverse impacts on habitat. An education/outreach program linked to licensing procedures has the possibility to disseminate significant amounts of information with minimal effort and associated costs.

At the same time, numbers of recreational shellfishermen can provide meaningful feedback to Town and State managers on various aspects of shellfish health and populations as well as aspects of their habitat—if provided with some level of understanding of life cycles, habitat interactions, etc.

Recommendations

- 1) *Provide information on “best fishing practices” for recreational fishermen, including tips on how to identify legally harvestable scallops, where to access the water, how to be safe while harvesting, and how to minimize impacts on the habitat. Improve outreach to let people know that recreational permits are required to harvest shellfish. Use the outreach opportunity as a way to improve community awareness of the issues facing the shellfisheries. Include information about how the money raised by license sales helps the fishery and the Island’s economy.*

List of implementing agencies/groups:

- *Harbor and Shellfish Advisory Board**
- *Marine and Coastal Resources Department or the Town*
- *NSA*
- *Maria Mitchell Association and Aquarium*
- *DMF*

- 2) *Improve access for recreational fishermen when feasible. Ensure that these new access points do not lead to illegal parking, blocking of traffic, culling on private property, and other similar issues.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Planning Office*

- 3) *Gather contact information from people when they purchase their recreational shellfish permits. Use that information to communicate with recreational fishermen about upcoming events; management changes; opportunities to provide input on shellfish management; opportunities to participate in surveys about recreational shellfishing; and other important issues/opportunities.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *NSA*

Objective IV: Provide opportunities to the commercial fishing fleet to participate in research projects and stock assessments, both as a means to gather high-quality information and to inform the fishing fleet as to on-going research efforts.

Issues

Fishery research projects and stock assessments are often limited in scope due to a lack of qualified personnel and/or adequate “boat-time” to gather the information required. A new approach to gaining fishery-related information is through the development of a “Cooperative Research” effort, where commercial fishermen are provided an incentive to join with scientists and managers to perform studies required to aid management decisions. Incentives range from recognition of their assistance to compensation for their time through extra fishing days/limits. Cooperative research programs not only facilitate an expanded research opportunity but also allow for improved communication between scientists, managers, and fishermen.

Recommendations

- 1) *Investigate other Fishery Cooperative Research Programs in the region with the intention of developing and implementing a program on Nantucket that will allow local fishermen to be involved in research and stock assessment efforts.*

List of implementing agencies/groups:

- NSA*
- Harbor and Shellfish Advisory Board
- Marine and Coastal Resources Department or the Town
- BOS

- 2) *Identify a select group of fishermen to assist with research by documenting bycatch details such as the percentage of seed and the types and abundance of predators.*

List of implementing agencies/groups:

- Nantucket Research Collaborative*
- Marine and Coastal Resources Department or the Town
- Board of Selectmen
- Harbor and Shellfish Advisory Board
- Nantucket Shellfish Association
- Commercial fishermen

Harvest Documentation

Goal I: Manage based on accurate and complete data on the amount and location of shellfish harvested

Objective I: Improve methods of recording commercial and recreational shellfish landings to ensure a complete and accurate accounting of the harvest

Issues

Accurate and comprehensive catch and effort data are critical to effective fisheries management. Daily catch data for bay scallops are gathered by shellfish wardens who check every catch every day—either on the water, at the docks, or at the shanties. This method of tracking catch has not been consistently used since commercial bay scalloping began, thus catch statistics cannot be reliably compared between years. The recently adopted SAFIS (Standard Atlantic Fisheries Information System) trip-level reporting—which requires fishermen to report trip-specific catch and effort information to DMF—has improved the accuracy and reporting of landings data and includes information on where shellfish are being harvested, though incentives for under- and over-reporting catch and effort exist, presenting potential bias in the data.

While some processes are in place to capture data about the commercial harvest of shellfish, recreational shellfish catches are much more difficult to estimate due to the less visible and less predictable harvesting conducted by recreational fishermen.

Improved mechanisms to collect and/or verify commercial and recreational catch information, including details specific to different areas of the Harbors, will help to create a better record of the fisheries and will contribute to an improved understanding of legally harvestable species abundance and habitat issues.

Recommendations

- 1) *Continue to utilize records from shanties to help monitor and verify commercial landings. Additionally, continue to utilize records from shanties for enforcement of limits.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *MA DMF*

- 2) *Implement a means to track the general locations where shellfish were harvested—both recreationally and commercially. The new trip-level reporting to DMF includes records of the growing areas fished and captures information about effort. Recreational fishing records should be designed to collect information similar to that reported for commercial harvests. While methods to track recreational fishing are imperfect, they could be augmented to also obtain information about where recreational fishermen fish. These commercial and recreational data should be analyzed jointly to understand where the fishing is greatest from year to year, and what significance that might have for management.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Commercial fishermen*
- *DMF*

Support of the commercial shellfishery

Goal I: Support the economic and physical structures of a viable shellfishery for both economic and traditional purposes

Objective I: Improve strategies to optimize the dollar value of harvested shellfish

Issues

The price of shellfish fluctuates throughout the season relative to product abundance, quality, and demand. Some of Nantucket's wholesalers describe a very competitive and secretive atmosphere—among both wholesalers and fishermen—with no one fully aware of who moves what quantity of shellfish to which buyers for what price. Still, there seems to be a collective interest in better understanding of how to enhance the value of shellfish coming from Nantucket waters. Of particular interest is finding a way to market the highly-prized Nantucket bay scallop in such a way that buyers can be sure their product truly came from Nantucket waters. Anecdotal reports tell of menus offering “fresh Nantucket Scallops” in October, before the commercial season has even opened, as well as incidents of scallops being flown to Nantucket and then shipped out, reportedly “from Nantucket.” This outside competition drives down the price of the real Nantucket bay scallop and can jeopardize the reputation of the shellfish's quality. Having the ability to prove that a bay scallop originated from Nantucket waters could help prevent the intrusion of imitation Nantucket bay scallops. UMass Boston is conducting research that might help address the problem of imitation Nantucket bay scallops. The research project involves (1) creating a catalog of scallops from known locations in Nantucket Harbor, (2) analyzing the geochemistry of the growing edge of the shell to identify chemistry of that particular habitat, and (3) building a classification model that will help identify the geographic origin of a bay scallop. Similar work with the meat of the scallops is in the beginning stages of development.

Another consideration with regard to the economics of the Nantucket bay scallop fishery is the fluctuation in price throughout the week and the season. Friday catches do not go to market until Monday, and because they are not as fresh as the scallops bought during the rest of the week, they typically bring in a lower price. Additionally, the price seems to drop off at the end of the season when consumers feel that the quality of the harvested shellfish is deteriorating. Lastly, prices seem to fall around Thanksgiving and Christmas.

In order to realize the maximum economic value of Nantucket bay scallops, there is potential to collectively control when the product hits the market, and how much goes to market. Additionally, branding the Nantucket bay scallop, sharing costs of harvesting and shucking the product, and identifying markets for shellfish by-products could improve the bottom line for those involved in the shellfisheries. While some strategies have already been discussed by fishermen and are identified in the following recommendations, a detailed economic analysis of the industry and the market(s) can help to identify additional strategies.

Recommendations

- 1) *Develop marketing strategies, such as branding the Nantucket bay scallop and/or controlling the rate at which scallops reach the market, to optimize the price of the Nantucket bay scallop. As part of this, continue to develop the concept of using a sticker to identify boxes of scallops as coming from Nantucket. Also consider developing quality standards (such as a freshness standard) that would be universally agreed upon and promoted by all who handle Nantucket bay scallops. Work with USDA to see if their marketing programs are applicable to the Nantucket bay scallop fishery. Link with ecotourism opportunities on Nantucket.*

List of implementing agencies/groups:

- NSA*
- Harbor and Shellfish Advisory Board
- Commercial fishermen
- Wholesalers

- *Outside experts as appropriate*
- 2) *Consider establishing a co-op for marketing purposes. As part of the development of this co-op, consider making participation optional, and look to other co-ops for examples of good strategies. Appendix H provides some guidelines and resources for developing this cooperative.*

List of implementing agencies/groups:

- *NSA**
 - *Harbor and Shellfish Advisory Board*
 - *Commercial fishermen*
- 3) *Develop marketing strategies to enhance the value of Nantucket shellfish by-products (e.g., shells as a buffering source for restoration projects, viscera as a protein source, guts as bait or food, gonads as food).*

List of implementing agencies/groups:

- *NSA**
 - *Harbor and Shellfish Advisory Board*
 - *Fishermen*
 - *Wholesalers*
 - *Shuckers*
 - *Outside experts as appropriate*
- 4) *Review options for timed fishing closures to ensure the quality and consistency of product reaching the market.*

List of implementing agencies/groups:

- *NSA**
 - *Harbor and Shellfish Advisory Board*
 - *Board of Selectmen*
 - *Fishermen*
 - *Marine and Coastal Resources Department or the Town*
- 5) *Explore the apparent correlation between the price of scallops and number of buyers. Determine whether or not the number of buyers affects the price they are willing to pay.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Outside experts as appropriate*

Objective II: Improve shoreside access for commercial fishermen

Issues

The 2006 Nantucket and Madaket Harbors Action Plan identified the need to maintain and enhance opportunities to access the Harbors for, among other uses, recreational and commercial shellfishing. Recommendations include using easements, Chapter 91 licenses, land purchases, and recovery of historical points of access as potential tools for acquiring public access points—including affordable dock and mooring space for commercial fishermen. Additionally, the Harbors Plan identifies Chapter 91, local zoning, and public and private investments as mechanisms for improving existing access-related infrastructure.

Recommendations

- 1) *In conjunction with the Harbor Plan Implementation Committee, consider opportunities to improve shore-side access and facilities through the expansion of existing access points and/or the creation of new access points. Establish mechanisms to ensure that these new access points do not result in the unreported taking of additional shellfish.*

List of implementing agencies/groups:

- *Marine and Coastal Resources Department or the Town**
- *Nantucket Land Bank*
- *Harbor and Shellfish Advisory Board*
- *Planning and Economic Development Commission*
- *Conservation Commission*
- *Roads and Right of Way Committee*

Objective III: Improve training needed to maintain a viable shellfishery.

Issues

Records indicate that the number of people obtaining commercial fishing licenses has been on a general decline since the early 1990s. Many scallopers describe how, as young children, they would help their parents shuck scallops and would catch their own limits before going to school in the morning. By contrast, very few young people are currently entering the shellfisheries for various reasons, including the overall downward trend in bay scallop population. Until very recently, most fishermen who entered a Nantucket shellfishery did so without any formal training or apprenticeship period. Recognizing this training void for new fishermen, SHAB now offers a mentoring program to new fishermen. This 40-day apprenticeship provides education on topics such as regulations, safety, and best practices. The program is still in its early years, and has the potential to reach many fishermen at a crucial time in their careers.

Recommendations

- 1) *Continue to enhance and implement a mentoring program to assist new entries into the fishery. As part of the enhancement, develop a check-list of topics for the teaching captain to cover with the apprentice. The checklist would include topics such as how to identify a legal bay scallop (to be taught by a Warden or shellfish biologist), how to cull a catch, a review of the regulations, and general etiquette at sea. Continue to allow the reduction of the 40-day limit to allow for shorter apprenticeships if fishermen demonstrate the appropriate knowledge and skills needed to operate safely. These shorter apprenticeships would require the approval of SHAB.*

List of implementing agencies/groups:

- Harbor and Shellfish Advisory Board*

Adaptation of plan

Goal I: The Shellfish Management Plan should respond to changing conditions in order to ensure that shellfish resources are not depleted below sustainable levels, thus ending the shellfish industry on Nantucket

Objective I: Shellfish management should be adaptive (i.e., can change from year to year or even during the season based on key pieces of information).

Issues

The one consistent aspect of shellfish and shellfishing on Nantucket has been its inconsistency. Shellfish populations rise and fall dramatically with changes in habitat, environment, and for reasons no one has yet determined. Numbers of commercial fishermen vary depending on economic conditions, shellfish populations, cost of fuel, and other variables. Funding for management efforts at both the Town and State levels change with economic conditions; and science continues to provide new information and raise new questions pertaining to shellfish and their habitats. Please refer to Section 11, Adaptation of this Plan for more specific information about how the Plan can be adapted.

Recommendations

- 1) *Bring together a group of people (a "Shellfish Management Plan Implementation Committee") responsible for overseeing the implementation and adaptation of this Plan. This group should meet regularly and should include representatives from multiple stakeholder groups including recreational fishermen, commercial fishermen, SHAB, the Department of Natural Resources, scientists, and managers. Off-Island expertise should be included as appropriate. Three-year term limits should be established for this Committee. The group should work closely with not-for-profit entities to help raise funds for management plan research and implementation activities, identify common data reporting/gathering techniques, prioritize research projects, and address other research-related issues.*

List of implementing agencies/groups:

- Board of Selectmen*
 - Marine and Coastal Resources Department or the Town
 - Harbor and Shellfish Advisory Board
 - NSA
 - Nantucket Land Council
 - UMass Boston Nantucket Field Station
 - Maria Mitchell Association
 - Conservation Commission
- 2) *Establish a system whereby a review of coordinated threshold criteria (e.g., number of weather-related fishing days lost, seed density, stock assessments, etc.) or a valid concern raised by a citizen would initiate a public process to address the issue(s)—including possible management actions.*

List of implementing agencies/groups:

- *Nantucket Research Collaborative**
- *Harbor Plan Implementation Committee*
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*
- *Outside experts as appropriate*

3) *Review and revise the Shellfish Management Plan every three years.*

List of implementing agencies/groups:

- *Shellfish Management Plan Implementation Committee**
- *Marine and Coastal Resources Department or the Town*
- *Harbor and Shellfish Advisory Board*
- *NSA*

SECTION 11: ADAPTATION OF THE SHELLFISH MANAGEMENT PLAN

This Plan is not designed to remain static over time. It is, rather, a reasoned attempt to manage a changing resource at a given time based on currently available knowledge. Because the Plan is designed to change over time, a Shellfish Management Plan Implementation Committee should be appointed by the Board of Selectmen to ensure not only that priority recommendations are implemented, but also to ensure that the entity which takes over adaptation when the Shellfish Management Plan Implementation Committee is dissolved, is given the resources needed to conduct a thorough review of the Shellfish Management Plan on a regular three-year schedule (See “Adaptation of Plan” section under Recommendations for more information about the Shellfish Management Plan Implementation Committee). The activities associated with this review will vary depending on the nature of the resources and the fisheries at the time of review; but, at a minimum, a public hearing should be held to address proposed modifications. This three-year review should be initiated by the Shellfish Management Plan Implementation Committee or the appropriate entity, but should also include participation from SHAB, the NSA, the Department of Marine and Coastal Resources, DMF, and any other entities involved in the catching, selling, and management of shellfish.

While the three-year review will be important, an additional mechanism must be established to address more urgent adaptations on an ongoing basis. Several possible reasons for adapting this Plan outside of the scheduled three-year review exist, including:

- **The availability of new information:** Scientific understanding related to shellfish management has grown and evolved but is still incomplete. New information, based on either scientific research or water-based observations, may become available which would warrant a change in a related management strategy.
- **The occurrence of a critical event:** Strandings, oil spills, harmful algal blooms, significant habitat alteration from a storm event or heavy fishing activity, and other similar events are largely unpredictable and may have devastating impacts on shellfish and/or their habitats. To the extent possible, management should adapt quickly to both address and minimize damage to the shellfish and their supporting habitats as well as react to the damage that does occur.
- **A shift in the legal and political framework:** The legal and political framework that creates the laws, regulations, and policies varies over time, and may necessitate the update of Plan elements.
- **A change in the economy of shellfishing:** As prices fluctuate, managers may consider options to modify the work-week, bushel amount, or other aspects of a fishery to adjust for the current economic circumstances.
- **A change in funding for shellfish management:** Funding for shellfish management may change from year to year depending on licenses sales, grant funding, budget cuts/increases, and other similar factors. As a result, management efforts may require adjustments to ensure that the level of management can be supported by the budget for any given year.

In instances of critical events, adaptation may be urgent. In these cases, a request by any concerned person may be made to the Chair of the Shellfish Management Plan Implementation Committee (while it is still intact) to hold a special meeting and public hearing. In consultation with the other members of the Shellfish Management Plan Implementation Committee, the Chair must decide if the issue warrants

a special meeting. If the Committee decides that the issue is both valid and urgent, a meeting should be announced and the Chair should work with appropriate entities (e.g., SHAB, NSA, the Department of Marine and Coastal Resources) to publicize the meeting. If the Shellfish Management Implementation Committee has been dissolved, the request for a special meeting and hearing should be made to SHAB or the appropriate entity.

The meeting should allow for debate of the issue, include multiple perspectives (those of managers, scientists, fishermen, and others), and result in a decision—as determined by a majority of the Committee—about what (if any) action is needed. These actions would then be brought before the Board of Selectmen as appropriate. Factors to keep in mind are:

- What are the legal parameters within which decisions can be made, (i.e., existing statutes, regulations, and policies limit management options to things that are currently “legal”), and who has the authority to make a specific decision?
- How will the impacts of the decision be monitored in order to determine if the decision has had the intended effects or is in need of modifications?
- What information is missing in order to make a decision with complete confidence, and can that information be obtained in a timely manner? If not, is the Committee willing to make a decision based on the best available information?

Non-urgent modifications to the Shellfish Management Plan—such as a change related to the availability of new funding and information—should follow a similar process in that a decision should be made by a majority of the Shellfish Management Plan Implementation Committee (or appropriate entity), should include debate of the issue(s), and should include multiple perspectives during the debate. The difference between the reviews of urgent and non-urgent issues should be the timing of the meetings. Whereas an urgent issue should warrant a special meeting to address that issue, a non-urgent issue should be addressed at a regularly scheduled meeting of the Shellfish Management Plan Implementation Committee or other appropriate entity, if the Committee is dissolved.

All modifications to this Shellfish Management Plan should be added as amendments, rather than making changes directly to an earlier version of the Plan.

SECTION 12: RESEARCH PLAN

Implementing the recommendations contained in this Shellfish Management Plan is the first step in improving management of Nantucket's shellfish resources. As mentioned throughout the document, however, there are significant knowledge gaps related to key topics such as the life cycle of the bay scallop, the impacts of propagation activities, the best approaches to restoring habitat, and the economic significance of shellfishing to Nantucket's economy. As the planning process illuminated these data gaps, recommendations were developed to address them.

The research-based recommendations (found in the Recommendations section of this Plan) have been reorganized in this Research Plan section to convey their significance to shellfish management on Nantucket. Some of these research needs are defined in very generic terms while others are very specific as to the nature and type of information needed, and all are based on a review of current information along with input from stakeholders. It should be noted here that many of the research needs are specific to the bay scallop, a commercially and culturally significant shellfish that has long held a special place in Nantucket's natural resource identity.

The vision is that this Research Plan will guide efforts to help organize research efforts and results; fill important knowledge requirements in the understanding of Nantucket's shellfish resources and their related habitats; and use new information to further promote sustainable shellfisheries management. The following does not address ongoing monitoring activities but efforts should be made to continue monitoring activities, analyze monitoring data and use the information gleaned from the monitoring to develop new research and management activities as appropriate. As with the rest of the Shellfish Management Plan, this Section is also intended to be something which is updated as new research needs and opportunities arise, and existing research needs are satisfied.

Shellfish Resources

A key requirement in the management of any biological resources is to have a thorough knowledge of the life history characteristics of the managed species and to understand the interactions between the managed species and the ecosystems within which they exist. This level of knowledge allows for the development of an ecosystem-based approach to resource management whereby all aspects of the ecosystem in question are considered, including the role of humans in altering the system, when developing management policies. While there is a long record of research knowledge on many of the species currently important to Nantucket, much of it is scattered among various locations and documents. In addition, there are still specific knowledge gaps that, if answered, could greatly assist shellfish management on the Island.

Goal: Manage shellfish based on a scientifically sound understanding of the animals' lifecycles, population dynamics, and other biological traits.

- ❖ Compile previous research focused on Nantucket shellfish resources.

Specific research projects include:

- Collect previous Nantucket shellfish research documents, data sets, metadata, and any other research deemed important to furthering the understanding of shellfish resources on the Island. This information should be available electronically, and a hard-copy should be maintained in the Town Archives.

Management Implications: This management planning effort identified several important sources of information pertaining to the management of shellfish. These documents provide important scientific and historical insight, and may prove useful as new management issues arise.

- ❖ Define the biological traits and life history characteristics of bay scallops, quahogs, conch, oysters, soft shelled clams, and other harvested shellfish.

Specific research projects include:

- Describe the spawning cycle of bay scallops on Nantucket and how environmental conditions may affect overall spawning effort.
- Explain the spawning cycle and contribution of nub scallops to the overall population of bay scallops.
- Understand the growth rates and movement patterns of conch.
- Conduct investigations into biology of other species as need arises.

Management Implications: The details of the bay scallops' spawning cycle, including the impact of environmental conditions on spawning effort will provide insight into causes for population fluctuations, and may help better predict the quality of the season before it begins. Having some insight as to what an upcoming season may look like can inform early planning in terms of the management strategies that would be most appropriate (e.g., extending or shortening the season). Additionally, if conclusions can be drawn to support a thickness gauge for identifying legally harvestable bay scallops, management might be changed to reflect a thickness rule rather than a growth ring and shell height rule.

Understanding the nub scallop's spawning cycle and its contribution to the population would help to clarify whether or not there is value in leaving nubs in the water and is critical to bay scallop management.

- ❖ Assess the populations of harvested shellfish resources.
 - Monitor the population characteristics of shellfish resources across the Island, assessing recruitment into the fishery and the standing stock, with a goal of defining the resource available for harvest. This could be done in a collaborative manner by working with local fishermen to assist in stock assessments.
 - Investigate the interrelationship between spat recruitment and post-set spat survival as it relates to the overall abundance of harvestable bay scallop stock.
 - Develop a population model with predictive capacity for bay scallop populations in Nantucket waters. Ground truth with data from the stock assessment suggested above.
 - Investigate the genetic variability among harvested shellfish.
 - Determine how enhancement activities have affected the bay scallop population in different areas of the Harbors.
 - Investigate the impacts of propagation activities.

Management Implications: Better understanding of population characteristics, including the impacts of spat survival on population abundance may help better predict the quality of the season before it begins. Having some insight as to what an upcoming season may look like can

inform early planning in terms of the management strategies that would be most appropriate (e.g., extending or shortening the season).

- ❖ Recognize the role that various environmental stressors may play in altering the ecosystem to an extent that affects shellfish resources, including the bay scallop.

Specific stressors of concern include:

- Excess nutrient run-off from all potential sources,
- Local application of pesticides, fungicides and other toxins used in upland management activities, and
- Marine-based toxicants, such as antifouling paints and chemicals used for maintenance of boats.

Management Implications: Understanding the impacts of chemicals and nutrients from upland and water-based sources will help target efforts to reduce those chemicals with significant impacts on Nantucket's shellfish and their supporting habitats.

Goal: Maintain and enhance the populations of scallops, quahogs, soft shell clams, mussels, conch, oysters, and other shellfish of commercial and/or recreational importance in Nantucket waters.

- ❖ Improve shellfish resources through enhanced spawning management

Specific research projects include:

- Continue to utilize and evaluate spawning sanctuaries to increase larval supply and monitor their impacts.
 - Identify areas with high hydrodynamic larval retention
 - Evaluate manipulating water flow for increased larval retention
- Identify annual shellfish spawning events
 - Monitor abundance of shellfish larvae in the local waters to assess spawning periods, intensity, distribution and survival.
 - Consider partnering with the Aquinnah Wampanoag Tribe, which is currently monitoring bay scallop larvae abundances in Menemsha Pond on Martha's Vineyard.
 - Monitor spat recruitment patterns in the Harbors using technologies such as spat bags or other spat settlement media.
- Continue the larval release strategy at various locations throughout Nantucket waters and evaluate the effectiveness of the program in terms of localized recruitment of spat.
 - Identify locations best suited for larval release activities.
 - Investigate whether or not the timing of the larval releases impact their effectiveness at enhancing local populations.
 - Identify where seed accumulate relative to a specific release site and correlate with known annual/seasonal water circulation patterns

- ❖ Improve shellfish resources through post-set release of bay scallops

Specific research projects include:

- Understand the impacts of post-set release, including predation, survivability, and effectiveness of various substrate-types.

Management Implications: Spawning management is a significant part of Nantucket's strategy to maintain sustainable shellfish populations. Understanding the impacts of existing spawning management efforts, and finding ways to improve those efforts will help to direct future spawning management activities so that they are most cost-effective.

❖ Improve opportunities for shellfish recruitment into the fishery

Specific research projects include:

- Catalog, map, and ground-truth information about the dominant habitat types (relative to shellfish survival) throughout Nantucket waters.
 - Explore alternative, less-costly options for obtaining habitat information.
- Research the potential for using natural or artificial substrates in the Head of the Harbor and explore other locations if more appropriate.
- Conduct collaborative annual surveys of juvenile shellfish stocks to assess the areas of spatfall.

Management Implications: By developing baseline data about the traits, trends, and locations of habitats significant to shellfish, efforts can be made to monitor the condition and extent of those habitats over time. This information will help identify where habitat protection strategies are needed and where artificial habitat might be appropriate. Additionally, information about habitat changes could provide insight into the quality of future seasons, and could influence pre-season management activities.

❖ Evaluate new methods for shellfish propagation in local waters

Specific research projects include:

- Evaluate the current propagation activities involving the shellfish hatchery post-set seed production and larval release
- Identify locations and times best suited for specific propagation-related technologies/activities, such as competent larval release, based on water quality, habitat value, larval distribution/retention, and growth/survival.

Management Implications: Propagation is a significant part of Nantucket's strategy to maintain sustainable shellfish populations. By identifying ways to increase the effectiveness of propagation activities (e.g., best technologies, significance of water quality conditions, etc.), future propagation activities can be more cost effective.

❖ Enhance shellfish resources through seed management activities

Specific research projects include:

- Develop and test handling protocols for transplanting seed, including stranded seed from a weather event as well as seed relayed from areas of exceedingly high densities.
- Evaluate and establish criteria for siting seed sanctuaries based on water quality, habitat value, and seed survival/growth.

- Investigate the role that fishing practices may play in relocating seed during harvest culling activities.

Management Implications: Many of Nantucket's current bay scallop seed management activities are conducted based upon the general expectation that efforts to relay and transplant seed and to create seed sanctuaries will benefit the overall bay scallop population. However, developing a scientifically-based understanding of how best to manage seed (e.g., through transplants, culling activities, and seed sanctuaries) will ensure that protocols for such seed management activities are successful.

Goal: Conduct predator management activities

- ❖ Evaluate the impacts of predators on shellfish resources during the various life stages for harvested species.

Specific research projects include:

- Measure and monitor pest/nuisance and predator abundance in local waters.
 - Survey shellfish harvest by-catch as a means to describe pest/predator abundance and distribution.
 - Survey for the presence of *Polydora* sp. (i.e., mud blister worm) impacts on shellfish resources with the intention of seeking preventative practices for the presence of the pest.
- Assess predator impacts.
 - Describe impacts of native versus non-native predators.
 - Study the impacts of predator removal—both on the harvested resources and on the biological communities in the Harbors.
- Implement a predator management protocol as appropriate, perhaps based on the identification of an “over-abundance” (which would need to be defined) of predators in the ecosystem.

Management Implications: An improved understand of predators and their impacts on Nantucket's shellfish resources can inform a predator management strategy to relieve that particular stressor to shellfish populations.

Habitat Management

While it is necessary to understand the life history of the resource for proper management, its existence is inexorably linked to its habitat. Therefore, knowledge of the quality and quantity of habitat specific for each shellfish resource is an important component to the knowledge base required for proper management. While we are rapidly gaining a better understanding of biological traits of a resource, there are large gaps still occurring in our knowledge of the habitat requirements for that same resource. Therefore, large questions of the role of habitat in managing a resource exist.

Goal: Maintain and improve the habitat associated with sustainable commercial and recreational shellfish fisheries

- ❖ Investigate the role of water circulation patterns on shellfish distribution, recruitment, growth, and survival

Specific research projects include:

- Better understand the overall hydrodynamics within Nantucket and Madaket Harbors
 - Interpret the impacts of water circulation on shellfish habitat and population dynamics, including a review of impacts on various different life stages.
 - Test options for improving circulation in local waters to benefit shellfish habitat and larval dispersal. For example, consider the impacts of raising the jetties at the entrance to Nantucket Harbor, and review the results of the SMAST modeling for N load reductions.
- Investigate the role of freshwater intrusion/inputs on scallop population dynamics

Management Implications: Understanding the role of water circulation patterns on shellfish populations will help identify specific management activities to best reduce related stressors to shellfish.

- ❖ Better understand the links between water quality, shellfish population dynamics, and anthropogenic activities that influence Nantucket waters.

Specific examples of activities of interest include:

- Understanding the impacts of applying fertilizers, herbicides, and pesticides on upland areas. This would entail:
 - gathering details about the chemicals being used, the quantities being applied, and the associated impacts
 - obtaining information about the condition of septic systems
- Researching the impacts of discharging grey water from vessels (and the related No Discharge Area designation)
- Evaluate methods for reducing nutrient inputs to local waters from anthropogenic sources. Use the SMAST modeling results as a guide.
- Understanding the impacts of boat maintenance activities such as boat washing and bottom painting as well as the overall impacts of boat activity in local waters, including petroleum hydrocarbon discharges and effects of propeller shear stress on larval survival.

Management Implications: Understanding the impacts of chemicals and nutrients from upland and water-based sources will help target efforts to reduce those chemicals with significant impacts on Nantucket's shellfish and their supporting habitats.

- ❖ Develop a better understanding of the sources and impacts of Harmful Algal Blooms (HABs) on shellfish and their habitat.

Specific research projects include:

- Identify sources of and track potentially harmful blooms in local waters.
- Investigate toxicities of new HAB occurrences to all shellfish resources.

Management Implications: Understanding the causes of HABs can help direct efforts to reduce those causes, and thus the occurrence of HABs. Tracking the impacts of HABs that do take place can suggest important information about the potential quality of the following shellfish season and can inform early planning in terms of the management strategies that would be most appropriate (e.g., extending or shortening the season).

- ❖ Maintain and, where possible, improve the condition and extent of eelgrass beds in Nantucket waters

Specific research projects include:

- Beginning with historical data compiled and maintained by the Massachusetts DEP, continue monitoring and evaluating the extent and health of eelgrass in Nantucket waters.
- Better understand the relationship between eelgrass health and the following;
 - density and shading from algal blooms or physical structures over the water surface
 - physical effects on eelgrass growth from overlying macroalgae (for example, observations suggest that *Gracilaria sp.* is covering eelgrass and causing it to lay flat during the spring)
 - effects to eelgrass from nuisance epiphytes growing directly on eelgrass such as, but not limited to the *Lyngbya* species
- Undertake a review of practices that may directly damage eelgrass beds to determine the short- and long-term nature and significance of the impacts
 - Physical damage (e.g., moorings, scallop dredges, propeller damage, etc.)
 - Other impacts (e.g., excess nutrient inputs from upland sources)
 - Explore methods to minimize those impacts.
- Evaluate the progress of modifying moorings in Nantucket Harbor to minimize damage to surrounding eelgrass beds.
 - Evaluate the effects of alternative mooring technologies, such as:
 - placing floats on mooring chains,
 - using helix or screw-in moorings, with an appropriate cap,
 - replacing chains with flexible bungee-style rope, or
 - placing multiple boats on one chain anchored between two moorings.
- Evaluate cost-effective strategies to protect/restore eelgrass in locations of significance to shellfish resources—both within and outside Nantucket and Madaket Harbors.
 - Current options include:
 - propagating eelgrass,
 - re-seeding areas,
 - removing stressors (e.g., moorings, excess nutrients) to existing and potential eelgrass habitats.
- Survey sediment within the Harbors to update and/or verify data sets (the Environmental Protection Agency, the Massachusetts Estuaries Project, and the Maria Mitchell Association all have data sets), with a focus on sediment types where eelgrass has been lost.

Management Implications: Understanding the condition and extent of eelgrass and the stressors to eelgrass condition and extent can inform eelgrass restoration and protection activities.

Additionally, monitoring can show trends in eelgrass habitat condition and extent, which may indicate the quality of the following shellfish season and lead to early planning in terms of the management strategies that would be most appropriate (e.g., altering gear used).

- ❖ Understand the impacts of harvesting-related activities on the habitat and the resources

Specific research projects include:

- Determine the impacts of recreational and commercial shellfish harvesting practices on the sustainability of the resource and the habitat.
 - Evaluate the impact of weights of dredges during seasonal changes of bottom, e.g., relative to eelgrass seasonal status.
 - Evaluate the impacts of harvesting strategies that would alter the genetic composition of the bay scallop population to give preference to bay scallops predisposed to late spawning. Consider the long-term implications to scallop size as well.
- Develop and/or promote more “habitat-friendly” shellfish harvest tools and methods, which would include the development of a “best practices” for commercial shellfish harvesting to incorporate into the apprenticeship program and promote among the fleet.

Management Implications: Understanding the impacts of shellfish harvesting may lead to changes in management strategies including such harvesting practices as gear restrictions and fishing locations.

Climate Change

The prevailing evidence indicates that the globe is undergoing a change in environmental conditions derived from anthropogenic impacts on our atmosphere. The buildup of carbon dioxide and other greenhouse gases has far-reaching consequences in terms of altering the marine environment, from small but significant temperatures changes, to sea level rise, to increases in the acidity of the waters. As the marine environment changes, it will directly influence the occurrence and behavior of many marine resources, including the shellfish resources around Nantucket. Therefore, it is necessary to recognize the potential changes that may occur as a result of climate change and to adapt management to accommodate those changes.

Goal: To ensure that the management of shellfish resources on Nantucket are prepared to adapt as our knowledge of the potential impacts of climate change develop.

- ❖ Develop a better scientific understanding of the impact that global climate change and associated changes in the environment will have on shellfish resources and how to adapt to those projected changes.

Specific research projects include:

- Enhance efforts to record water temperature, changes in pH, and/or other details, such as when the harbors freeze over
- Determine the role of freshwater inputs on scallop population dynamics
- Investigate the role that environmental change may have in altering shellfish populations on Nantucket, including sea level rise, ocean acidification, and climate change.
- Evaluate the impacts of returning shell to the Harbors in terms of the ability to buffer pH levels.

Management Implications: Understanding the impacts of climate change on shellfish populations will provide important information about the future of the fishery, and may influence the importance of management actions such as propagation activities and pH buffering.

Support of the Commercial/Recreational Shellfishery

Nantucket's shellfish industry plays a number of important roles in the fabric of the Island. Shellfish harvesting is a marine-related business that provides an economic return to the Island through the sales of shellfish products on- and off-Island. Secondly, shellfishing enhances economic activity on the Island through the support of a wide variety of ancillary businesses, from shucking houses to boat and motor sales to hotels and equipment purveyors. Equally as important is the cultural significance of commercial and recreational fishing to the Island, particularly that of the bay scallop fishery. Bay scallops are sought far and wide as the premier seafood product coming from Nantucket, and they have become an icon for the uncompromised environment and way of life that is Nantucket. Research in support of protecting this cultural and economic engine is a high priority for the Management Plan.

Goal: Support structure of a viable shellfishery for both economic and traditional purposes.

- ❖ Understand the role of shellfish harvests to the economy and culture of Nantucket.

Specific research projects include:

- Assess the economic impact of recreational and commercial shellfisheries to Nantucket, including:
 - employment rates (including jobs both directly and indirectly affected by shellfishing) and wages,
 - impact to other sectors of the economy,
 - cash-flow through the Island economy,
 - economic trends related to shellfishing.

Management Implications: A better understanding of the economic significance of shellfishing can help elevate its significance among researchers, funders, and the general public. Such increased attention may lead to the acquisition of new knowledge, the increased general will to protect the natural resources related to shellfishing, and the influx of financial resources to study and manage the shellfisheries.

Goal: Enhance the economic return derived from harvest of shellfish on Nantucket.

- ❖ Improve strategies to optimize the dollar value of harvested shellfish

Specific research projects include:

- Research the potential of marketing strategies, such as branding the Nantucket bay scallop and/or controlling the rate at which scallops reach the market, to optimize the price of the Nantucket bay scallop.
- Research the effectiveness of using a sticker to identify all containers of scallops as coming from Nantucket.

- Research the potential for and effectiveness of establishing quality standards (such as a freshness standard) that would be universally agreed upon and promoted by all who handle Nantucket bay scallops.
 - Research opportunities to link recreational shellfish harvesting to other aspects of ecotourism when promoting Nantucket as a destination.
 - Review options for timed fishing closures to ensure the quality and consistency of product reaching the market, and the impact on price due to change in supply.
 - Evaluate establishing a co-op for marketing purposes.
 - As part of the development of this co-op, consider making participation optional, and look to other co-ops for examples of good strategies.
- 6) Investigate the use and commercial value of by-products from the Nantucket shellfishery. For example:
- Shells to augment sediment as a buffer for restoration projects or as cultch for oyster enhancement,
 - Viscera as a protein source in animal food or used as bait,
 - Develop “roe-on” products

Management Implications: Understanding how to optimize the dollar value of harvestable shellfish will lead to such management actions as branding the Nantucket bay scallop, using timed closures to increase the price of shellfish, developing a co-operative of fishermen, and developing/refining guidelines for the use of shellfish by-products.

Education

The significance of Nantucket’s commercial and recreational shellfishing activities is best understood by those whose livelihoods and/or traditions are directly connected to shellfishing—wholesalers, fishermen, marine suppliers, etc. While many of those with an obvious stake in the health of Nantucket’s shellfisheries have some level of appreciation for the significance of shellfishing, many residents and visitors lack a true understanding of the ways in which shellfishing shapes the Island’s economy and culture. This lack of understanding likely contributes to unintentional negative impacts on the shellfisheries, such as the over-application of fertilizers, the use of traditional moorings, etc. An education campaign designed to convey both the significance of shellfishing as well as the ways in which human actions jeopardize the health of shellfish stocks, can help inspire changes in behavior and may contribute to increased support (including financial support) for steps to manage stressors to shellfish and their habitat.

Goal: Increase public education/outreach efforts to create a better understanding of how human activities affect important shellfish resources

- ❖ Investigate ways to effectively educate the general public about the significance of shellfishing to the Island’s economy, culture, and history

Educational projects of specific interest include:

- An oral history of commercial and recreational shellfishermen and those associated with the industry as part of the historical records of the Island.
- Collaboration to build off of other educational efforts on Nantucket (past and present).

- A research project designed to determine the direct and induced economic significance of commercial and recreational shellfishing in Nantucket waters.
- Alternative yard maintenance options.
- A review of the capabilities of conservation moorings
- A program about the relationship between spawning biomass, larval supply, and post-set recruitment.
- A mobile display conveying the significance of shellfishing on Nantucket.

Management Implications: An improved understanding of how best to reach out to the general public (e.g., how to work with existing education efforts, how to make shellfishing significant to the general public, and how to inspire environmentally responsible behavior with regard to impacts on shellfish) may lead to efforts to minimize anthropogenic impacts such as septic maintenance, impervious surface reduction, and yard care practices.

Collaborative Research

The Department of Marine and Coastal Resources, the Maria Mitchell Association, the Nantucket Field Station, the Nantucket Land Council, the Nantucket Shellfishermen's Association, and the Massachusetts DEP are responsible for most of the current research and monitoring projects related to Nantucket's shellfish and habitats. Communication among these research entities is sufficient in terms of creating a shared understanding of ongoing projects; and despite their own specific objectives and individual strengths, there is an apparent willingness to work together when appropriate and feasible.

While the existing approach to research has generated a great deal of knowledge about Nantucket's shellfish and habitats, this Plan takes an important step beyond the status quo by clearly identifying research topics that will inform and advance shellfish management. The next step is to capitalize upon the existing relationships and capabilities of the various research entities (on and off-Island) in a way that will result in a logical approach to addressing these research needs—giving priority to those projects that (1) are most urgent, (2) have the greatest potential to significantly improve management strategies, and/or (3) are necessary building blocks for additional research activities.

Given the specific need to improve scientific understanding in a way that will inform management strategies, a collaborative (the Nantucket Research Collaborative) should be developed to facilitate conversations dedicated to the research needs and opportunities identified in this Plan and those that arise as a result of new information and/or the passage of time.

Specific objectives of the Research Collaborative might include:

- Coordinate research proposals and programs so that all relevant partners are involved.
- Share data, methods, experiences, etc., to improve the planning and execution of research.
- Ensure that new projects build upon past projects and integrate with ongoing projects. For example, a habitat restoration proposal by one partner should take advantage of long-term monitoring by another.
- Collectively update and re-prioritize research needs on an on-going basis, giving specific attention to how research projects address management issues.
- Grow the total pool of research funds by demonstrating diverse partnerships and accessing unique sources.

- Provide a vehicle for introducing off-island experiences, expertise and collaborations into local research and management.
- Engage fishermen in specific, approved research programs that directly address information needs identified by the Research Collaborative. Incentives for fishermen's participation could be economic, either by allowing extra fishing days or bag limits or directly compensating the fishermen for their efforts. (This strategy has proven to be highly successful for the off-shore scallop fishery where new innovations in gear technology have been developed through collaborative efforts among fishermen, scientists and engineers that are supported in part by enhanced fishing opportunities parlayed to participating fishermen.)

The most limiting resource for the local research community is and will continue to be funding. In contrast, the greatest strength of the local research community is the breadth of its institutional foundation, expertise, and certainly commitment to the resource and community. The diversity of groups engaged in research on Nantucket allows access to a variety of outside funding opportunities. For example, the MCRD has access to local tax and license fee revenue, and can apply for state and federal bonds as a municipal agency. NSA and its members can apply for grants available only to commercial fishing organizations, and perhaps small business owners as well. UMass Boston has access to traditional academic funding sources, as well as resources of the larger University of Massachusetts system. The Maria Mitchell Association and the Nantucket Land Council can apply for foundation and provide donor funds typically available only to non-profits.

Although most research is currently conducted by State, municipal, and NGO entities, many fishermen have intimate knowledge of Nantucket's marine resources and conditions, and could be assets to a variety of research projects. Likewise, researchers located off-Island are looking at many issues relevant to Nantucket (e.g., eelgrass restoration strategies, waste water as it relates to harmful algal blooms and effects of propagation activities). Fishermen and scientists (and others engaged in economics and education) should be encouraged to apply their expertise to some of the research questions on Nantucket. Often times, it is difficult and/or expensive to collect data that addresses a specific research need through having a research scientist continually on site and responsible for the day to day data collection. A well-planned research project may be successfully undertaken through the combined efforts of a mentoring scientist and collaborating fishermen, who are more familiar with the local environment, on the water and involved with the fishery daily, and have the motivation and interest to carefully collect required data.

There are a number of variations on the theme of collaboration in the area of applied research (i.e., research designed to assist in a specific management issue). Along this continuum are instances where:

- The research question is defined and the research is funded by (or funding is found by) local interests. Then a research entity (or "consultant") is hired to perform the work. The results are provided to the local entity for implementation. An example of this would be when a "consultant" is employed to shed light on the impacts of a specific development project or to assess water quality, sources of contamination, and impacts.
- Similar to the above, but relatively consistent funding is provided through a governmental, academic, or foundation program (perhaps requiring a local match). Examples of this model include the various state Sea Grant Programs including the Woods Hole Oceanographic Institution Sea Grant Program (www.whoi.edu/seagrants/page.do?pid=34015) which does applied research and includes a public outreach/education component. The Centre for Shellfish Research at Vancouver Island University (www.viu.ca/csr/index.asp) supports faculty and

student research projects and works closely with the aquaculture community to identify research needs. The Haskin Shellfish Research Laboratory at Rutgers University (hsrl.rutgers.edu/index.html) offers similar features.

- Similar to the above, but the local entity provides an on-site facility, logistical support, and an existing data base for use by researchers. This is the model employed by the National Estuarine Research Reserves and, to some extent, by the UMass Boston Nantucket Field Station.
- As above, but the research effort includes data collection and support by local fishermen. In some instances, researchers accompany local fishermen and collect data during normal fishing activities. In others, boats and their crews are hired as adjunct researchers either working on their own after training and/or instruction by researchers or under the direct supervision of researchers. A local example is the work done by the School for Marine Science and Technology (SMAST) at the University of Massachusetts Dartmouth (www.smast.umassd.edu/) which used commercial fishing vessels and their crews in collecting data related to stock assessment of Yellowtail Flounder in the Nantucket Lightship Closed Area.

Further investigations into other existing collaboratives will help to identify the ideal composition of the potential Nantucket Research Collaborative, and should provide insight into the specific functions and required resources of the Collaborative. A highly functional low/no cost research collaborative might include representatives from existing on-Island research entities and the fishing community, augmented by an Advisory Board of off-Island experts. This group could meet quarterly (either in private or public meetings) to review research results and opportunities (e.g., new funding sources, new data sources, and opportunities to write letters of support), coordinate research efforts, re-visit research priorities, and present research findings from on and off-Island.

At a minimum, it is anticipated that this Research Collaborative will discuss information needs, data collection methods, data recording/reporting protocols; funding opportunities; research priorities; and means to engage outside experts.

- ❖ Develop a system for collaborative management and research, coordinating the activities and interests of the relevant Town of Nantucket boards and departments, commercial and recreational fishermen and associations, DMF, and nonprofit organizations.

Specific objectives could be:

- Nantucket's research entities, along with the Town and fishermen, should work together to further develop and implement the Research Plan associated with this Shellfish Management Plan, identifying priority research sites, data needs, and a standardized method for data collection, recording and reporting.
- Investigate other Fishery Cooperative Research Programs in the region with the intention of developing and implementing a program on Nantucket that will allow local fishermen to be involved in and compensated for research and stock assessment efforts. In particular, look to other examples for insight on functions, required resources, and lessons learned.

Management Implications: The inclusion of fishermen in research activities will necessitate the development of compensation guidelines for their involvement. Additionally, a coordinated approach to research will lead to the development of data collection guidelines and data repositories, and will potentially affect shellfishing by setting aside research areas in the Harbors, allowing for the experimentation with new gear types, etc.

- ❖ The Brant Point Boathouse is an important facility for the Town to continue to utilize and support for sustaining shellfish resources on the Island.

Specific objectives could be:

- Develop a budgetary mechanism to continue to support the activities and facilities at the Boathouse.
 - a. At its current level of utilization
 - b. Consider various budget scenarios for expanded use of the facility and investigate means to support those expanded activities.

Management Implications: Research into ways to finance activities at the Boathouse could lead to changes in the Town budget, the use and amount of fines, permit fees, etc.

Application of Information to Shellfish Management

As new information is generated and routine information is better appreciated, the conversion of information to management techniques requires interpretation and application of the information. Assuming that (1) shellfish research specific to Nantucket shellfish will increase, and (2) that catch reporting information will become more reliable and more accessible with the continued use of SAFIS, one possibility is to develop a “traffic-light index” approach to management modifications.

The data-limited nature of the Nantucket shellfishery does not allow application of traditional stock assessment models that estimate biological reference points and stock status relative to those reference points. Even if the fishery was more data-rich, the life history and ecology of local shellfish, such as the bay scallop, are likely not amenable to traditional stock assessment methods. However, the potential for any species, even bay scallops, to reach dangerously low levels that threaten economic, ecological or even outright biological extinction calls for some means of gauging the health and trends of the stock and, therefore, consideration of approaches other than traditional stock assessment models.

One tool that could be useful in summarizing and visualizing a variety of variables related to shellfish stock health and tracking trends is the checklist or “traffic light” method (Caddy, 1999). The traffic light approach applies scores and then sums or averages a variety of relevant indicators, typically using a three-level system, e.g., positive/neutral/negative, +1/0/-1, or green/yellow/red. A given traffic light system might weight certain indicators more heavily than others in the final scoring based on knowledge of their significance to the status of the stock. The scores might be used to assess the need for modifications in management practices.

Examples of the traffic light approaches used for Atlantic Canadian shrimp and Pacific Northwest salmon are provided in Appendix I. The shrimp example uses primarily population and fishery data, with some broader ecosystem indicators included as well (water temperature and predation pressure). In contrast, the salmon example uses primarily ecosystem indicators with some survey-based population data (Coho and Chinook salmon abundance in trawl surveys) and no fishery data. This is because the salmon tool aims to predict returns of fish to the river (where the fishery will take place) from the ocean environment where environmental factors are significant drivers and before fishing has taken place.

A traffic light index for Nantucket bay scallops would probably use a combination of fishery-dependent data, fishery-independent population data, and environmental indicators (described in Table 15) due to both the availability of each type of data and its relevance to stock dynamics.

Table 15: There are several possible variables for use in a traffic light index. This table provides examples of some of those variables.

Data type	Description	Possible data source(s)
<i>Fishery-dependent data</i>		
Total harvest	Bushels harvested by the commercial (and recreational?) fleet over the previous 1–3 years	Town data and/or SAFIS reports
Coarse effort	Total licenses purchased and/or fished	Town data and/or SAFIS reports
Precise effort	Total days fished by the fleet, including changes over the fishing season	Will likely require a subset of fishermen volunteering or being compensated (by dollars or extra catch allowances) to collect the additional data
Coarse Catch Per Unit Effort	Average bushels-per-license over the whole fishing season	Town data and/or SAFIS reports
Precise CPUE	Catch-per-tow, catch-per-hour, or catch-per-day; precise CPUE data might include seed and/or nub catch separately from classic catch	Will likely require a subset of fishermen volunteering or being compensated (by dollars or extra catch allowances) to collect the additional data
<i>Fishery-independent data</i>		
Scallop abundance		MMA/MCRD surveys
Spat collections	Abundance and location (i.e., within or outside Harbor)	MMA program
Scallop life history	Growth, mortality and reproductive data	MMA/MCRD surveys
Stranding events	Monitoring of “return” area	MCRD/Fishermen reports
<i>Environmental variables</i>		
Water temperature		UMB Field Station/MCRD water quality/MMA monitoring
Salinity		UMB Field Station/MCRD water quality monitoring
Algal blooms	Simple presence or some measure of intensity (abundance, duration, etc.)	UMB Field Station/MCRD water quality monitoring
Eelgrass status	Total areal coverage, perimeter: area ratio, mean shoot density, mean shoot height	MMA/MCRD surveys
Invasives affecting eelgrass	Fouling organisms (e.g., slime molds, tunicates) or competitors (e.g., <i>Codium</i>)	MMA/MCRD surveys
Predation pressure	Abundance of native and non-natives, especially crustaceans and drills	MMA/MCRD surveys

Management Implications: The use of a traffic light model would help to identify key pieces of information to be collected, and would provide a useful structure for monitoring trends—perhaps even identifying important thresholds for which management actions might be required. See Appendix F for more information on traffic light models.

APPENDIX A: MATRIX OF RECOMMENDATIONS

The matrix of recommendations is a summary of the recommendations contained in the body of this plan. Addressing any of the recommendations outlined in this matrix will improve the understanding and management of Nantucket's shellfish fisheries. However, in the face of limited resources available to address these recommendations, the Shellfish Management Plan Committee sought to identify a smaller subset of the most important recommendations that collectively will result in the greatest progress toward improved fisheries. These recommendations, representing approximately 25% of the full set of recommendations, are ranked "high." Opportunities or interest in addressing any of these recommendations will benefit Nantucket's shellfish fisheries. The ranking of some recommendations as "high" does not mean that, if the opportunity arises, other recommendations (ranked either "medium" or "low") should not be pursued.

The capacity to address more recommendations and to do so more effectively will be enhanced by creation of the Nantucket Research Collaborative, which will facilitate pooling resources, integrating projects, and increasing the range of outputs.

The Shellfish Management Plan Committee also felt that evaluation criteria (to be developed by the Shellfish Management Plan Implementation Committee) may be useful in helping to determine some metrics to assess whether or not each recommendation has successfully been implemented - and to what effect. Accordingly, the matrix includes a place-holder column for evaluation criteria.

		Objective	Recommendation #	Recommendation	Implementing Agencies/Groups	Priority	Evaluation Criteria
Habitat Management	Goal 1	Objective 1	Recommendation 1	Conduct and/or support research to better understand the hydrodynamics within Nantucket and Madaket Harbors and the impacts of water circulation on shellfish habitat and population dynamics. This research should include a study to determine the effects of raising the jetties. With better information on water circulation and its impacts, options for improving circulation could be considered and implemented as appropriate.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Department of Marine and Coastal Resources or the Town • Outside experts as appropriate • Harbor Plan Implementation Committee 	Med	

		Recommendation 2	<p>Support research activities, regulatory management changes, public education initiatives, capital improvements, and related fund-raising activities aimed at reducing nutrient inputs from anthropogenic sources, both in Nantucket waters and in Nantucket Sound.</p> <p>Nantucket is currently addressing nutrient reduction from anthropogenic sources through a variety of activities, including reviewing the Massachusetts Estuaries Report project and implementing the Best Management Practices guide developed by the Article 68 Work Group.</p> <p>Additionally, the Harbor Plan Implementation Committee, in conjunction with the Town, is currently developing an educational initiative called the “Nantucket Blue Pages” that was recommended as part of the Harbor Plan.</p> <p>Nantucket is supporting a water quality testing effort to assess the effectiveness of activities to reduce nutrient input into local waters. Researchers are looking into the possibility of using barriers of natural materials (e.g., woodchips) to remove nitrogen from groundwater. A federal No Discharge Area for Nantucket Sound is under development. Stakeholders should support these types of activities by lending their expertise, raising awareness of important information, events and developments, such as meetings or the dissemination of publications; and helping to secure financial resources.</p>	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Board of Selectmen • Board of Health • Marine and Coastal Resources Department or the Town • Conservation Commission • Harbor Plan Implementation Committee • Maria Mitchell Association • University of Massachusetts Boston Nantucket Field Station • Harbor and Shellfish Advisory Board • Nantucket Shellfish Association • Outside experts as appropriate 	High	
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		Recommendation 3	<p>Conduct and/or support research to better understand the links between shellfish habitats, population dynamics, and anthropogenic activities that introduce chemicals into Nantucket waters. Examples of activities of interest include: the application of fertilizers, herbicides, and pesticides on upland areas (including details about the chemicals being used, the quantities being applied, and the associated impacts); the use of septic systems; the discharge of grey water from vessels (and the related No Discharge Area designation); the discharge of petroleum hydrocarbon; and boat maintenance activities such as boat washing and bottom painting.</p>	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Board of Selectmen • Board of Health • Mosquito Working Group • Marine and Coastal Resources Department or the Town • Conservation Commission • Nantucket Land Council • Maria Mitchell Association • University of Massachusetts Boston Nantucket Field Station • Boat yards and marinas • Outside experts as appropriate 	High	
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			<p>Recommendation 4</p> <p>Develop a better understanding of the sources and impacts of HABs on shellfish and their habitat. Support or conduct research to address identifying and tracking potentially harmful blooms in local waters.</p>	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • The Marine and Coastal Resources Department • Nantucket Land Council • Nantucket Biodiversity Initiative • Maria Mitchell Association • University of Massachusetts Boston Nantucket Field Station • Outside experts as appropriate 	High	
			<p>Recommendation 5</p> <p>Conduct and/or support studies to investigate the role that environmental changes may have in altering shellfish populations on Nantucket, including sea level rise, ocean acidification, and climate change. As part of this, continue, and where appropriate, enhance efforts to record water temperature, changes in pH, and details about when the Harbors freeze over.</p>	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Maria Mitchell Association • Outside experts as appropriate 	Med	

		Recommendation 6	Explore options to reduce the financial cost and temporal delay currently associated with obtaining water quality results. Include a review of on-Island options for “in house” local analysis.	<ul style="list-style-type: none"> • The Marine and Coastal Resources Department* • Nantucket Research Collaborative • Nantucket Waste Water Management group • Maria Mitchell Association • University of Massachusetts Boston Nantucket Field Station 	High	
	Objective 2	Recommendation 1	Beginning with historical data compiled and maintained by the Massachusetts DEP, encourage continued monitoring of the extent and health of eelgrass in Nantucket waters, and explore the relationships between eelgrass beds and other aquatic vegetation such as epiphytic growth, which can influence eelgrass health. To the extent possible, connect with regional eelgrass mapping exercises.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Massachusetts DEP • US EPA • Outside experts as appropriate 	Med	

			<p>Recommendation 2</p> <p>Undertake a review of practices that may directly damage eelgrass beds (e.g., moorings, scallop dredges, propeller damage, excess nutrient inputs from upland sources) to determine the short-and long-term nature and significance of the impacts and explore methods to minimize those impacts.</p> <p>As part of this, look at options to modify dredging activity throughout the season (e.g., starting with a 40-pound limit at the beginning of the season, and reducing weight as the season progressed; changing the design of the dredge to reduce impacts to eelgrass; etc.). Specifically evaluate the progress of modifying moorings in Nantucket Harbor to minimize damage to surrounding eelgrass beds. Evaluate the effects of alternative technologies, such as placing floats on mooring chains, replacing chains with flexible bungee-style rope, or placing multiple boats on one chain anchored between two mushroom moorings. Once the effects and capabilities of these technologies are understood, work to implement appropriate mooring strategies to reduce impacts on eelgrass.</p> <p>Additionally, explore the option of charging an extra fee for people who do not upgrade to more environmentally sensitive mooring technologies and for dedicating those funds to mitigation of damaged resources.</p>	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Nantucket Land Council • Marine and Coastal Resources Department or the Town • Great Harbor Yacht Club • Nantucket Land Council • Conservation Commission • SHAB 	High	
			<p>Recommendation 3</p> <p>Develop and implement a cost-effective strategy to protect/restore eelgrass in locations of significance to shellfish resources—both within and outside Nantucket and Madaket Harbors. This strategy should take into consideration options such as propagating eelgrass, re-seeding areas, and removing stressors (e.g., moorings, excess nutrients) to existing and potential eelgrass habitats.</p>	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Nantucket Land Council • Maria Mitchell Association • SHAB 		

	Recommendation 4	Until a new strategy to protect eelgrass is in place, enforce existing mooring regulations and ensure that moorings are not located in productive shellfish beds. This will require a substantial reduction in the number of permits.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • SHAB 	Med	
	Recommendation 5	Support research to better understand the relationship between eelgrass health and density and shading from various algal blooms, physical effects on eelgrass growth from overlying macroalgae (for example, observations suggest that Gracilaria sp. is covering eelgrass and causing it to lay flat during the spring, but it may also serve as a settlement substrate for bay scallops), and effects to eelgrass from nuisance epiphytes growing directly on eelgrass.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Massachusetts DEP • Outside experts as appropriate • Nantucket Land Council 	Low	
	Recommendation 6	Conduct research to better understand changes in sediment within the Harbors since the most recent data were gathered.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Maria Mitchell Association • UMass Boston Nantucket Field Station • Outside experts as appropriate 	Low	

	Objective 3	Recommendation 1	Catalog, map, and ground-truth information about the dominant habitat types (relative to shellfish survival) throughout Nantucket waters. If adequate funding for these activities cannot be secured, explore alternative, less-costly options for obtaining habitat information. Use this information as baseline data and as a basis for prioritizing and protecting shellfish habitat and promoting an awareness of the need for managing habitat as an important element in managing the shellfishery.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • SHAB • UMass Boston Nantucket Field Station • Maria Mitchell Association 	Med	
		Recommendation 2	Work with the Nantucket Department of Public Works to institute a shell recycling program where most, if not all, shells are returned to the Harbors for pH buffering and settlement substrate purposes (potentially with assistance from fishermen). Ensure that the deposition of shells does not harm existing habitat features (such as eelgrass beds) or create new habitat dominated by predators. Adhere to DMF's Shellfish Planting Guidelines for placing shells in the water: "Oyster, quahog and softshell clam shell used as cultch shall be aged on land for a minimum of one year. Shell from other species of bivalves such as surf clam, ocean quahog, scallops and mussels may be used without limitations. All issues regarding approved shell cultch must be addressed by Marine Fisheries prior to placement into coastal waters." (Hickey et al., 2012). Conduct research to identify the most appropriate locations for returning the shells and monitor the deposition sites to better understand the impacts of such activities.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Department of Public Works • Massachusetts Division of Marine Fisheries • Nantucket Shellfish Association 	High	

			Recommendation 3	Continue to monitor dissolved oxygen in benthic areas of the Harbors, and expand monitoring to include monitoring of sediment acidity.	<ul style="list-style-type: none"> • Maria Mitchell Association* • The Marine and Coastal Resources Department or the Town • Conservation Commission 	Med	
			Recommendation 4	Continue monitoring spat settlement throughout the waters of Nantucket by way of spat collection and enumeration.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Maria Mitchell Association 	Med	
			Recommendation 5	Conduct collaborative annual surveys of juvenile shellfish stocks to assess the areas of spatfall to aid in management decision-making.	<ul style="list-style-type: none"> • The Marine and Coastal Resources Department* • Maria Mitchell Association • Harbor and Shellfish Advisory Board • Nantucket Shellfish Association • UMass Boston Nantucket Field Station 	High	

		Objective 4	Recommendation 1	Conduct and/or support studies to determine the impacts of recreational and commercial shellfish harvesting (including the impacts of by-catch) on the sustainability of the resource and the habitat.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Nantucket Shellfish Association • Commercial fishermen • SHAB • Outside experts as appropriate 	Low	
			Recommendation 2	Monitor and assess the overall intensity of shellfish harvest practices (including impacts stemming from by-catch) and manage activities within specific harvest areas to minimize the risk of detrimental impacts from excessive harvest practices.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • The Marine and Coastal Resources Department • Nantucket Shellfish Association • SHAB 	Med	
		Objective 1	Recommendation 1	Develop and implement a strategy to track the effectiveness of propagation activities in terms of supplementing the commercial and recreational harvests. As part of this, identify locations best suited for larval release (e.g., areas with larval retention), examine the timing of larval release in terms of survival, and conduct post-set release and associated monitoring for survivability.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Nantucket Shellfish Association • Commercial fishermen • UMass Boston • Nantucket Field 	High	
Shellfish Resources	Goal 1						

					Station • Outside experts as appropriate		
			Recommendation 2	Continue current propagation efforts such as the larval release program and, based on the results of the study of propagation effectiveness, consider pursuing opportunities to expand propagation activities, including expansion to different species (i.e., oysters).	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Nantucket Shellfish Association • Commercial Fishermen 	High	
		Objective 2	Recommendation 1	Develop seed management protocols for transplanting seed. Outline criteria for establishing seed sanctuaries and for determining compensation to volunteers who assist with seed management. Review the effects of the protocols and adapt as appropriate.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Harbor and Shellfish Advisory Board 	High	
			Recommendation 2	Develop and/or support studies to evaluate the efficacy of seed management activities. Adjust seed programs to improve effectiveness.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town 	Med	

		Recommendation 3	Better understand impacts of wind-driven strandings on the bay scallop population. Topics of interest include survivability of seed returned to the water and the effects on the seed population (i.e., what percent of seed is stranded).	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Maria Mitchell Association • Outside experts as appropriate 	Med	
	Objective 3	Recommendation 1	Continue to develop spawning sanctuaries, through the use of spawning cages, to increase larval supply, and monitor impacts of sanctuaries. Particular focus should be on utilizing areas with high larval retention and evaluating the manipulation of water flow for larval retention.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Harbor and Shellfish Advisory Board • UMass Boston Nantucket Field Station 	High	
		Recommendation 2	Institute new steps—and continue existing efforts—to identify spawning events and monitor spat levels in the Harbors such as by the strategic placement of spat bags strategically around the Harbors.	<ul style="list-style-type: none"> • The Marine and Coastal Resources Department or the Town* • Maria Mitchell Association • Harbor and Shellfish Advisory Board 	Med	

			Recommendation 3	Continue larval release at various locations throughout Nantucket waters and evaluate its effectiveness in terms of localized recruitment of spat. Investigate whether or not the timing of the releases affects their effectiveness at enhancing local populations.	<ul style="list-style-type: none"> • The Marine and Coastal Resources Department* • Nantucket Shellfish Association 	High	
	Goal 2	Objective 1	Recommendation 1	Measure and monitor predator abundance in Nantucket waters (in part through a survey of by-catch) and measure impacts on shellfish resources during the various life stages for each species. Understand the impacts of native versus non-native predators and implement a predator management protocol as appropriate, perhaps based on the identification of an “over-abundance” (which would need to be defined) of predators in the ecosystem. As part of the protocol, conduct research to understand the impacts of predator removal—both on the harvested resources and on the biological communities in the Harbors. Specifically look at the impacts of the mud blister worm (Polydora).	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Shellfishermen • Outside experts as appropriate 	Low	
	Goal 3	Objective 1	Recommendation 1	Conduct and/or support current and future research to better understand the spawning cycle of scallops, and specifically the spawning cycle of nub scallops.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Maria Mitchell Association • University of Massachusetts • Massachusetts Division of Marine Fisheries 	Med	

					<ul style="list-style-type: none"> • Massachusetts bay scallop fishing communities • Outside experts as appropriate 		
			Recommendation 2	Better understand and define the biological traits of and stressors to bay scallops, quahogs, conch, oysters, soft-shelled clams, and other harvested shellfish. Use that knowledge to make informed management decisions. Specific topics of interest include (1) the relationship between spat recruitment and post-set spat survival as it relates to the overall abundance of shellfish, and (2) the genetic variability among harvested shellfish.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Maria Mitchell Association • Outside experts as appropriate 	Med	
Regulations	Goal 1	Objective 1	Recommendation 1	Monitor the population characteristics of important shellfish resources across the Island, assessing recruitment into the fishery and the standing stock available for harvest, in order to provide information for management decisions. This monitoring could possibly lead to the development of a predictive population model for Nantucket shellfish. Additionally, this monitoring could be done in a collaborative manner by working with local fishermen.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA • Maria Mitchell 	Med	

				Association		
		Recommendation 2	Continue to limit the size and mechanics (power hoisting) of dredges and enforce existing restrictions such as the current 40-pound limit on the weight of the dredge.	<ul style="list-style-type: none"> • Board of Selectmen* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	Med	
		Recommendation 3	Work with other Massachusetts-based shellfishing communities and DMF to identify and conduct research designed to evaluate the definition of a legally harvestable bay scallop. As part of this, consider research to inform the potential use of a thickness gauge to measure harvestable bay scallops.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Board of Selectmen • Harbor and Shellfish Advisory Board • NSA 	Med	

			Recommendation 4	Increase oversight of recreational shellfishermen and enforcement of recreational regulations more widely. This includes expanding enforcement efforts during the summer, obtaining data on recreational catches throughout the shellfishing seasons, and enforcing the regulation requiring people to wear the pins which prove they have purchased licenses.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* 	Med	
	Goal 2	Objective 1	Recommendation 1	Implement the steps needed to institute the adaptive management section of this Plan. As a first step, the Town should establish a Shellfish Management Plan Implementation Committee. This Committee should be responsible for developing specific rules about adaptation, including the timing of meetings, whether or not a “traffic light” approach to management is logical/feasible (see Appendix F), etc.	<ul style="list-style-type: none"> • Board of Selectmen* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	High	
	Goal 3	Objective 1	Recommendation 1	Develop alternative commercial and recreational permit fee structures to generate more revenue for Nantucket. Investigate opportunities for changes to permit fees from time to time. Any direct revenues should be put toward propagation activities. Follow-up studies should be conducted to determine the economic impacts of any new fees.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Board of Selectmen • Harbor and Shellfish Advisory Board • NSA 	Low	

Management Implementation	Goal 1	Objective 1	Recommendation 1	Ensure stable funding for sufficient staffing of all management activities including research, water quality testing and analysis, propagation, enforcement and the use of interns and seasonal employees (estimated to cost at least \$150,000). Funding sources should include money for salaries and equipment out of the general fund, money for propagation from fines, and additional income from grants, gifts, and the sale of licenses. One hundred percent of license fees must be used for propagation efforts. Consider various budget scenarios for expanded propagation activities, and the hiring of a second biologist.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Board of Selectmen 	High	
		Objective 2	Recommendation 1	All personnel involved in management of shellfish resources and enforcement of shellfish regulations should attend periodic joint-training sessions (facilitated by fishermen and managers together) to ensure consistency of enforcement. These sessions should be open to commercial and recreational shellfishermen in the interest of improving compliance and communication between managers and the regulated community. Continue to include attendance in a training session as part of the penalty for harvesting seed scallops.	<ul style="list-style-type: none"> • Harbor and Shellfish Advisory Board* • Marine and Coastal Resources Department or the Town • Board of Selectmen • NSA • Commercial fishermen 	High	
			Recommendation 2	Work with other fishing communities in Massachusetts to identify and make recommendations to DMF in areas where changes might benefit Nantucket shellfisheries, such as with the size of a legally harvestable bay scallop. Prepare and make widely available clear guidance on identifying harvestable scallops.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Board of Selectmen • Harbor and Shellfish Advisory Board • NSA 	Med	

				<ul style="list-style-type: none"> • Fishermen • Other fishing communities in Massachusetts • Outside experts as appropriate 		
		Recommendation 3	Work with the Harbor Plan Implementation Committee to develop the data clearinghouse for Harbors-related topics, including information pertaining to shellfish. Include the resources listed in this Management Plan, and ensure the availability of information pertaining to previous research on Nantucket shellfish.	<ul style="list-style-type: none"> • Shellfish Management Plan Implementation Committee* • Marine and Coastal Resources Department or the Town • Board of Selectmen • Harbor and Shellfish Advisory Board • NSA • Maria Mitchell Association • UMass Boston Nantucket Field Station 	Low	

		Recommendation 4	Nantucket's research entities, along with the Town and fishermen, should work together to further develop and implement the coordinated Research Plan associated with this Shellfish Management Plan, identifying priority research sites, data needs, and a standardized method for data collection, recording and reporting. This research coordination should be overseen by a group of local and outside experts with knowledge of research issues contained in the Research Plan. For purposes of this Plan, that group is referred to as the "Nantucket Research Collaborative."	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Maria Mitchell Association • University of Massachusetts Boston Nantucket Field Station • Department of Health • School for Marine Science and Technology • Massachusetts DEP • Other experts as needed 	Med	
	Objective 3	Recommendation 1	Continue to develop and implement an action plan to increase available space and use of space for aquaculture in Town waters. The action plan should address qualifications of bidders; a requirement for a business plan, and; management standards. The action plan should also ensure that shellfishing activities are not impaired as a result of aquaculture, and stress the participation of fishermen in hearings pertaining to aquaculture decisions.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Board of Selectmen • Harbor and Shellfish Advisory Board • NSA 	Med	

			Recommendation 2	Continue to work with DMF to identify and consider (1) potential aquaculture locations outside of the agency's usual physical siting requirements and (2) approval of a block of sites in advance of the DMF's issuance of a license to an individual.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Board of Selectmen • MA Division of Marine Fisheries • Harbor and Shellfish Advisory Board • NSA 	Med	
		Objective 4	Recommendation 1	Identify and make publically available areas for recreational fishing. Recreational fishing already dominates those shallow areas of the Harbors most easily accessible to recreational fishermen. Information about those areas should be made available to recreational fishermen. Those areas should be officially identified and set aside for recreational fishing, though commercial fishing should not be excluded from those areas.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Board of Selectmen • Harbor and Shellfish Advisory Board • NSA 	Med	
		Objective 1	Recommendation 1	Design and implement a study to assess the economic impact of recreational and commercial shellfishing to Nantucket. This study should address topics such as employment rates (including jobs both directly and indirectly impacted by shellfishing), wages, impacts to other sectors of the economy, cash-flow through the Island economy, and economic trends related to shellfishing.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	Med	
Education	Goal 1	Objective 1	Recommendation 1	Design and implement a study to assess the economic impact of recreational and commercial shellfishing to Nantucket. This study should address topics such as employment rates (including jobs both directly and indirectly impacted by shellfishing), wages, impacts to other sectors of the economy, cash-flow through the Island economy, and economic trends related to shellfishing.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	Med	

				<ul style="list-style-type: none"> • Outside experts as needed • Nantucket Planning and Economic Development Commission 		
	Recommendation 2	Develop and implement a public outreach strategy to highlight the significance of shellfishing both from a cultural and an economic perspective. This may include components such as a series of articles in local newspapers and magazines; a mail campaign; outreach activities at fairs and festivals; recruitment of recreational shellfishers for the NSA; a “meet the fishermen” event; the development and distribution of the Blue Pages book; and an informational display that can be moved from venue to venue (appearing in such places as the library, Town Hall, ferry terminals, the airport, etc). This strategy should be developed in a way that fosters collaboration with other existing outreach plans so as to not duplicate efforts or send mixed messages to audiences.		<ul style="list-style-type: none"> • Shellfish Management Plan Implementation Committee* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	High	
	Recommendation 3	Develop an oral history of commercial and recreational shellfishermen and those associated with the industry as part of the historical records of the Island.		<ul style="list-style-type: none"> • Nantucket Historical Society* • NSA • Harbor and Shellfish Advisory Board 	Low	

	Objective 2	Recommendation 1	<p>Develop and implement an outreach strategy to educate the public about how land and water-based activities can affect shellfish habitat. The outreach strategy should consider opportunities to coordinate with existing education efforts such as those identified in the Harbors Plan.</p> <p>This outreach strategy should make every effort to reach landowners, boaters, yacht clubs and their members, students, Maritime Festival audiences, and others, as appropriate. Additionally, electronic communication methods, including social network tools, should be explored. Examples of possible topics include fertilizer applications and their impact on shellfish habitat, and the dangers of dropping anchor in a shellfish bed.</p>	<ul style="list-style-type: none"> • Shellfish Management Plan Implementation Committee* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA • Harbor Plan Implementation Committee • Marine Science Teacher(s) • Egan Maritime Institute • reMain Nantucket • Nantucket Health Department • Nantucket Department of Public Works • Others as appropriate 	High	
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		Recommendation 2	Support the Harbor Plan Implementation Committee's work to develop and circulate a Blue Book modeled after those found in many communities on Cape Cod and Martha's Vineyard. Assist with content development and distribution.	<ul style="list-style-type: none"> • Shellfish Management Plan Implementation Committee * • Harbor Plan Implementation Committee • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	Med	
	Objective 3	Recommendation 1	Provide information on "best fishing practices" for recreational fishermen, including tips on how to identify legally harvestable scallops, where to access the water, how to be safe while harvesting, and how to minimize impacts on the habitat. Improve outreach to let people know that recreational permits are required to harvest shellfish. Use the outreach opportunity as a way to improve community awareness of the issues facing the shellfisheries. Include information about how the money raised by license sales helps the fishery and the Island's economy.	<ul style="list-style-type: none"> • Harbor and Shellfish Advisory Board* • Marine and Coastal Resources Department or the Town • NSA • Maria Mitchell Association and Aquarium • DMF 	High	
		Recommendation 2	Improve access for recreational fishermen when feasible. Ensure that these new access points do not lead to illegal parking, blocking of traffic, culling on private property, and other similar issues.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Harbor and Shellfish Advisory 	Low	

				<ul style="list-style-type: none"> Board • NSA • Planning Office 		
		Recommendation 3	Gather contact information from people when they purchase their recreational shellfish permits. Use that information to communicate with recreational fishermen about upcoming events; management changes; opportunities to provide input on shellfish management; opportunities to participate in surveys about recreational shellfishing; and other important issues/opportunities.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • NSA 	Low	
	Objective 4	Recommendation 1	Investigate other Fishery Cooperative Research Programs in the region with the intention of developing and implementing a program on Nantucket that will allow local fishermen to be involved in research and stock assessment efforts.	<ul style="list-style-type: none"> • NSA* • Harbor and Shellfish Advisory Board • Marine and Coastal Resources Department or the Town • BOS 	Low	
		Recommendation 2	Identify a select group of fishermen to assist with research by documenting bycatch details such as the percentage of seed and the types and abundance of predators.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Marine and Coastal Resources Department or the Town • Board of Selectmen • Harbor and 	Low	

					Shellfish Advisory Board		
					<ul style="list-style-type: none"> • Nantucket Shellfish Association • Commercial fishermen 		
Harvest Documentation	Goal 1	Objective 1	Recommendation 1	Continue to utilize records from shanties to help monitor and verify commercial landings. Additionally, continue to utilize records from shanties for enforcement of limits.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • MA DMF 	Med	
			Recommendation 2	Implement a means to track the general locations where shellfish were harvested—both recreationally and commercially. The new trip-level reporting to DMF includes records of the growing areas fished and captures information about effort. Recreational fishing records should be designed to collect information similar to that reported for commercial harvests. While methods to track recreational fishing are imperfect, they could be augmented to also obtain information about where recreational fishermen fish. These commercial and recreational data should be analyzed jointly to understand where the fishing is greatest from year to year, and what significance that might have for management.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Commercial fishermen • DMF 	Med	

Support of the Commercial Fishery

Goal 1

Objective 1	Recommendation 1	Develop marketing strategies, such as branding the Nantucket bay scallop and/or controlling the rate at which scallops reach the market, to optimize the price of the Nantucket bay scallop. As part of this, continue to develop the concept of using a sticker to identify boxes of scallops as coming from Nantucket. Also consider developing quality standards (such as a freshness standard) that would be universally agreed upon and promoted by all who handle Nantucket bay scallops. Work with USDA to see if their marketing programs are applicable to the Nantucket bay scallop fishery. Link with ecotourism opportunities on Nantucket.	<ul style="list-style-type: none"> • NSA* • Harbor and Shellfish Advisory Board • Commercial fishermen • Wholesalers • Outside experts as appropriate 	Med	
	Recommendation 2	Consider establishing a co-op for marketing purposes. As part of the development of this co-op, consider making participation optional, and look to other co-ops for examples of good strategies. Appendix H provides some guidelines and resources for developing this cooperative.	<ul style="list-style-type: none"> • NSA* • Harbor and Shellfish Advisory Board • Commercial fishermen 	Low	
	Recommendation 3	Develop marketing strategies to enhance the value of Nantucket shellfish by-products (e.g., shells as a buffering source for restoration projects, viscera as a protein source, guts as bait or food, gonads as food).	<ul style="list-style-type: none"> • NSA* • Harbor and Shellfish Advisory Board • Fishermen • Wholesalers • Shuckers • Outside experts as appropriate 	Low	
	Recommendation 4	Review options for timed fishing closures to ensure the quality and consistency of product reaching the market.	<ul style="list-style-type: none"> • NSA* • Harbor and Shellfish Advisory Board • Board of Selectmen 	Low	

				<ul style="list-style-type: none"> • Fishermen • Marine and Coastal Resources Department or the Town 		
		Recommendation 5	Explore the apparent correlation between the price of scallops and number of buyers. Determine whether or not the number of buyers affects the price they are willing to pay.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Harbor and Shellfish Advisory Board • NSA • Outside experts as appropriate 	Low	
	Objective 2	Recommendation 1	In conjunction with the Harbor Plan Implementation Committee, consider opportunities to improve shore-side access and facilities through the expansion of existing access points and/or the creation of new access points. Establish mechanisms to ensure that these new access points do not result in the unreported taking of additional shellfish.	<ul style="list-style-type: none"> • Marine and Coastal Resources Department or the Town* • Nantucket Land Bank • Harbor and Shellfish Advisory Board • Planning and Economic Development Commission • Conservation Commission • Roads and Right of Way Committee 	Low	

		Objective 3	Recommendation 1	Continue to enhance and implement a mentoring program to assist new entries into the fishery. As part of the enhancement, develop a check-list of topics for the teaching captain to cover with the apprentice. The checklist would include topics such as how to identify a legal bay scallop (to be taught by a Warden or shellfish biologist), how to cull a catch, a review of the regulations, and general etiquette at sea. Continue to allow the reduction of the 40-day limit to allow for shorter apprenticeships if fishermen demonstrate the appropriate knowledge and skills needed to operate safely. These shorter apprenticeships would require the approval of SHAB.	• Harbor and Shellfish Advisory Board*	Med	
Adaptation of the Plan	Goal 1	Objective 1	Recommendation 1	Bring together a group of people (a “Shellfish Management Plan Implementation Committee”) responsible for overseeing the implementation and adaptation of this Plan. This group should meet regularly and should include representatives from multiple stakeholder groups including recreational fishermen, commercial fishermen, scientists, SHAB, the Department of Natural Resources, and managers. Off-Island expertise should be included as appropriate. The group should work closely with not-for-profit entities to help raise funds for management plan research and implementation activities, identify common data reporting/gathering techniques, prioritize research projects, and address other research-related issues.	• Board of Selectmen*• Marine and Coastal Resources Department or the Town• Harbor and Shellfish Advisory Board• NSA• Nantucket Land Council• UMass Boston Nantucket Field Station• Maria Mitchell Association• Conservation Commission	High	

		Recommendation 2	Establish a system whereby a review of coordinated threshold criteria (e.g., number of weather-related fishing days lost, seed density, stock assessments, etc.) or a valid concern raised by a citizen would initiate a public process to address the issue(s)—including possible management actions.	<ul style="list-style-type: none"> • Nantucket Research Collaborative* • Harbor Plan Implementation Committee • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA • Outside experts as appropriate 	Low	
		Recommendation 3	Review and revise the Shellfish Management Plan every three years.	<ul style="list-style-type: none"> • Shellfish Management Plan Implementation Committee* • Marine and Coastal Resources Department or the Town • Harbor and Shellfish Advisory Board • NSA 	Med	

APPENDIX B: RESOURCES

- Abraham, B.J., and P. L. Dillon. (1986). Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic)--softshell clam. U. S. Fish Wildl. Serv. Biol. Rep. 82(11.68). U.S. Army Corps of Engineers, TR EL-82-4.
- Andrews, C. (1990). Fishing Around Nantucket. Maria Mitchell Association; Nantucket, MA.
- Andrews, J.C. (1944). Map of Nantucket Harbor showing eelgrass colonies in the 1940's. Town of Nantucket Report.
- Baier, C. (2000). Red Tide and Shellfish Poisoning: Toxic Products of Marine Algae. Online at: http://www.agls.uidaho.edu/etox/resources/case_studies/REDTIDE2.PDF (last viewed 2/14/2012).
- Bixby, A. (2005). Town of Nantucket Beach Management Plan. Adopted by Board of Selectmen.
- Boyce, P. (2012). Personal communication.
- Broadaway, B.J., Hannigan, R.E. (2009). Shell chemistry used to identify essential habitat for Bay Scallops in Nantucket, MA. American Geophysical Union Annual Meeting, 2009, San Francisco.
- Broadaway, B.J. (2010). The Role of Sulfur in Biomineralization: Argopecten Irradians and the Impact of Ocean Acidification.
- Broadaway, B.J. (2011). Is sulfur in scallop shells an indicator of stress response in ocean acidification? Society for Environmental Toxicology and Chemistry Annual Meeting, 2011, Boston.
- Broadaway, B.J., Hannigan, R.E. (2012). Is the Taurine/Glycine Ratio an Indicator of Stress Response to Ocean Acidification. American Society of Limnology and Oceanography Ocean Sciences meeting, 2012, Salt Lake City.
- Burkholder, J.M., Mason, K.M., Glasgow, H.B. (1992). Water-column Nitrate Enrichment Promotes Decline of Eelgrass *Zostera marina*: Evidence from seasonal mesocosm experiments. Marine Ecology Progress Series. 81(163-178). Online at: <http://www.int-res.com/articles/meps/81/m081p163.pdf> (last viewed 2/14/2012).
- Census Bureau. (2000). U.S. Census 2000
- Census Bureau. (2010). U.S. Census 2010
- Cohen, A. N. (2011). The Exotics Guide: Non-native Marine Species of the North American Pacific Coast. Center for Research on Aquatic Bioinvasions, Richmond, CA, and San Francisco Estuary Institute, Oakland, CA. Revised September 2011. Online at: <http://www.exoticsguide.org> (Last viewed 2/15/2012).
- Colarusso, P. (2011). Personal Communication regarding impacts to eelgrass.
- Commonwealth of Massachusetts. (2009). Nantucket Harbor Embayment System Total Maximum Daily Loads for Total Nitrogen. Report #97-TMDL-2 Control #249.0. Online at: www.mass.gov/dep/water/resources/nantucktdoc
- Conant, K. (2000a). Spat Collection.
- Conant, K. (2000b). Soft-shell Clam Propagation.
- Conant, K. (2000c). Nantucket Aquaculture Quahog Growout 2000.
- Conant, K. (2000d). Spat Collection: Scallop 2000.
- Conant, K. (2000e). Soft Shell Clam Propagation 2000.
- Conant, K. (2002). Shellfish Survey Memo.
- Conant, K. (2003). Shellfish Propagation.

- Conant, K. (2004a). Predator Investigation.
- Conant, K. (2004b). Shellfish Propagation.
- Conant, K. (2005a). Nantucket Bay Scallop Fisheries Management Plan Proposal
- Conant, K. (2005b). Shellfish Propagation.
- Conant, K. (2006a). Letter from K. Conant to D. Fronzuto re: the Boat House at Brant Point
- Conant, K.L. (2006b). Madaket Harbor/Long Pond Annual Report 2006.
- Conant, K.L. (2006c). Shellfish Propagation 2006.
- Conant, K.L. (2007). Madaket Harbor/Long Pond Annual Report 2007
- Conant, K.L. , Curley, T.L. (2005). Nantucket Scallops, *Argopectin irradians*, overwinter twice and spawn
Division of marine Fisheries. (2011). Personal Communication (August).
- Costello, C.T. (2011). Twelve-Year Mapping and Change Analysis of Eelgrass (*Zostera marina*) Areal
Abundance in Massachusetts (USA) Identifies Statewide Decline. *Estuaries and Coasts*.
- Curley, T. (2002). Nantucket Harbor Water Quality, Annual Report
- DMF. Shellfish Sanitation and Management. Online at:
<http://www.mass.gov/dfwele/dmf/programsandprojects/pspmoni.htm#shelsani> (Last viewed
3/1/2012).
- Edumndson, S. (2012). Personal Communication regarding her research on conchs.
- Fay, C.W., R.J. Neves, and G.B. Pardue. (1983). Species profiles: life histories and environmental
requirements of coastal fishes and invertebrates (Mid-Atlantic)—bay scallop. U.S. Fish and Wildlife
Service, Division of Biological Services, FWS/OBS-82/11.12. U. S. Army Corps o f Engineers, TR EL-82-
4. 17 pp.
- Fronzuto, D. (2011). Personal Communication (12/22/2011).
- Fronzuto, D. (2012). Personal Communication regarding updates to the SMP.
- Gobler C.J., Berry, D.L., Anderson,O.R., Burson, A., Koch, F., Rodgers, B.S., Moore L.K., Goleski J.A., Allam,
B., Bowser, P., Tang, Y., Nuzzi, R. (2008). Characterization, dynamics, and ecological impacts of
harmful *Cochlodinium polykrikoides* blooms on eastern Long Island, NY, USA. *Harmful Algae* 7: 293–
307.
- Goldsborough, W. J. (1997). Human Impacts on SAV - A Chesapeake Bay Case Study, in *Atlantic Coastal
Submerged Aquatic Vegetation: A Review of its Ecological Role, Anthropogenic Impacts, State
Regulations, and Value to Atlantic Coastal Fish Stocks*, ASMFC Habitat Management Series #1, Eds.
C. Dianne Stephahn and Thomas E. Bigford.
- Harwell, M. C., Orth, R. J. (2002). Long-distance Dispersal Potential in a Marine Macrophyte. *Ecology*
83(12) 3319-3330.
- Herr, M. (2011). Personal Communication.
- Hickey, J.M., Shields, T., Kennedy, J., Ford, K. (2012). Shellfish Planting Guidelines.
- Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, and E. Eichner (2006). Linked Watershed-
Embayment Model to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor, Town
of Nantucket, Nantucket Island, MA. Massachusetts Estuaries Project, Massachusetts Department of
Environmental Protection. Boston, MA.
- Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, and E. Eichner. (2010). Linked
Watershed-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Madaket

- Harbor and Long Pond System, Towns of Nantucket, MA. Online at: http://www.nantucket-ma.gov/pages/nantucketma_marine/madharborest.pdf (last viewed 2/14/2012).
- Howes, B. (2010). Madaket Harbor and Long Pond, Nantucket, MA. Online at: <http://www.oceanscience.net/estuaries/Madaket.htm>. (Last viewed 2/14/2012).
- Karney, R.C. Ten Years of Scallop Culture on Martha's Vineyard. Online at: <http://mvshellfishgroup.org/article.php?id=45> (Last visited 2/15/2012).
- Kelley, K.M. (1981). The Nantucket Bay Scallop Fishery: The resource and its management.
- Kelley, K.M. (1989). Distribution of Eelgrass in Nantucket Harbor, MA., Summer 1989. Town of Nantucket Health Department, Report
- Kelley, K.M. (1986). An Update on the Management of the Nantucket Bay Scallop Resource. Nantucket Shellfish and Marine Department.
- Kilburn, D. (1986). Nantucket's Scallopers Hope to Bolster a Faltering Industry. Nat. Fisherman, Oct: 12-13
- Leschen, A.S., R.K. Kessler, and B.T. Estrella. (2009). Eelgrass Restoration As Construction Impact Mitigation in Boston Harbor, Massachusetts. Massachusetts Division of Marine Fisheries Technical Report TR-37.
- Leschen, A.S., Kessler, R.K., Estrella, B.T. (2007). Eelgrass Restoration Project (July 1, 2004-October 31, 2007). Online at: http://www.mass.gov/dfwele/dmf/programsandprojects/hubline/hubline_5yr_eelgrass_restoration.pdf. (Last viewed 2/14/2012)
- MacFarlane, S.L. (1999). Bay Scallops in Massachusetts Waters: A Review of the Fishery and Prospects for Future Enhancement and Aquaculture. For Barnstable County's Cape Cod Cooperative Extension and Southeastern Massachusetts Aquaculture Center.
- MacKenzie, C.L. (2008). The Bay Scallop, *Argopecten irradians*, Massachusetts through North Carolina: Its Biology and the History of Its Habitats and Fisheries. Marine Fisheries Review. 70(3-4).
- Marine Biological Laboratory. Marine Organism Database. Online at: http://www.mbl.edu/marine_org/marine_org.php?func=detail&myID=BX9887. (Last viewed 2/15/2012.)
- Martha's Vineyard Data Report. (2006). Martha's Vineyard Data Report. Online at: <http://www.mvcommission.org/doc.php/Housing%20Data.pdf?id=618> (Last visited 2/14/2012).
- Nantucket Conservation Foundation, Inc. (2005). Coaue. On line at: http://www.nantucketconservation.com/info_files/properties/coatuef.html. (Last viewed on August 2, 2003).
- Nantucket Marine and Coastal Resources Department. (2007). Seed Relay Protocol.
- Nantucket Marine and Coastal Resources Department. (2010). Guidelines for Lease of Bottom Land for Aquaculture "Draft."
- Nantucket Planning and Economic Development Commission. (1980). Commercial Fishing... Can Nantucket Bring it Back?
- Newell, R.I.E. (1989). Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (North and Mid Atlantic) – blue mussel. U.S. Fish. Wildl. Serv. Biol. Rep. 82(11). U.S. Army Corps of Engineers, TR E1-82-4.)
- Norton, A.B. (2000). Nantucket Bay Scallop Resource Conservation Management Plan. Prepared for the Marine and Coastal Resources Department Town of Nantucket, Massachusetts.

- NYS Seagrass Taskforce. (2009). Final Report of the New York State Seagrass Task Force: Recommendations to the New York State Governor and Legislature. Online at: http://www.dec.ny.gov/docs/fish_marine_pdf/finalseagrassreport.pdf (last viewed 2/14/2012).
- Oktay, S., Barham, A. (2009). Nantucket Harbor Water Quality Research - submitted to REMAIN and MCRD.
- Oktay, S., Barham, A. (2010). Nantucket Harbor Water Quality Research - submitted to REMAIN and MCRD.
- Oktay, S. (2012). Personal Communication regarding percent of Harbor Plan recommendations complete. (12/16/2012).
- Paerl, H., Paul, V., O'Neil, J.M., Joyner, J., Arthur, K., Joyner, A., Capper, A., Ross, C., Heil, C. Lyngbya Toxicology. Online at: http://www.agls.uidaho.edu/etox/resources/case_studies/REDTIDE2.PDF (last viewed 2/14/2012).
- Patrick, James E. and Robert Benchley III. (2002). Scallop Season: A Nantucket Chronicle. Nantucket: Autopsco Press.
- Peters, J. A. (1978). Scallops and their utilization. Mar. Fish. Rev. 40(11): 1-9.
- Ray, R. (2010). Personal Communication re: the number of licensed shanties on Nantucket.
- Rhode Island Sea Grant. Did you Know? Shellfish Aquaculture is Good for the Environment! Online at: <http://www.ecsga.org/Pages/Sustainability/BenefitsBrochure.pdf>. (Last viewed 6/7/2012.)
- Riley, T, Boyce, P. (2011). Personal communication regarding larval release.
- Riley, T. (2012). Personal Communication regarding spawning protocols.
- Smithsonian Marine Station at Fort Pierce. Conch Description. Online at http://www.sms.si.edu/irlfieldguide/Busyco_canali.htm. (Last viewed 2/14/2012.)
- Stanley, J. G., and DeWitt, R. (1983). Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) - - hard clam. U.S. Fish Wildlife Services. FWS/OBS-82/11.18. U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.
- Stanley, J.G., and Sellers, M.A. (1986). Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic)--American oyster. U. S. Fish Wildl. Serv. Biol. Rep. 82(11.65). U.S. Army Corps of Engineers, TR EL-82-4.
- Starbuck, K. Is There a "Recipe" for a Sustainable Wild bay Scallop (*Argopecten irradians irradians*) fishery on Nantucket Island, MA, USA
- Talmage, S.C. and Gobler, C.J. (2010). Effects of Past, Present, and Future Ocean Carbon Dioxide Concentrations on the Growth and Survival of Larval Shellfish. Proceedings of the National Academy of Sciences of the United States of America.
- Tettelbach, S.T. and Feng, S.Y. (1986). Intensity of crab predation on northern bay scallops *Argopecten irradians irradians*: effects of prey size and predator assemblages on seasonal patterns. Journal of Shellfish Research.
- Tettelbach, S.T., and Smith, C.F. (2009). Bay Scallop Restoration in New York. Ecological Restoration. 27:20-22.
- Tettelbach, S.T., Barnes, D., Aldred, J., Rivara, G., Bonal, D., Weinstock, A., Fitzsimons-Diaz, C., Theil, J., Cammarota, M.C., Stark, A., Wejnert, K., Ames, R., Carroll, J. (2011). Utility of High Density Plantings in Bay Scallop, *Argopecten irradians irradians*, Restoration. Aqua Int. 19:715-739.

The Committee to Establish the Nantucket Marine Collaborative. (2006). Nantucket Marine Collaborative.

Town and County of Nantucket. Annual Report. Fiscal Years 2001 through 2010.

Town of Nantucket. Nantucket Master Plan. (2009).

Town of Nantucket. Harbor and Shellfish Advisory Board Website. Online at: http://www.nantucket-ma.gov/pages/nantucketMA_BComm/shab. (Last viewed 2/15/2012).

Town Shellfish Regulations §230

Urban Harbors Institute. (2009). Nantucket and Madaket Harbors Action Plan.

Willauer, W. (2008) How to Manage our Scallop Fishery!

Weissberger, E., Chintala, M. (2012). Personal communication re: EPA bay scallop habitat study and related sediment data.

APPENDIX C: LIST OF COMMITTEE MEMBERS

Matthew Herr	Chair	Fisherman
Frank Dutra	Vice Chair	Nantucket Shellfish Association
Tara Riley	Secretary	Department of Marine and Coastal Resources
Sarah Oktay		University of Massachusetts Boston Nantucket Field Station
Peter Boyce		Maria Mitchell Association, Harbor and Shellfish Advisory Board
Doug Smith		Harbor and Shellfish Advisory Board
Carl Sjolund		Nantucket Shellfish Association
Jake Kritzer		Environmental Defense Fund
Cormac Collier		Nantucket Land Council
Dave Fronzuto		Department of Marine and Coastal Resources

APPENDIX D: LIST OF COMMITTEE AND PUBLIC MEETINGS

Committee Meetings:

2010

October 13
November 17
December 1
December 15

2011

January 12
February 1
February 15
March 1
March 16
April 11
April 25
May 10
September 21
October 5
October 19
November 16
November 30
December 7
December 14

2012

January 26
February 23
September 26

Public Meetings:

2010

November 10
December 1

2012

April 17

APPENDIX E: LIST OF RECOMMENDATIONS CONSIDERED BUT NOT INCLUDED IN THIS PLAN

The recommendations contained in the Shellfish Management Plan represent those that the Committee feels are most appropriate for the current commercial and recreational shellfishing situation. However, during the course of plan preparation, a number of other recommendations were identified through research, interviews, and Committee discussions. Some of those were deemed not currently applicable to the management of Nantucket's shellfish, but may be of use as changes in the shellfisheries occur over time or as new information becomes available. Those recommendations with potential applications for the future are identified below, along with a description of the benefits of the recommendation and the reason for not including the recommendation in this version of the Shellfish Management Plan.

Recommendation: Include provisioning of seed as a requirement of a private shellfish aquaculture license.

Benefits: Seed is an important part of the Island's propagation activities. Obtaining seed from aquaculture enterprises would reduce the Town's expenses, and would also engage the aquaculture enterprises in caring for the wild stock of shellfish in Nantucket waters.

Reason for non-inclusion: While the State DMF noted that the Town could ask for seed, the licensee could not be required to provide seed of greater value than the \$25/acre license fee. The Committee decided that the amount of seed did not warrant the license requirement.

Recommendation: Require commercial shellfishermen to provide assistance with research, propagation, seed management, education, and other shellfish-related activities as part of the commercial shellfish license requirements.

Benefits: Fishermen have both the equipment and the knowledge needed to help with many tasks that could benefit their fisheries. Additionally, engaging fishermen in research, education, and management activities provides fishermen with a different perspective on the fishery, builds relationships and understanding between managers and fishermen, and provides cost-saving resources to the town.

Reason for non-inclusion: While DMF considers such a requirement to be allowable, the Committee decided to remove the recommendation of fishermen participation as a license *requirement*. Instead, the idea of collaboration between fishermen, researchers, and managers is heavily stressed in the Research Plan, is an important part of the Plan's adaptation strategies, and appears throughout the recommendations. An additional difference is that the Plan now incentivizes fishermen's participation rather than making it a requirement.

Recommendation: Reduce bay scallop limits for the "occasional" commercial fisherman.

Benefits: Reducing limits for those who commercially fish part-time would, in theory, leave more shellfish to be caught by people who fish all season and who depend on fishing for their livelihoods.

Reason for non-inclusion: In part, this recommendation was not included due to the uncertainty of the definition of an “occasional” fisherman. Additionally, the Committee did not generally support any reductions in catch allotments.

Recommendation: Reduce the number of bushels landed per day.

Benefits: Catch reduction is a very common fisheries management strategy used to relieve pressure on fish stocks and to encourage successful reproduction and re-building of populations.

Reason for non-inclusion: Given the uncertainty about (1) why bay scallop populations fluctuate, (2) the reproductive cycle of scallops, and (3) the cause(s) of the general downward trend in bay scallop population, the Committee did not see the value in reducing catches when there was no indication that doing so would reverse the population trend or make the fishery more stable from year to year (Note: in the early 1990s, the limit was reduced from 12 bushels per day to 5.)

Recommendation: Implement a four-day/week fishery, with same total number of bushels allowable per week.

Benefits: A shorter work week with the same total weekly harvest would allow fishermen to make more efficient use of their time on the water, and might positively affect the price of scallops. It is generally believed that bay scallops caught on Friday do not go to market until the following Monday. Given that they are not freshly caught, they are considered by buyers to be an inferior product and bring in less money per pound than those shellfish sold Tuesday–Friday.

Reason for non-inclusion: There is insufficient information about when catches are sold and for what price, therefore the impact of a four-day week on bay scallop prices is not well-enough understood to make the recommended change. Furthermore, a four-day work week with the same catch limit would put an additional burden on those responsible for processing the catch. The Committee decided that, rather than make this an outright recommendation, a means should exist (the adaptation process) to consider this strategy if circumstances warrant. Research to understand the impacts of a 4-day week without an increase in bushels/day could influence whether or not to implement such a recommendation in the future.

Recommendation: Develop official shellfish landing locations throughout the Harbors to improve inspection and recording of each catch.

Benefits: Strategically located official shellfish landing locations would help improve accuracy of data on catch amounts and allow for more thorough inspections.

Reason for non-inclusion: The availability of shellfish wardens fluctuates, making it difficult to commit to staffing each landing location. Additionally, the routes of fishermen would likely be affected if their landing locations were limited potentially adding to fuel costs and shortening time available for fishing.

Recommendation: Use shanties as a way to facilitate inspection and record of catch.

Benefits: Shanties process a large portion of the bay scallop harvest and could provide a cost-effective way of gathering information about catches and enforcing size regulations.

Reason for non-inclusion: The general feeling is that shanties should not be involved in the enforcement aspect of the shellfish industry to a greater extent than already used.

Recommendation: Eliminate the 30-day delayed entry (“hardship”) license.

Benefits: Some believe that the delayed entry license is an easy way for people to unfairly circumvent the need to purchase a scalloping license prior to the start of the season, thus rewarding people who do not show a strong commitment to the fishery.

Reason for non-inclusion: Very few people take advantage of the delayed entry license, and they are penalized a month of fishing at the start of the season. Also, few people actually make use of the hardship license, therefore the impact is fairly small. (For example, in the 2011–2012 season, 10 people applied for the delayed entry license, 4 were issued, 3 were used sporadically, and only 1 was still being used in January 2012 (Fronzuto, Personal Communication, 2012)). For these reasons, most of the committee felt there was little need to go through the steps required to do away with the license.

Recommendation: Identify and designate areas for use solely by recreational shellfishermen.

Benefits: Recreational shellfishing is a significant part of Nantucket’s shellfishing culture. Setting aside places where recreational fishermen could harvest exclusively might reduce user conflict between recreational and commercial fishermen.

Reason for non-inclusion: For the most part, the methods used by commercial and recreational shellfishermen separate them spatially, and conflicts between recreational and commercial shellfishermen are rare. At this time, there is no need to set aside exclusive recreational areas.

Recommendation: Create a cooperative whereby fishermen would have access to shucking, marketing, training, and other joint resources.

Benefits: A cooperative could help reduce individual costs (e.g., shared shucking facilities) and offer new opportunities (e.g., a joint marketing strategy), thus providing a bit of stability in an unstable industry.

Reason for non-inclusion: The idea of establishing a cooperative has not been successful in the past for reasons including the cost of operating a cooperative, differences of opinion about what a cooperative should or should not do, and a general disinterest in joining and running a cooperative. For these reasons, the idea of a general cooperative was not included in the recommendations; however the Plan does include a recommendation for a marketing cooperative. This type of organizing appealed to members of the Committee who saw it as a way to increase the fishermen’s ability not only to earn more money from the sale of their catch, but also as a way to prevent other products from being marketed as Nantucket bay scallops.

Recommendation: Promote the “Nantucket Marine Collaborative,” envisioned to involve fishermen and researchers in the enhancement of shellfish stock, largely through propagation activities at the Brant Point Boat House.

Benefits: An organization that involves fishermen and researchers, can apply for funding, and can work specifically to enhance shellfish populations would be of great benefit to the Island’s shellfish resources.

Reason for non-inclusion: The “Nantucket Marine Collaborative” concept was developed at a time in which the Town did not have a shellfish biologist focusing on propagation issues. With the employment of Tara Riley, the Town now has in-house propagation expertise. This Plan does, however, recognize the value of involving fishermen in research, propagation, and education activities. Accordingly, the Plan makes recommendations to ensure more predictable

and appropriate funding to continue propagation and outreach activities that include fishermen, managers, and researchers.

Recommendation: Implement a “traffic-light” system for adapting shellfish management activities whereby the monitoring of trends and thresholds would trigger a change in management.

Benefits: A traffic-light system provides a great deal of structure and predictability and helps to identify the key pieces of information needed in order to make management decisions.

Reason for non-inclusion: While the Committee generally liked the structure that the traffic-light approach provides, it felt that (1) the requisite data do not yet (and may never) exist to inform a traffic-light-type decision-making process, (2) the concept would not receive wide acceptance from the fishing community, and (3) that the approach’s real value was in helping to organize important information. Rather than linking a traffic-light system directly to adaptation measures, the concept is included in the Research Plan as a means to organize and better understand and interpret data.

Recommendation: Implement a catch limit for the bay scallop fishery

Benefits: A catch limit for the bay scallop fishery (as opposed to catch limits for each fisherman) might help protect spawning biomass.

Reason for non-inclusion: The Committee did not support any limits on catch that might be more restrictive than the current limits.

Recommendation: Research the potential for using natural or artificial substrates in the Head of the Harbor and explore other locations if more appropriate.

Benefits: Artificial substrates can provide important habitat for shellfish species.

Reason for non-inclusion: The Committee felt this recommendation was not necessary.

APPENDIX F: EXAMPLES OF TRAFFIC LIGHT CONTROL RULES IN DATA-POOR FISHERIES

Fisheries management often aims to estimate and manage toward maximum sustainable yield (MSY), which is an estimate of the average harvest that can be maintained year in and year out without overfishing the stock. MSY-oriented management often requires complex stock assessment models, which might not be applicable to species that are short-lived with high population turnover and high variability in year-to-year stock size with dynamics driven heavily by environmental conditions external to stock demography. Many coastal shellfish species, certainly including bay scallops and other species in the waters surrounding Nantucket, exhibit these attributes. For species such as these, trends in the population or ecosystem might be more useful than stock status relative to some reference point for determining management actions. One tool for capturing these trends in a way that provides a single assessment index is known as the “traffic light” method.

Traffic light indices use a range of variables that are relevant to the productivity of the stock, including fishery-dependent and fishery-independent data (e.g., catch, catch-per-unit-effort, mean size, recruitment rates, etc.) and ecosystem monitoring (e.g., temperature, rainfall, habitat condition, abundance of predators and prey, etc.). Fishermen and biologists determine the suite of important metrics and the data available to estimate each. Then, each year each metric is ranked as green if the value suggests good conditions for the stock, yellow if the value suggests no change or average conditions, and red if the value suggest poor conditions. These rankings can be determined based on empirical research on the stock (e.g., thermal tolerances), or based on time series values (e.g., whether the value falls in the top third, middle third or bottom third of the past ten years). The average of all of the metrics determines the overall index for the stock in that year. If the metrics include a wide range of ecosystem attributes, the index might also provide a good index of overall system health, although the choice of variables to include is often biased toward those of most importance to key target species.

One disadvantage of traffic light methods is that a time series of data is typically needed to establish relative values and trends. A fishery starting from scratch with these methods might require 5 years of data or more before the outputs can be used to make management decisions. However, if enough data sets already exist, then the fishery can establish a retrospective time series against which to evaluate current conditions from the outset. In most cases, it is likely that data will exist for a subset of the chosen metrics, allowing a partial index to be estimated immediately and additional variables to be added through time as the database grows. Once an index has been established and fine-tuned, the outputs can be used to adjust fishery management measures (catch limits, license numbers, season length, etc.) and other environmental regulations (fertilizer or pesticide use, number of boat moorings in key habitats, other aspects of coastal development and use).

Following are examples of traffic light indices that have been developed for the northern shrimp fishery of the Canadian Maritime Provinces and the salmon fishery in the Pacific Northwest of the United States.

Atlantic Canadian Shrimp

Fisheries for northern shrimp off the Maritime Provinces of Canada have adopted traffic light systems that are tailored slightly to specific fishing locations on the coast. Below are examples from two of these locations, Sept Iles and Hawke Channel, from the 1999 fishing year, reproduced from the paper by Koeller et al. (2000). For both locations, most of the indicators used are stock and fishery data, although

each also incorporates one ecosystem variable. For Sept Îles, the ecosystem variable is an index of predation pressure, whereas for Hawke Channel temperature data are used. At the time of Koeller et al.'s paper, the traffic light indices were not yet linked to management measures, and instead were simply a gauge rather than a control rule².

TABLE 3. Performance report for Sept Îles for 1999. Evaluations are + (green) positive, 0 (yellow) uncertain, r - (red) negative.

INDICATOR	OBSERVATION	INTERPRETATION	EVALUATION
FISHING SUCCESS			
Landings	40% increase in TACs and landings since 1995; TAC taken easily since 1995	Large biomass	+
Catch (number)	19% increase since 1995; decrease in males (12%), increase in females (62%)	High abundance; mean weight of catches has increased	+
Effort	40% reduction between 1994 and 1995; effort low and stable since 1995	High density	+
Seasonal pattern	High monthly CPUEs in 1998; CPUEs decline over season	High density; return to seasonal pattern of early 1980s	0
Spatial pattern	Effort reduced in southern part of Laurentian Channel; effort increased in western part of area	Change in distribution; geographic range may be shrinking	0
Stock distribution	Drop in densities in southern part of Laurentian Channel; increase in densities in western part of area	Change in distribution; geographic range may be shrinking	0
Industry perception	Good concentrations of shrimp in areas different from other years; few or no small shrimp	Densities still high, but change in distribution and low recruitment	0
STOCK ABUNDANCE			
Biomass index	Increasing since 1992–93; 1998 stable in relation to 1997; 1997 and 1998 values highest in series	Large biomass	+
CPUE	Increasing since 1992–93; 1998 value highest in series	High density	+
Abundance index	Increasing since 1992–93; 1998 stable in relation to 1997; 1997–98 values similar to that of 1990	High abundance	+
NPUE	Increasing since 1992–93; 1998 value highest in series	High density	+
RESOURCE PRODUCTIVITY			
Population structure	Age structure stable from year to year; growth gradient from east to west	No loss of female component; productivity lower in eastern part of Gulf	+
Size of males	Size of last mode of males smaller in 1998	Size at sex change will drop in 1999; females will be smaller	0
Size of females	Increasing since 1994; very big in 1998	Fewer individuals for same catch	+
Female abundance	Increasing since 1992–93; 1998 value highest in series	Large spawning stock	+
Male abundance	Abundance of all male components relatively stable in 1992–96, but fell in 1998 to average level	Average recruitment to spawning stock	0
Recruitment	Drop in male abundance to average level; very few small males in 1998 survey	Low recruitment to fishery	--
Predation	Cod and redfish abundance low, but increase in turbot	Predation pressure will rise	0
Exploitation rate	No increase with recent rise in catches; 1998 rates were same as those of early 1990s	Fishing mortality has not increased since early 1990s	+
ASSESSMENT			
All indicators combined	Stock in very good condition in 1998, but could begin to decline in 1999 because of lower recruitment		0

² This might have changed in the decade since the paper, and would be worth researching.

TABLE 5. Performance report for Hawke Channel + Div. 3K for 1999.

INDICATOR	OBSERVATION	INTERPRETATION	EVALUATION
FISHERY DATA			
CPUE – kg/hr	Increased for offshore fleet up to 1996 and has remained at a high level (> 2000 kg/hr). Inshore sector, including inexperienced fishers, had high catch rates when the fishery began in 1997.	Reflects an increase in the resource up to 1996, remaining at a high level since.	+
Spatial pattern	Eastward expansion in effort by offshore vessels in early 1990's.	Reflects the discovery of high concentrations of shrimp along the shelf slope during the exploratory fishery in 1992 and 1993. These areas previously were thought to be unproductive.	+
Temporal pattern	A winter-spring fishery for the offshore fleet and a summer-fall fishery for the inshore fleet.	Commercially viable concentrations of shrimp available throughout the year.	+
Male abundance	The abundant 1991 year-class began to recruit in 1994 and produced higher catch rates in 1995 and 1996. The 1993 year-class dominated in 1997 and 1998 but appears weaker than the 1991.	Good recruitment of year-classes produced in the early 1990's resulted in high catch rates of males since 1995.	+
Female abundance	Catch rates of the female component increased from 1993 to 1996 and stabilized in 1997 and 1998.	Continued good recruitment since the mid 1980's is responsible for the increase in spawning stock throughout the 1990's. Spawning component remains healthy.	+
Sex inversion	The median size at sex change varied between 21 and 22 mm carapace length throughout the 1990's.	Stability in maturity schedules suggests that favourable sex ratios are being maintained within the population.	+
RESEARCH DATA			
Biomass/abundance index	The lower 95% confidence intervals for the biomass/abundance indices averaged about 400,000 tons/90 billion animals during the 1996 to 1998 period.	High biomass/abundance.	+
Spatial pattern	Widely distributed throughout the management area.	Wider distribution in the 1990's compared to the 1980's, reflecting higher stock size.	+
Recruitment (male age structure)	Survey abundance in 1996 and 97 was dominated by males of the 1993 and 1994 year-classes. The 1994 year-class dominated in 1998. The 1995 and 1996 year-classes appear weaker.	Recruitment of males will likely decline, beginning in 1999 and continuing into the next millennium.	0
Spawning stock (females)	Relatively stable. Increase in 1998 survey due to small females, possibly part of the 1993 year-class.	Female abundance should be maintained in the short term (1999 and 2000) by the continued recruitment of the 1993 and 1994 year-classes.	+
ANCILLARY DATA			
Predation	Abundance of known predators such as cod, redfish, skate and American plaice remains low in the offshore areas.	Predation mortality remains low relative to periods of high predator abundance.	+
Environment	Warmer than average water from 1996 to 1998.	Could result in lower catch rates (reduced recruitment to the fishery) beginning in 1999 and continuing into the next millennium.	0
Industry perspectives	Catch rates were high in recent years with similar offshore catch rates in early 1999.	The resource is perceived to be healthy by both inshore and offshore sectors.	+
ASSESSMENT			
Exploitation rate	Ratio of nominal catch to survey biomass index (lower confidence intervals) has been less than 12% for the past 3 years.	Catchability of the survey gear is believed to be <1. Therefore, exploitation rate likely has been <12%.	+
Stock Status		Current status favourable with high biomass/abundance of male and females.	+
Future Prospects		Available information suggests a decline in recruitment for 2000+, so it is uncertain if the current TAC can be sustained	0

Pacific Northwest Salmon

The Northwest Fishery Science Center, in collaboration with Oregon State University, has developed a traffic light index for Chinook and Coho salmon run strength that relies primarily on ecosystem indicators, including aspects of both physical and biological oceanography, as well as abundance of salmon in ocean trawl surveys. The table below from the report by Peterson et al. (2010) illustrates the variables used, their scores from 1998–2009, and the overall index produced each year. Furthermore, the figures following the table show that this index has impressive predictive capacity for these populations, with a very strong correlation between the index values and run size. However, this index is not yet linked to management measures either.

Table 2. Rank scores upon which color-coding of ocean ecosystem indicators is based. Lower numbers indicate better ocean ecosystem conditions, or "green lights" for salmon growth and survival, with ranks 1–4 green, 5–8 yellow, and 9–12 red. To arrive at these rank scores, 12 years of sampling data were compared across years (within each row), and each year received a rank between 1 and 12. Note that 2008 was characterized by the best ocean conditions over the 12-year period, whereas 2009 ranked 7th of 12, suggesting below-average returns of coho in 2010 and Chinook in 2011.

<i>Environmental Variables</i>	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
PDO (December-March)	11	4	2	8	5	12	7	10	9	6	3	1
PDO (May-September)	9	2	3	4	6	11	10	12	8	7	1	5
MEI Annual	12	1	3	5	11	10	8	9	6	4	2	7
MEI Jan-June	12	2	3	5	8	10	7	11	4	9	1	6
SST at 46050 (May-Sept)	10	8	3	4	1	6	12	9	5	11	2	7
SST at NH 05 (May-Sept)	8	2	1	4	6	7	12	11	5	9	3	10
SST winter before going to sea	12	7	5	6	4	8	11	10	9	3	1	2
Physical Spring Trans (Logerwell)	8	7	2	1	4	10	9	12	10	3	6	5
Upwelling (Apr-May)	7	1	11	3	6	10	9	12	7	2	4	5
Deep Temperature at NH 05	12	5	6	3	1	8	9	10	11	4	2	7
Deep Salinity at NH05	12	5	6	4	3	10	11	8	7	1	2	9
Length of upwelling season	7	3	2	10	1	11	9	12	6	5	8	4
Copepod richness	12	2	1	5	3	9	8	11	10	6	4	7
N.Copepod Anomaly	12	9	3	6	2	10	7	11	8	5	1	4
Biological Transition	11	5	4	7	6	10	8	12	9	2	1	3
Copepod Community structure	12	3	4	6	1	8	9	11	10	7	2	5
Catches of salmon in surveys												
June-Chinook Catches	11	2	3	9	6	8	10	12	7	5	1	4
Sept-Coho Catches	9	2	1	4	3	5	10	11	7	8	6	12
Mean of Ranks of Environmental Data	10.4	3.9	3.5	5.2	4.3	9.1	9.2	10.8	7.7	5.4	2.8	5.7
RANK of the mean rank	11	3	2	5	4	9	10	12	8	6	1	7

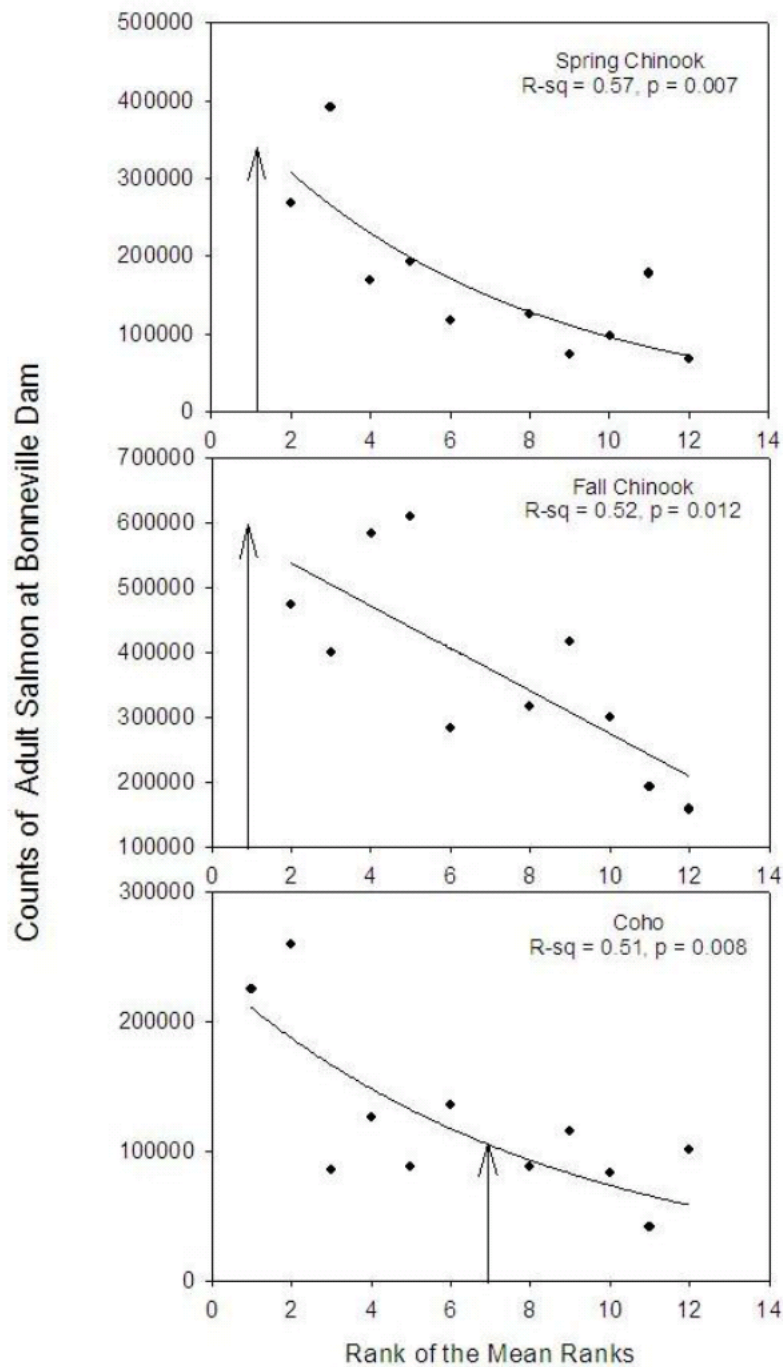


Figure 36. Counts of adult salmon vs. rank of mean ranks for ocean indicators. Vertical arrows indicate expected returns based on the year of ocean entry (2008 for Chinook salmon, when overall ocean conditions were ranked 1st, and 2009 for coho salmon, when overall ocean conditions ranked 7th).

APPENDIX G: CONSIDERATIONS FOR DEVELOPING A MARKETING COLLABORATIVE

In the broadest sense, a cooperative (or co-op) is simply a group of people working together to collectively improve their situation. There is a long history of such cooperatives for the purposes of energy production, localized wastewater treatment, agricultural crop raising and marketing, craft sales, and so on. The marketing of scallops from Nantucket is considerably more focused but there is much that can be transferred from these broader initiatives.

The Nantucket Shellfish Association already fulfills portions of the role of a shellfish cooperative, providing assistance in resource planning, research, propagation, and management solutions. The areas of marketing and product sales, however, have historically been the purview of individual fishermen. From time to time there have been discussions of ways to improve the product value of “Nantucket Scallops” (as opposed to those taken or produced in other locations) with the implication that scallops from the Island’s waters should be considered more desirable. To date there has been marginal implementation of any of these ideas.

The Committee’s recommendation is that a cooperative, group effort could lead to the “branding” of Nantucket Scallops and a marketing effort that would result in higher prices per unit for scallops taken in local waters.

Benefits of a Cooperative

At a 2010 workshop sponsored by the University of Maine SeaGrant Program (www.seagrants.umaine.edu/extension/shellfish-marketing), Robert Rheault, the Executive Director of the East Coast Shellfish Growers Association discussed how their cooperative worked in the production and marketing of shellfish raised through aquaculture. Many of his points are applicable to potential use on Nantucket.

Rheault began by stating his group’s experience that the branding and appropriate marketing of specific groups of shellfish could add about 8% to the sale price of the product. In this process he emphasized the role of the co-op as a “price maker” (the entity that can, if not entirely control the price of the product, work with an existing distribution system to improve the price) rather than a “price taker” (an entity that takes whatever price a buyer sets). This enhanced value can sometimes be the difference between economic success and failure on the part of the growers; or, in the case on Nantucket, the fishermen.

This enhanced value was accomplished by establishing the product as a recognized brand, complete with a brand description, marketing materials, logos, and packaging. His organization worked to establish brand recognition as well as “product category.” In the Nantucket instance the message would be something like, “Shellfish are good, and Nantucket Scallops are the best.” Rheault emphasized that building brand recognition is not an overnight occurrence; it can take years to build such brand recognition. (The benefits can be destroyed overnight, however, with one instance of poor quality or service.)

Marketing differs from broad-scale advertising in that it is focused on a particular market and offers a message tailored to that market. If a market survey shows that most shellfish are sold to restaurants, for example, the marketing might emphasize such aspects as freshness, healthfulness, consistency in

size and appearance (important to chefs), and distinctive taste. A goal might be to have the name Nantucket scallops listed on a menu as a specialty item. Shellfish growers sometimes compare their product to wines; just as Riesling grapes can be grown in many different areas, each producing its own distinct flavoring of wine—distinct to the “sophisticated” wine fancier—so too can shellfish from specific area bring their own distinctive taste to the table.

Establishment of a Cooperative

There are several guides to establishing cooperatives available through government or non-profit entities. The US Department of Agriculture has an entire office dedicated to various types of cooperatives through its Rural Business-Cooperative Service Branch. The Cooperative Development Institute; Northeast Center for Cooperative Business in South Deerfield, MA (www.cdi.coop) provides “education, training and technical assistance to start-up cooperatively-structured enterprises in all business sectors.”

The Committee’s recommendation for a cooperative is limited to enhancing market access and broadening of market opportunities. As such, it is an extension of existing activities of the fishermen. A typical process for determining the need or desirability for a co-op and its implementation if determined to be desirable would follow a pattern somewhat similar to that following.

- Determining whether there is a need and/or opportunity for cooperative efforts
Generally this would entail a survey of the existing fishermen to see whether they see sufficient potential benefits to even continue the discussion.
- Establishing the level of interest
Is there a broad section of the industry willing to participate? Will there be sufficient interest to provide financial support to further the process? Will there be sufficient interest to participate in meetings, committee work, etc.?
- Conducting a Feasibility Study for a co-op.
This would involve a more formalized market analysis and cost analysis for the efforts anticipated by the co-op and a preliminary cost-benefit analysis for participants. It is critical that this step involve an impartial market analysis and not merely rely on unsubstantiated opinions.
- Developing a Business Plan
What sort of administrative/management structure will be needed to operate the co-op? What sort of financing will be required for both start-up and continuing operation? What will be the “end products” of the co-op and how will they be developed?
- Developing a Marketing Plan
Who are the competitors now? How will they react to the co-op development and implementation? What is the current product distribution system and will it change with the establishment of a co-op? How will success be determined?

Disadvantages of a Co-op

There can be a downside to the establishment of a cooperative and any group contemplating such an exercise would do well to consider these and decide whether they are applicable in the particular instance under consideration.

Some of the potential disadvantages include:

- Members have to give up some of their independence and function in a group setting rather than individuals.
- Depending on the Business Plan of the Co-op, there may be a cost to the individual members. The Business Plan should give a realistic estimate as to when the benefits will outweigh the costs, but this will only be an estimate and unexpected situations may affect the pay-back time.
- There needs to be broad participation and support by members of the industry (in this case the Nantucket scallop fishermen), otherwise there could be a situation where a limited few are working to improve the value of the entire crop—a situation that is ripe for failure.
- It may be necessary to hire staff for the implementation of the marketing effort. This involves oversight of personnel, meeting payrolls, and various logistical actions.

Example of a Co-op comparable to that recommended for Nantucket

The Copper River/Prince William Sound Marketing Association, based in Cordova, AK (<http://copperrivermarketing.org/>) was established to “develop regional seafood brands” and prepare and implement a broad-based marketing plan to promote those brands. They define the purposes of the organization to:

- Develop regional seafood brands.
- Develop marketing plan for regions brands.
- Secure funds and implement the marketing plan.
- Facilitate member marketing program through common development of informational documents, market research, and promotion.
- Promote, foster and encourage quality assurance standards to attain highest industry standards.
- Promote improvements to the commercial fishing industry infrastructure in the region.

To implement these actions the group has incorporated as a non-profit organization under federal and state tax laws and created a Board of Directors and staff to administer the organization programs. Some of the specific activities they undertake (as described on their web site) are to:

- Coordinate site visits for the press,
- Host events for food writers,
- Provide a listing of where to get product and contacts for fishers who sell directly to restaurants/retailers,
- Establish and/or link to consumer web sites using or mentioning their product (think NantucketScallops.com),
- Participate in seafood shows across the country
- Prepare public relations/press releases on their products that tell the story of the product, provide fishermen profiles (i.e., “humanize” or “put a face on” the product), provide the history and tradition of the fishery, etc.,
- Utilize social media such as Facebook to get their message out to a wider segment of the public, and

- Prepare printed materials common to the fishery (as opposed to specific fishers) including informational brochures, promotional materials, flyers and packaging used as part of product shipments.

For Further information

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Bibliography

Many of the following materials relate to aquaculture. Despite being based on a "wild" crop, because the Nantucket scallop industry involves a single species taken from a well-defined, limited area, it has many similarities to aquaculture.

Free Publications

From the USDA Rural Business-Cooperative Service

How to Start a Cooperative

www.rurdev.usda.gov/rbs/pub/cir7/cir7rpt.htm

Understanding the Cooperatives: Who Runs the Cooperative Business?

www.rurdev.usda.gov/rbs/pub/cir456.pdf

Co-ops 101

www.rurdev.usda.gov/rbs/pub/cir55/cir55rpt.htm

Do Yourself a Favor: Join a Cooperative.

www.rurdev.usda.gov/rbs/pub/cir54.pdf

AK Dept. of Commerce and Economic Development. 1997. Alaska Fishermen's Direct Marketing Manual. 93p <http://seagrants.uaf.edu/bookstore/pubs/MAB-53.html>

Anonymous, 2003. Aquaculture Marketing Analysis and Opportunities in the Northeast Region. Northeast Regional Aquaculture Center White Paper 03-07. 72p.
www.nrac.umd.edu/files/Whitepapers/wp_no3_marketing.pdf

Gilbert, R. (1989). Small-Scale Marketing of Aquaculture Products. Southern Regional Aquaculture Center, No. 350. 4p.
<https://srac.tamu.edu/index.cfm/event/getFactSheet/.../64/>

Swann, L., and Reipe, J.R. (1991). Making Wise Choices When Direct Marketing Your Aquaculture Products. Illinois-Indiana Sea Grant, IL-IN-SG-FS-91-2, 6p.
www.aces.edu/dept/fisheries/education/ras/.../marketingAS-464.pdf

Peterson, H.C., and Fronc, K. (2005). A White Paper on Marketing Research Needs for the North Central Region. North Central Regional Aquaculture Center. 9p.
www.extension.org/mediawiki/files/e/e3/Aquaculturemarketing.pdf

Pomeroy, R. (2003). Developing an Aquaculture Business Plan. CT Sea Grant, CTSG-03-14. 2p.
seagrants.uconn.edu/publications/aquaculture/busplan.pdf

Strombom, D.B. and S.M Tweed. (1992). Business Planning for Aquaculture: Is it Feasible? Northeast Regional Aquaculture Center, No. 150-1992.
darc.cms.udel.edu/AquaPrimer/bizplannrac150.pdf

Publications for Purchase

Chaston, I. (1984). Business Management in Fisheries and Aquaculture. Fishing News Books.

Engle, C. and Quaghtainie, K. (2006). Aquaculture Marketing Handbook. Blackwell Publishing.

Shang, Yung, C. (1980). Aquaculture Economics: Basic Concepts and Methods of Analysis. Westview Press, Inc.

Shaw, Susan. (1990). Marketing: A Practical Guide for Fish Farmers.

APPENDIX H: SEAFOOD BRANDING AND MARKETING INITIATIVES

While there is no universal definition for environmental labeling or eco-labeling, the Organisation for Economic Co-operation and Development (OECD) has defined environmental labeling as the *"voluntary granting of labels by a private or public body in order to inform consumers and thereby promote consumer products which are determined to be environmentally more friendly than other functionally and competitively similar products"* (<http://www.fao.org/fishery/topic/12283/en>).

Ecolabeling is a market-based economic instrument that seeks to direct consumers' purchasing behavior so they consider product characteristics other than price. These characteristics may be associated with economic, social, environmental, or ecological objectives. Consumers' preferences for different characteristics will produce price and/or market share differentiation between products with and without ecolabels. These differences provide economic incentive for businesses to seek product certification under the ecolabel. Consumers are provided with relevant product information via the ecolabel that may impact their purchasing and consumption decisions (<http://www.fao.org/fishery/topic/12283/en>).

In the case of seafood branding, the labeling program appeals to consumer preferences for sustainably harvested, high-quality seafood from a known, local source, and also a desire to support community businesses and grow the local economy. The program encourages these consumer preferences by identifying seafood that meets these criteria as defined in program standards. The suppliers in the seafood industry therefore have financial motivation to seek certification under the program to profit from these consumer preferences and to support their own interests.

The following is a summary of primary seafood branding programs operating at an international, regional, or state-level.

Marine Stewardship Council

The Marine Stewardship Council (MSC) (<http://www.msc.org/>) is a global, independent, non-profit organization designed to use ecolabel and fish certification programs to: (1) recognize and reward sustainable fishing practices, and thereby contribute to health of the world's oceans; (2) influence consumer seafood purchases; and (3) work with partner organizations to create a sustainable seafood market. These MSC programs are the first in the world to be completely consistent with the United Nations Food and Agriculture Organization (FAO) Guidelines for the Eco-labeling of Fish and Fishery Products from Marine Capture Fisheries.

The MSC is recognized as the global leader in certification for sustainable wild-capture seafood. The Council distinguishes itself through its scientific approach, independence, and transparency. The MSC has two core standards: (1) MSC environmental standard for sustainable fishing; and (2) MSC chain of custody standard for seafood traceability. Fisheries and seafood businesses voluntarily seek certification against the relevant standard.

MSC Standards

Sustainable Fishing

The MSC standard for sustainable fishing (http://www.msc.org/documents/scheme-documents/msc-standards/MSC_environmental_standard_for_sustainable_fishing.pdf) has 3 overarching principles, each supported by detailed criteria, that every fishery must prove that it meets:

Principle 1: Sustainable fish stocks

The fishing activity must be at a level which is sustainable for the fish population. Any certified fishery must operate so that fishing can continue indefinitely and is not overexploiting the resources. For those populations that are depleted, the fishery must operate in a manner that demonstrably leads to their recovery.

Principle 2: Minimizing environmental impact

Fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which the fishery depends.

Principle 3: Effective management

The fishery must meet all local, national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability.

Each of these three principles are developed further by detailed criteria in the MSC Environmental Standard for Sustainable Fishing

Seafood Traceability

The MSC standard for seafood traceability (<http://www.msc.org/documents/scheme-documents/msc-standards/msc-coc-standard-v3>) has 4 overarching principles, each supported by detailed criteria, that every fishery must prove that it meets:

Principle 1: The organization shall have a management system

Principle 2: The organization shall operate a traceability system

Principle 3: There shall be no substitution of certified products with non-certified products

Principle 4: There shall be a system to ensure all certified products are identified

MSC Certification Requirements

The MSC certification requirements (1) establish how the two core standards should be interpreted by certifiers conducting assessments; (2) ensure proper assessment methodology of fisheries and businesses against MSC standards; and (3) ensure consistent assessments against MSC standards regardless of when, where, and by whom the assessment is performed. The most current MSC certification requirements can be found at: <http://www.msc.org/documents/scheme-documents/msc-scheme-requirements/msc-certification-requirements-v1.2/view>

Third Party Certification

MSC operates a third party certification program (<http://www.msc.org/about-us/standards/third-party-certification>). This type of program is central to MSC impartiality and credibility. MSC establishes standards for sustainable fishing or seafood traceability, and fisheries and businesses can be certified if they meet these standards. Under a third party certification program, however, MSC establishes the standards but it does not conduct certification assessments or issue certificates. Instead, independently accredited certifiers perform impartial assessments of fisheries and businesses using MSC standards. In addition, as another level of impartiality, a third organization Accreditation Services International GmbH (ASI) conducts the accreditation of independent certifiers to conduct MSC assessments.

In contrast, in second-party certification an organization, product or service, meets standards established by peers, such as an industry association. In first-party certification, an organization,

product, or service establishes the standards and assesses itself against those standards. A third-party certification, conducted by impartial experts, therefore offers the highest level of quality assurance and lack of bias.

Review process for MSC standards & certification requirements

MSC standards are officially reviewed every 5 years in an inclusive, transparent, and multi-stakeholder process that follows the MSC Standard Setting Procedure (<http://www.msc.org/about-us/standards/review>).

MSC certification requirements also are reviewed regularly by the MSC Technical Advisory Board (TAB) to keep up with the most current scientific knowledge and industry practices (<http://www.msc.org/about-us/standards/reviewing-methodologies>).

Success and Criticism

The reputation of the MSC continues to expand across the globe. According to 2010 research conducted in the United States, Canada, United Kingdom, Germany, France, and Japan, 23% of adults are aware of the MSC ecolabel program (<http://www.msc.org/newsroom/news/latest-research-shows-leap-in-public-awareness-of-the-msc-ecolabel>). This recognition is a significant increase from 9% in 2008.

In January 2012, however, eight major Alaska salmon processors, which constitute approximately 72% of the Alaska salmon catch, withdrew from participation in the MSC certification program, effective October 2012 (<http://www.msc.org/newsroom/news/msc-statement-regarding-alaska-salmon>). These processors claim the process of MSC recertification every five years is cumbersome and expensive and they wish to seek a broader marketing message. In addition, the processors assert the MSC certification was an independent affirmation of an already established and invariable fact, namely that since statehood, Alaska's salmon fishery has always been sustainably managed (<http://pressroom.alaskaseafood.org/alaska-salmon-processors-pull-back-from-msc-fao-based-certification-gets-a-boost/>).

Some critics also claim that MSC certification has lost cache because of its increased prominence and prevalence in the seafood industry. MSC also has been criticized for the certification of controversial fisheries with questionable sustainability, such as Patagonian toothfish (Chilean Seabass) and Antarctic krill.

Gulf of Maine Responsibly Harvested Program

The Gulf of Maine Responsibly Harvested branding program was developed by the Sustainable Seafood Initiative within the Gulf of Maine Research Institute (GMRI), an independent, non-profit, marine research and education institution. The program is designed to: (1) Reward traceable and responsibly harvested seafood products through market differentiation; (2) Enable consumers to support products that they can feel good about; (3) Motivate improvements to the sustainable harvest and traceability of Gulf of Maine seafood; (4) Unify the region's seafood industry around a shared identity; and (5) Achieve an economically and ecologically thriving and stable seafood industry (<http://www.gmri.org/mini/index.asp?ID=33&p=111>).

In contrast to the Marine Stewardship Council, a third-party certification program where one party establishes the standards but another independent party conducts certification against the standard, the Gulf of Maine Responsibly Harvested Program is a first-party certification program where the same part both establishes the standards and conducts certification. The Gulf of Maine Responsibly Harvested Program describes itself as a verification program instead of a certification program.

Standard for Responsibly Harvested Seafood

Overall the Gulf of Maine Responsibly Harvested brand signifies the following standards:

1. The seafood product was harvested or grown and processed in the Gulf of Maine region and meets criteria regarding sustainability and traceability;
2. Supply chain participants have made a commitment to the continuous improvement to the Gulf of Maine seafood industry;
3. A portion of the proceeds supports the Gulf of Maine Research Institute's efforts to motivate and reward improvements to the sustainable harvest of seafood.

The Gulf of Maine Responsibly Harvested brand has developed standards for both wild and farmed species ([http://www.gmri.org/upload/files/GMRH_Standard_with_Header\[1\].pdf](http://www.gmri.org/upload/files/GMRH_Standard_with_Header[1].pdf)). These standards were developed through engagement with fisheries management authorities, the fishing industry, the scientific community, environmental interest groups, fish processors, dealers, and retailers. In addition, the standards were based on notable existing seafood branding standards and programs, including the FAO guidelines and MSC standards discussed in the above section.

Standard for Wild Seafood

For *wild* seafood to qualify for participation in the program, the seafood must have been harvested at a level that enables utilization while maintaining its availability for present and future generations. This includes the following:

- Fisheries are managed by competent authorities and have management plans in place that incorporate a science-based approach to ensure sustainability.
- If stock sizes are below management target levels, whether due to natural or man-made causes, management plans are established that enable rebuilding within a specified timeframe.
- Sufficient data exists to determine harvest levels.
- Monitoring and compliance measures are in place to ensure acceptable harvest levels.
- Enforcement exists to ensure that harvesters follow regulations, and to prevent illegal practices and unreported harvest.

Standard for Farmed Seafood

For *farmed* seafood to qualify for participation in the program, production must comply with all state and federal regulations, including the following:

- Indigenous marine life and its environment are not threatened.
- Discharge of drugs and pesticides is prevented.
- Discharges of excess feed are minimized.
- Numbers and weights of animals, amounts of feed, and frequency of cleaning, inspections, maintenance, and repairs are recorded and available.

In addition to the seafood product meeting the criteria outlined above, participants in this cooperative branding program must demonstrate the following:

- The seafood product meets all relevant government regulations regarding its production.
- The seafood product is traceable from the management area or farm in which it was harvested to the point of sale.
- The seafood product was harvested or grown, and processed within the region, which is defined above.

There is no automatic assessment of specific wild or farmed seafood. Instead GMRI will assess fisheries and farms on an ongoing basis based on available time and resources. A seafood supply chain partner seeking GMRI certification must submit an application that includes a description of the seafood product, proof of traceability, and an outline of how the applicant will contribute to seafood sustainability in the coming year. GMRI does recognize other existing seafood branding efforts, however, and those fisheries and other seafood businesses that are certified under the Marine Stewardship Council, Global Aquaculture Alliance's Aquaculture Certification Council, or the Maine Aquaculture Association will be considered by GMRI to satisfy the sustainability and traceability requirements of the GMRI brand.

But, there are automatic qualifiers—MSC and others.

Participant annual review and traceability audit

A supply chain partner who seeks to maintain GMRI certification must submit to an annual review and traceability audit.

Review process for Gulf of Maine Responsibly Harvested Standards

GMRI will conduct an annual standards review. GMRI will consult with the fishing community, including management authorities, industry, scientists, consumers and environmental groups, in this review. After two years of implementation, GMRI will engage a third party to conduct a critical review.

Current Status

As of February 2012, the Gulf of Maine Responsibly Harvested Program has verified the following seven species: Haddock, Northern Shrimp (US), American Lobster, Atlantic Cod (US), Atlantic Sea Scallops (US), Atlantic Pollock, and Whiting (Silver Hake) (US).

Maine

Port Clyde Fresh Catch

In an effort to preserve their fishing heritage, small community, and fishing resources, the fishermen based in the small village of Port Clyde, Maine developed the Port Clyde Fresh Catch™ brand (www.portclydefreshcatch.com). Under the brand, wild seafood is caught locally in the Gulf of Maine and harvested using environmentally conscious fishing methods. The brand guarantees 100% supply-chain traceability that begins at harvest, and continues through packaging at the Port Clyde-based, Hazard Analysis and Critical Control Point (HAACP)-certified processing facility.

Port Clyde's fleet consists of approximately one dozen groundfishing vessels that fish from Portland to the Canadian border. Catch includes shrimp and groundfish, including haddock, flounder, cod, pollock, and hake. Catch is sold through wholesale and their local Community Supported Fishery.

Port Clyde developed the first Community Supported Fishery (CSF) in the nation. Community Supported Fisheries are analogous to the Community Supported Agriculture (CSA) model. CSF customers pre-purchase a "share" or specific quantity of seasonal catch. Various share sizes are available to suit customer needs. These seafood shares are delivered weekly, biweekly or monthly, depending on the program, to a designated delivery located during a specific time slot. Through the CSF the customer receives exceptionally fresh, high-quality, local seafood at a competitive price, and can directly support local fishermen and the community. In return the fishermen receive crucial pre-season capital to finance their fishing efforts, increased profit by selling direct to consumers, and a guaranteed market for their variety of seasonal catch. Many fishing communities across the country have followed Port Clyde's example and established their own local branding and associated CSF.

Massachusetts

Cape Ann Fresh Catch

The Gloucester Fisherman's Wives Association followed the example of Port Clyde and established the Cape Ann Fresh Catch (CAFC) Community Supported Fishery (CSF) in 2008, with initial delivery in June 2009 (<http://www.capeannfreshcatch.org/index.html>). CAFC has established a CSF based on sustainably caught local seafood from the Gulf of Maine, but does not publicly advertise a trademarked brand name.

CAFC offers weekly and biweekly shares of whole fish, fillets, and alternating whole/fillet available five days per week, at a total of 16 pick-up locations. CSF catch varies according to season but is comprised primarily of groundfish, such as cod, hake, haddock, pollock, whiting, and flatfishes, such as yellowtail flounder and grey sole.

Seafood Marketing Commission

The Commonwealth of Massachusetts has established a Seafood Marketing Commission, which held its first official meeting on January 31, 2012. The Commission is comprised of lawmakers, state officials, restaurant owners, and commercial fishermen. The goal of the Commission is "to brand Massachusetts seafood—the way Maine does with lobster and Alaska promotes salmon—as a healthy, sustainable food that supports the local economy" (Abelson, 2012). The Commission is investigating current seafood branding programs in other states and pursuing funding to launch a Massachusetts branding program.

New Hampshire

NH Fresh & Local Seafood

The NH Fresh & Local Seafood brand originated from collaboration between New Hampshire Sea Grant, the City of Portsmouth, and local commercial fishermen (<http://extension.unh.edu/Marine/NHSeafood.htm>). The brand signifies seafood that is sustainably caught and processed in New Hampshire. NH Fresh & Local Seafood Branding Standards are available at <http://extension.unh.edu/marine/Docs/NHS-standards-v1-11.pdf>. The program currently has 12 local restaurant partners, 10 retail partners, and 4 wholesale partners.

New Jersey

Jersey Seafood

The Jersey Seafood brand and logo (<http://www.jerseyseafood.nj.gov/>) were established by state statute in 2008 (<http://www.jerseyseafood.nj.gov/Seafoodreg.pdf>) under the New Jersey Department of Agriculture. The program is modeled after the state's Jersey Fresh branding program for agricultural produce.

Aquatic farmers, commercial seafood harvesters, and packer/processors of New Jersey seafood may apply for a license from the New Jersey Department of Agriculture to market their products using the Jersey Seafood logo.

North Carolina

Several local fishing communities in North Carolina have established local seafood branding programs, including the following:

- Outer Banks Catch (<http://www.outerbankscatch.com>)
- Carteret Catch (<http://carteretcatch.org/>)
- Brunswick Catch (<http://www.brunswickcatch.com>)
- Ocracoke Fresh (<http://www.ocracokeseafood.com>)

All of these seafood recognition programs are local initiatives to sustain the livelihood and heritage of the local fishing industry, and to promote the benefits of eating and buying local seafood. None of these programs are initiated by state statute; however, they are often a product of collaboration between local fishing industry associations, North Carolina Sea Grant, and other interested organizations. In all programs, the brand signifies seafood caught by the local county or island fishermen.

Alaska

Alaska Seafood

The Alaska Seafood branding and marketing program is a professional, extensive and comprehensive program managed by the Alaska Seafood Marketing Initiative (ASMI) (<http://www.alaskaseafood.org>). ASMI is a public-private partnership between the State of Alaska and the Alaska seafood industry. The mission of ASMI is to increase the economic value of the Alaska seafood resource through the following measures:

- Increasing the positive awareness of the Alaska Seafood brand,
- Collaborative marketing programs that align ASMI and industry marketing efforts for maximum impact within the food industry,
- Long-term proactive marketing planning,
- Quality assurance, technical industry analysis, education, advocacy and research, and
- Prudent, efficient fiscal management.

ASMI also oversees Alaska Seafood certification under sustainability standards (<http://sustainability.alaskaseafood.org/certification>) and chain of custody standards (<http://sustainability.alaskaseafood.org/chain-of-custody>). These certifications assure customers that only sustainable seafood from a certified Alaska fishery will carry the Alaska Seafood brand label.

Louisiana

Louisiana Wild Seafood Certification Program

Funding for this program was provided by British Petroleum (BP) following the Deepwater Horizon oil spill in the Gulf of Mexico in April 2010. BP awarded \$48 million to the Louisiana Department of Wildlife and Fisheries. This award includes \$18 million for seafood safety testing and \$30 million for an extensive marketing and advertising campaign. The funds for each program will be paid out over a three-year period (<http://www.louisianaseafoodnews.com/2011/11/23/where-and-when-the-money-flows-%E2%80%93-applying-bp-dollars-for-louisiana-seafood-industry-restoration/>).

The Louisiana Wild Seafood Certification Program (LWSCP) was established by state statute as a collaborative effort among state agencies: “The secretary of the Department of Wildlife and Fisheries is authorized to establish a quality certification program for Louisiana wild fish [as defined by statute]...and for Louisiana wild seafood products, including wild-caught shrimp, which are taken, harvested, or landed in Louisiana... in cooperation with the Louisiana Department of Agriculture and Forestry, Louisiana Department of Health and Hospitals, Louisiana State University, and any other state or federal agency deemed appropriate.” (<http://www.legis.state.la.us/lss/lss.asp?doc=727850>).

An overview of the program can be found at:

- http://www.wlf.louisiana.gov/sites/default/files/pdf/document/6584-LA%20Wild%20Seafood%20Certification%20Program%20Overview/La_Certification_Program_Overview_4-23-10.pdf
- http://www.wlf.louisiana.gov/sites/default/files/pdf/shrimp_task_force/34822-Shrimp%20Task%20Force%20Meeting%20Thursday,%20November%2029,%202011/lwscp_rene_-_stf.pdf

The program is expected to launch in spring 2012.

References:

Abelson, Jenn. “State officials say they want to find ways to better market local fish.” *Boston Globe* 31 January 2012. Website: <http://www.boston.com/Boston/businessupdates/2012/01/state-officials-say-they-want-find-ways-better-market-local-fish/gDt8EuVXQLfioonCrPvaHJ/index.html>

APPENDIX I: MEMO OF HARVESTING CRITERIA



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Ian A. Bowles
Secretary

Mary B. Griffin
Commissioner

MEMORANDUM

TO: Marine Fisheries Advisory Commission (MFAC)

FROM: Paul Diodati, Director *Paul J. Diodati*

DATE: January 9, 2009

SUBJECT: Recommendations on final action regarding bay scallop harvest criteria

On November 13th the Division took emergency action at the request of Nantucket officials that provided relief to the Nantucket bay scallop fishery. The fishery was confronting a dire season of harvest due to the preponderance of scallop "seed" that were restricted from harvest because of a policy definition. Although these scallops were in their second summer, they did not conform to the long-held policy standards that describe location of the growth ring. The policy required that the growth ring must measure at least 10 mm from the hinge. The emergency rule allowed scallops with a well defined growth ring less than 10 mm from the hinge to be harvested as long as the shell height was 2 ½" or greater. **I recommend this regulation be enacted as a final rule to allow Nantucket to continue to fish under this standard through the end of the bay scallop season (March 31), and to maintain this standard into the future.**

Background

Bay scallop fisheries have been managed using the century-old wisdom and scientific findings of Dr. David Belding, considered the pre-eminent marine biologist of the early 20th century. The strategy (captured in state law: MGL Chapter 130, sec 70) prohibits the harvest of sexually immature "seed" scallops, those under one-year old whose shells do not have the tell-tale raised annual growth line. This line is distinguishable by sight and especially by touch by running one's fingernail along the curve of the shell from the origin to the margin.

Section 70. No person shall take from the flats or coastal waters of the commonwealth scallops other than adult scallops, or sell or offer for sale or have in possession such scallops. For the purposes of this section an adult scallop shall be a scallop with a well-defined raised annual growth line, and any scallop without such line shall be deemed a "seed" scallop. Scallops taken from the coastal waters shall immediately be culled when taken, and all scallops other than adult scallops shall forthwith be returned alive to the coastal waters whence taken; but it shall not be unlawful to sell or have in possession scallops other than adult scallops unavoidably left in the catch after it has been culled, to the amount of not more than five per cent of the total catch remaining. All scallops taken in accordance with this section shall be taken ashore in the shell. This and section seventy-one shall not apply to seed and adult scallops carried by storm or tide from the natural beds and deposited on beaches and flats where, in the opinion of the director, they cannot survive, but the taking of said seed scallops and the taking and sale of said adult scallops may be authorized by him at any season of the year. The director shall promulgate rules and regulations governing the taking and sale of said seed and adult scallops by special permits.

which he is empowered to issue without fee, or otherwise so as to prevent the sale of seed scallops at any time, or the sale of adult scallops between April first and the following October first, except as authorized herein. Whoever violates any provision of this section shall be fined not less than ten nor more than fifty dollars and imprisonment for thirty days or both.

The growth line usually lies mid-shell (1.2 to 1.6" inches from the hinge) with last year's growth reflected below the line and this year's growth above the line to the shell margin. Belding's historical work recognized that at times there were exceptions to the location of the annual growth ring. Based on Belding's long-standing published work, it has been the policy of DMF and towns that the raised growth line must be at least 10mm from the hinge, else it is considered seed.

Recent years have seen an increase in water temperatures resulting in longer periods of warm water into the fall that tend to lengthen spawning seasons. An extraordinary late spawn of bay scallops in late/summer fall of 2007 in Nantucket resulted in an abundance of scallops in 2008 that were in their second year but whose raised growth line was very close to the shell hinge, less than 10 mm. According to DMF Shellfish Program Leader Mike Hickey, this scenario was not unprecedented. This situation has occurred in the past on Nantucket in 1980, 1999, 2000 as well as Chatham 1977, Orleans 1979 and Edgartown in 1995. It has also been seen in Wellfleet. This is not a conclusive list but indicates that this phenomenon although unusual is not rare. The Division of Marine Fisheries (*Marine Fisheries*) has always taken the position that these scallops are "large seed." Locally known as "nub" scallops, nubs are difficult to distinguish from large seed so are prohibited from harvest. Shellfish biologists have found many of these nubs spawn as normal 1-year old scallops (in their second summer) but the smaller individuals may not have spawned - but would spawn in their third summer if they survive the winter.

Last November, 85% of Nantucket's scallop population consisted of one-year old nubs. Consequently, the state and town's policy requiring all legal scallops to have a raised growth line at least 10mm from the hinge became a significant restraint on harvest. Nantucket shellfish officials worked diligently to estimate scallop standing stock and reproductive status. They petitioned the Division to bring relief to the industry by creating a rule that would honor the century-old standard to protect seed scallops, but allow some nub scallops with a raised growth line less than 10 mm from the hinge to be harvested if they measured at least 2.5" shell height. Based on data collected by Nantucket's shellfish biologists, this strategy would allow about 43% of the nubs to be harvested, presumably most of those that have spawned, yet continue to protect 57% of the smaller immature nubs.

An emergency action (effective for 90 days) was taken by the Director on November 11th to provide instant relief for the fishermen and the industry. The benefits to the industry have been well-documented by Nantucket. The scallop harvest was increased three-fold and came at a particularly crucial time given the current economic conditions. Nantucket biologists and town officials deserve credit for their efforts to characterize the population. The documentation accompanying the request for a rule change was impressive, revealing and convincing.

Public Hearing Summary

The January 6th public hearing was held in Hyannis and was well attended, especially by Nantucket officials, fishermen, and a scallop researcher. There was universal praise and gratitude for the accelerated response to Nantucket's request for the rule change that allowed the current fishery to succeed. Additional comments were received from off-island communities (notably Edgartown) generally in favor of the rule because it has the potential to improve enforcement and compliance.

At the hearing, Nantucket shellfish biologist Jeff Mercer gave a formal presentation that came from the Harbor and Shellfish Advisory Board Scallop Workgroup requesting that DMF consider a modification to the final rule by replacing the 2 ½" shell-height criteria with a 1" shell thickness standard. According to testimony, this substitute measure was preferred by the industry for many reasons, including ease of measure and improved enforcement. It was noted by many speakers at the hearing that the apparent unanimity on this position is unusual and regulators should capitalize on the support that this measure has with all involved.

My recommendation to adopt the original emergency (scallops with a raised growth line less than 10 mm from the hinge could be harvested if they measure at least 2.5" shell height) rule as a permanent regulation and not the substitute measure (replace the 2 ½" shell-height criteria with a 1" shell thickness standard) proposed by Nantucket fishermen and their representatives comes after careful consideration. This recommendation is based on our interpretation of Nantucket's data. We are apprehensive that the substitute measure is too liberal and will result in increased harvest of nub scallops with consequent reductions in future spawning potential. At issue is the question of what contribution nub scallops contribute to next summer's spawning events. There is evidence that significant numbers of nub scallops survive their second winter and may contribute to the upcoming summer's spawning events, thereby making it prudent to protect a substantial portion of the nub scallops.

Nantucket's data show many of the smaller nubs have not spawned and some scallop research suggests immature nubs will survive to spawn if allowed to reach their third summer. According to their data, the 2 ½" shell height standard protects an estimated 57% of Nantucket's nub population while the 1" shell thickness standard only protects 22.5%. (Note: the effect of the 1" thickness standard is similar to a 2 ¼" shell height standard that was considered as an alternative but rejected in DMF's early discussions with Nantucket due to inadequate protection of a proportion of nubs.) In summary the shell height standard that resulted in the potential harvest of 43% of the standing stock of nubs was a reasonable compromise that should be studied further before being liberalized. Because this is a statewide measure we should be somewhat cautious in our deliberations.

Summary of Possible Management Options			
	Shell Height 2.5"	Shell Height 2.25"	Shell Thickness 1"
Seed			
Nub			

DMF will continue to work with town officials in Nantucket and other communities that have the few remaining bay scallop fisheries to study the practicality of this new rule and the potential to modify the rule to consider enacting the 1" thickness standard for nub scallops or other future alternatives. I suggest at least two field seasons are warranted with sampling from various locations before further liberalization. Nantucket officials have pledged to continue data collection to understand the impacts and long-term consequences of this new rule and any alternatives.

We must determine if this standard that was based on an intense data collection exercise in a single area and year can hold up to the natural annual and regional variability in growth and spawning success that is a hallmark of the bay scallop fisheries.

Finally, a comment on the issue of local control is warranted. Numerous comments and correspondence has been received noting the potential for a town to enact these standards unilaterally under the authority of MGL Section 52. We oppose having town-specific standards on biological measures, and instead believe the

Commonwealth would be better served having a statewide standard on this particular issue. While it is true that section 52 allows towns to manage shellfish fisheries under their jurisdiction, any rule that is contrary to state law (and regulations) would not be valid.

Proposed final rule governing bay scallop harvest criteria: The only changes from the previously enacted emergency regulation is the more thorough incorporation of the expression: " well-defined raised annual growth line, to be more consistent with the statute, MGL C. 130 sec 70.

6.11 Bay Scallops Harvest Criteria

(1) Definitions.

(a) Bay Scallop means that species of marine mollusk known as *Argopecten irradians*.

(b) Shell height means a straight line measurement from the middle of the hinge to the opposing valve margin.

(c) Seed scallop means scallops that are sexually immature and do not bear a well-defined **raised** annual growth line

(2) Prohibition on harvest and possession of seed scallops. No person shall land or possess scallops without a well-defined **raised annual** growth line and that growth line shall measure at least 10 millimeters from the hinge of the shell.

(a) Exception. Bay Scallops that have a **well-defined raised** annual growth line located less than 10 millimeters (mm) from the hinge of the shell, shall be lawful to harvest and possess if the shell height is at least 63.5 millimeters or 2.5 inches.