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ABSTRACT

Historically, Nantucket Island's unique character and culture as a small fishing community was centered on harvesting whales, cod and shellfish. Currently, the northern bay scallop (*Argopecten irradians irradians*) fishery is the last commercial fishery remaining on Nantucket and one of the largest bay scallop fisheries left in the country. Northern bay scallop fisheries used to span along the Eastern seaboard from New Jersey to Cape Cod, but have become depleted due to numerous environmental and anthropocentric factors. The Nantucket bay scallop fishery is in danger of following the same footsteps. In the last 20 years, the number of bay scallops harvested has declined by approximately 85%, alarming the Nantucket community about the sustainability of this traditional fishery. As of late, Nantucket coastal waters have experienced a decline in eelgrass (*Zostera marina*) and water quality, which are two key components for a healthy bay scallop habitat. Economically, other scallop species are sold on the market with the incorrect label of "Nantucket Bay Scallop," threatening the reputation of the autochthon bay scallop, as well as its economic value. Socially, Nantucket is struggling to balance tourism with maintaining the character of a unique, small fishing community. My project analyzed environmental, social and economic aspects of the fishery and created a 'recipe' of management recommendations aimed at sustaining the Nantucket bay scallop fishery.

PROJECT DESCRIPTION

For the last fifty years, bay scallop populations have declined in abundance, resulting in the collapse of most bay scallop fisheries throughout the country. The present study is centered on sustaining one of the last bay scallop fisheries remaining in the country: the Nantucket bay scallop fishery. Although the Nantucket bay scallop fishery is still active, harvests have declined 80-85% since the early 1980s, creating concern among the Nantucket community. To keep this fishery alive, my project aims to create a 'recipe' of management recommendations geared towards creating a sustainable *wild*[1] Nantucket bay scallop fishery.

John Elkington's "Triple Bottom Line" theory was used as a base to create this 'recipe.' According to this theory, three elements of a business - environment, economic, and social - are constantly in motion and are affected by the issues occurring within.[2] These three elements interact with each other much like tectonic plates.[3] If one of the elements of the business is suffering, the other two elements will also be impacted, thereby affecting the overall sustainability of the business.[4] Unlike John Elkington's theory that the economy sets the limits for sustainable development and use, my project is based on the concept that the environment is the foundation for a sustainable business (Figure 1.1).[5] In order words, without a healthy environment, the social and economic elements of the business will suffer, resulting in an unsustainable business.[6]

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[1] To enhance bay scallop abundance, the Nantucket community is currently propagating the harbor with bay scallop seeds. The goal of this project is to create a fishery that is considered *wild* (i.e. a fishery that is sustainable without seeding efforts).
[2] John Elkington, *Cannibals with Forks: The Triple Bottom Line of 21 Century Business* (Canada: New Society Publishers, 1998), 69.
[3] *Id.*
[4] *Id.*
[5] Anamarija Frankic, conversation with author, October 23, 2008.
[6] *Id.*

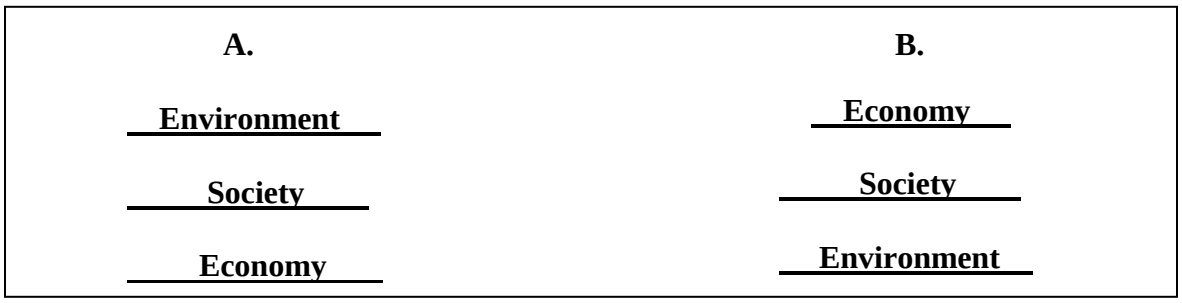

Figure 1.1: "Triple bottom line" theory. "Theory A" represents John Elkington's concept that the economy sets the base for sustainable development; "Theory B" shows Anamarija Frankic's concept that the environment sets the base.[7] "Theory B" was used as the foundation for my project.

The methodology for creating this 'recipe' is centered on an assessment of environmental, social and economic elements of the fishery. This assessment consisted of discussions with various stakeholders of the fishery, an extensive literature review (research studies, management plans, newspaper articles, journals, etc), and an "Economic Trend Survey." In 2005, this survey was distributed to restaurants, wholesale dealers, and fishermen to assess the importance of the bay scallop fishery to the island's economy.

At the end of each element assessment, a table was created to display goals and recommendations, as well as a timeline for accomplishing the recommendations (either "near-term" (0-2 years) or "long-term" (2-5 years)). The timeline was based on the importance of each recommendation to improving the sustainability of the bay scallop fishery, as well as the time needed to complete the recommendation; finances were not considered. If finances were considered, the timeline may be different.

The struggles faced by the Nantucket bay scallop fishery are similar to those encountered by a number of fisheries worldwide. If the Nantucket bay scallop fishery recovers to a sustainable level, the fishery could be used not only as a model for bay scallop fisheries that have collapsed, but also for other small, community-based fisheries worldwide.

[7] *Id.*

BACKGROUND

"It is more than just a business.

It is a direct thread to the past."

- Jim Patrick & Rob Benchley on the Nantucket bay scallop fishery[8]

To a number of communities throughout the world, fishing represents a cultural tradition, an economic and dietary means for existence, and an irreplaceable "relationship" with the surrounding marine ecosystem.[9] This "relationship," which symbolizes a link between the seasons of the ecosystem and the culture of community, "provides a strong sense of place that fishermen feel on the fishing grounds."[10] Fishing communities often depend on surrounding marine resources for subsistence, creating a feeling of independence and self-sufficiency from outsiders that enhances community morale.[11]

Unfortunately, almost all of the global 200 fisheries monitored by the FAO are in danger of depletion, creating concern among these fishery-dependent communities.[12] Reasons for this decline in fisheries include: environmental degradation, overfishing, management issues, etc. Many fishermen have been forced to seek employment elsewhere, which has alarmed a number of communities about the potential loss of this cultural tradition. Precautionary approach and adaptive management based on thorough research will hopefully alleviate the struggles faced by fisheries.

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[8] J. Patrick and R. Benchley, *Scallop Season* (China: Autopscot Press, 2002), 2.
[9] Lacey Burns, *Alaska's Changing Coastal Communities – A Case Study of Kodiak Island: Implications of Low Salmon Prices and Sustainability*, http://www.4alaskafishers.com/id4.html (July 17, 2008)
[10] *Id.*
[11] *Id.*
[12] FAO Corporate Document Repository, *Understanding the Cultures of Fishing Communities*, http://www.fao.org/DOCREP/004/Y1290E/y1290e04.htm#bm04 (July 17, 2008)

BAY SCALLOP

The Atlantic bay scallop (*Argopecten irradians)* fishery is a prime example of a fishery that represents a connection between the community and its surrounding ecosystem. Bay scallops are small, sweet-tasting mollusks which are found in bays and estuaries from Cape Cod to Texas.[13] The bay scallop has three subspecies: the northern bay scallop, *Argopecten irradians irradians* (found from New Jersey to Cape Cod), the southern bay scallop, *Argopecten irradians concentricus* (found from New Jersey to the Chandeleur Islands) and *Argopecten irradians amplicostatus* (found from Galveston, TX to Laguna Madre, TX).[14] My project primarily focuses on the northern bay scallop.

Figure 1.2: Photo of a northern bay scallop (*Argopecten irradians irradians*).[15]

The adductor muscle, also known as the "eye," is the part eaten by consumers, while the rest of the scallop is considered non-edible.[16] Bay scallops prefer shallow waters near the coast, making them vulnerable to human development.[17] Similar to most other species of bivalves, bay scallops filter-feed by pumping water through their mantle cavity to capture food particles in

[13] United States Fish and Wildlife Service, *Bay Scallop, Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)* (1983), 1.
[14] *Id.*
[15] Photo taken by: Kim Starbuck
[16] D.L. Belding, *A Report Upon the Scallop Fishery of Massachusetts* (Boston: Wright & Potter Printing Co., State Printers, 1910) 16.
[17] *United States Fish and Wildlife Service*, 3.

their cilia.[18] They typically prey upon benthic diatoms and other planktonic forms of microalgae.[19] They also have a number of predators, including crabs, gastropods, birds, and, of course, humans.

Bay scallops are hermaphroditic and normally spawn only once during their two year life cycle, when the scallop is at least one year of age.[20] For the northern bay scallop, spawning typically occurs in either June or September when there is a quick change in water temperature to approximately 20-22 degrees C.[21] When the newly-born scallops overwinter, their shell growth slows, creating a "well-defined and raised growth line."[22] Nub scallops are scallops that are born in September, have a shortened "well defined, raised growth ring," and typically spawn later than other scallops, at 21-22 months.[23] The growth line can be used as an indicator of the scallop's age and is very important for the management of the fishery.

NORTHERN BAY SCALLOP FISHERIES

In 1858, bay scalloping first began along the Atlantic seaboard with the use of pushrakes, nets, or by hand.[24] As technology advanced, most fisheries upgraded to the use of power boats and dredges. Northern bay scallop fisheries used to range from New Jersey to Cape Cod, with

[18] *Id.* at 8
[19] *Id.* at 8
[20] Conant & Curley, as quoted in Urban Harbors Institute, *Revised Nantucket & Madaket Harbors Action Plan* (Nantucket, MA: Prepared for the Nantucket and Madaket Harbors Plan Review Committee & the Department of Marine and Coastal Resources, 2007), 39.
[21] *Id.*
[22] *Id.*
[23] *Id.* at 39-40.
[24] Patrick and Benchley, 2.

the largest fisheries occurring in Peconic Bay NY, Niantic River CT, Rhode Island, Martha's Vineyard, MA, and Nantucket, MA.[25]

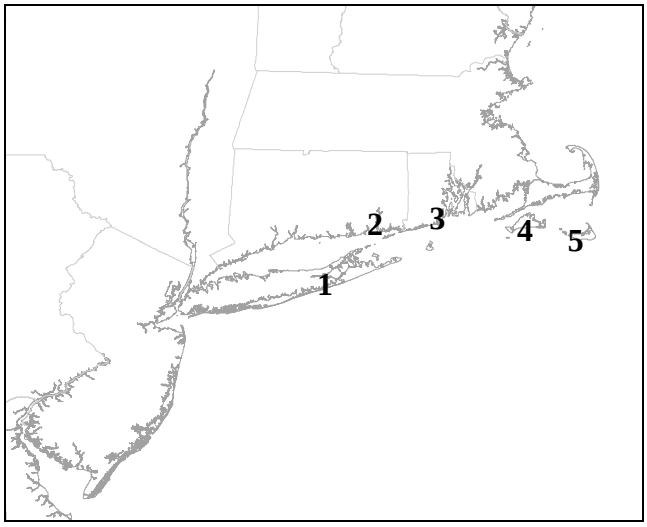

Figure 1.3: Main historic northern bay scallop fisheries (1- Peconic Bay NY, 2- Niantic River CT, 3- Rhode Island, 4- Martha's Vineyard MA, 5- Nantucket MA).

The majority of these locales currently do not have enough of a bay scallop population to support a fishery, aside from Nantucket and Martha's Vineyard which have the largest bay scallop fisheries remaining in the country. Fisheries located in Peconic Bay NY, Niantic River CT, and Rhode Island collapsed primarily because of environmental degradation. The fishery located on Martha's Vineyard, MA has been experiencing a decline in the bay scallop population as well, but still supports a small, propagation-based fishery. It is useful to note the suspected reasons for the collapse of these fisheries to prevent Nantucket from following in similar footsteps.

a. Peconic Bay, NY

[25] Sandra L. MacFarlane, *Bay Scallops in Massachusetts Waters: A Review of the Fishery and Prospects for Future Enhancement and Aquaculture* (Barnstable, MA: Prepared for Barnstable County's Cape Cod Extension & Southeastern Massachusetts Aquaculture Center 1999), 5.

Peconic Bay used to be the main source of bay scallops for the country, supplying approximately 28% of the country's bay scallops and generating millions of dollars for the local community.[26] In 1985, Peconic Bay experienced its first recorded brown tide event[27] which killed off the majority of the bay scallop population.[28] Although the brown tide chrysophyte, *Aureococcus anophagefferens*, was detected in the bays during the following years, the bay scallop population seemed to slowly rebound until 1994 when another major brown tide occurred.[29] Bay scallop harvests decreased from more than 500,000 pounds a year in 1982 to 50 pounds a year in 1996.[30]

In the mid 1990s, the SeaGrant's Brown Tide Research Initiative and other research organizations began to analyze the causes for these brown tides.[31] They determined that inorganic nutrient loading could be a main cause for the brown tide blooms in Peconic Bay. A number of other potential causes for brown tides have also been analyzed and more research is currently being conducted to enhance the understanding of brown tide blooms.

Despite seeding and research efforts, the Peconic bay scallop population is still suffering. Fishermen that are still dedicated to harvesting bay scallops typically spend most of the day sorting through bycatch only to find few bay scallops.[32] The Peconic Bay community is still

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[26] U.S. EPA, *Whitman Puts Plan to Preserve Long Island's Peconic Bay into Effect*, http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/2bf649cc0256fd1d8525716900500e458!OpenDocument (July 17, 2008).

[27] Chapter II "Environmental Assessment" will discuss the effect of brown tides on bay scallop populations in more detail.

[28] http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/2bf649cc0256fd1d852571690050e458!OpenDocument.

[29] Julie Zeidner, *Finding a Cure for Brown Tide*, New York SeaGrant, http://seagrant.gso.uri.edu/noreaster/noreasterFW95/brown_tide_fw95.html (July 17, 2008).

[30] http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/2bf649cc0256fd1d852571690050e458!OpenDocument.

[31] *Id.*

[32] *Id.*

determined to recover the bay scallop population, because if they "lose a grip on shellfishing and the fishing industry, (they) lose the heart and soul of this area (they) love."[33]

b. Niantic River, CT

Before the 1930s, Niantic River, CT did not contain enough bay scallops to sustain a fishery.[34] In the early 1930s, Niantic River, CT suffered from the eelgrass wasting disease[35] that drastically reduced eelgrass abundance throughout the river. Although most research has shown that the presence of eelgrass is essential for bay scallop survival, the decline in eelgrass was actually beneficial for Niantic River bay scallops.[36] The lack of eelgrass enhanced circulation, making it easier for the bay scallops to attain food (benthic diatoms, etc.).[37] Instead of attaching to eelgrass during the first few months of their lives, the bay scallops adhered to "small branching algae."[38] The absence of eelgrass actually created enough of a bay scallop population to support a fishery that lasted until the mid-1980s.[39]

In the years following the wasting disease, eelgrass abundance slowly recovered and returned to historic levels in the 1970s.[40] In the mid-1980s, researchers recognized that both the eelgrass abundance and bay scallop population were once again suffering.[41] Unlike previous years when the eelgrass depletion was beneficial for the bay scallops, this depletion resulted in a decline in bay scallop population.[42] Keser et. al (2003) suggests that nitrogen runoff from

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[33] *Id.*

[34] Nelson Marshall, *Studies of the Niantic River, Connecticut with Special Reference to the Bay Scallop, Aequipecten irradians,* (Narragansett Marine Laboratory, University of Rhode Island, Kingston, Rhode Island, 1960), 86.
[35] Chapter II "Environmental Assessment" will discuss the eelgrass wasting disease in more detail.
[36] Marshall, 86.
[37] *Id.*
[38] *Id.*
[39] *Id.*
[40] *Id.*
[41] *Id.*
[42] Steven Chupaska, "Niantic River Open for Scallop Harvesting." *The Waterford Times,* January 18, 2008.

shoreline development polluted the estuary and reduced water clarity, thereby causing eelgrass death.[43] Other theories for eelgrass death include swan grazing and green crab disturbances.[44]

Due to the decline in water quality, loss of eelgrass beds, and disappearance of bay scallop populations, the Niantic River Watershed Protection Plan was developed in 2006 to reduce nutrient loading.[45] In hopes to further improve water quality, the rivers and coastal waters of Long Island Sound were also designated "No Discharge Zones."[46] Recently, studies have shown a slight recovery in both eelgrass abundance and bay scallop population.[47] In 2008, for the first time in six years, the river was opened for recreational bay scallop harvesting, but with severely reduced harvest limits; fishermen must obtain a permit and cannot harvest more than a half-bushel a day.[48]

c. Rhode Island

In the late 1800s, Rhode Island used to be one of the main sources of bay scallops for New York.[49] Narragansett Bay, RI and Greenwich Bay, RI had the best bay scallop populations in the state until the 1930s, when the eelgrass wasting disease decimated eelgrass abundance.[50] In 1985, Rhode Island suffered from the same brown tide bloom as Peconic Bay, eliminating the small eelgrass and bay scallop populations remaining.[51] Currently, neither Narragansett Bay nor Greenwich Bay has a significant bay scallop population.[52]

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[43] Milan Keser et al., "Decline in Eelgrass (*Zostera marina* L.) in Long Island Sound near Millstone Point, Connecticut (USA) unrelated to thermal input," *Journal of Sea Research* 49 (2003), 11.
[44] *Id.* at 23.
[45] *Niantic River Watershed Plan*, http://www.kxchange.com/nrwp/_docs/NRWPP/Section1.pdf (November 23, 2008).
[46] http://www.kxchange.com/nrwp/_docs/NRWPP/Section3.pdf.
[47] Chupaska, "Niantic River Open for Scallop Harvesting."
[48] *Id.*
[49] Save the Bay, *About Bay Scallops*, http://www.savebay.org/NetCommunity/Page.aspx?pid=615&srcid=611 (July 17, 2008).
[50] *Id.*
[51] *Id*
[52] *Id.*

Researchers believe that recent brown tide blooms were caused by a number of factors including increased development and water pollution.[53] To aid in the recovery of the bay scallop population, various organizations are currently introducing cages of scallops to open water bays.[54] The scallops within these cages will hopefully spawn during the summer months and enhance the population of the bay scallops.[55] Efforts are also being made to restore the bay scallop habitat. Currently, various organizations are attempting to improve eelgrass abundance through transplants and research. The Department of Environmental Management is also working towards reducing nutrient loading and improving water quality.[56]

d. Martha's Vineyard, MA

Martha's Vineyard is host to the other main bay scallop fishery remaining in the country. Although there are still a handful of commercial fishermen, the majority of the fishery is focused on recreational harvesting.[57] There are a number of different ponds and inlets around the island that contain bay scallop populations, such as Oaks Bluff, Vineyard Haven, Chilmark, and Edgartown. In the 2006-07 season, Martha's Vineyard actually harvested more bay scallops than Nantucket, with 6,296 bushels harvested in Tisbury alone.[58] The daily commercial limit is three bushels per fisherman, which is two bushels less than Nantucket.[59]

Although fishermen still continue to catch bay scallops, the number of bushels harvested has severely declined from previous years.[60] Shellfish constable Mr. Paul Bagnall stated that

[53] *Id.*
[54] *Id.*
[55] *Id.*
[56] *Id.*
[57] Jack Shea, "Bay Scallop Season Opens Across Island with Predictions for a Decent Harvest," *Vineyard Gazette*, November 2, 2007.
[58] *Id.*
[59] *Id.*
[60] *Id.*

Martha's Vineyard "catch(es) in a week what (they) used to catch in a day 50 years ago."[61] Similar to the other fisheries, researchers blame this decline in bay scallop harvests on environmental deterioration from nutrient loading and eelgrass depletion, as well as predation by green and asian box crabs.[62]

[61] *Id.*
[62] *Id.*

CHAPTER I:

NANTUCKET ISLAND, MASSACHUSETTS &

THE NANTUCKET BAY SCALLOP FISHERY

Figure 1.4: Photo of Sankaty Head Lighthouse, Nantucket Island, Massachusetts.[63]

[63] *Sankaty Gold Club*, http://www.sankatygolfclub.org/f/Sankaty_Lighthouse.jpg (November 15, 2008).

BACKGROUND INFORMATION

Thirty miles south of Cape Cod, the small, foggy island of Nantucket has a unique, historic character that sets it apart from the mainland. More than 800 grey-shingled houses that were built prior to the Civil War are still standing[64] and the antique windmills and cobblestone roads create a distinctive atmosphere. The lack of traffic lights and fast-paced chain restaurants enhance the calm, serene island "way of life" that is appreciated by its residents and visitors.

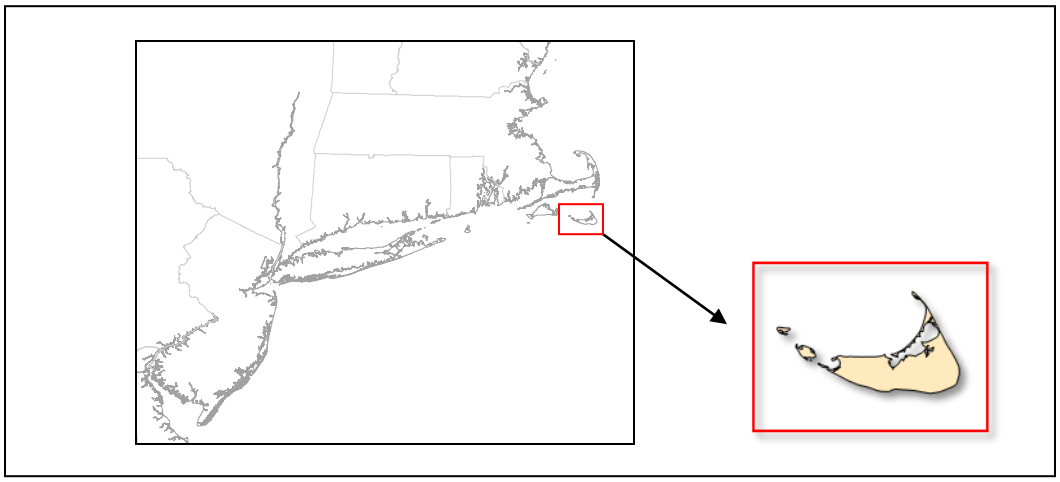

Figure 1.5: Location of Nantucket Island, Massachusetts.

The conservation and protection of the island's natural environment is very important to the Nantucket community. Approximately 36% of the island is conservation land, making Nantucket a prime habitat for a number of endangered species, such as the piping plover, least tern, and osprey.[65] Organizations, such as the Nantucket Conservation Foundation, Sustainable Nantucket, and the Nantucket Shellfish Association, are dedicated to protecting the natural environment.

[64] Nantucket Island Chamber of Commerce, *Nantucket Trivia*, http://www.nantucketchamber.org/visitor/trivia.html (July 17, 2008).
[65] *Id.*

Nantucket is also the home to some of the most beautiful beaches on the east coast, making the island a popular summer tourist destination. Approximately 10,000 residents live on Nantucket year round, while during the summer months, the tourist population peaks to around 55,000.[66] The island is challenged by balancing tourism with Nantucket's serene "way of life" and unique maritime culture.[67] The two harbors, Nantucket and Madaket harbors, are the center of this maritime culture, providing transportation, tourism, recreation, and food.[68]

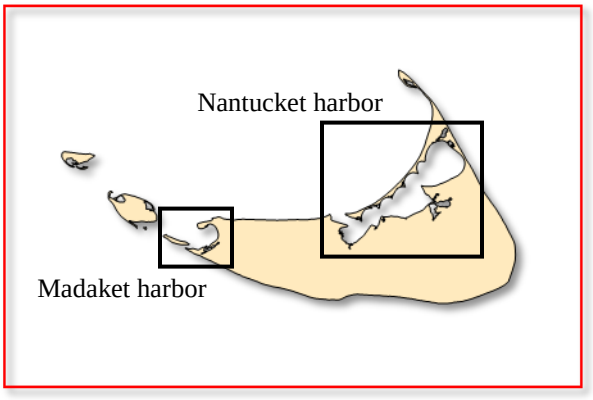

Figure 1.6: Two main harbors of Nantucket Island, Massachusetts. The majority of the bay scallop fishing occurs within these two harbors.

In the 1600s, the Quakers first settled on the island in pursuit of religious freedom and used this maritime lifestyle as a means of establishing independence from the mainland. Fishing activities brought in food and revenue, giving the community a feeling of self-sufficiency. Early settlers primarily hunted whales, which quickly provided a significant source of income to the Nantucket community. When Nantucket's whaling industry collapsed in the mid-1800s, the Nantucket community shifted its fishing efforts toward cod, quahogs, and northern bay scallops.

[66] Nantucket.net, *Facts about Nantucket*, http://nantucket.net/links/facts.php (July 17, 2008).
[67] Aaron B. Norton, *Nantucket Bay Scallop Resource Conservation and Management Plan* (Prepared for the Nantucket Marine and Coastal Resources Department 2000) 1.
[68] *Id.*

Currently, the northern bay scallop fishery is the last commercial fishery remaining on Nantucket.

OVERVIEW OF THE NANTUCKET BAY SCALLOP FISHERY

Bay scallop fishing officially started on Nantucket in 1881.[69] For the last 150 years, the Nantucket community has primarily focused its fishing efforts on the bay scallop, which is now considered one of the finest scallop species in the world.[70] The bay scallop fishery has allowed Nantucket to sustain its small fishing community culture, as well as maintain a sense of self-sufficiency from the "mainland."[71] There are also a number of people living on-island that economically benefit from the fishery, such as fishermen, wholesale dealers, restaurant owners, cullers, shuckers, gear shop owners, etc. All community members have some connection to bay scallop fishing, whether it is a direct connection or a connection through family or friends.[72]

Today, approximately 250-300 fishermen live on-island, but only 100-150 of those fishermen are active.[73] Most fishermen only scallop part-time, and spend the rest of their time working in the tourism industry.[74] Fishermen use small boats that are approximately 16-24 feet in length and harvest the scallops with power dredges, pushrakes, and dip nets. Scallops harvested are collected in ~ 1 x 2 x 1 (ft.) milk crates called "bushels." Most fishermen sell their catch on-island to wholesale dealers, who then sell the bay scallops in bulk to restaurants, individuals, other wholesale dealers, hotels, supermarkets, etc.[75]

[69] Ken Kelley, "History of Nantucket's Bay Scallop Industry," *Yesterday's Island*, 1996.
[70] Patrick and Benchley, 1.
[71] Norton, 4.
[72] Patrick and Benchley, 2.
[73] Keith Conant, conversation with author, March 2008.
[74] Retail, construction, etc.
[75] Chapter IV "Economic Assessment" discusses the bay scallop chain of delivery in more detail.

The wholesale dealers "set" the price paid to the fishermen for one pound of bay scallops, which can fluctuate throughout the season. The price per pound of bay scallops is influenced primarily by supply and demand (as discussed in Chapter 4). In past years, as the supply of bay scallops decreased, the price per pound of bay scallop meat generally increased. Off-island demand also greatly influences the price of the scallop because approximately 90% of all bay scallops are shipped off-island by wholesale dealers. Off-island demand is affected by the availability of other seafood substitutes, success of previous seasons, economy conditions, etc.[76]

The number of bay scallop bushels harvested and licenses issued on Nantucket varies every year.

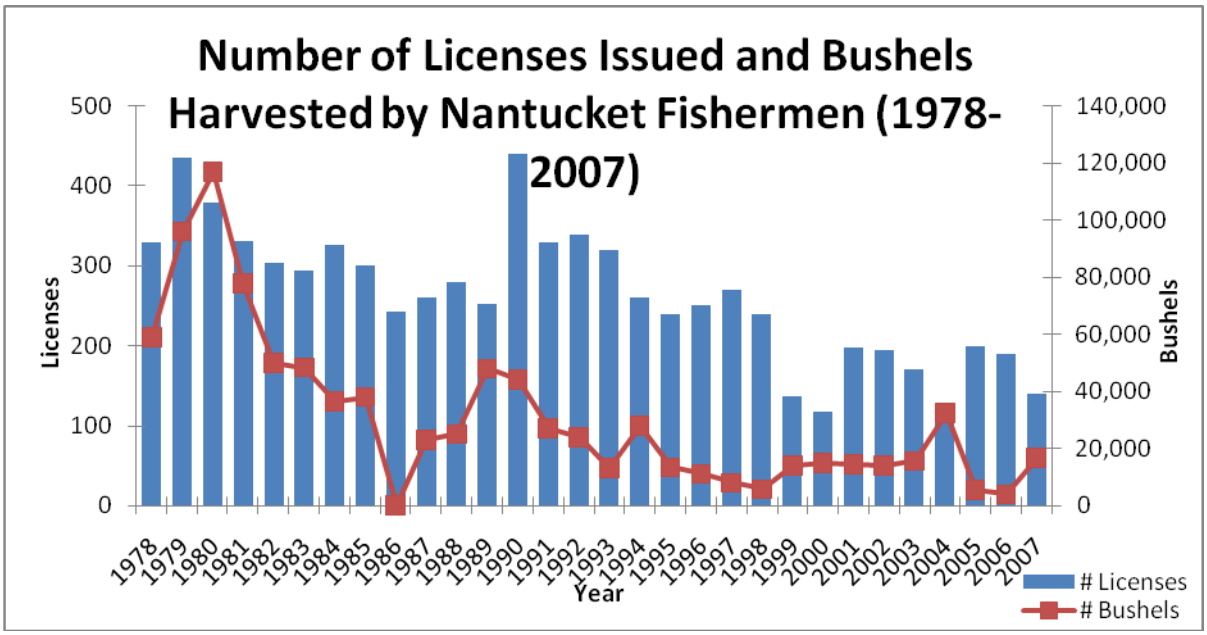

Figure 1.7: Number of licenses issued and bushels harvested by Nantucket fishermen between 1978 and 2008. No data is available for the number of bushels harvested in 1986.

[76] Chapter IV "Environmental Assessment" discusses off-island demand for bay scallops in more detail.

In the 1980-81 season, Nantucket fishermen harvested an all time high of nearly 117,000 bushels of bay scallops, which brought in approximately $4 million to the fishermen alone.[77] Since the early 1980s, the bushels of bay scallops harvested have steadily declined. Low scallop yields have created frustration among the fishermen, resulting in fewer licenses issued. The 2005-06 and 2006-07 seasons were the worst scallop seasons yet recorded, with bushels harvested at 5,500 and 3,850 respectively.[78] The 2007-08 season was considerably better than the two years prior, with harvests close to 16,000 bushels, but these yields are still only about 20% of previous fishery yields.

Among the many speculated reasons for the decline in the Nantucket bay scallop fishery are: environmental deterioration, the lack of a long term sustainable Shellfish Management Plan, fewer shellfish licenses issued, overharvesting, and the natural fluctuations of the bay scallop population. This decline in the fishery has created a great deal of concern among those directly involved in the fishery, as well as the entire Nantucket community.

CURRENT EFFORTS TOWARDS ENHANCING THE NANTUCKET BAY SCALLOP FISHERY

To aid in the recovery of the Nantucket bay scallop fishery, the community is raising money to create the Nantucket Marine Collaborative (NMC). The goal of the NMC is to develop a "small, stand-alone, world class shellfish propagation facility, research laboratory, and education venue" by 2010.[79] The concept of an NMC has been supported by various Nantucket

[77] The $4 million accounts solely for the revenue generated by the fishermen alone. This revenue does not include the money earned by other members of the community, such as wholesale dealers, scallop openers, cullers, etc.
[78] Conant & Curley, as quoted in Urban Harbors Institute, "Revised Nantucket & Madaket Harbors Action Plan," 39.
[79] National Shellfish Association - The Committee to Establish the Nantucket Marine Collaborative, *A Plan to Create the Nantucket Marine Collaborative,* 3.

organizations and the 2007 Revised Nantucket and Madaket Harbors Action Plan ("Harbors Action Plan").[80] This NMC would be situated at the former Coast Guard Boathouse near Brant Point lighthouse on Nantucket Island. The NMC would contain a shellfish hatchery, labs, educational space for visiting classrooms, and access to the public.[81]

The Boathouse has a history of propagation and marine research. In 1989, a facility called the Nantucket Marine Laboratory was constructed at the Boathouse.[82] The Nantucket Marine Laboratory was primarily used for "shellfish aquaculture" and marine research, including water quality analyses.[83] The Nantucket Aquaculture Program also was created and received $250,000 annually from the Federal government.[84] Two years after the Nantucket Aquaculture Program was initiated, the federal funding was taken away, and in 1997, the Nantucket Marine Laboratory was closed.[85]

Currently, the Boathouse is primarily being used as storage for moorings and boating equipment, but there is also a small amount of research and propagation occurring at the Boathouse.[86] Two scientists are provided with minimal funding to research bay scallop reproduction and physiology. Quahogs and oysters are also grown-out at the Boathouse in two floating upweller shellfish seed nursery systems (FLUPSYs).[87] Furthermore, Nantucket bay scallops are sent to an off-island aquaculture facility, and the spat from these bay scallops are also grown-out at the Boathouse prior to being released into Nantucket harbor.[88] It is estimated

[80] The Harbors Action Plan will be discussed more on page 28.
[81] *Id.*
[82] *Id.* at 2.
[83] *Id.*
[84] *Id.*
[85] *Id.* at 3.
[86] *Id.*
[87] *Id.*
[88] *Id.*

that $10 million is needed to construct the Nantucket Marine Collaborative.[89] My project will be useful during the creation of the Nantucket Marine Collaborative and the fundraising process.

The Harbors Action Plan also states that a Shellfish Management Plan should be created and implemented as soon as possible.[90] The concept of a Shellfish Management Plan has been around on Nantucket for decades, but a plan has not yet been developed. The information and recommendations from my project will be useful when developing a Shellfish Management Plan aimed at sustaining the bay scallop fishery.

CURRENT MANAGEMENT OF THE NANTUCKET BAY SCALLOP FISHERY

Although Nantucket does not have a formal Shellfish Management Plan, the "Commercial Shellfish Regulations" are in place to avoid issues that are associated with open access fisheries (see Appendix A). In open access fisheries, property rights are not assigned to the pool of fish, leading to a "tragedy of the commons" situation. "Tragedy of the commons" often leads to overexploitation because there are no regulations imposed on the amount of resources harvested or the fishing effort expended. Point OA in Figure 1.8 represents an open access fishery.

[89] *Id.*
[90] The Harbors Action Plan stated that the Shellfish Management Plan should be enacted by October 2008, but this goal has not yet been achieved. The Harbors Action Plan will be discussed more on page 28.

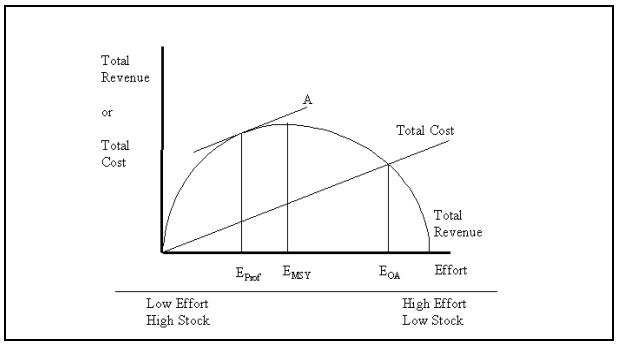

Figure 1.8: Fishing effort versus total revenue/cost.[91]

In an open access fishery, fishermen typically will continue fishing until their total revenue equals their total cost (Point OA).[92] Expending any effort beyond that point is unprofitable because the costs of additional fishing effort are greater than the resulting revenue, thus leading to a loss of money. From an economist's point of view, Point Prof represents the ideal amount of fishing effort. At Point Prof, the total revenue minus total costs is the greatest, resulting in the maximization of society's profits. At Point OA, the society is expending too much effort for not enough fish, leading to an economically inefficient fishery.

Point OA is also beyond Point MSY (maximum sustainable yield), which is the amount of stock that can be harvested "without impairing its renewability through natural growth."[93] Thus, at Point OA, the fishery is overfished because the fishermen have tried to capture all of the economic rent, resulting in a decline of adults available to reproduce.[94] Therefore, an open access bay scallop fishery on Nantucket would most likely lead to its collapse because Point OA is beyond the amount of effort necessary for an economically efficient fishery, as well as a biologically sustainable fishery.

[91] Louisiana State University- Natural Resource Economics, http://courses.agecon.lsu.edu/3000/AGEC3503/images/module2/L1Slide6.GIF (November 15, 2008).
[92] Tom Tietenberg, *Environmental and Natural Resource Economics* (Boston:Pearson, 2006), 295.
[93] OECD, *Glossary of Statistical Terms*, http://stats.oecd.org/glossary/detail.asp?ID=3075 (November 23, 2008).
[94] Tietenberg, 295.

To avoid an open access bay scallop fishery on Nantucket, the fishery is managed in a limited entry fashion by regulations put forth through the "Commercial Shellfish Regulations." Limited entry is a regulatory mechanism aimed at limiting the total amount of inputs into the fishery, thereby reducing the quantity of effort expended.[95] Limited entry can regulate the number of vessels, fishermen, fishing methods, or type of vessel used.[96]

The "Commercial Shellfish Regulations" state that all commercial fishermen must be Nantucket residents and purchase a shellfish license from the Department of Marine and Coastal Resources to legally harvest bay scallops.[97] Legally harvested scallops must have this "well-defined, raised growth line" and can only be harvested for commercial purposes from November 1st through March 31st, and for recreational purposes from October 1st through March 31st.[98] Recreational fishermen cannot sell their catch.[99]

Commercial fishermen are allowed to scallop Monday through Friday, and can harvest five bushels a day.[100] The type of dredging equipment utilized by the commercial fishermen is regulated by length, type, and mesh size.[101] Recreational fishermen scallop Wednesday through Sunday, harvest one bushel a week, and cannot use dredges.[102] There are a number of penalties involved with violating any of these regulations, resulting in fines, license suspensions and imprisonment.[103]

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[95] J. A. Crutchfield, "Economic and Social Implications of the Main Policy Alternatives for Controlling Fishing Effort," *Journal of the Fisheries Resource* (July1979), 742.
[96] R. Quentin Grafton, "Private property rights and crises in world fisheries: turning the tide?" *Contemporary Economic Policy* 14 (October 1996), 1.
[97] Town of Nantucket, *Commercial Shellfish Regulations*, http://nantucket-ma.gov/Pages/NantucketMA_Marine/commercial.pdf (November 23, 2008).
[98] *Id.*
[99] *Id.*
[100] *Id.*
[101] *Id.*
[102] *Id.*
[103] *Id.*

Although these regulations are aimed at reducing fishing effort to either Point Prof or Point MSY, the decline in bay scallop supply and increase in fishermen leaving the fishery to find more profitable work on-land implies that the fishery is still suffering from overfishing and economic inefficiency. This suggests that the Nantucket bay scallop fishery is operating at a fishing effort that is beyond both Point MSY and Point Prof. It is possible that the regulations put forth through the "Commercial Shellfish Regulations" are not set to achieve MSY. These regulations also could be limiting the fishing effort in ways that are actually encouraging economic inefficiency.

Because of this, the fishery is in need of a Shellfish Management Plan that contains more stringent regulations centered on maximizing profits and achieving MSY. These regulations will hopefully enhance not only the biomass of the bay scallop population, but also create a more economically efficient fishery that will increase the profits generated by the Nantucket community.

CURRENT MANAGEMENT OF NANTUCKET AND MADAKET HARBORS

The Harbors Action Plan is primarily aimed at minimizing the impact of human activities on the surrounding environment. The recommendations created by this plan are currently being undertaken by various Nantucket organizations. Key issues addressed in this plan include:

- Water quality
- Eelgrass abundance
- Fisheries, and
- Waterfront access

CHAPTER II: ENVIRONMENTAL ASSESSMENT

Figure 2.1: Photo of Madaket beach, Nantucket Island, Massachusetts.[104]

[104] Photo taken by: Kim Starbuck

BACKGROUND INFORMATION

Nantucket Island is currently home to the largest bay scallop fishery remaining in the country. Because of this, it is considered to have a prime environment for hosting a bay scallop fishery. Other bay scallop fisheries throughout the country have collapsed primarily due to a decline in environmental quality. Research has suggested that Nantucket is experiencing similar water quality and habitat degradation, which may be one of the reasons for the reduction in harvest yields.

A rise in population may be to blame for this environmental degradation. Over the last twenty years, the number of people on Nantucket, both during the tourist season and off-season, has increased considerably. The most recent population census in 2006 reported that the resident population is 10,240, which is a 41% increase from the 6,000 residents living on Nantucket in 1990.[105] During the summer months, the population typically rises to approximately 55,000.[106] This population "boom" has resulted in an increase in house construction, boating and vehicle activity. These activities may be creating a variety of environmental issues that may influence the bay scallop habitat.[107]

BAY SCALLOP HABITAT

Based on the literature review and current knowledge, I selected three categories of environmental factors that bay scallops depend on:

A. Chemical and physical habitat conditions (water quality, salinity and currents)

B. Eelgrass abundance, and

C. Predators

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[105] US Census Bureau, *Nantucket County Quickfacts from the US Census Bureau*, http://quickfacts.census.gov/qfd/states/25/25019.html (July 17, 2008).
[106] Norton, 1.
[107] Patrick and Benchley, 334.

A. Chemical and physical habitat conditions (water quality, salinity and currents)

Water quality

Bay scallops often live in shallow waters close to the shoreline and development, making them vulnerable to poor water quality conditions. As filter feeders, bay scallops are highly impacted by changes in water quality and are sometimes considered an indicator species for the ecosystem's health.[108] Many scientists believe that poor water quality is responsible for the collapse of a number of bay scallop fisheries throughout the Atlantic seaboard, including Peconic Bay, NY and Rhode Island. [109]

Poor water quality conditions are normally a result of inorganic nutrient loading from anthropogenic sources, such as waste water input and fertilizer runoff. These conditions often lead to nutrient-rich conditions that can negatively impact bay scallops. Nutrient loading reduces water clarity and shades sunlight from eelgrass beds, often resulting in eelgrass death. Since bay scallops rely on eelgrass beds for protection from predators, eelgrass death typically reduces bay scallop abundance.

Nutrient loading also can lead to harmful algal blooms, which can negatively impact bay scallops through eelgrass shading, toxicity, and starvation. [110] Algal blooms can occur naturally, but nutrient loading increases the likelihood of a bloom. The two most common types of algal blooms that cause toxicity and starvation are brown tide chrysophyte (*A. anophagefferens*) and red tide dinoflagellate (*Alexandrium tamarense*) blooms.

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[108] Florida Fish and Wildlife Institute, *Bay Scallop Sea Stats Publication*, http://research.myfwc.com/features/view_article.asp?id=6287 (July 17, 2008).
[109] Tampa Bay Watch, *Conservation & Restoration Great Bay Scallop Search*, http://www.tampabaywatch.org/index.cfm?fuseaction=content.home&pageID=25 (July 17, 2008).
[110] http://seagrant.gso.uri.edu/noreaster/noreasterFW95/brown_tide_fw95.html.

Brown tide chrysophyte (*A. anophagefferens)* blooms are one of the main causes for the collapse of bay scallop fisheries throughout the country.[111] Because *A. anophagefferens* organisms are larger in size than most phytoplankton, some studies suggest that these organisms clog the feeding appendages of the bay scallops, causing bay scallop starvation.[112] On the other hand, some studies have shown that high densities of *A. anophagefferens* organisms are toxic to the bay scallops, leading to scallop death.[113] It is suspected that the bay scallop fisheries located in Peconic Bay, NY, and Rhode Island collapsed due to brown tide chrysophyte blooms.

A. anophagefferens is a unique type of chrysophyte because it thrives in environments with high levels of organic nutrients (e.g. urea or glutamate) and low levels of inorganic nutrients (e. g. nitrates and nitrites), while most other chrysophytes thrive under the opposite conditions.[114] After decades of research, scientists have determined that there are a number of factors that could induce brown tide chrysophyte blooms.[115] Below are the suspected chronological events necessary for an *A. anophagefferens* bloom:

- Groundwater runoff from precipitation that is concentrated with inorganic nutrients from fertilizers and sewage cause a non-*A. anophagefferens* spring bloom[116]
- Density of non-*A. anophagefferens* phytoplankton from spring bloom increases, reducing the amount of light penetrating to low depths[117]
- When the non-*A. anophagefferens* spring bloom phytoplankton dies off, the cells decay and introduce dissolved organic nutrients into the water.[118] This system is now

[111] *Id.*
[112] Department of Environmental Conservation, *Atlantic Bay Scallops*, http://www.dec.ny.gov/animals/6946.html (July 17, 2008).
[113] Gallagher et al., as quoted in Sandra E. Shumway, *Scallops: Biology, Ecology and Aquaculture Second Edition* (New York: Elslevier, 1991), 917.
[114] NOAA, *Brown Tide Research Initiative*, http://www.cop.noaa.gov/stressors/extremeevents/hab/past/hab-btri.html (July 17, 2008).
[115] SeaGrant New York, http://www.seagrant.sunysb.edu/# (July 17, 2008).
[116] *Id.*
[117] *Id.*
[118] *Id.*

ideal for *A. anophagefferens*, because it thrives in low light, high-dissolved organic nutrient environments[119]

- Researchers believe that fluctuations in precipitation play a role in the ratio of inorganic nitrogen to organic nitrogen.[120] If researchers can determine a pattern between precipitation levels and the ratio of inorganic nitrogen to organic nitrogen, it may be possible to predict, or possibly even prevent, upcoming *A. anophagefferens* blooms.

More research needs to be conducted to determine the environmental factors that induce brown tides, as well as their impact on bay scallop populations.

Red tide dinoflagellate (*A. tamarense* and *Ptychodiscus brevis*) blooms, commonly called "red tides," have toxic effects on bay scallops.[121] During a red tide, bay scallops often consume billions of these organisms in one day through filter feeding.[122] Although the exact cause of red tides is unknown, studies have shown that anthropogenic influences (nutrient loading and sea temperature rise) and natural influences (upwelling and wind patterns) can influence red tide occurrences.[123]

The North Carolina bay scallop fishery is a prime example of a fishery decimated by a red tide occurrence. In 1987, the North Carolina coastline experienced a red tide dinoflagellate (*P. brevis*) outbreak which resulted in the recruitment failure of juvenile southern bay scallops (*Argopecten irradians concentricus*) and a 21% mortality rate of adult bay scallops.[124] The pounds of bay scallops harvested by the North Carolina fishery dropped from 455,000 to 39,000,

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[119] *Id.*
[120] NOAA, *Brown Tide Research Initiative*, http://www.cop.noaa.gov/stressors/extremeevents/hab/past/hab-btri.html (July 17, 2008).
[121] Henry C. Summerson and Charles H. Peterson, "Recruitment failure of the bay scallop, *Argopecten irradians concentricus*, during the first red tide, *Ptychodiscus brevis*, outbreak recorded in North Carolina," *Estuaries and Coasts* (September 1972), abstract.
[122] Urban Harbors Institute, 28.
[123] Wikipedia, *Red Tide*, http://en.wikipedia.org/wiki/Red_tide (July 17, 2008).
[124] Summerson and Peterson, abstract.

and the fishery has yet to recover.[125] Therefore, similar to brown tides, red tides can lead to the collapse of bay scallop fisheries.

Poor water quality and algal blooms can also have dangerous health implications for bay scallop consumers.[126] Through filter feeding, bay scallops accumulate pollutants, bacteria, and harmful toxins within the digestive tract tissues. The consumption of these contaminated tissues could result in illness or disease.[127] Since consumers normally eat the muscle of the bay scallop rather than the digestive tract, the risk is lessened.[128] Bacteria can also be eliminated through the cooking of the bay scallop.[129] The United States monitors the water quality of the shellfish beds to minimize the risk of consuming toxic meat.[130] In Europe, bay scallops are purified to eliminate dangerous toxins.[131]

Salinity

Bay scallops prefer to inhabit bays and estuaries with high salinity concentrations (~30 ppt.).[132] One study found that the minimum salinity necessary for settling of bay scallop spat is approximately 14 ppt.[133] Various other studies have shown that the bay scallop cilia stop beating in low salinity environments (12.0-15.0 ppt. salinity).[134] The response of the cilia to low salinity levels is suspected to represent the effect of low salinity on the entire animal.[135] Since bay scallops normally inhabit shallow waters that are close to shore, they are often exposed to

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[125] *Id.*
[126] *Bay Scallop: Capture and Culture Species*, http://www7.taosnet.com/platinum/data/species/scallopbay.html (November 23, 2008).
[127] *Id.*
[128] *Id.*
[129] *Id.*
[130] *Id.*
[131] *Id.*
[132] William P. Duggan, "Reactions of the Bay Scallop, *Argopecten irradians*, to Gradual Reductions in Salinity," *Chesapeake Science* (December 1975), 284.
[133] *Id.*
[134] Vernberg et al. "The influence of temperature and salinity on ciliary activity of excised gill tissue of mollusks from North Carolina," *Comp. Biochem. Physiol.* (1963), 284.
[135] *Id.*

freshwater inputs from streams and rivers.[136] Rainfall amounts and mixing from currents could also affect salinity levels.[137]

Currents

Studies have shown that water currents and circulation impact bay scallop populations through altering larval dispersion, food distribution, and feeding behaviors.[138] Altering feeding behaviors can influence bay scallop growth rates, which in turn affect the size and weight of the adductor muscle. Although a number of studies have shown that currents and circulation impact bay scallop populations,[139] the exact effect is yet to be determined. Some studies have shown that an increase in current speed enhances bay scallop growth rates, while other studies have shown the opposite.

Kirby-Smith (1972) stated that bay scallops are capable of filter feeding phytoplankton more efficiently at lower current speeds, resulting in a more "meaty" adductor muscle.[140] The bay scallop growth rate was found to be the largest at current speeds of less than 1 cm/s, with the maximum growth rate occurring at ~0.21 cm/s.[141] Kirby-Smith (1972) also found that current speeds faster than 12 cm/s resulted in no scallop growth.[142] If food availability was scarce, current speeds did not play a factor in bay scallop growth.[143] Similar to Kirby-Smith (1972), Cooper and Marshall (1963) also found that as current velocity decreased, the muscle volume increased.[144] On the other hand, Marshall (1960) noted that when the circulation in Niantic

[136] Duggan, 284.
[137] *Id*.
[138] M.J. Broom, as quoted in United States Fish and Wildlife Services, "Bay Scallop," 13.
[139] *Id*.
[140] W. Kirby-Smith, as quoted in United States Fish and Wildlife Service, "Bay Scallop," 13.
[141] *Id*.
[142] *Id*.
[143] *Id*.
[144] R. Cooper and N. Marshall, as quoted in United States Fish and Wildlife Service, "Bay Scallop," 13.

River increased, bay scallop growth rates and abundance responded positively.[145] This exception shows that other environmental factors, such as food availability, may determine how current speed affects bay scallop success rates.[146]

Current speed and direction also affect larval distribution and juvenile settlement.[147] As larvae, bay scallops are plankton and currents determine their movement and dispersion patterns.[148] These currents also determine the location within the bay or estuary of juvenile attachment to eelgrass blades. When bay scallops leave the juvenile stage and become adults, they fall to the ground and circulation only affects their "directionality of movement."[149]

B. Eelgrass abundance

Eelgrass (*Zostera marina*) beds are used as a shelter by a number of marine animals including flounders, crabs, and bay scallops.[150] Studies have shown that the presence of eelgrass is necessary for bay scallop survival.[151] Juvenile bay scallops (10 to 19 days) preferentially attach by byssal threads to eelgrass, which they use as protection from predators, such as crabs and sea stars.[152] As bay scallops move into the adult stage of life, they detach from the eelgrass blades, but they still remain within the vicinity of eelgrass beds.[153] Adult bay scallops can move by "clapping" their shells together.

Since bay scallops rely on eelgrass throughout all stages of their life, a decline in eelgrass abundance most likely affects their success rates. A decline in eelgrass abundance could be

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[145] Marshall, 86.
[146] *Id.*
[147] J.K. Moore and N. Marshall, as quoted in United States Fish and Wildlife Service, "Bay Scallop," 3.
[148] *Id.*
[149] *Id.*
[150] Save the Bay, *The Uncommon Guide to Common Life on Narragansett Bay*, http://www.edc.uri.edu/restoration/html/gallery/plants/eel.htm (July 17, 2008).
[151] *Id.*
[152] *Id.*
[153] United States Fish and Wildlife Service, 6.

attributed to a number of anthropogenic and natural factors, including water pollution (nutrient loading), eelgrass diseases, mooring chains, dredging activities, and a competing macroalgal species- *Codium fragile.*

1. Water Pollution (nutrient loading)

As briefly discussed in the "Water Quality" section, nutrient loading and algal blooms reduce the clarity of the water, lessening the amount of sunlight capable of penetrating to the ocean floor.[154] Since sunlight is necessary for eelgrass survival, poor water quality often causes eelgrass mortality. Eelgrass is capable of retaining nutrients in its stems and leaves, making it possible for eelgrass to thrive in low-nutrient environments.[155] Since eelgrass does not perform well in nutrient-rich environments, eelgrass abundance can be used as an indicator of water quality.[156]

2. Eelgrass Diseases

Eelgrass diseases have historically been a main cause for eelgrass die-offs. In 1931, an eelgrass wasting disease infected the North Atlantic Ocean and resulted in the death of approximately 90% of the eelgrass population in both North America and Europe.[157] This disease, which is thought to be composed of a pathogenic strain of *Labyrinthula zosterae,* greatly impacted a number of the bay scallop fisheries throughout the east coast.[158] By the 1960s, the majority of the eelgrass populations had rebounded.[159] In the mid-1980s, another wasting disease infected the eelgrass population, resulting in the collapse of bay scallop fisheries in CT,

[154] http://www.dec.ny.gov/animals/6946.html.
[155] Curley, as quoted in Urban Harbors Institute, "Revised Nantucket & Madaket Harbors Action Plan," 6.
[156] *Id.*
[157] Cornell University Cooperative Extension of Suffold County Marine Program, *Threats and Human Impacts on Eelgrass*, http://counties.cce.cornell.edu/Suffolk/habitat_restoration/seagrassli/conservation/threats_impacts.html (July 17, 2008).
[158] Frederick T. Short, Lisa K. Muehlstein and David Porter, "Eelgrass Wasting Disease: Cause and Recurrence of a Marine Epidemic," *Biological Bulletin* (December 1987), abstract.
[159] *Id.*

RI, and Cape Cod.[160] Some studies suggest that there is a similar disease still infecting waters in Massachusetts.[161]

Nantucket Island, MA and Niantic River, CT were the only two northern bay scallop fisheries that were not negatively impacted by the eelgrass wasting disease. The eelgrass in both Nantucket and Madaket harbors seemed unaffected by the disease, leading researchers to hypothesize that the disease did not reach the harbors. On the other hand, as previously discussed, Niantic River, CT did experience eelgrass die-offs, but the bay scallop fishery actually benefitted from the absence of eelgrass.[162]

3. Mooring chains

The mushroom anchor contains a heavy bottom chain that scrapes the ocean floor as boats rotate around the mooring, resulting in circular scars in the eelgrass beds.[163] The removal of mushroom anchors for boating off-season further damages eelgrass beds by disrupting the sediment.[164] In the picture below, the arrows are pointing towards circular scars in eelgrass beds caused by bottom chain scraping.

[160] Patrick and Benchley, 2.
[161] MacFarlane, 23.
[162] Marshall, 86.
[163] Urban Harbors Institute, 105.
[164] *Id*.

Figure 2.2: Photo of eelgrass scars caused by mushroom moorings.[165]

4. Dredging activities

Dredges are the most common type of gear used by commercial fishermen to harvest bay scallops. Studies have shown that dredging activity both positively and negatively affect eelgrass populations.[166] Dredging activities can either result in the "trimming" of eelgrass blades or the uprooting of eelgrass shoots. Some studies have shown that the "trimming" of eelgrass blades by dredging activities enhances eelgrass biomass.[167] This is similar to the concept of a lawnmower trimming grass, which normally increases grass biomass. On the other hand, eelgrass shoots can be uprooted by dredging activities, thereby reducing eelgrass biomass.[168] Dredging activity can also cause juvenile bay scallop displacement and benthic disturbances.[169]

5. Competing macroalgal species – *Codium fragile*

[165] Buzzards Bay National Estuary Program, *Physical Disturbance to Eelgrass in Buzzards Bay*, http://www.buzzardsbay.org/eelgrass-disturbance.htm (August 14, 2008).
[166] Melanie J. Bishop, "Effects of harvesting methods on sustainability of a bay scallop fishery: dredging uproots seagrass and displaces recruits," *Fishery Bulletin* (October 2005), 2.
[167] *Id.* at 4.
[168] *Id.*
[169] *Id.* at 1.

In general, eelgrass tends to out-compete macroalgal species in good water quality conditions; in poor water quality conditions, macroalgal species out-compete eelgrass.[170] *C. fragile* is an example of a macroalgal species that performs better than eelgrass in poor water quality conditions. *C. fragile* is an invasive macroalga species that was brought to Northwest Atlantic Ocean in 1956.[171] Although the exact relationship between eelgrass and *C. fragile* is unknown, studies have shown that eelgrass and *C. fragile* do not directly compete with each other.[172] In general, *C. fragile* prefers to attach to hard substrates while eelgrass normally binds to finer sediments, reducing the potential for space competition.[173]

The conflict between eelgrass and *C. fragile* normally occurs in areas of eelgrass die-off.[174] In these areas, eelgrass is no longer present to trap the finer sediments, allowing the area to become filled with coarser grained sediments, which is the preferred substrate for *C. fragile* attachment.[175] Once *C. fragile* has inhabited an area of coarser grained sediments, it is unlikely that eelgrass will recolonize.[176] This reduces the space available for eelgrass to proliferate.

C. Predators

Aside from humans, the main predators of the bay scallop within Nantucket and Madaket harbors include, but are not limited to: green crabs (invasive), asian box crabs (invasive), sea

[170] Chris Pickerell and Stephen Scott, *Peconic Bay Estuary Program: Long Term Eelgrass Monitoring Program* (Suffolk County Department of Health Services Office of Ecology, 2004), 15.
[171] *Id.* at 20.
[172] *Id.*
[173] *Id.*
[174] *Id.*
[175] *Id.*
[176] *Id.*

stars (native), oyster drills (native), and conch (native).[177] On shore and in shallow waters, sea gulls and terns have also been known to feast on bay scallops.[178]

GOALS & RECOMMENDATIONS BASED ON ENVIRONMENTAL ASSESSMENT

1. GOAL: Minimize nutrient loading into the harbors and limit occurrences of harmful algal blooms

Annual water quality reports indicate a decline in water quality conditions within Nantucket harbor. Water quality issues are exasperated by the shape and geography of Nantucket harbor which is not very conducive to circulation and tidal flushing (Figure 2.3). As shown by Figures 2.3 and 2.4, the section of the harbor that is furthest away from the channel experiences the least amount of tidal flushing, resulting in nitrogen concentrations with levels near 0.400 mg/L. Sections of the harbor that are close to the channel have better water quality with nitrogen concentrations of ~0.260 mg/L.

[177] United States Fish and Wildlife Service, 8.
[178] United States Fish and Wildlife Service, 9

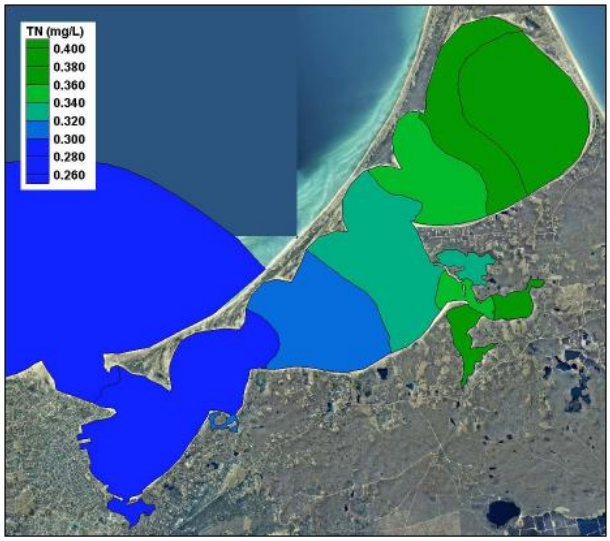

Figure 2.3: Contour plot of average total nitrogen concentrations from results of the present conditions loading scenario, for the Nantucket Harbor system.[179]

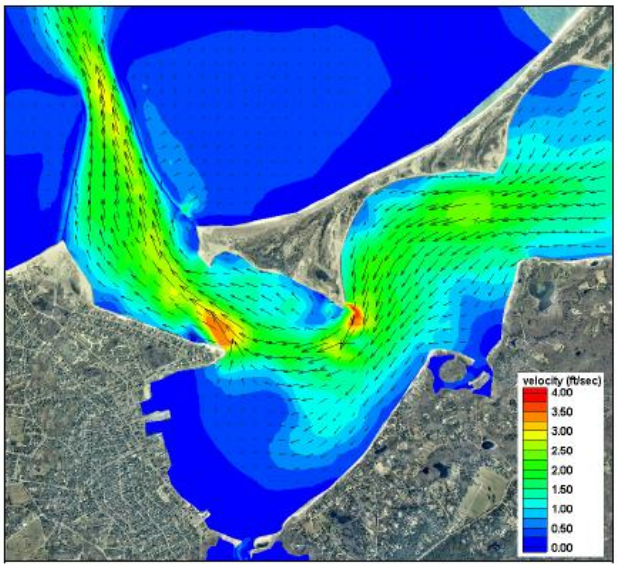

Figure 2.4: Example of hydrodynamic model output for a single step where maximum ebb velocities occur for this tide cycle. Color contours indicate velocity magnitude, and vectors indicate direction of flow.[180]

[179] University of Massachusetts Dartmouth: School of Marine Science and Technology, *Massachusetts Estuaries Project: Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Nantucket Harbor, Town of Nantucket, Massachusetts* (prepared for the Massachusetts Department of Environmental Protection), 112.
[180] University of Massachusetts Dartmouth: School of Marine Science and Technology, 99.

On the other hand, as shown by Figure 1.6, the shape of Madaket harbor allows for more circulation and tidal flushing than Nantucket harbor. Because of this, water quality reports have shown that Madaket harbor has better water quality than Nantucket harbor. Since Nantucket harbor is the primary location for bay scallop fishing and has more water quality issues than Madaket harbor, water quality recovery efforts should primarily focus on Nantucket harbor.

In 1993, with reference to CMR 314-4.00, Nantucket harbor's water quality received a grade of SA or "excellent."[181] SA indicates that "classified waters are suitable for any high quality water use, including bathing, swimming, and shellfishing."[182] Recent annual water quality reports indicate an increase in nutrient loading and an overall decline in water quality.[183] This decline in water quality is most likely because of an increase in tourism, housing developments, leaking septic systems, boat traffic, and runoff from fertilizer use.[184] A recent study conducted by the Department of Environmental Protection (DEP) estimated the total maximum daily load (TMDL) for Nantucket harbor and determined that nitrogen concentrations need to be reduced by 53%.[185]

An increase in circulation within the harbors is one proposed strategy to solving the water quality issues.[186] DEP estimated that increasing the circulation of Nantucket harbor by 15% should alleviate the majority of the water quality issues.[187] This increase in circulation would be achieved through dredging and installing bulkheads in certain parts of the harbor.

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[181] Urban Harbors Institute, 20.
[182] *Id*.
[183] Keith L. Conant, *Nantucket Harbor Water Quality Annual Report 2006,* (Marine and Coastal Resources Department), 1.
[184] Urban Harbors Institute, 20.
[185] Peter B. Brace, "State: Improved circulation is key to keeping Nantucket harbor clean," *The Nantucket Independent* October 17, 2007.
[186] Brace, "State: Improved circulation is key to keeping Nantucket harbor clean."
[187] *Id*.

Although increasing the circulation within Nantucket harbor may improve water quality, enhanced circulation could negatively impact bay scallops. As discussed in the "Current" section, the speed of water circulation has been known to affect bay scallop feeding efficiency and growth rates, but the exact effect has yet to be determined. Some studies have shown that an increase in water current speed reduces bay scallop growth rate,[188] while other studies show the opposite.[189] An increase in water current speed has also been known to tear up eelgrass beds.[190] Therefore, prior to enhancing circulation within Nantucket harbor, town officials should consider the impact of increased current speed on bay scallop and eelgrass populations. Furthermore, if the majority of the clean-up effort is focused on enhancing circulation, effort geared towards preventing water quality issues (such as reducing fertilizer use, repairing faulty septic systems, etc.) may not be a priority. It is important for town officials to primarily focus on the source of the water quality issues, rather than rely on reactive measures.

Poor water quality conditions within Nantucket harbor could lead to harmful algal blooms. Red tide dinoflagellate (*A. tamarense)* blooms are the most common type of algal bloom in New England. In 2005, Nantucket Island and the rest of New England suffered from the worst *A. tamarense* outbreak since 1972.[191] Although the exact cause of the red tide is unknown, it is suspected that nutrient loading and/or wind patterns were main factors. The shellfish beds on Nantucket, consisting primarily of mussels, conch, etc., were closed during this period. The bay scallop fishery did not experience bed closures because the bloom occurred during the summer, which is the "off-season" for the bay scallop fishery. The season following the red tide (2006-07 season) was the worst season in bay scallop fishery history, with the

[188] W. Kirby-Smith, as quoted in United States Fish and Wildlife Service, "Bay Scallop," 3.
[189] Marshall, 86.
[190] Kerry Griffin, *Commercial Oyster Cultivation and Eelgrass Ecology in Tillamook Bay, Oregon* (as prepared for The Tillamook Bay National Estuary Project, July 1997), 7.
[191] Urban Harbors Institute, 28.

scalloping fleet harvesting only 3,850 bushels. The 2005 red tide may be to blame for the poor landing totals.[192]

There have been no recorded brown phytoplankton blooms on Nantucket Island. Recent water quality reports and plankton samples have also not revealed any issues with brown phytoplankton.

Recommendations:

- **Water quality sampling**: Static systems and towed arrays should be used to enhance the consistency of water quality sampling.[193] Sampling should also analyze the ratio of organic to inorganic nutrients. Studies have shown that the ratio of organic to inorganic nutrients may influence the likelihood of brown phytoplankton bloom occurrences. When conducting water quality analyses, nutrient ratios should be analyzed to determine if conditions are conducive for a brown phytoplankton bloom. If nutrient ratios suggest that the environment is suitable for a brown phytoplankton bloom, various management actions should be taken to improve nutrient conditions.
- **Community outreach**: To improve water quality conditions, it is important for both residents and tourists to alter some of their behaviors. Nantucket should focus on creating an effective outreach program that discusses the importance of the bay scallop fishery to the culture and character of the island, and reinforce ways that both residents and tourists can improve water quality conditions within the harbors. The residents and tourists embrace the small fishing community character of Nantucket, and if presented correctly, should support altering their activities to improve the bay scallop fishery.

[192] Summerson and Peterson, abstract.
[193] *Id.* at 83.

Some ideas include: reducing or eliminating quick release fertilizers[194]; prohibit dumping into storm drains[195]; continue repairing faulty septic systems; include water quality conservation messages in school curricula.[196]

- **Enhance the consistency and quality of plankton sampling**: Considering the impact of phytoplankton blooms on bay scallop fisheries, it is important to increase the consistency and quality of plankton sampling. When sampling, biologists should analyze the samples for the presence of red tide dinoflagellates (*A. tamarense)* and brown tide chrysophytes (*A. anophagerefferens).*

2. GOAL: Better understand the role of salinity in the fluctuations of bay scallop populations

Due to little freshwater inputs from streams and rivers, both Nantucket and Madaket harbors have salinity concentrations that are normally above 30 ppt.[197] Although salinity levels in Nantucket harbor are normally ideal for bay scallops, research has shown that salinity concentrations in Nantucket harbor are influenced by rainfall amounts. Figure 2.5 represents the 2006 average monthly rainfall, while Figure 2.6 displays the salinity concentrations taken from six different sites in Nantucket harbor. Site location is shown by Figure 2.7.

[194] *Id.* at 86.
[195] *Id.* at 86.
[196] *Id.* at 80.
[197] Kenneth M. Kelley *The Nantucket Bay Scallop Fishery: The Resource and its Management* (1980), 9.

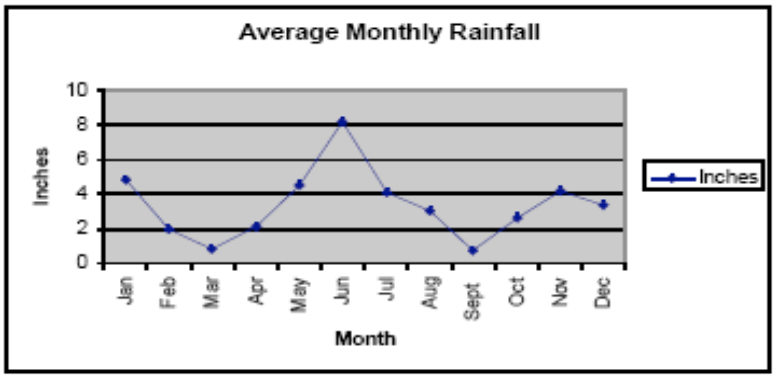

Figure 2.5: Average monthly rainfall (inches) on Nantucket Island during the year of 2006. [198]

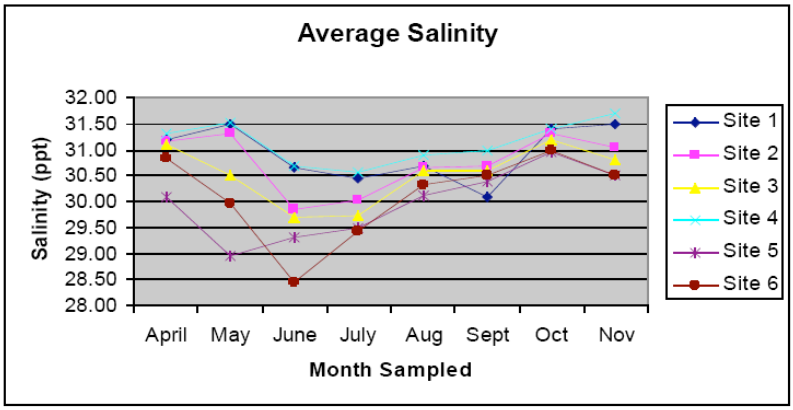

Figure 2.6: Average salinity (ppt.) at six different sites in Nantucket Harbor between April-November 2006. [199]

[198] Conant, 8.
[199] Conant, 7.

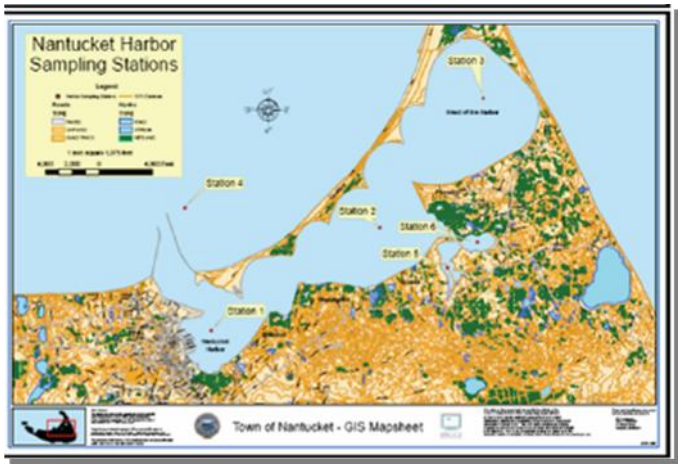

Figure 2.7: Site location in Nantucket Harbor.[200]

The average salinity from April – November of 2006 was 30.57 ppt., which is ideal for bay scallops. The lowest salinity concentrations were recorded in June 2006, when Nantucket Island received an annual high of 8.23 inches of rain and the salinity dropped to 29.78 ppt. Since the first spawning event occurs in June and scallop spat are more successful in high salinity environments, this drop in salinity is a concern. Although previous studies have not found any correlations between monthly rainfall amounts and spat survival, researchers have yet to analyze the impact of isolated heavy rainfall events on spat survival.[201]

Recommendation:

- **Research study- Impact of heavy rainfall events on juvenile spat survival and settlement**: Isolated heavy rainfall events during the months of June and September may

[200] Conant, 14.
[201] Kelley, 10.

be detrimental to juvenile settlement. This study will be helpful when analyzing the reasons for fluctuating bay scallop harvests from year to year.

3. GOAL: Determine the effect of circulation on bay scallop growth and survival

Various studies have shown that circulation patterns within both Nantucket and Madaket harbors impact the success rates of bay scallops. However, the quantifiable effect of circulation on bay scallop growth rates is unknown. It is suspected that scallops in areas with high current speeds, such as the harbor inlet of East Jetty, have slower growth rates due to inefficient feeding behaviors.[202]

On the other hand, there are a few sections of the harbors where fast current speeds result in larger, meatier bay scallops. Since currents are largely responsible for food distribution, faster currents may provide more food (specifically benthic diatoms) to the scallops, resulting in larger adductor muscles.[203] Nantucket shoals, West Pocomo Point, and Tuckernut contain large amounts of bay scallop food which is carried by currents to the two harbors.[204] Because of its shape and location, Madaket harbor is more open to these currents, resulting in larger, more "meaty" bay scallops.[205] On the other hand, the "closed-off" nature of Nantucket harbor restricts these currents, resulting in smaller bay scallops.[206]

Recommendation:

- **Research circulation in coastal waters and impact on bay scallop growth rates**: As previously stated, some studies have recommended that Nantucket officials increase the circulation within the harbors to improve water quality. Prior to altering circulation

[202] Kirby-Smith, as quoted in United States Fish and Wildlife Service, "Bay Scallop," 13.
[203] Kelley, 12.
[204] Kelley, 9.
[205] Kelley, 12.
[206] *Id.*

patterns within the harbors, more research needs to be conducted to determine the exact relationship between circulation, nutrients, and bay scallop feeding behaviors.

4. GOAL: Enhance eelgrass abundance

Both Nantucket and Madaket harbors have experienced a 10.7% decline in eelgrass abundance between the years of 1995-2001 (Figure 2.8).[207] Since these two maps only represent eelgrass loss between 1995 and 2001, the full extent of the historic eelgrass loss within the harbors is not represented. Eelgrass abundance has been analyzed for decades and studies have shown a gradual decline of eelgrass abundance in parts of the harbors, such as Head of the Harbor and Polpis Harbor.[208]

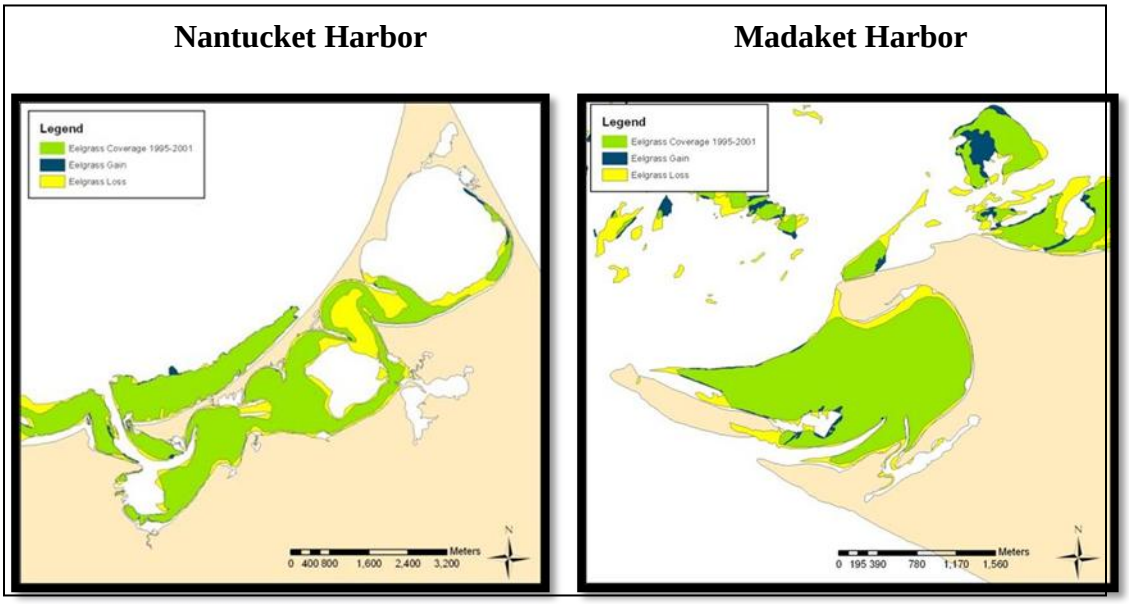

Figure 2.8: Eelgrass abundance in Nantucket and Madaket harbors between 1995-2001.[209]

[207] Department of Environmental Protection, as quoted in Urban Harbors Institute, "Bay Scallop," 25.
[208] University of Massachusetts Dartmouth: School of Marine Science and Technology, 133.
[209] GIS layers provided by MassGIS.

As previously stated, a decline in eelgrass abundance within the harbors could be attributed to a number of anthropogenic and natural factors, including nutrient loading, eelgrass diseases, mooring chains, dredging activities, and/or a competing macroalgal species. Curley (2002) states that nutrient loading is the main reason for the decline in eelgrass abundance in both Nantucket harbor and Madaket harbors.[210] In Nantucket harbor (Figure 2.8), the majority of the eelgrass loss (displayed in yellow) has occurred in areas with the greatest concentration of nutrients, such as the upper and mid sections of the harbor.[211] These sections experience the least amount of circulation, resulting in the build-up of nutrients (Figure 2.3).[212] In Madaket harbor, most eelgrass loss has occurred close to the land, suggesting that nutrient loading from land runoff may be to blame. Eelgrass loss is not as prevalent in Madaket harbor most likely because of better water quality conditions.

Mooring chains and dredging activities are also responsible for eelgrass loss within the harbors. The mushroom anchor is used in both Nantucket and Madaket harbors and has caused a number of circular scars in the eelgrass beds.[213] Once these scars are created, it is difficult for eelgrass to recolonize the area. The removal of these mushroom anchors for scalloping season causes further damage to the eelgrass beds.[214] The uprooting of eelgrass from dredging activities may also be reducing eelgrass abundance.

Finally, *C. fragile* abundance appears to be increasing within the harbors and may be negatively impacting eelgrass populations. In 2003, the Nantucket Harbor Study stated that *C. fragile* "was common throughout the harbor, although at relatively low coverage."[215] Recent

[210] *Id.*
[211] University of Massachusetts Dartmouth: School of Marine Science and Technology, 112.
[212] *Id.*
[213] Urban Harbors Institute, 105.
[214] *Id.*
[215] University of Massachusetts Dartmouth: School of Marine Science and Technology, 133.

observations show that *C. fragile* abundance may be increasing in the harbors, which could be problematic for eelgrass populations. Figure 2.9 shows the flora and fauna caught while dredging for scallops in Nantucket harbor. From Figure 2.9, it can be inferred that *C. fragile* is prevalent within the harbor.

Figure 2.9: Photo taken while dredging for bay scallops in Nantucket harbor (March 2008).[216]

Since *C. fragile* prefers to adhere to hard substrates, *C. fragile* is also often found attached to bay scallop shells.[217] Figure 2.10 displays a *C. fragile*-infested bay scallop that was caught in Nantucket harbor.

[216] Photo taken by: Kim Starbuck
[217] Kenneth M. Kelley and Mary Kirby, *Codium Fragile and Its Effect on the Nantucket Bay Scallop Industry*, (Southeastern Massachusetts University, North Dartmouth, MA), 1.

Figure 2.10: *C. fragile*-infested bay scallop caught in Nantucket harbor (March 2008)[218]

C. fragile often weighs down the scallops, reducing its ability to swim away from predators.[219] *C. fragile* also makes it difficult for shuckers to pry open scallop shells.[220] A study conducted in 1980 found that *C. fragile* was present on ~16% of the bay scallops in Nantucket harbor and ~5% of the bay scallops in Madaket harbor.[221]

Recommendations:

- **Improve water quality**: As previously stated in the water quality section, eelgrass suffers in environments with poor water quality.
- **Consider alternate mooring options**: Since mushroom moorings can be damaging to eelgrass beds, Nantucket should consider alternate mooring options that may be less destructive.[222] Helix moorings, which have been used by the Department of Marine and Coastal Resources, are drilled into the ocean floor.[223] These moorings

[218] Photo taken by: Kim Starbuck
[219] Kelley and Kirby, 1.
[220] *Id.* at 4.
[221] *Id.* at 1.
[222] Urban Harbors Institute, 105.
[223] *Id.*

appear to be less damaging than mushroom moorings because they lack the heavy chain that drags on the ocean floor and tears up eelgrass beds.[224]

Unlike the mushroom moorings, helix moorings are difficult to install and uninstall.[225] It may be difficult to remove helix moorings for scalloping seasons, thereby impeding the work of the scallop fishermen.[226] More research should be conducted to analyze the potential use of the helix mooring in Nantucket and Madaket harbors, or other more feasible mooring options.[227]

- **Rotate "closed areas":** The rotation of "closed areas" each season is beneficial for juvenile bay scallop settlement and gives sections of the fishing grounds a break from potentially damaging dredging activity. A "closed area" rotation program should be a key part of the Shellfish Management Plan. Nantucket experimented with the concept of "closed areas" during the 2007-08 season with the creation of a "Seed Sanctuary" in Nantucket Harbor. Approximately 850,000 bay scallop seeds were distributed in this sanctuary and dredging was prohibited. Prior to the 2008-09 season, the biomass of the scallop population both within and surrounding the "Seed Sanctuary" should be assessed to determine the success of the "closed area." Furthermore, in the 2008-09 season, the location of the "Seed Sanctuary" should be rotated to a different part of the harbor.
- **Eelgrass restoration programs**: Eelgrass restoration programs, such as transplanting and seeding, have varying degrees of success. Transplanting typically

[224] *Id.*
[225] *Id.*
[226] *Id.*
[227] *Id.*

involves the relocation of wild or aquaria-grown eelgrass plants.[228] Save the Bay uses a transplant methodology called "Transplanting Eelgrass Remotely with Frames" (TERF). With this methodology, eelgrass is attached to a wire frame and placed on the ocean floor. After a few weeks, the eelgrass settles onto the ocean floor and the wire frame is removed.[229] Since the success of transplanting programs has yet to be determined, Nantucket should try small-scale eelgrass transplants in different areas of the harbor. If those transplants are successful, Nantucket should invest in a larger eelgrass transplant program.

Efficient transplanting programs often require a large number of volunteers. Nantucket organizations should advertise the need for volunteers to both the local community and tourists. This advertisement will not only attract volunteers, but will also increase awareness about the issues affecting the harbors. In general, the local community is knowledgeable about the environmental issues affecting the harbors, but most tourists are probably uninformed. An eelgrass volunteer program will hopefully educate tourists and the community about ways they can help improve conditions within the harbors.

Seeding is another eelgrass restoration program option. Eelgrass seeds can either be broadcasted from a boat or can be directly placed on the ocean floor using a "boat-pulled sled."[230] Similar to eelgrass transplanting programs, the success of seeding

[228] Rhode Island Habitat Restoration, *Restoration Methods*, http://www.edc.uri.edu/restoration/html/tech_sci/restsea.htm (July 17, 2008).
[229] Coastal Resources Management Council, *Restoring Coastal Habitats for Rhode Island's Future*, http://www.edc.uri.edu/restoration/html/tech_sci/restsea.htm (November 23, 2008).
[230] Kate Matso, *Sowing Seeds For Eelgrass Harvests*, http://seagrant.gso.uri.edu/41N/Vol1No2/matso.pdf (July 17, 2008).

also has yet to be determined. Nantucket should conduct small-scale seeding experiments before investing in a larger seed restoration effort.

- **Research study- Long-term water quality, eelgrass abundance, and macrolagal coverage study**: A long term *C. fragile* research study should be conducted in both Nantucket and Madaket harbors to determine the relationship between water quality, *C. fragile* inhabitation, and eelgrass abundance. This study should be modeled after the "Peconic Estuary Program: Long Term Eelgrass Monitoring Program (1997-2002)." The Peconic Estuary Program analyzed the effect of water quality on eelgrass abundance and macroalgal coverage. Conducting a similar study would be useful when analyzing the causes for eelgrass decline and ways to enhance eelgrass populations.
- **Research study- *Codium fragile* attachment studies**: A study should be conducted that analyzes the effect of *C. fragile* attachment on bay scallop swimming rates. It is hypothesized that *C. fragile* attachment decreases the bay scallop's ability to swim away from predators, but the exact effect has yet to be studied. The percentage of bay scallops with *C. fragile* attached to their shells should also be determined. The most recent study that analyzed *C. fragile* attachment occurred in 1980, and it appears that *C. fragile* abundance has increased in the harbors in the last thirty years. If a large percentage of bay scallop shells are infested with *C. fragile*, the Nantucket community must consider ways to reduce the abundance of *C. fragile*.
- **Removal of *Codium fragile* by Nantucket fishermen**: In the 1960s, Nantucket scallopers were paid $1 for every bushel of *C. fragile* they removed from the

harbors.[231] Although it is unknown whether this program was successful, similar methods could be used to reduce *C. fragile* abundance.

5. GOAL: Remove and limit predators (focusing on invasive predators)

Both green crabs and asian box crabs are invasive species that are prevalent throughout Nantucket and Madaket harbors. These invasive species are also predators of the bay scallop.[232]

Recommendations:

- **Continue culling green crabs and asian box crabs**: Scallop fishermen are encouraged to cull all green and asian box crabs. Traps also should be used to remove green and asian box crabs from the harbors.
- **Research study- Long-term study analyzing the abundance of green crabs and asian box crabs**: To determine the effectiveness of current management practices, a research study should be conducted that analyzes the abundance of green crabs and asian box crabs throughout the years. If crab populations are increasing, more stringent management practices should be developed.

[231] Kelley and Kirby, 4.
[232] Keith Conant, as quoted in Urban Harbors Institute, "Revised Nantucket and Madaket Harbors Action Plan," 79.

Environmental Assessment 'Recipe': Goals and Recommendations
Goal: Minimize nutrient loading into the harbors and limit occurrences of harmful algal bloom
Near-term (0-1 year): Community outreach Near-term (0-1 year): Water quality sampling Near-term (1-2 years): Enhance the consistency and quality of plankton sampling
Goal: Better understand the role of salinity in the fluctuations of bay scallop populations
Long-term (4-5 years): Research study (Impact of heavy rainfall events on juvenile spat survival and settlement)
Goal: Determine the effect of circulation on bay scallop success rates
Near-term (1-2 years): Research study (Effect of circulation on bay scallop growth rates)
Goal: Enhance eelgrass abundance
Near- term (0-1 year): Rotate "closed areas" Near-term (0-1 year): Removal of *Codium fragile* by Nantucket fishermen Near-term (1-2 years): Consider alternate mooring options Long-term (2-3 years): Eelgrass restoration programs Long-term (2-3 years): Research study (*Codium fragile* attachment studies) Long-term (3-4 years): Improve water quality Long-term (4-5 years): Research study (Long-term water quality, eelgrass abundance, and macroalgal coverage study)
Goal: Remove and limit predators (specifically invasive predators)
Near-term (0-1 year): Continue culling green crabs and asian box crabs Long-term (4-5 years): Research study (Long-term study analyzing the abundance of green crabs and asian box crabs)

Table 2.1: Environmental Assessment 'Recipe': Goals and Recommendations.

CHAPTER III: SOCIAL ASSESSMENT

Figure 3.1: Photo of Straight Wharf, Nantucket Island, Massachusetts.[233]

[233] Photo taken by: Kim Starbuck

BACKGROUND INFORMATION

For centuries, Nantucket Island has been known as a small fishing community that has primarily harvested cod, whales and bay scallops.[234] The bay scallop fishery is currently the last commercial fishery remaining on Nantucket.[235] As previously stated, Nantucket is also commonly known as a tourist destination, and tourism appears to be on the rise. Because of this, the Nantucket community is concerned about a general shift from a fishing-dominated community to a tourism-dominated community. Since fishing activities are a large part of Nantucket's culture and character, the community is concerned about this potential shift.

Historically, fishing has represented to Nantucket a means for self-sufficiency and independence from the mainland. This desire for independence originated in the 1600s when a number of Quaker families fled from England in pursuit of religious freedom.[236] When the Quakers first settled on Nantucket, they created an existence that mainly revolved around fishing. Fishing efforts focused on cod, quahogs, lobsters and whales. When whaling became more profitable than other types of fishing, the Nantucket community focused its efforts primarily on whales.

In the 1800s, Nantucket had 88 whaling ships traveling throughout the oceans, which gave Nantucket the reputation of "whaling capital of the world."[237] Nantucket was home to approximately 10,000 people, making it the third largest city in Massachusetts behind Boston and Salem.[238] As the whaling industry expanded worldwide and boat sizes increased, the small and shallow nature of Nantucket harbor forced the "whaling capital of the world" to shift to New

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[234] Patrick and Benchley, inner flap.
[235] There are a few fishermen that harvest mussels and conch.
[236] Elizabeth Oldham, *Brief History of Nantucket*, Nantucket Historical Association, http://www.nha.org/library/faq/briefhistory.html (July 17, 2008)
[237] ATS 2004, *Some Information about Nantucket*, http://www.aas.org/~pboyce/ATS2004/info.htm (July 17, 2008).
[238] Nantucket Island Chamber of Commerce, Nantucket Trivia, http://www.nantucketchamber.org/visitor/trivia.html (July 17, 2008).

Bedford.[239] At this point, the Nantucket community needed a new way to sustain independence from the mainland and focused on a different maritime activity: bay scallop fishing.[240]

CULTURAL SIGNIFICANCE OF THE NANTUCKET BAY SCALLOP FISHERY

Bay scallop fishing has allowed Nantucket to continue the tradition of using maritime activities to maintain a feeling of independence from the mainland.[241] While other bay scallop fisheries disappeared along the Atlantic seaboard, the Nantucket bay scallop fishery has remained strong and now is home to the largest bay scallop fleet remaining in the country.[242] The independent nature of the island, consisting of "physical distance from mainland soil and spiritual distance from mainland thinking,"[243] is probably the main reason why Nantucket holds this honor. This "distance" has allowed Nantucket to sustain a habitat suitable for bay scallops, as well as regulate a fishery independent of the other bay scallop fisheries on the mainland. Since the bay scallop fishery is also the last commercial fishery remaining on the island, it represents Nantucket's last connection to its unique culture that is centered on maritime activities.[244]

The bay scallop fishery is a source of pride for the entire Nantucket community and nearly everyone on the island has some connection to scalloping in their life.[245] The importance of the bay scallop fishery to the island stems from a love for the profession that has been passed on as a family tradition from generation to generation.[246] Most fishermen have relatives that

[239] *Id.*
[240] Norton, 4.
[241] *Id.*
[242] Patrick and Benchley, 1.
[243] *Id.* at 2.
[244] *Id.*
[245] *Id.*
[246] *Id.* at 57

scalloped, while some even have family members that were part of the historic whaling fleet.[247] The fishermen learned the "tricks of the trade" from their parents or grandparents, whom pass on useful techniques and hints.[248] It is an exciting day when a child is old enough to brave the cold weather and head onto the water with an elder to continue the family tradition.[249]

Although some consider scalloping to be a solitary activity, scalloping brings a sense of unity and oneness to the Nantucket community. Each scalloping boat is separate out on the water, but they are all part of the same fleet, which "carries a special acknowledgement of inclusion."[250] The excitement prior to the opening of the season also brings the community together, sharing in the anticipation for the upcoming season.[251] Boats are repaired and shanties are cleaned in preparation for the season. Some scallopers return to their favorite fishing grounds, while others try different spots each year.[252]

The intensity of the work, physically draining and at times dangerous, is a large part of the profession.[253] In one short story named *The Nobel Scalloper*, Henry Mitchell states that "even nobler than the Great Nantucket Bay Scallop is the man who hunts him."[254] Since scalloping is a wintertime profession, scallopers are faced with a number of challenges, such as cold weather, rough seas, and frozen harbors and inlets. The bay scallop profession also brings about other challenges, such as long hours, low harvest yields, and price fluctuations. Armed with trousers and cold-weather gear, many enjoy these challenges because it is different than the "everyday rut on the island."[255]

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[247] *Id.*
[248] *Id.* at 58
[249] *Id.* at 80
[250] *Id.* at 66.
[251] *Id.* at 19.
[252] *Id.* at 22.
[253] *Id.*at vi.
[254] *Id.* at 5.
[255] *Id.* at 82.

Although at times challenging, scallopers take a great deal of pride out of their work and are known for meeting the difficulties of their profession with great dignity, strength, and fortitude.[256] Nearly all scallopers maintain and repair their own equipment, and gain fulfillment from this process.[257] Scallopers also enjoy a welcomed change from the jobs they hold throughout the year, such as carpentry, painting, and caretaking homes.[258] Although a number of scallopers continue to work at these jobs during the scalloping season, they enjoy taking a break from their yearly jobs to head out on the bay. Scalloping allows them to take advantage of the beautiful island they live on.

Scalloping also represents an important connection between land and sea that is valued by the community. Scallopers think of the ocean as a symbol of the unknown, both mysterious and powerful, and most feel connected to the ocean through scalloping.[259] Scallopers take pride from "gathering food from nature, from the sea" which is considered to be "one of the most enduring of human instincts."[260] Depending on the type of shellfish license acquired, scallopers either sell the scallops, or keep the scallops for their own consumption.

Every scalloper has his/her own unique story about the importance of the bay scallop fishery to the individual fisherman, and the Nantucket community as a whole. The book, "Scallop Season" by Jim Patrick and Rob Benchley, is a compilation of personal stories about the scalloping season. These stories range from tales of scalloping from the early 1900s, to stories about the current bay scallop fishing fleet.

GOALS AND RECOMMENDATIONS BASED ON SOCIAL ASSESSMENT

[256] *Id.* at 8.
[257] 2005 Economic Trend Survey.
[258] Patrick and Benchley, 93.
[259] *Id.* at 107.
[260] *Id.* at 7.

1. GOAL: Preserve and enhance Nantucket's fishing culture

Since the bay scallop fishery is the last commercial fishery remaining on the island and the fishery appears to be struggling, there is a great deal of concern among the Nantucket community about the loss of the last remaining fishery. The study named "Commercial fishing... can we bring it back" (1980) was conducted by the Nantucket Planning & Economic Development Commission (NPEDC) to discuss the importance of fishing to the Nantucket community and the desire to enhance commercial fishing.[261]

In the survey, most Nantucket residents stated that the fishing industry is very important to the community's heritage, character, and economy.[262] One resident noted that "the best times of my life have been spent fishing in the waters of Nantucket." The study estimated that the fishing industry (including shellfish, cod, groundfish, etc.) made up about 1/8 of the local economy in 1980.[263] The fishing industry is also very important in terms of diversifying the tourism-centric economy.[264]

In the last fifty years, Nantucket appears to be experiencing a shift from a fishing-dominated community to a tourism-dominated community.[265] In the NPEDC survey, most Nantucket residents noted that the fishing culture on Nantucket was slowly fading away, and tourism was on the rise. There was concern among the residents about "tourism rapidly spoiling the island."[266] One respondent stated that Nantucket struggles between balancing tourism with

[261] It should be noted that this survey was conducted during the most successful years of the fishery (refer to Figure __), so the responses may not reflect the current status of the fishery; but the responses do provide a good perspective of the historic importance of fishing to the island.
[262] *Id.*
[263] *Id.*
[264] *Id.*
[265] Nantucket Planning & Economic Development Commission, "Commercial Fishing... can we bring it back?" 1980: 1
[266] *Id.* at B-4.

its small fishing community character.[267] Another respondent was fearful that Nantucket was "turn[ing] into the next Coney Island."[268]

Since the fishing culture is so important to Nantucket, the current status of the fishing culture on the island should be analyzed. The number of fishermen involved in the fishery is one way to determine the prevalence of the fishing culture on the island. Figure 3.2 displays the number of shellfish licenses[269] purchased by the Nantucket community from 1978-2007. In general, there has been gradual decline in the number of shellfish licenses purchased by the Nantucket community in the last thirty years.

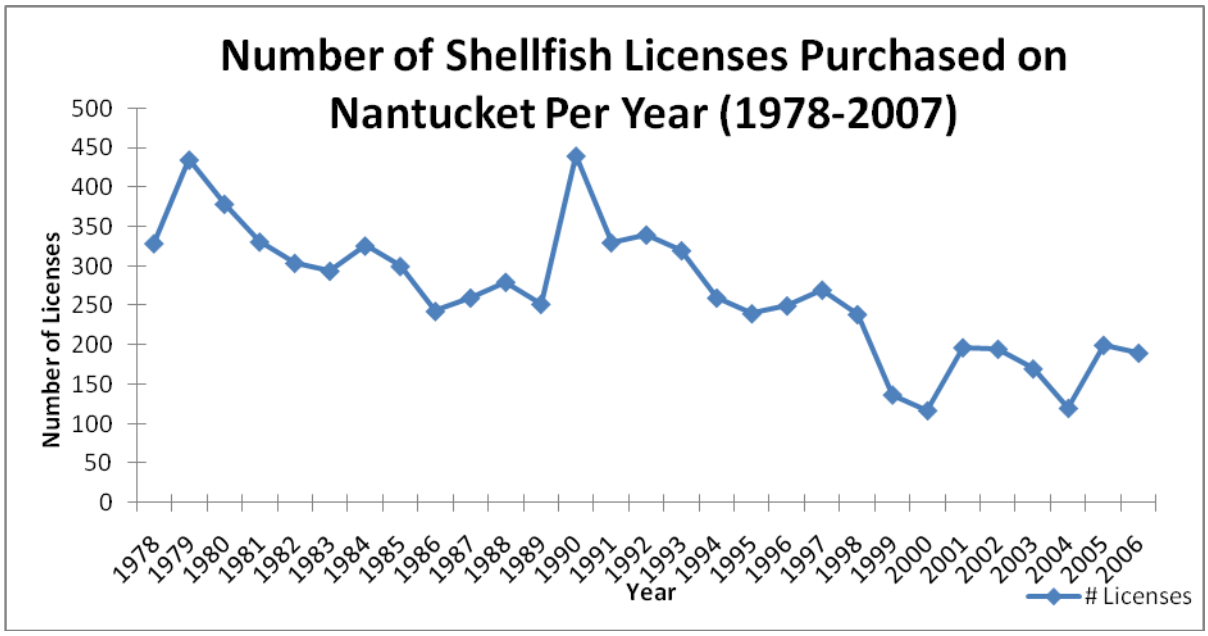

Figure 3.2: Number of shellfish licenses purchased on Nantucket per year (1978-2007).
* Note: A number of fishermen purchase shellfish licenses, but do not actually use them. These licenses are considered "unemployment insurance," because fishermen only use the licenses if they have difficulty finding on-land work. On-land work is often more profitable and easier to find. In reference to the 2005 Economic Trend Survey (discussed in Chapter IV), 12/40 fishermen that responded purchased shellfish licenses, but did not actually use them. Therefore, the graph above represents only the number of shellfish licenses purchased; not the number of fishermen that actually scallop. This graph can be used to show general trends in the number of fishermen interested in the fishery.

[267] *Id.* at 1.
[268] *Id.* at B-2.
[269] Shellfish licenses are required to harvest all types of shellfish, such as bay scallops, conch, clams, etc. Since the bay scallop fishery is the last commercial fishery remaining on the island, most shellfish licenses are used to harvest bay scallops.

Since the number of shellfish licenses purchased appears to be decreasing, it can be inferred that the number of fishermen involved in the fishery is also declining, which may be leading to a loss of fishing culture. In the 2005 Economic Trend survey,[270] a number of "old-time" fishermen stated that they are no longer involved in the fishery, and one fisherman noted that he "still miss[es] the best job [he] ever had." Figure 3.2 also shows the fluctuations in shellfish licenses that occur from year to year. There are a number of reasons why the "shellfish licenses purchased" fluctuate. Some of these reasons include:

- **Availability of on-land work (painting, carpentry, etc.)**

  Example: The number of shellfish licenses purchased between the years of 1986-1992 can primarily be explained by the availability of on-land work. From 1986-1989, Nantucket was experiencing a "building boom" which created a large number of jobs in the construction industry, thereby reducing the number of shellfish licenses purchased.[271] When the recession hit Nantucket in 1990, the construction of new houses slowed down and the availability of on-land work declined.[272] Because of this, more fishermen purchased shellfish licenses and returned to bay scallop fishing.[273] In 1991, Hurricane Bob destroyed a number of houses on Nantucket which increased the need for construction workers, resulting in fewer shellfish licenses purchased.[274]

- **Supply of scallops (previous seasons)**

  Example: During the 2004-05 season, the fishermen harvested 32,500 bushels, which was more than the fleet had harvested in approximately 10 years. Because of this, more

[270] The "Economic Trend Survey" is discussed in Chapter IV.
[271] Patrick and Benchley, 320.
[272] *Id.*
[273] *Id.*
[274] *Id.*

fishermen purchased shellfish licenses the next year in hope that the 2005-06 season would be as plentiful as the previous season.

- **Interest of new fishermen in the fishery**

  Example: Most bay scallop fishermen have been involved in the fishery for decades. Although the number of licenses purchased fluctuates from year to year, between 1978 and 2007 there was gradual decline in the number of shellfish licenses purchased. In general, very few new fishermen are joining the fishery, causing this decline. There are a number of reasons why new fishermen are hesitant to join the fishery, including:

  - Expensive gear (boat, dredges, trousers, etc.): ~$25,000
  - Supply of scallops appears to be declining
  - Unpredictable income (supply, prices, weather, etc.)
  - Increase in tourism-related jobs

The representation of the current and historic fishing culture also plays a role in the status of Nantucket's fishing culture. Because of its history as a whaling port, Nantucket Island is known by most as a fishing community. Most visitors expect to get a sense of Nantucket's history as a whaling port, as well as its current fishing culture. Tourists can visit the Nantucket Whaling Museum, the Atheneum library, and the Historical Association to learn about Nantucket's fishing culture.

The Whaling Museum has exhibits explaining Nantucket's whaling industry, as well as a number of artifacts from the whaling era. There is also a small exhibit that discusses the bay scallop fishery. The Atheneum library has a number of books and old newspaper articles about Nantucket's maritime past. The Historical Association has a research library which is home to a

"special collections repository of primary resources focusing on Nantucket history."[275] Visitors can learn more about Nantucket's fishing history through the various scrapbooks, ship logs, photographs, and family papers.[276]

Although there are a number of ways that visitors can learn about Nantucket's historic and current fishing industries, the fishing culture is not always obvious to the unsuspecting visitor. Most visitors are unaware that the cobblestone roads on Nantucket were built during the whaling era because normal concrete roads could not withstand the weight of trucks filled with whale oil. Furthermore, the small town named Siasconset (commonly called 'Sconset), has a unique whaling history that few visitors recognize. The name, Siasconset, is a Native American word that means "near the great whale bone."[277] 'Sconset was first settled by whalers in the 17th and 18th century and was used as a whaling outpost.[278] A tall lookout tower was placed in the center of 'Sconset and was used to spot whales.[279] Since the whaling history of 'Sconset is not well represented, few visitors are aware that the town is a large part of Nantucket's whaling history.

Because bay scallop fishing occurs during the tourist off-season, most visitors are also unaware of Nantucket's current fishing industry. A large number of respondents to the NPEDC survey noted that the current fishing industry (primarily centered on the bay scallops) is not well represented to visitors.[280] When visitors arrive on the island, they normally first notice the businesses geared towards tourism, such as small souvenir shops or restaurants, rather than the fishing culture.

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[275] Nantucket Historical Association Research Library & Archives, *About the NHA Library & Archives*, http://www.nha.org/library/index.html (July 17, 2008).
[276] *Id.*
[277] The Wade Cottages, *Sconset*, http://www.wadecottages.com/pages/Sconset.html (July 17, 2008).
[278] *Id.*
[279] *Id.*
[280] Nantucket Planning & Economic Development Commission, 1.

During the summer months, the fishing boats have normally been hauled out of the water to make room for large tourist boats, and fresh bay scallops are not for sale in restaurants or fish shops. One survey respondent noted that "Nantucket's history as a whaling port draws tourists, who are amazed to find no fishing industry alive on the island today."[281] Therefore, not only is there a general decline in the number of fishermen involved in fishing activities, the fishing industry that is still alive is not being well represented.

Recommendations

- **Increase size of fishing fleet/increase supply of bay scallops:** An increase in the size of the fishing fleet would enhance the prevalence of fishing within the community. Aside from some fluctuations, the bay scallop supply appears to be declining and most fishermen are hesitant to join the fishery because it is a large investment for an unpredictable profession. If the supply of bay scallops increases, the profession would become more reliable and more fishermen would be interested in joining the fishery.

  Environmental degradation is one of the main reasons for the decline in bay scallop abundance. As previously discussed in "Chapter II: Environmental Assessment," there are a number of environmental issues affecting the bay scallop's habitat. Poor water quality and a decline in eelgrass abundance are probably the two largest issues faced by the harbors. Improving environmental conditions will hopefully enhance bay scallop abundance, which in turn will entice more fishermen to join the scallop fleet.

[281] *Id.* at B-6.

Furthermore, it is currently legal to harvest nub scallops, which are scallops that typically spawn at 21-22 months but may be harvested at ~12 months of age.[282] Since nub scallops may be harvested prior to spawning, the current regulations may be harming the future generations of bay scallops. A study is being conducted to further analyze the spawning age of the nub scallops. Nantucket should take the "precautionary approach"[283] and prohibit the harvesting of nub scallops until more research has been conducted.

- **Better represent fishing culture (historic and current):** The Nantucket community should better represent both the historic and current fishing culture, which would increase the overall awareness of the fishing industry. This increased awareness could be used to generate funds devoted to research and propagation. The fishing culture could be better represented through creating:
    - **A harbor walk with educational signs:** A "Harbor Walk" would target those tourists that are not interested in visiting the various historical sites on the island, as well as those that cannot afford the Whaling Museum. The educational signs should be focused on Nantucket's historic and current fishing culture.[284] Donation bins should be made available for fundraising purposes.
    - **A larger and more descriptive bay scallop exhibit in the Whaling Museum:** The Whaling Museum is primarily focused on Nantucket's whaling history. Although the Museum has a small bay scallop exhibit, a larger and more descriptive bay scallop exhibit should be created to increase awareness. The exhibit should discuss the importance of the bay scallop fishery to Nantucket and

[282] Conant and Curley, as quoted in Urban Harbors Institute, "Revised Nantucket and Madaket Harbors Action Plan," 39.
[283] The "precautionary approach" is the principle that if an action or policy may cause harm to either the environment or human health, the action or policy should not be undertaken until more research is conducted.
[284] Urban Harbors Institute, 135.

the current issues facing the fishery. A donation bin should be provided to encourage visitors to contribute.

- **"Bay Scallop Tour":** During the summer months, bay scallop fishermen should organize a "Bay Scallop Tour" geared towards tourists and summer camps. This program would increase the general awareness of the fishery and could be used to generate money for the fishermen during the bay scallop off-season. Money from this program should also be devoted towards bay scallop research and/or propagation. The "Bay Scallop Tour" should consist of:
  - Fishing boat trip: Tour of the harbor, talk about the habitat of the bay scallop, explain dredging equipment, use a video camera to show the bay scallop habitat
  - Grow-out cages: Show visitors the scallop seeds, discuss bay scallop research efforts
  - Education: Emphasize the importance of Nantucket's fishing history, accept donations to be used for bay scallop research/ improving environmental conditions on Nantucket Island
- **"History of Fishing on Nantucket Island Tour":** Similar to the concept of the "Bay Scallop Tour," fishermen should organize a "History of Fishing on Nantucket Island Tour" geared towards tourists and summer camps. This program would be based on-land and would travel to different parts of the island and discuss Nantucket's history as a small fishing community. This tour should also be used to generate money and increase awareness about Nantucket's fishing history.

Social Assessment 'Recipe': Goals and Recommendations
Goal: Preserve and enhance Nantucket's fishing culture
Near-term (1-2 years): Create a harbor walk with educational signs Near-term (1-2 years): Create a larger and more descriptive bay scallop exhibit in the Whaling Museum Long-term (2-3 years): Create a "Bay Scallop Tour" Long-term (2-3 years): Create a "History of Fishing on Nantucket Island Tour" Long-term (4-5 years): Increase size of fishing fleet/increase supply of bay scallops

Table 3.1: Social Assessment 'Recipe': Goals and Recommendations.

CHAPTER IV: ECONOMIC ASSESSMENT

Figure 4.1: Photo of a typical bay scallop dish at a Nantucket restaurant.[285]

[285] Glidden's Island Seafood, http://www.gliddensislandseafood.com/img/scallops/scallops.jpg (November 15, 2008).

BACKGROUND INFORMATION

Although bay scallop fisheries make up a minor component of the United States total commercial fishery landings each year, these fisheries have historically been an essential part of local economies throughout the country. Currently, Nantucket is one of the few places remaining that has enough of a bay scallop population to support a fishery. Since Nantucket bay scallops are shipped throughout the country, the Nantucket bay scallop fishery economically impacts not only those living on-island that are directly involved in the fishery, but also various people and organizations located off-island. Those that live on-island and off-island and benefit economically from the bay scallop fishery include, but are not limited to:

On-island:

- Fishermen
- Cullers
- Shuckers
- Restaurant owners
- Wholesale dealers (fish markets)
- Boat repairers

Off-island:

- Wholesale dealers
- Restaurants
- Transportation (Fedex, USPS, etc.)

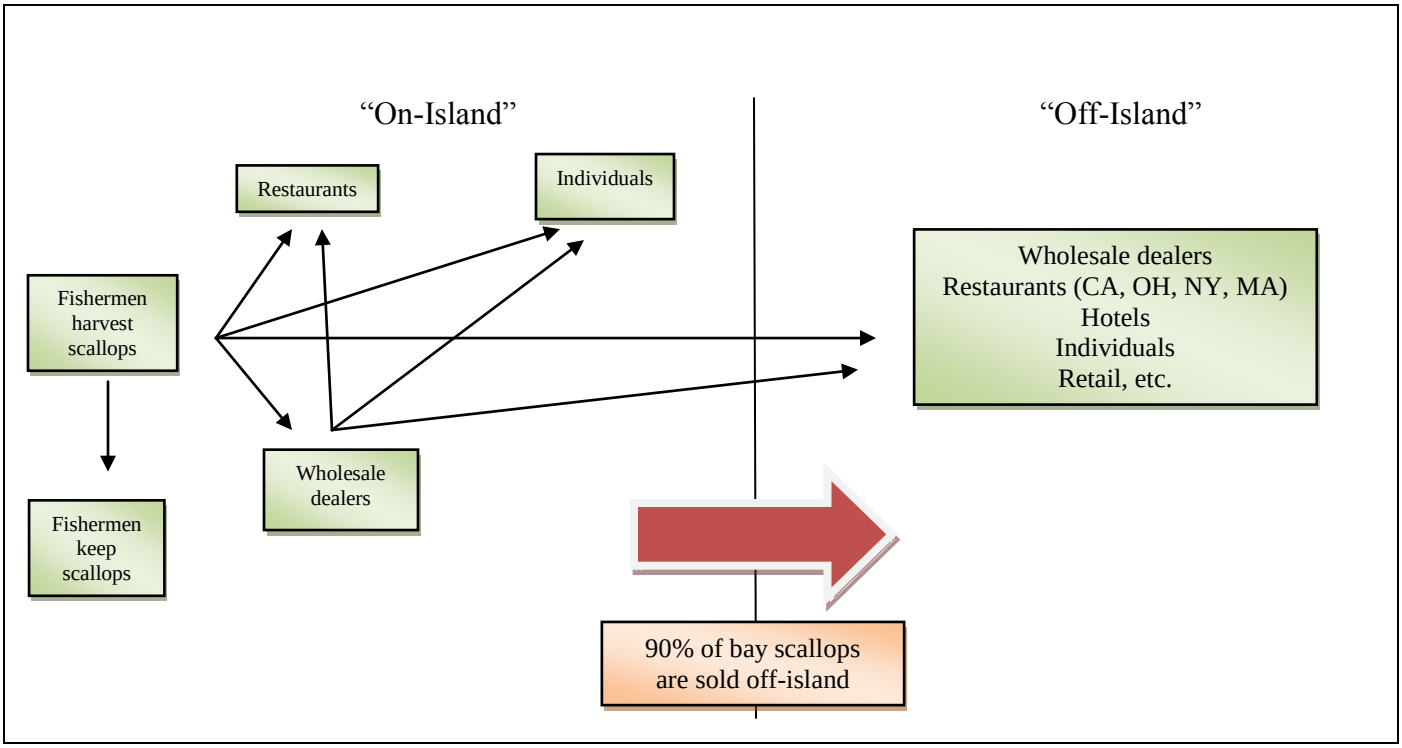

Figure 4.2: Generalized chain of delivery for Nantucket bay scallops.

For the purpose of my project, only the economic value of the fishery to those living *on-island* will be assessed.

BAY SCALLOP PRICING

Bay scallop pricing largely affects the economic value of the fishery to the Nantucket community. Nantucket bay scallops are notorious for their expensive pricing. In the 2007-08 season, Nantucket bay scallops were priced at approximately $27.99-$29.99/lb. at various fish markets and supermarkets throughout Massachusetts. In New York and Boston, bay scallops were sold for approximately $40/lb. Their close relative, the sea scallop, was priced at $15/lb. in 2007-08, making bay scallop prices seem even more inflated.[286] In 2007, *Cape Cod Times* labeled the bay scallop as the "priciest seafood in the Northeast."[287]

[286] *Id.*
[287] Doug Fraser, "Bay scallops available now: for a price," *Cape Cod Times*, October 8, 2007.

The price of bay scallops fluctuates throughout the season, as well as from season to season each year. Figures 4.3 and 4.4 show these price fluctuations.

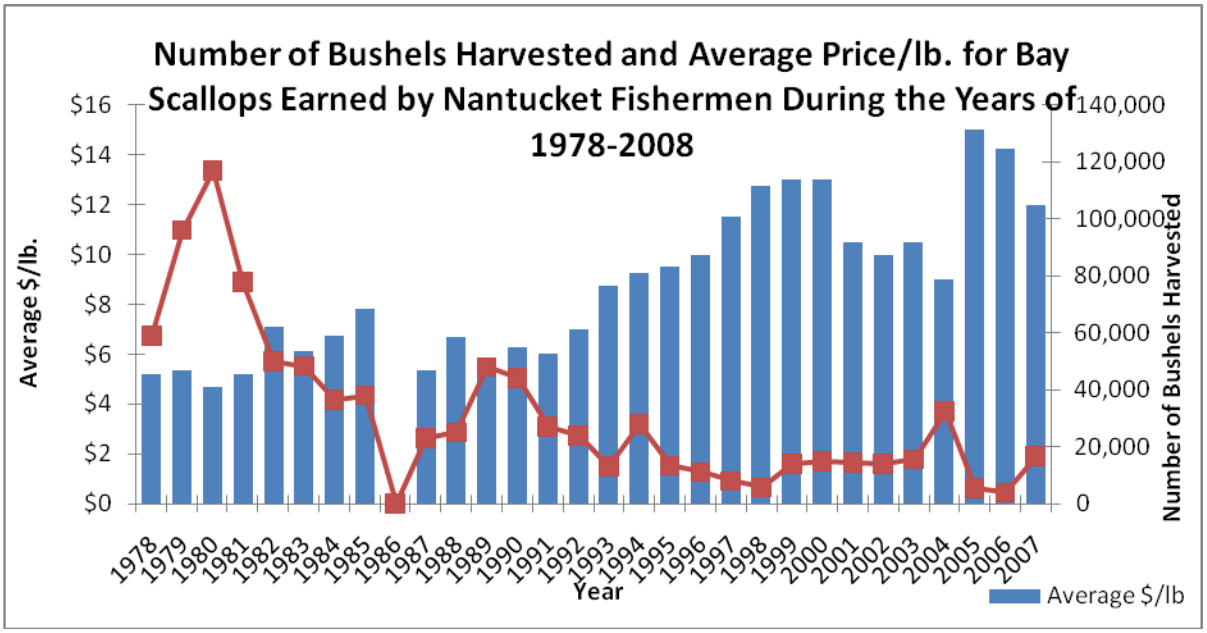

Figure 4.3: Number of bushels harvested and average price/lb. earned by the Nantucket fishermen per year of scalloping season. There is no data for the year of 1986.

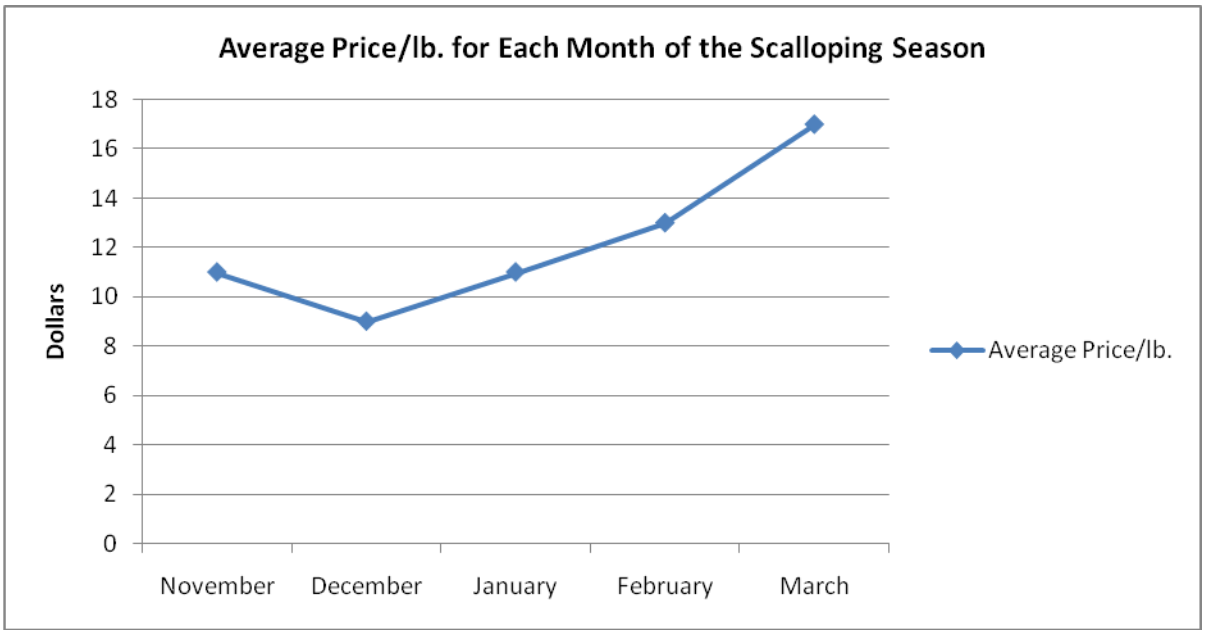

Figure 4.4: Average price/lb. for each month of the scalloping season.

*Note: Figure 4.4 is an example of price fluctuations that occured throughout the 2007-08 bay scallop season (November – March). On opening day, the average price/lb. started at $11. As the season progressed, the fishermen harvested more bay scallops than expected, and the wholesale dealers had difficulty finding bay scallop customers. Because of this, wholesale dealers lowered the price to $9/lb., which in turn lowered the price of scallops for the customers off-island. As the season continued, the supply declined and the price steadily rose again. By the end of the season, fishermen were earning $17/lb.

Figures 4.3 and 4.4 also represent the price fluctuations that occur off-island. When bay scallops are sold off-island, they often go through a number of different "hands" before reaching their final place of sale. With each "hand", the price/lb. increases. In general, off-island price fluctuations mirror on-island price fluctuations. Factors influencing the price of bay scallops include:

- Demand
    - Substitutions (other species of scallop)
    - Health value
    - Harvests from previous seasons
    - Other "premium" seafood items
    - Economy conditions
- Supply

An increase in demand normally raises the price/lb. of bay scallops. Demand for bay scallops can be influenced by a number of factors. First off, the bay scallop is often in high demand by expensive restaurants because it has a sweet, unique taste that cannot be replicated by other species of scallop. Bay scallops are considered a rare delicacy by consumers, fish markets,

and restaurants. Therefore, it is difficult to find substitutions for the bay scallops. Both the calico scallop (*Argopecten gibbus*) and the sea scallop (*Plactopecten magellanicus*) are at times used as substitutions for the bay scallops, but their taste is not considered as delectable.

The calico scallop, a close relative of the bay scallop, can be found from Delaware to Brazil[288] and has meat that is considered tougher and less desirable than the bay scallop.[289] At times, consumers are tricked when calico scallops are wrongfully sold as bay scallops.[290] The number of calico scallop landings has severely declined in the last twenty years most likely due to parasite infestations and fishery management issues.[291]

Sea scallops are found from Newfoundland to North Carolina at depths between 25 and 200 meters.[292] In the United States, the sea scallop is the most commercially important species of scallop, landing close to 60 million pounds in 2006.[293] Sea scallops are normally less expensive and larger than the bay scallops and can be harvested year round, making them an obvious substitute. Although sea scallops seem like a more economic solution, many consumers still claim that sea scallops are "bland" in taste and do not compare to the bay scallop.[294]

Seafood is also high in protein and low in fat which increases the demand for seafood products by health-conscious consumers.[295] By 2020, the demand for protein in the United States is expected to increase to over 1 billion pounds and seafood is the best low-fat protein

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[288] K. Hill, Smithsonian Marine Station at Fort Pierce, *Argopecten gibbus.* http://www.sms.si.edu/IRLSpec/Argope_gibbus.htm (July 17, 2008).
[289] Practically edible, *The World's Biggest Food Encyclopedia*, http://www.practicallyedible.com (July 17, 2008).
[290] Environmental Defense Fund, *Bay scallops (farmed)*, http://www.environmentaldefense.org/page.cfm?tagID=15815 (July 17, 2008).
[291] http://www.sms.si.edu/IRLSpec/Argope_gibbus.htm.
[292] NOAA, *Status of Fishery Resources off the Northeastern US*, http://www.nefsc.noaa.gov/sos/spsyn/iv/scallop/ (July 17, 2008).
[293] *Id.*
[294] Jonathon Levitt, "Sweet on Scallops." *Boston Globe*, 19 December 2007.
[295] Professor's House, *Scallops*, http://www.professorshouse.com/food-beverage/food/scallops.aspx (July 17, 2008).

option.[296] Although seafood is a good low-fat protein option, seafood tissues are often concentrated with toxins that can lead to illness. Toxins normally accumulate in the digestive tract of the bay scallops rather than the adductor muscle which is the part normally consumed, making scallops a more healthy option than other types of seafood.[297] Scallops also contain vitamin B-12 which has been known to enhance cardiovascular health.[298]

There are also a number of factors that can decrease the demand for bay scallops, which often results in a lowering of the price/lb. The supply of bay scallops from previous seasons can affect the demand. For example, wholesale dealers normally lose a number of customers during poor bay scallop seasons. When a good bay scallop season follows a number of poor seasons, it is often difficult for wholesale dealers to find customers for the bay scallops. This will decrease the demand for bay scallops, which lowers the price/lb. Another factor that decreases the demand for bay scallops is the supply of other "premium" seafood on the market. In general, if other types of "premium" seafood (such as Dover Sole or the Alaskan King Crab) are being sold on the market for a cheaper price than the bay scallop, the demand lessens leading to a lower price/lb.

Finally, economy conditions also affect the demand for bay scallops. Since bay scallops are typically more expensive than other types of seafood, consumers are less likely to purchase bay scallops during tough economic times. When the economy is prosperous, the demand for bay scallops typically rises. For example, after 9/11, the US economy was struggling and the demand for bay scallops decreased, resulting in a lower bay scallop price/lb. than the previous year (refer to Figure 4.3).

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[296] Seafood Choice Alliance, *Seafood and Your Health*, http://www.seafoodchoices.com/resources/SeafoodHealth.php (July 17, 2008).
[297] http://www7.taosnet.com/platinum/data/species/scallopbay.html.
[298] PeerTrainer, *Scallops*, http://www.peertrainer.com/DFcaloriecounterB.aspx?id=4343 (July 17, 2008).

Bay scallop supply also affects pricing. In general, as the supply of bay scallop decreases, the price/lb. normally rises (Figure 4.3). In the 1800s, bay scallops were so plentiful that they were often used as fertilizer.[299] In the last thirty years, the supply of bay scallops throughout the East Coast has steadily declined and most fisheries have collapsed. The once productive northern bay scallop fisheries of Peconic Bay NY, Niantic River CT and Rhode Island have collapsed for reasons stated in the "Background" section. The southern bay scallop (*Argopecten irradians concentricus* and *Argopecten irradians amplicostatus)* fisheries are also virtually depleted.

Today, the main supply for bay scallops comes from Nantucket and Martha's Vineyard. Although Nantucket is considered the largest bay scallop fishery remaining in the United States, the number of bushels harvested has decreased about 80% from thirty years ago. This decline in harvests has led to price inflation.

ECONOMIC TREND SURVEY

To analyze the economic impact of the bay scallop industry to Nantucket Island, a mail survey ("Economic Trend Survey") was distributed in the summer of 2005[300] to 194 fishermen, 6 wholesale dealers, and 35 restaurant owners on-island. These three groups were chosen because they were inferred to be the most economically impacted by the bay scallop fishery. The intention of the survey was to gain information about the bay scallop chain of delivery and the economic impact of the fishery to fishermen, restaurants and wholesale dealers (revenue generated, costs associated with bay scallop fishing, etc.)

[299] Patrick and Benchley, 109.

[300] Since the surveys were distributed in the Summer of 2005, some of the information may be outdated. When using this data, it must be noted that the information was collected in 2005.

	Fishermen	Wholesale Dealers	Restaurants
Surveys mailed	**194**	**6**	**35**
Bounced	**18 bounced; 7 no address available**	**0**	**0**
Surveys completed and returned	**40/169 = 23.6%**	**0/6 = 0%**	**14/32 = 43.8%**

Table 4.1: Survey return statistics for the "Economic Trend Survey."

The 194 fishermen were identified as "scallop fishermen within the last five years" by the National Shellfish Association (NSA). Of the 194 fishermen, 57 were NSA members. Surveys were also mailed to all 6 wholesale dealers and 35 restaurants located on-island. Since surveys were not distributed nor returned at random, the results of the survey only represent the responding population. Because wholesale dealers did not respond to the survey, the survey results will primarily focus on the value of the bay scallop to fishermen and restaurants, and the economic value of the fishery to the wholesale dealers will be estimated.

SURVEY RESULTS

1. ECONOMIC IMPACT OF THE BAY SCALLOP FISHERY TO THE FISHERMEN

The economic value of the fishery depends on the supply of bay scallops. The fishermen responded to the survey based on their last commercial scalloping season. When analyzing survey results, it is important to note which scallop season is being referred to. The 40 fishermen that returned surveys can be divided into three groups:

- **Group A**: Fished commercially in 2004-05 and responded based on that season (21/40= **55%** of the returned surveys). All 21 of these fishermen answered the majority of the questions on the survey. Therefore, most (21/26) of the answers in this survey represent the 2004-05 season, and the other 5 surveys represented Group B.
- **Group B**: Did not fish commercially in 2004-05, but have fished commercially in the last five years and responded to the survey based on the last commercial fishing season (7/40= **18%** of the returned surveys). Of these seven fishermen, five answered questions in the survey (only one (SC58) noted they responded based on 2002-03 season).
- **Group C**: This group is composed of fishermen that bought commercial licenses in the last five years, but did not fish (12/40= **30%** of the returned surveys). For the most part, Group C did not respond to any of the questions in the survey, but did leave some comments in the "Comment Section." Two fishermen stated that they continue to buy commercial shellfish licenses in case they become unemployed or decide to "go commercial" at some point during the season. The only question that four out of the twelve Group C fishermen responded to was "How long have you been scalloping?" These four fishermen stated that they had been scalloping for more than ten years.

Background information on fishermen from Groups A and B

Figure 4.5 shows the length of time the 26 fishermen in Groups A and B have been scalloping for. The majority of the fishermen (77%) have scalloped for 10 years or more.

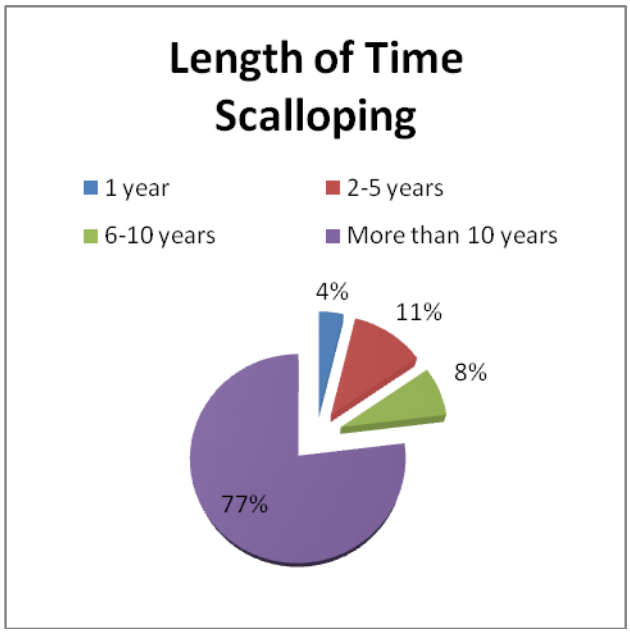

Figure 4.5: Length of time scalloping. (26 fishermen respondents)

Of the 18 fishermen that responded, 17 stated that the 2004-05 season was their best season, while one fisherman stated that 2003-04 was his/her best season. During the 2004-05 season, the fishermen harvested 32,500 bushels, which is largest amount harvested in over ten years. Since most fishermen responded based on an unusually profitable bay scallop season, the economic value of the fishery to the fishermen may be inflated.

Percentage of income from scalloping

Out of 19 fishermen that responded, 7 commercially scallop as a "supplement to their income" (33% or less of total income), and 12 commercially scallop as a "significant source of their income" (greater than 33% of total income).[301] Responses may be somewhat inflated since 18/19 responses represented the 2004-05 season, and the 2004-05 season was an unusually

[301] This terminology ("supplement to their income" and "significant source of their income") was created for this project to categorize percentages of total income.

profitable season. The other response represented the 2003-04 season. The answers ranged from 10% to 65%, and the mean was 38% (Figure 4.6).

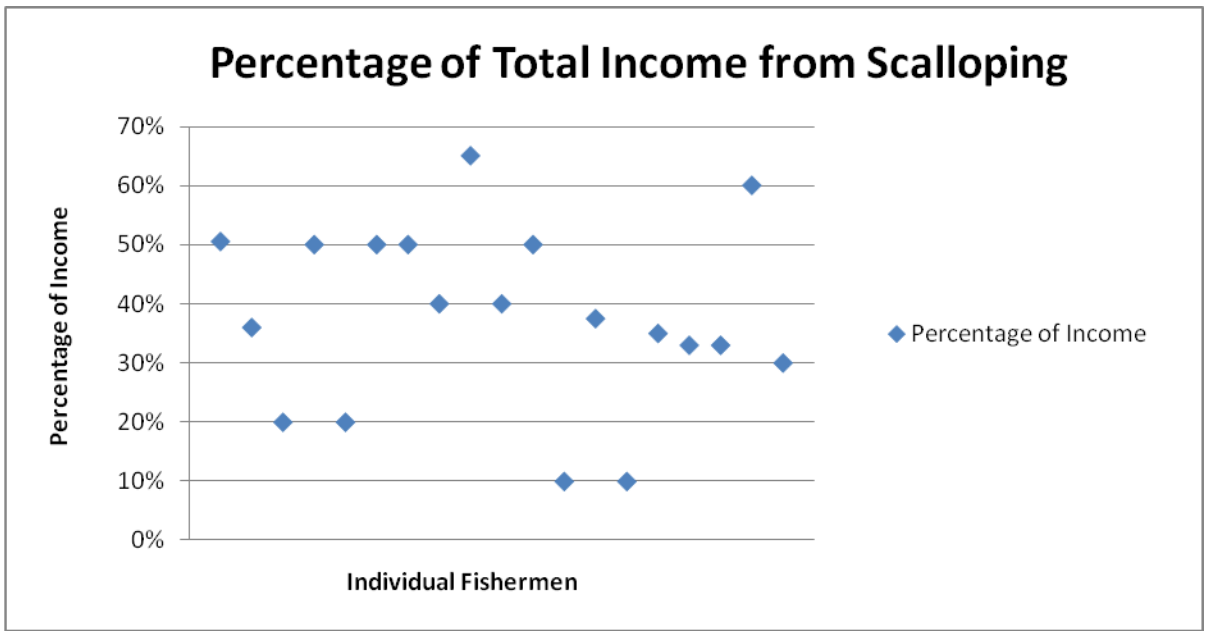

Figure 4.6: Percentage of total income from scalloping. (19 fishermen respondents)

Profits from scalloping for fishermen

The following equation is used to calculate profits:

Revenue – Costs = Profit

The profits generated by fishermen are calculated by subtracting costs associated with scalloping (fuel, shuckers, gear, etc.) from the revenue generated by fishermen through the sale of bay scallops. 18/22 fishermen kept less than 5% of their catch for family or friends (total percentage of catch kept by fishermen ranged from 0% to 100%, with a mean of 9.2%). Of the 23 fishermen that responded, 19 sold 100% of their catch on-island (percentage of catch sold on-island ranged from 5% to 100%, with a mean of 94.1%).

Most fishermen also sold the majority of their catch to on-island wholesale dealers (95.2% of the catch to wholesale dealers, 3.2% of the catch to restaurants, and 0.4% to private sales/individuals (25 respondents)). Only 2/40 fishermen sold 100% of their catch to off-island wholesale dealers. As shown by Figure 4.7, there are a number of wholesale dealers that purchase bay scallops, with Sayles Seafood and Nantucket Seafoods being the most popular options for the fishermen.

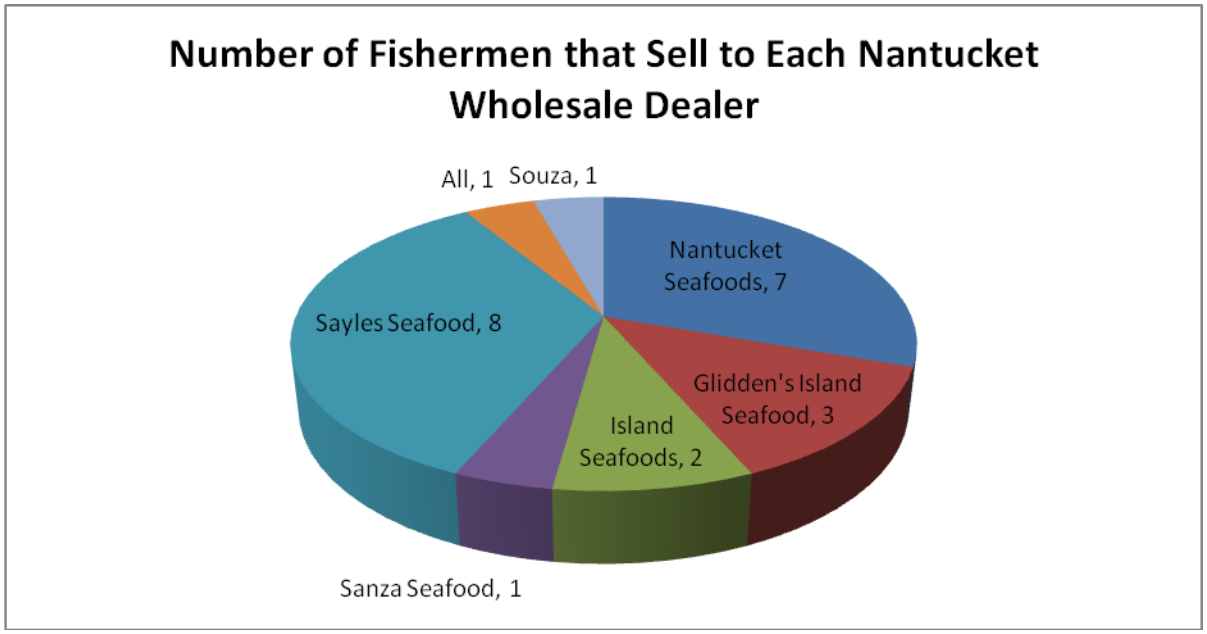

Figure 4.7: Number of fishermen that sell to each Nantucket wholesale dealer. (23 fishermen respondents)

Very few fishermen have a wholesale license, which is necessary to sell scallops to entities other than wholesale dealers on-island. Fishermen with wholesale licenses can sell bay scallops to individuals, restaurants, off-island wholesale dealers, etc. To purchase a wholesale license, the fisherman needs to have a shanty inspected by the State Health Department. The State Health Department shanty regulations are very strict and limit the number of shanties capable of passing inspection. Real estate prices also make it difficult for fishermen to have enough property to build a shanty.

To calculate revenue generated by the fishermen, it is estimated that each bushel holds approximately 7 lbs. of scallop meat, and in 2004-05, the scallop meat was selling on average for $9/lb. To determine revenue, the following calculation was used:

# of bushels harvested * 7 lbs. of bay scallop meat/bushel * $9/lb. of bay scallop meat

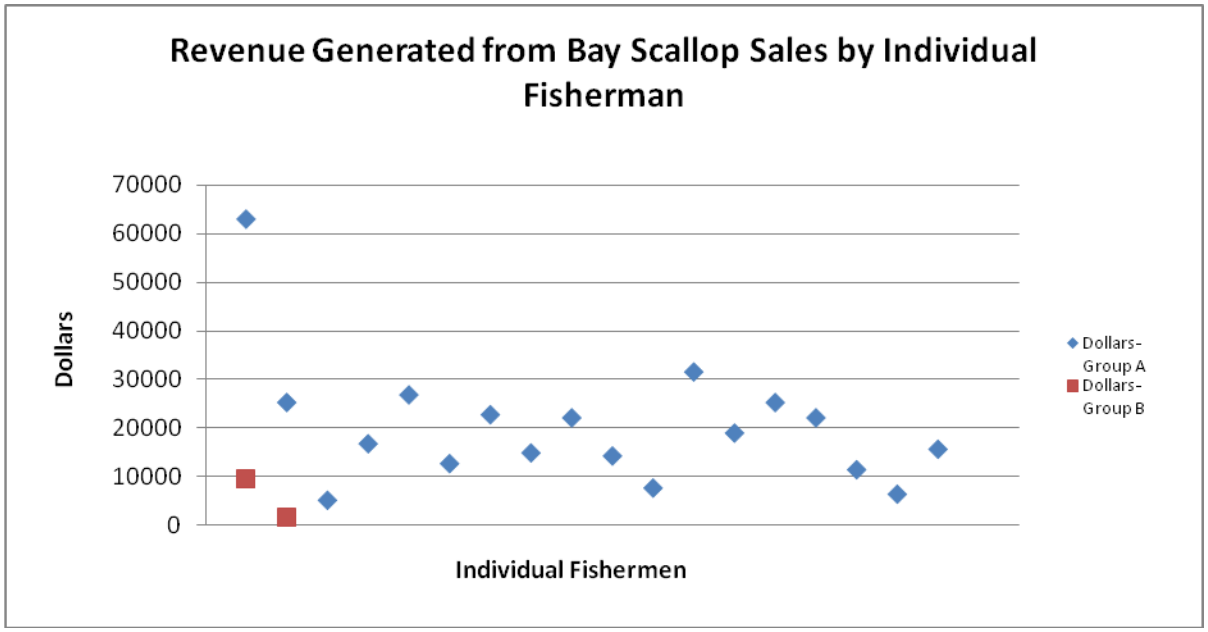

Figure 4.8: Revenue generated by each individual fisherman through the sale of scallop harvests. The diamond shaped symbols refer to "Group A" fishermen (2004-05 season), while the square shaped symbols refer "Group B" fishermen (scalloping season other than 2004-05). (20 fishermen respondents)

To calculate the profit earned by fishermen, the costs associated with scalloping were determined.[302] These associated costs are often re-distributed to the Nantucket community (fuel

[302] Because of calculation difficulties, cost of human labor and cost of boat degeneration are not included.

shops, marine shops, hired help, etc.). For my project, costs refer only to the "Costs to the Individual Fisherman."[303] Some of the "Costs to the Individual Fisherman" include:

a. Commercial Shellfish License
b. Scallop openers (shuckers)
c. Cullers
d. Fuel
e. New equipment
f. Maintenance of boat, motor, or trailer

a. Commercial shellfish license

Massachusetts General Law Chapter 130 states that "no person without a shellfish permit shall take shellfish[304]....by any means from the waters of the Town of Nantucket."[305] The Marine and Coastal Resources Department authorizes the Board of Selectmen on Nantucket to issue these permits yearly. Fishermen must pay $250 for the commercial scallop license and $150 for all other species per year.[306] Approximately 75% of the money generated through the sale of licenses is used for shellfish propagation.

b. Scallop openers (shuckers)

Shuckers are employed by some fishermen to open scallops and remove the meat. Of the 23 fishermen that responded, 65% employed shuckers to help with opening scallops. 83% employed one shucker, while 17% employed two (13 respondents). All fishermen paid the

[303] There are a number of other costs associated with scalloping, such as environmental costs (cost of boating activity, cost of dredging), society costs (cost of devoting labor to scalloping), opportunity cost of removing scallops from the environment (removal from ecosystem, removal of nub scallops prior to spawning), etc. Because of calculation difficulties, these costs are not included in the analysis.
[304] Shellfish is defined as "clams, conch, limpets, mussels, oysters, periwinkles, quahogs, razor clams, scallops, sea clams, sea quahogs, sea scallops and winkles" (Commercial shellfish regulations)
[305] http://nantucket-ma.gov/pages/nantucketmA_marine/commercial.pdf.
[306] Urban Harbors Institute, 39.

shuckers 20% of the revenue generated by the scallops opened (13 respondents, but used information from only 12 respondents since one did understand the question).

c. Cullers

Cullers assist the fishermen by hauling scallop dredges and separating scallops from bycatch. Most Nantucket fishermen stated that they did not employ cullers (75% did not employ cullers, 17% employed cullers, and 8% had their "significant other" act as a culler (24 respondents)). The method of payment varied among the fishermen. Two fishermen paid 33% of their generated revenue from the day's catch, one paid a flat rate of two hundred dollars per day, and one paid "two bushels for culling only; three bushels if they haul one side of the boat."

d. Annual fuel costs

To determine the fuel costs associated with scalloping, the following calculation was used:

Annual fuel costs[307] * Percentage of boat usage devoted to scalloping[308]

The mean annual fuel cost was $1423, with costs ranging from $66 to $5600.

[307] If a range of fuel costs was given, the lower number was used for the calculations.
[308] If no percentage was given, it was assumed that the percentage of boat usage devoted to scalloping was 100%.

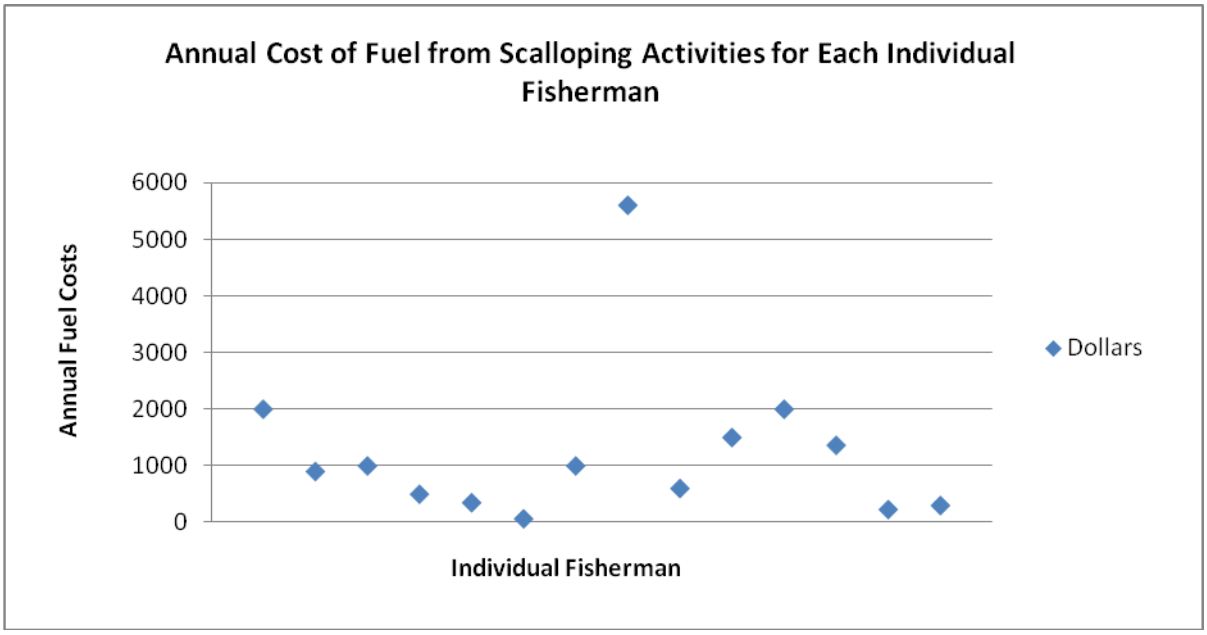

Figure 4.9: Annual cost of fuel from scalloping activities for each individual fisherman. (14 fishermen respondents)

e. New equipment at the beginning of the season

Similar to the calculations for annual fuel costs, if the fishermen gave a range of cost for new equipment, the lower value was used. Of the 22 respondents, the mean new equipment cost was $491, with costs ranging from $50 to $1000. As Figure 4.10 displays, the amount of money spent by fishermen on new equipment varies greatly between each fisherman.

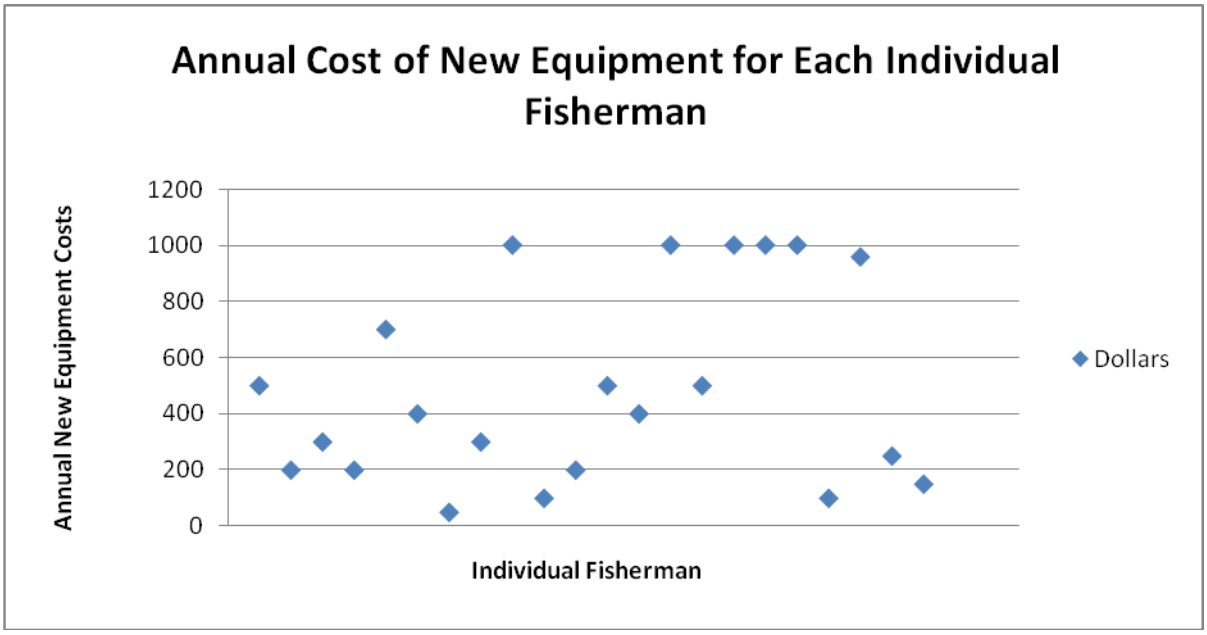

Figure 4.10: Annual cost of new equipment for each individual fisherman. (22 fishermen respondents).

f. Maintenance of boat, motor or trailer

71% of the fishermen maintained their own boat, motor or trailer, 5% hired help, and 24% did their own maintenance and hired help (21 respondents). Out of the 5% of the fishermen that hired help, three out of the four fishermen estimated that they paid ~ $1000, and one fisherman stated that s/he paid ~ $200.

Final Profit Charts

Figures 4.11 and 4.12 represent the "Revenue vs. Profit Earned by Each Individual Fisherman" and the "Percentage of Revenue that Fishermen Spend on Associated Costs." These charts reflect the revenue generated through sale of bushels minus the costs associated with scalloping (license, scallop openers, cullers, fuel, new equipment, and boat, motor or trailer maintenance). These charts do not include the fisherman's labor cost, boat degeneration cost, environmental costs, etc.

The values from the "Percentage of Revenue that Fishermen Spend on Associated Costs" chart range from 2% to 65% with a mean of 31.3%.

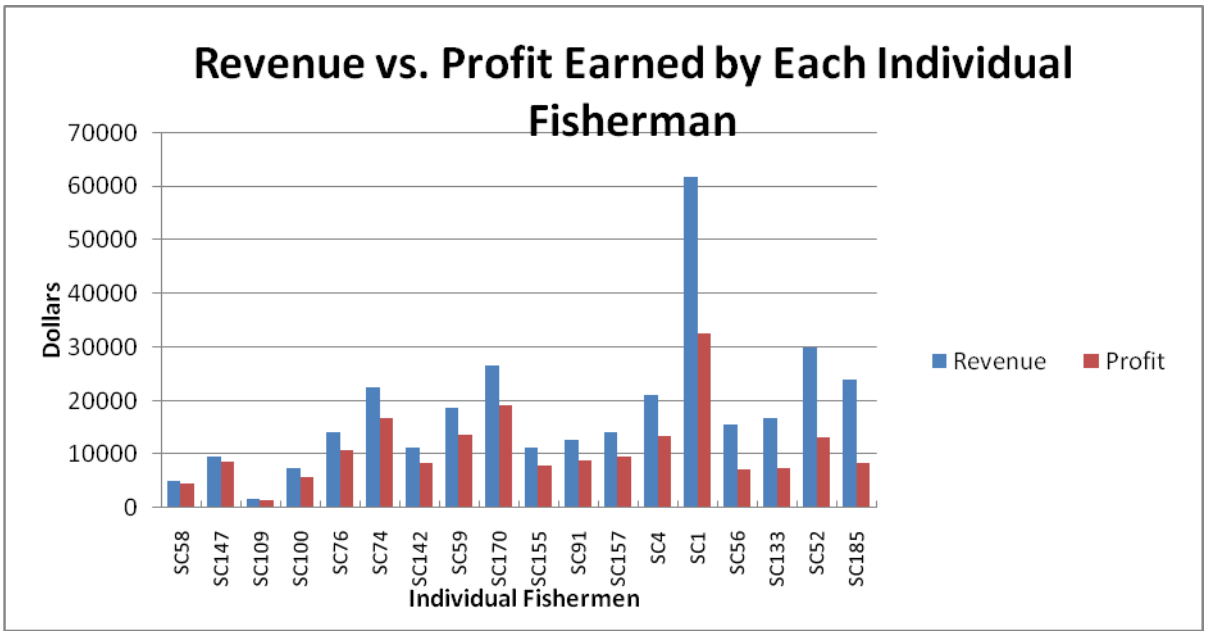

Figure 4.11: Revenue before costs subtracted vs. revenue after costs subtracted. (18 fishermen respondents)

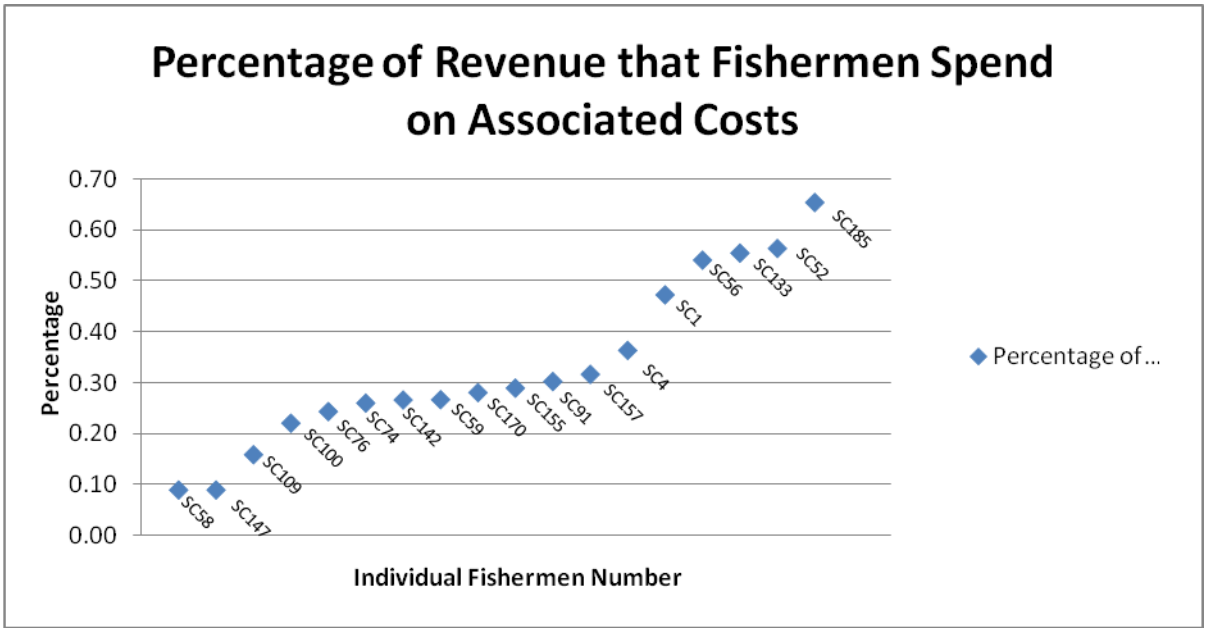

Figure 4.12: Percentage of revenue that fishermen spend on associated costs. (18 fishermen respondents)

2. ECONOMIC IMPACT OF THE BAY SCALLOP FISHERY TO NANTUCKET RESTAURANTS

A number of restaurants on Nantucket are economically impacted by the bay scallop fishery. The 14 restaurants that responded to the survey can be broken down into two categories:

- Group A: Restaurants that advertise bay scallops on the menu (9 restaurants)
- Group B: Restaurants that do not advertise bay scallops on the menu (5 restaurants)

Of the restaurants in Group B that do not advertise bay scallops, 3 are closed during the scalloping season and do not sell frozen seafood products. The remaining 2 restaurants in Group B are open during the scalloping season. These restaurants do not advertise bay scallops on the menu, but they do sell them as a small appetizer special. The reason these bay scallops are only sold as an appetizer special is "so that they may be protected against overfishing."[309]

The mean percentage of meals prepared by restaurants with bay scallops was 13.1% (8 respondents from Group A). Two other restaurants did not give a percentage, but they stated they each served one bay scallop entrée. Of the 10 restaurants that responded, the mean price for a bay scallop entrée was $28.90, which is approximately $2-7 more than other seafood entrees.

Many restaurant owners stated that selling bay scallops increases business. 6/9 restaurants from Group A stated that bay scallops were an important part of their marketing strategy. 5 restaurants from Group A also believed that having Nantucket bay scallops on the menu increased business. 4 of these 5 restaurants believed that bay scallops increased business by 10-20%, and one restaurant did not note the increase in business. One restaurant stated that

[309] Anonymous survey respondent.

their dollar amount increased $500 dollars due to serving bay scallops, and the other stated their dollar amount increased $500-$1000.

3. ECONOMIC IMPACT OF THE BAY SCALLOP FISHERY TO WHOLESALE DEALERS

Since none of the wholesale dealers responded to the survey, the economic impact of the bay scallop fishery to wholesale dealers must be estimated. Wholesale dealers on the island "set" the price paid fishermen for each pound of bay scallop. As discussed in the "Bay Scallop Pricing" section, the price/lb. fluctuates during the season. Most wholesale dealers on the island sell bay scallops along with a wide range of other types of seafood. The wholesale dealers sell bay scallops on-island in fish markets, and they also sell bay scallops off-island to other fish markets, hotels, restaurants, and larger wholesale dealers primarily located in New Bedford and Massachusetts. It can be inferred that wholesale dealers make approximately a $6-7/lb. profit margin through the sale of bay scallops.

GOALS & RECOMMENDATIONS BASED ON THE ECONOMIC ASSESSMENT

GOAL: Enhance the money generated by the Nantucket community (fishermen, wholesale dealers, restaurants, etc.) from the bay scallop fishery

From the results of the survey, it can be inferred that the bay scallop fishery economically impacts not only fishermen, restaurants and wholesale dealers, but also other members of the community that are either employed by the fishermen or provide supplies to the fishermen. During years when the bay scallop supply is plentiful, bay scallop fishing can be a significant

source of income to a number of fishermen. One fisherman earned as high as ~65% of his/her income from bay scallop fishing.

The economic value of the fishery to the wholesale dealers is dependent on the number of bushels harvested by the fishermen. It is suspected that they earn a $6-7/lb. profit margin through the sale of scallops. Although the income of the wholesale dealer is not solely reliant on bay scallops, they are popular throughout the country and high prices can generate a great deal of money for wholesale dealers.

Since bay scallops are considered a premium item, restaurant owners sell bay scallop dishes for a higher price than other seafood meals. Some restaurant owners also believe that having bay scallops on the menu increases business. It is also possible that tourists travel to Nantucket during the winter months to eat fresh bay scallops, thereby providing business to the island during the tourist off-season.

As shown by Figure 4.13, the declining supply[310] of bay scallops has reduced the dollars generated by the Nantucket fishermen. For instance, in 1980, fishermen harvested an all time high of 117,000 bushels, which generated close to four million dollars for the fishermen alone. Since, the number of bushels harvested has declined along with the amount of dollars generated by the fishermen. It can be inferred that the amount of money earned by the community from the bay scallop fishery is correlated to fishermen earnings.

[310] It can be inferred that a decrease in the number of bushels harvested is an indicator of a decline in the supply of bay scallops within the harbors.

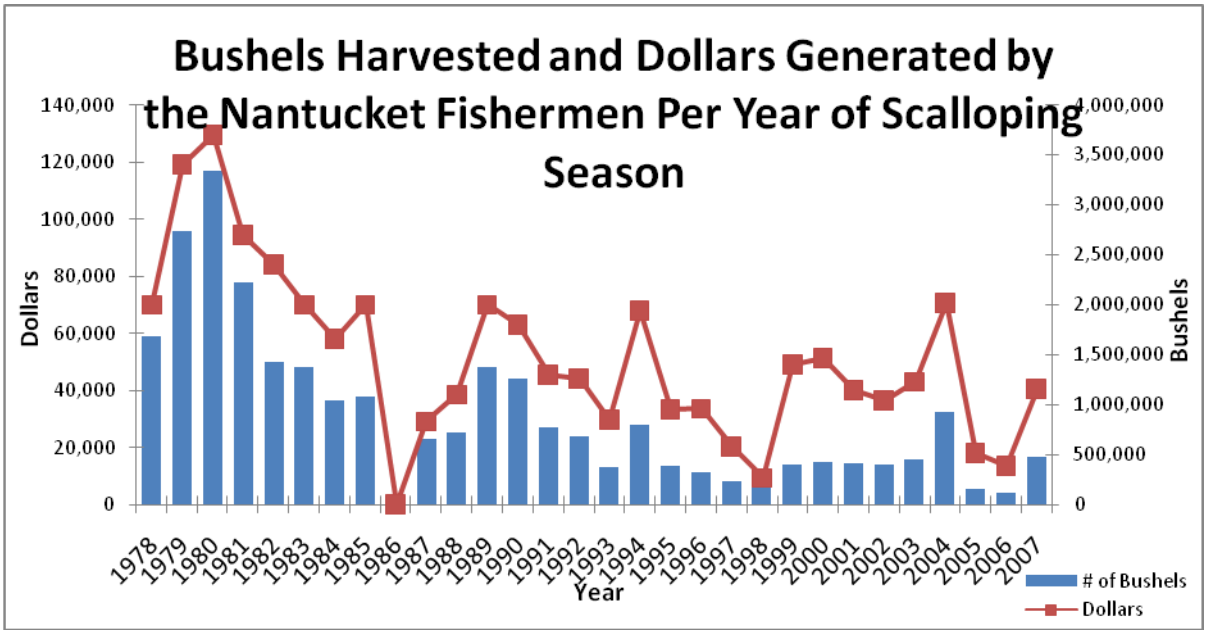

Figure 4.13: Bushels harvested and dollars generated by the Nantucket fishermen per year of scalloping season. There is no data for the year of 1986.

According to the survey, some fishermen spend a large percentage of their revenue on associated costs, with a mean percentage of 31.3%. In some ways, these costs are good because they provide money to other community members, such as the gear shop workers, gas station owners, etc. On the other hand, fishermen are already disgruntled by the price/lb. earned and high associated costs may further deter them from the scalloping profession. In the 2007-08 season, the fishermen were earning approximately $12/lb., while bay scallops were being sold for $30-40/lb. in New York. This price discrepancy is due to the number of "hands" the bay scallops pass through before final sale.

Acquiring a wholesale license would allow fishermen to have more control over the price/lb., but obtaining the license is not easy. As previously discussed, strict shanty regulations and real estate prices limit fishermen from acquiring the license, which puts them at the mercy of wholesale dealer prices. If fishermen open their scallops at a shanty owned by a wholesale

dealer, the fishermen are required to sell their scallops to that wholesale dealer, meaning that fishermen have no control over the price/lb.

The economic value of the bay scallop to the Nantucket community is influenced by a number of factors. The rate that bay scallops are "dumped" on the market can affect the price/lb. Most bay scallops are "dumped" on the market as soon as they are harvested. Since the bay scallop supply is limited, the majority of the fishing effort occurs at the beginning of the season when the supply is plentiful. Approximately 90% of the total bay scallops landed for the season is harvested by the end of December, at which point most fishermen leave the fishery and seek alternative forms of employment. Because the majority of the fishing effort occurs at the beginning of the season, most Nantucket bay scallops are "dumped" on the market at once. Since other towns are also "dumping" their bay scallops at the same time, the market becomes flooded with scallops, resulting in a lower price/lb. generated by fishermen and wholesale dealers.

For instance, at the beginning of the 2007-08 season, bay scallops were being sold to wholesale dealers off-island for approximately $15-16/lb., which meant that the fishermen were only making $9/lb. When the supply became more limited at the end of the season, wholesale dealers priced their bay scallops at ~$23-24/lb., meaning that the fishermen were earning ~$17/lb. In general, selling bay scallops at the end of the season has resulted in higher prices.

The Chinese bay scallop aquaculture business and the mislabeling of scallops also have impacted the economic value of the bay scallop to the Nantucket community. In 1982, 26 Nantucket bay scallops were sent to China to start a bay scallop aquaculture business. From these 26 Nantucket bay scallops, the Chinese aquaculture business has grown, and China currently sells a large portion of their bay scallops on the US market. The Chinese bay scallops

are also normally sold for approximately $3.99-4.99/lb., which is a lot cheaper than the Nantucket bay scallop which can be priced as high as $40/lb. Since the Chinese bay scallops are less expensive, more people tend to buy the Chinese bay scallops over Nantucket bay scallops, thereby reducing the demand for Nantucket bay scallops.

In general, most consumers think that Chinese bay scallops are not as delectable as Nantucket bay scallops. These bay scallops are normally labeled "bay scallops," but have been found with the label of "Nantucket Bay Scallops." If Chinese bay scallops are mislabeled as "Nantucket Bay Scallops," consumers may develop a false impression about the quality and taste of the Nantucket bay scallop, which may further reduce the demand. Other less desirable scallops, such as the Calico scallop, are also often mislabeled as "Nantucket bay scallops," which could further reduce the demand for Nantucket bay scallops.

Economic inefficiency could also be negatively impacting the economic value of the bay scallop fishery to the Nantucket community. One economic efficiency issue is the excess of "latent capacity." "Latent capacity" refers to fishing gear and equipment that is owned by the fishermen, but is currently not being used. Due to the limited supply of bay scallops, the majority of the fishermen that own fishing gear do not actually scallop, resulting in large amounts of "latent capacity." It is possible that if the supply increases due to the Shellfish Management Plan or environmental regulations, this "latent capacity" could largely be alleviated because there would be a need for the "unused" fishing gear.

Another issue that could be affecting the economic efficiency of the Nantucket bay scallop fishery is the high costs associated with fishing; specifically the high cost of time spent fishing. In the beginning of the season when the supply is plentiful, most fishermen are capable of harvesting their five bushel limit within the first two hours of their fishing day. Although the

amount of time spent fishing seems minimal, these fishermen spend a great deal of time and gas money traveling to and from these fishing grounds everyday during their five day fishing week.

Recommendations

- **Improve environmental conditions:** As previously discussed, to increase the supply of bay scallops, environmental conditions need to be improved. Recommendations for improving environmental conditions can be found in the Chapter II: Environmental Assessment.
- **Branding and advertising of Nantucket bay scallops:** To avoid the mislabeling of China aquaculture bay scallops and Calico scallops as Nantucket bay scallops, the Nantucket community should consider a branding program. Nantucket should follow the examples set by the "Maine lobster" and "Vermont Maple Syrup" and create a unique label for the Nantucket bay scallop. All Nantucket bay scallops exported from the island should have this unique label printed on the container to reduce mislabeling issues.

  Along with branding, Nantucket also needs to advertise the quality of the bay scallops. When Maine developed a branding program, they advertised their lobster as "The World's Finest Lobster" which was very important in securing customers.[311] Since many consumers feel that the Nantucket bay scallop is the best type of bay scallop in the world due to its sweet taste and size,[312] Nantucket also needs to consider an advertising campaign.
- **Unify fishermen:** Currently, the Nantucket fishermen are not very unified. One fisherman noted that the scallopers are similar to "one hundred seagulls flying in a

[311] Maine Lobster, *The World's Finest Lobster Comes From Maine*, http://www.lobsterfrommaine.com/ (July 17, 2008).
[312] Patrick and Benchley, 1.

different direction."[313] To improve the economic value of the bay scallop, the fishermen must become more unified. The fishermen should consider joining the "Massachusetts Fishermen's Partnership," which is an umbrella organization for a wide-range of Massachusetts' fisheries. Through the partnership, fishermen can conduct fishery-related research projects, and the fishermen and their families can acquire health insurance. Since most fishermen are extremely knowledgeable, they have great insight about the research studies needed to improve upon the fishery. Once unified, the fishermen should focus their efforts on achieving the following recommendations aimed at enhancing the economic value of the bay scallop.

- **Limit "days at sea":** The number of bay scallop fishing days is currently limited to five days a week, but further limiting the number of days and staggering the fishing effort could have a number of benefits. Staggering the fishing effort may enhance the price/lb. generated by the Nantucket fishermen. Because the majority of the fishing effort occurs at the beginning of the season, most Nantucket bay scallops are "dumped" on the market at once. Since other towns are also "dumping" their bay scallops at the same time, the market becomes flooded with scallops, resulting in a lower price per pound generated by fishermen and wholesale dealers. Reducing the "days at sea" may stagger the number of scallops harvested during the season, resulting in more bay scallops landed towards the end of the season when prices are generally higher. Scallops harvested at the end of the season are also approximately 20-30% larger than scallops harvested at the beginning of the season, which could lead to enhanced revenue. Nantucket fishermen have considered reducing "days at sea" before, but the concept has never been put into effect.

[313] Anonymous, conversation with author, March 18, 2008.

Since limiting "days at sea" would stagger rather than reduce fishing effort, the total amount of dredging activity would probably remain the same. But, the change in the time of season that the majority of the dredging occurs could enhance the chances of survival for the juvenile bay scallops. When scalloping season first begins, most juvenile bay scallops (which were born in either June or September) are still attached to eelgrass blades. As the season continues on, the scallops detach from the eelgrass blades and fall to the ocean floor, where they remain for the rest of their lifespan. Reducing the amount of dredging activity that occurs at the beginning of the season will hopefully minimize the number of juvenile bay scallops that become displaced or die due to dredging activity. Later in the season there is a greater chance that most juveniles have detached from the eelgrass blades, which may reduce the negative impacts associated with dredging.

- **Freeze bay scallops:** The input could be further staggered by freezing the bay scallops and "dumping" them on the market at the most profitable time. Some consumers think that frozen bay scallops are not as delectable as fresh bay scallops, while others do not notice a difference in taste. Prior to freezing bay scallops, it is important to determine if there is a noticeable difference in taste between fresh and frozen bay scallops.
- **Build a central public shanty:** Because it is difficult for fishermen to own a private shanty, most fishermen are forced to open their scallops at a shanty owned by a wholesale dealer. If fishermen use a shanty owned by a wholesale dealer, they are required to sell their scallops to that wholesale dealer. Because of this, many fishermen have little control over the price/lb. If Nantucket builds a central public shanty and packaging facility (which would be used to ship bay scallops off-island), the fishermen could have more control over the price/lb, as well as the "dumping" of bay scallops on the market.

Wholesale dealers could be involved in advertising bay scallops and securing customers off-island.

A central public shanty would also make enforcement of the fishery more efficient. Shellfish Wardens are in charge of checking the fishermen's catch to ensure that daily limits and growth line regulations are being followed. There are a number of different shanties located on island, and the Shellfish Wardens are responsible for traveling to the various shanties and ensuring that "catch" regulations are being followed. Since there are only three Shellfish Wardens on-island, it is difficult to monitor all of the fishermen's catches. A central public shanty would make monitoring easier for the Shellfish Wardens and more efficient.

- **Mandatory to land catch at the Town Pier**: Currently, there are no rules regarding where fishing boats can land, making it difficult for the Shellfish Wardens to check catches. An important part of the Shellfish Management Plan should be focused on improving these enforcement issues. Since most fishermen land their catch at the Town Pier, the management plan should make it mandatory for all fishermen to land their catch at the pier. The central public shanty should be located close to the Town Pier. This would enhance the economic efficiency of the fishery and make it easier for the Shellfish Wardens to accurately check the bushels for catch violations.
- **Improve the economic efficiency of the fishery**: At the beginning of the season, if the fishermen were allowed to harvest their weekly limit of 25 bushels in one day, rather than traveling to the fishing grounds every day to harvest 5 bushels, the costs associated with fishing would be greatly reduced. Fishermen would spend less time traveling back and forth to the fishing grounds and they would utilize less gas.

To avoid “dumping” all the scallops on the market at once, it is possible that fishermen can be assigned a different day a week to scallop (for instance, some fishermen scallop Mondays, some scallop Tuesdays, etc.). When the supply becomes more limited towards the end of the season and the fishermen cannot harvest their full 25 bushels a week, the town would probably have to resort back to the five bushel a day limit to ensure all fishermen have a fair chance of catching their limits each day.

Economic Assessment 'Recipe': Goals and Recommendations

Goal: Enhance the money generated by the Nantucket community (fishermen, wholesale dealers, restaurants, etc.) from the bay scallop fishery

Near-term (1-2 years): Branding and advertising of Nantucket bay scallops
Near-term (1-2 years): Unify fishermen
Near-term (1-2 years): Limit "days at sea"
Near-term (1-2 years): Freeze bay scallops
Near-term (1-2 years): Mandatory to land catch at Town Pier
Long-term (2-3 years): Build a central public shanty
Long-term (3-4 years): Improve economic efficiency of the fishery
Long-term (4-5 years): Improve environmental conditions

Table 4.2: Economic Assessment 'Recipe': Goals and Recommendations.

CONCLUSION

Final 'Recipe' for a Sustainable *Wild* Bay Scallop Fishery on Nantucket Island, MA

ENVIRONMENT

Goal: Minimize nutrient loading into the harbors and limit occurrences of harmful algal bloom

Near-term (0-1 year): Community outreach
Near-term (0-1 year): Water quality sampling
Near-term (1-2 years): Enhance the consistency and quality of plankton sampling

Goal: Better understand the role of salinity in the fluctuations of bay scallop populations

Long-term (4-5 years): Research study (Impact of heavy rainfall events on juvenile spat survival and settlement)

Goal: Determine the effect of circulation on bay scallop success rates

Near-term (1-2 years): Research study (Effect of circulation on bay scallop growth rates)

Goal: Enhance eelgrass abundance

Near- term (0-1 year): Rotate "closed areas"
Near-term (0-1 year): Removal of *Codium fragile* by Nantucket fishermen
Near-term (1-2 years): Consider alternate mooring options
Long-term (2-3 years): Eelgrass restoration programs
Long-term (2-3 years): Research study (*Codium fragile attachment studies*)
Long-term (3-4 years): Improve water quality
Long-term (4-5 years): Research study (Long-term water quality, eelgrass abundance, and macroalgal coverage study)

Goal: Remove and limit predators (specifically invasive predators)

Near-term (0-1 year): Continue culling green crabs and asian box crabs
Long-term (4-5 years): Research study (Long-term study analyzing the abundance of green crabs and asian box crabs)

SOCIAL

Goal: Preserve and enhance Nantucket's fishing culture

Near-term (1-2 years): Create a harbor walk with educational signs
Near-term (1-2 years): Create a larger and more descriptive bay scallop exhibit in the Whaling Museum
Long-term (2-3 years): Create a "Bay Scallop Tour"
Long-term (2-3 years): Create a "History of Fishing on Nantucket Island Tour"
Long-term (4-5 years): Increase size of fishing fleet/increase supply of bay scallops

ECONOMIC

Goal: Enhance the money generated by the Nantucket community (fishermen, wholesale dealers, restaurants, etc.) from the bay scallop fishery

Near-term (1-2 years): Branding and advertising of Nantucket bay scallops
Near-term (1-2 years): Unify fishermen
Near-term (1-2 years): Limit "days at sea"
Near-term (1-2 years): Freeze bay scallops
Near-term (1-2 years): Mandatory to land catch at Town Pier
Long-term (2-3 years): Build a central public shanty
Long-term (3-4 years): Improve economic efficiency of the fishery
Long-term (4-5 years): Improve environmental conditions

Table 4.3: Final 'Recipe' for a Sustainable *Wild* Bay Scallop Fishery on Nantucket Island, MA.

"Great institutions, in order to remain great, must change" – Bart Giamatti[314]

Considering the decline in the Nantucket bay scallop fishery in the last thirty years, it is important for the Nantucket community to make changes as soon as possible to enhance the sustainability of the fishery. While using John Elkington's "Triple Bottom Line" theory as a base, this assessment of the fishery highlighted issues occurring within the fishery and created a 'recipe' of environmental, social and economic recommendations. This 'recipe' will hopefully enable the fishery to operate in a sustainable manner, thereby allowing the Nantucket community to continue with this important cultural tradition. This 'recipe' can also be used as a model for bay scallop fisheries that have collapsed, as well as other struggling fisheries located throughout the world.

[314] Patrick and Benchley, 335.

Appendix A

Commercial Shellfish Regulations

COMMERCIAL SHELLFISH REGULATIONS

ARTICLE I

[Readopted 12/1/93; amended 11/1/95; amended 10/18/06]

NOTES:

- Under the authority of Massachusetts General Law, Chapter 130.
- Under the authority of Chapter 122 of the Code of the Town of Nantucket.

230-1: PERMIT REQUIRED; TAKING OF SHELLFISH; SEASONS; LIMITS

A. The Board of Selectmen shall authorize the issuance of permits by the Marine & Coastal Resources Department under the authority of Chapter 130 of the General Law of the Commonwealth of Massachusetts and subject to the following conditions: No person without a shellfish permit shall take any shellfish as defined in M.G.L. Chapter 130, Section 1 by any means from the waters of the Town of Nantucket. The term shellfish is defined as clams, conch, limpets, mussels, oysters, periwinkles, quahaugs, razor clams or razor fish, scallops, sea clams, sea quahaugs, sea scallops and winkles. **[Amended 10/18/06]**

(1.) Applications for permits shall be filed between January 1st and March 31st for the season beginning the following November 1st.

(2.) Late applications shall be subject to the following penalty: the permit shall be valid either as of December 1st or as of the thirtieth (30th) day after the date of application, whichever date is later. **[Amended November 1, 1995]**

B. The Board of Selectmen shall allow the taking of legal scallops for commercial purposes during the period from November 1st to March 31st, inclusive. The Marine Superintendent is authorized, as he/she determines necessary, to close the commercial scalloping season during times when seed scallops are stranded on the beach. **[Amended December 1, 1993]**

C. Scallops shall be taken by hand only for family use and not over one bushel per person per week, and not for commercial purposes during the month of October.

D. No scallops shall be taken under permit issued by the Board of Selectmen unless they shall have a **well-defined raised growth line**, as provided by section 70 of Chapter 130 of the General Laws of the Commonwealth of Massachusetts.

1. A first violation of this Section 230-1.D. shall be punished by a mandatory revocation of permit for one day. The violator must also attend a seed scallop identification course provided by the Town Biologist.
2. A second violation of this section 230-1.D. shall be punished by a mandatory revocation of permit for one week.
3. A third violation of this Section 230-1.D. shall be punished by a mandatory revocation of permit for one year from the date of the violation. **[Amended 10/18/06]**

E. Not over five standard type boxes (provided by the Town) of scallops shall be taken per man per day, including shells, and not over ten standard type boxes of scallops, including shells, shall be taken per boat per day. This limit of five and ten shall be interpreted as including scallops taken under this commercial permit and family permit. Boxes may not be filled to exceed a "level" with the top of said box.

F. No scallops shall be taken from the waters of Nantucket when the air temperature has not reached 28 degrees Fahrenheit by 10:00 AM. Official thermometer will be installed at the Marine & Coastal Resources Department, 34 Washington Street, Nantucket, MA. At the same location and at Madaket launching pier will be flown a square red flag designating low temperature, no scalloping. Scalloping will not be allowed when the red flag is up. Flag will be lowered by official members of the Marine & Coastal Resources Department or their designees. **[Amended March 16, 1994]**

G. No clams, quahogs , oysters, or scallops shall be taken by hand or otherwise from such seed areas as are now set off or closed by action of the Board of Selectmen or from such areas as may be set off or closed by the Board of Selectmen during the period these regulations remain in force. Clams must measure 2.5 inches or more and quahogs must measure 2 inches or more. Notwithstanding the above, the Marine Superintendent in consultation with the Harbor and Shellfish Advisory Board may designate "seed scallop areas" which may be closed at his/her discretion. **[Amended December 1, 1993]**

203-2: USE OF DREDGES

A. The use of dredges is permitted between the hours of 6:30 AM and 4:30 PM. All scallop boats must be at the off-loading points by 4:30 PM. The use of dredges on Sunday is prohibited during the legal scallop season, and no scallops shall be taken on Sunday by hand for commercial purposes. **[Amended March 16, 1994]**

B. The use of two or more dredges connected together by an iron bar or any similar device is prohibited. No dredge or dredges of greater width than twenty-eight inches across the mouth will be permitted. Power hoisting of dredges is authorized provided no dredge is more than twenty-eight inches wide, seven rings deep, the bar on the dredge is not over eighteen mesh long and the complete dredge does not exceed forty lbs. in weight. **[Amended December 1, 1993]**

230-3: PERMIT FEES

A. The fee for a permit to take scallops under this article shall be two hundred fifty dollars ($250.00), effective January 1, 1998. There shall be no fee for individuals over sixty years of age. **[Amended July 16, 1997]**

230-4: VIOLATIONS; PENALTIES

A. A first violation of any of the provisions of this article shall be punishable, upon a hearing by the Board of Selectmen, by revocation of permit for not more than thirty (30) days from the date of the

Board of Selectmen's action revoking said permit. If penalty should carry over the end of the season, the balance of the penalty remaining shall be carried over and be effective in the next scallop season.

B. A second violation of any of the provisions of this article shall be punishable, upon a hearing by the Board of Selectmen, by revocation of permit for one year from the date of the Board of Selectmen's action revoking said permit.

C. Any violation of any rule or regulation made by the Board of Selectmen under the authority of Chapter 130 of the General Laws of the Commonwealth of Massachusetts shall, in addition to any other penalty provided therein, be punished by a fine of not less than fifty ($50.00) nor more than one thousand dollars ($1,000.00) or by imprisonment for not more than three months, or both.

Appendix B

Fisherman, Restaurant and Wholesale Dealer Surveys

& Survey Results

Fisherman Survey

Fisherman

According to the Nantucket Shellfish Association, we believe you to have been a scallop fisherman within the past five years. If you have not, please write NA and mail the survey back to me.

1. Did you fish commercially in the 2004 season? Yes No

If not, please answer the survey for your last commercial fishing season.

Please circle the appropriate answers.
2. How long have you been scalloping?

1 year 2-5 years 6-10 years more than 10 years

3. During the 2004-05 season, what was your approximate harvest – number of bushels?

4. What percentage of your 2004 income was from scalloping?

5. Think of the last five seasons. Circle the appropriate answers.

What was your worst season (in terms of harvest)?

Worst: 1999-2000 2000-01 2001-02 2002-03 2003-04 2004-05

What was your best season?

Best: 1999-2000 2000-01 2001-02 2002-03 2003-04 2004-05

How much better was your best season compared to your worst season?

Was your best year 1 ½, 2, 3, or more than 3 times better than your worst year?

6. Do you employ anybody to help with fishing? Yes No Husband/Wife

7. If so, how many people do you employ to help with fishing?

8. How much do you pay them (daily rate? Hourly rate?)

9. Do you employ anybody to help with shucking? Yes No

10. If so, how many people do you employ to help with shucking?

Please check the best answer.
11. Do you pay them by the hour ____ , the bushel____ , or the pound _____?

12. How much do you pay them?

13. What percentage of your total catch do you sell on-island_____, off-island_____?

Please fill in the answers.

14. What percentage of your **on-island** sales goes to:

Wholesalers/dealers	_____
Restaurants	_____
Private sales to individuals	_____
Other (please specify)	_____
Total 100%	

Please list the names of the wholesalers and the restaurants that you sell bay scallops to **on-island**.
Wholesalers/dealers:

Restaurants:

Please fill in the answers.

15. What percentage of your **off-island** sales goes to:
Wholesalers/dealers _____
Restaurants _____
Private sales to individuals _____
Other (please specify) _____
Total: 100%

Please list the names of the wholesalers and the restaurants that you sell bay scallops to **off-island**.

Wholesalers/dealers:

Restaurants:

16. What % of your catch do you keep for your family or give to friends/neighbors?

Please check the best answer.
17. If you sell your catch on the mainland, how do you package and ship your scallops off-island:
_____U.S. Postal Service
_____UPS
_____Fed Ex
Other (Please write in)_____

18. Who pays the shipping costs, you_____ or the recipient_____?

19. Can you estimate the shipping cost price per pound of scallops?

20. How much do you typically spend on new equipment to get ready for an average season? (boots, gloves, ect.)

21. Do you maintain your boat, motor and trailer, or do you pay someone?

22. If you pay someone, how much do you pay them for your annual maintenance?

23. What are your total annual maintenance costs – boat and equipment?

24. What percentage of your boat usage is devoted to scalloping?

25. What are your annual fuel costs?

26. In your opinion, how healthy is the scallop fishery? Do you believe it is sustainable?

27. If not, what do you think should be done to maintain a healthier fishery?

28. Do you think the town biologist is doing enough?

Additional Comments:

Would you be interested in an oral interview? Yes No

If you would like a copy of the results please include your address or email address.

Code for Survey Answers - Fisherman Survey

Number	Question	1	2	3	4	5	6
1	Did you fish commercially in the 2004 season? If not, please answer the survey for your last commercial fishing season	Yes	No	N/A			
2	How long have you been scalloping?	1 year	2-5 years	6-10 years	more than 10 years		
3	During the 2004-05 season, what was your approximate harvest- number of bushels						
4	What percentage of your 2004 income was from scalloping						
5	Think of the last five seasons.						
5a	What was your worst season (in terms of harvest)	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
5b	What was your best season	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
5c	How much better was your best season compared to your worst season						
5d	Was your best year times better than your worst year	1.5	2	3	more than three		
6	Do you employ anybody to help with fishing	Yes	No	Husband	Wife		
7	If so, how many people do you employ to help with fishing						
8	How much do you pay them (daily rate? Hourly rate?)						
9	Do you employ anyone to help with shucking	Yes	No				
10	If so, how many people do you employ to help with shucking						
11	Do you pay them by the hour, bushel, or pound	hour	bushel	pound			
12	How much do you pay them (daily rate? Hourly rate?)						
13a	What percentage of your total catch do you sell on-island						
13b	What percentage of your total catch do you sell off-island						
14a	What percentage of your on-island sales go to wholesale/dealers						
14b	What percentage of your on-island sales go to restaurants						
14c	What percentage of your on-island sales go to private sales to individuals						
14d	What percentage of your on-island sales go to other						
14e	Please list the names of the wholesalers that you sell bay scallops to on-island						
14f	Please list the names of the restaurants that you sell bay scallops to on-island						
15a	What percentage of your off-island sales go to wholesale/dealers						
15b	What percentage of your off-island sales go to restaurants						
15c	What percentage of your off-island sales go to private sales to individuals						
15d	What percentage of your off-island sales go to other						
15e	Please list the names of the wholesalers that you sell bay scallops to off-island						
15f	Please list the names of the restaurants that you sell bay scallops to off-island						
16	What % of your catch do you keep for your family or give to your friends/neighbors						
17	If you sell your catch on the mainland, how do you package and ship your scallops off island	USPS	UPS	Fed Ex	Other		
18	Who pays the shipping costs	You	Recipient				
19	Can you estimate the shipping cost price per pound of scallops						
20	How much do you typically spend on new equipment to get ready for an average season (boots, gloves, etc.)						
21	Do you maintain your boat, motor, and trailer	You	Pay someone				
22	If you pay someone, how much do you pay them for your annual maintenance						
23	What are your total annual maintenance costs- boats and equipment						
24	What percentage of your boat usage is devoted to scalloping						
25	What are your annual fuel costs						
26a	In your opinion, how healthy is the scallop fishery	Healthy	Not healthy	Somewhat			
26b	Do you believe the scallop fishery is sustainable	Yes	No				
27	If not, what do you think should be done to maintain a healthier fishery						
28	Do you think the town biologist is doing enough	Yes	No				

Survey Answers (1-14f) – Fisherman Survey[315]

Survey number	Want results?	Interested in interview?	#1	#2	#3	#4	#5a	#5b	#5c	#5d	#6	#7	#8	#9	#10	#11	#12	#13a	#13b	#14a	#14b	#14c	#14d	#14e	#14f
SC1		2	1	1	247	50.5%						0		1	1	3	4945.3	75.36%	100-75.36%	100.0%				Nantucket Seafood	
SC100	2	2	1	4	225	36.0%		6		4	2	2		2	1	3		100.0%		100.0%				Sayles Seafood	
SC109		2	1	4	120	20-25%	2	6	10-20%	2	2	2		2	1	3	20	100.00%		100.0%			Ted Jonesen- Old Glory	Nantucket Seafoods?	
SC110		2	2	4			1	2	$2000's		2	2		1	1	3		100.00%		100.0%				Sayles	
SC114			3	0																					
SC116			3	4																					
SC133	1	1	1	4	500	50.0%	4	6		4	4	1		1	2	3	20	100.00%		100.0%			Nantucket Specialty	Seafood	
SC141			3	0																					
SC142	1	2	1	4	300	20.0%		6		2	2			1	1	3	20%	100.00%		100.0%			Gildant's Island	Seafood	
SC143			3	0																					
SC147	2		2	3	25		4																		
SC150			2	0																					
SC155		1	1	4	400	50.0%	1	6	50.0%	4	2	2		1	1	3	20	100.00%		100.0%					
SC157			1	4	350	50.0%	1	6		4	2	1		1	1	3	20	5.00%	95.00%	95.0%		5.0%	Sanza Seafood	Individuals	
SC16			3	4																					
SC163		1	1	4		40.0%	3/67		50.0%	2	1	1 rate)	200 (daily	1	1	3	20%	100.00%		100.0%			Island Seafoods		
SC164			3	4																					
SC170	1	2	1	3	180	65.0%	4	6	45.0%	4	2			2				100.00%		100.0%			Nantucket Seafoods		
SC174			3	0																					
SC185		2	1	2			4	5																	
SC189	1	1	1	2	100	0.0%	3	6	50.0%	2	2			2	1	3	20	100.00%		100.0%		50 donations, gifts	Sayles		
SC191			2	0																	20.0%				
SC193		2	3	0																					
SC28			3	0																					
SC34		1	4				6				2			2											
SC4	2	2	1	4	1000	40.0%	1	6	5 times better%		3			1	2	3	20%	85.00%	15.00%	100.0%			Sayles Seafood		
SC52		1	1	4	400	50.0%	2	6		1	1	3 or 4	33%	1		3	20	100.00%		80.0%	10.0%		All of them	Seafoods	
SC54	1	2	1	4	60	10.0%					2							100.00%		100.0%			Nantucket Seafoods		
SC56	1	1	1	2	285	37.5%	2	6	Infinitely!	3	1	1 liter haul	2 bushels for outing only; 3 bushels if 1	1	1 or 2	3	20	100.00%		100.0%			Nantucket Seafoods		
SC57	1	1	2	4							1			1	1 to 3	20		100.00%		100.0%			Gildants		
SC58	2	2	2	4	150	10.0%	4	3.5x%		4	2		33%	2				100.00%		100.0%			Sayles		
SC59	1	1	1	4	425	35.0%		6			2			1	1	3	20	100.00%		100.0%			Nantucket		
SC73			3	4																			Seafoods		
SC74	1	2	1	4	200	<33	5	6	Like day and night	3	2			1	1	3	20% ($10/pound, $2/pound for the opener)	100.00%		100.0%			Sayles Seafood		
SC78		1	1	4	360	33.0%	3	6			2			1	1	3	20%	100.00%		100.0%			Sayles Seafood		
SC80		1	3	0																					
SC91		1	1	4	295	60.0%	5	Since the limit was 5 bushels, the time it took to catch them was two or three times longer		1	2			2				98.00%	2.00%	95.0%		5.0%	Sayles Seafood	Gildants	Don't have a dealers license which is now required
SC95		2	1	4	350	30.0%		6 a lot		3	2			2				100.00%		100.0%					
SC97		2	3	4	4495						2			2		3	10	100.00%		100.0%			Sayles Native Seafood		
SC98 or 99?																									

[315] Due to the anonymous nature of the survey, each survey was assigned a code (i.e. SC47).

Survey Answers (15-28) – Fisherman Survey

survey number	#15a	#15b	#15c	#15d	#15e	#15f	#16	#17	#18	#19	#20	#21	#22	#23	#24	#25	#26a	#26b	#27	#28
SC1	100				Chatham Seafood		0.0%	4	2	$2.5lb	$5lb	1	0	746.83	100.0%	1514.37	2	2	Limit number of boats	2
SC100											200	1		2000	100.0%	1000				
SC109							1.0%				500	1		1000	90.0%		1	1		
																			Leave it alone. Enforce existing laws. Raised annular growth ring is enough. Forge about this nub	
SC110							1-2%				150	1		1000	80.0%	300-400	1	1	thing	1
SC114																				
SC116																				
																			Ban high nitrogen fertilizers on lawns and ban boat washdown with phosphates. Also try to eliminate	
SC133							5.0%				400	3	85/hour	1500	50.0%	7000	2	1	introduced species- green crabs, codium, etc.	2
SC141																				
SC142							1.0%				1000-2000	3			100.0%		1			2
SC143																				
SC147																				
SC150																				
SC155							50.0%				500	1			90.0%	600	2	2	propogation, maintaining investment	2
SC157							1-5%													
SC16											1000	1	250 to 300	1200-1500	75.0%	1500 to 1800	1	1	Town biologist should work with fishermen	2
SC163							0.1%				1000	1		400-600	100.0%		1	1		2
SC164																				
SC170							1.0%				1000	1			100.0%	2000-4000	1	1		2
SC174																				
SC185							0.0%					3			100.0%		1			
SC189							100.0%	3	1	$6-8/pound	100	1 (with friend)					1	1		2
SC191																				
SC193																				
SC26																				
																			do not expand the summer mooring and anchorage	
SC24							10 pounds				200	1	100		60.0%	very low	3	1	Hussey shoal is covered with anchorage vessels	2
SC4	100						2.0%	3	1	$2/lb	500	3		500	100.0%	2000	3	1	summer 2015!	2
SC52							5.0%				300	2	1000	1500-2000	100.0%	1500	1	1	More water tests	2
SC54											200	1					1	1	hatchery	2
																			Ban use of fertilizers on 'trophy house' lawns that run off into the harbor, controls on 'gray water' eg no washing your pleasure boat in the Nantucket harbor, use of propogation by Shellfisherman's association, controls on polluting the harbor, ban dredging of any	
SC56							0.0%	3	2	No	700	1		A lot- 1000 at least	100.0%		3		Kind by GHYC	2
SC57							2-3%					1			100.0%		3			2
SC58							0.0%				250-1000	1		Gear	75.0%	5-10%	3	1	Stop fertilizer and septic runoff	2
SC59							1.0%				400	1	1000	3000	33.0%	500	1	1	reduce pollution, nitrogen loading, more seed, collect spat, spawning sanctuaries	2
SC73																				
SC74							<10%				$50	1	<100		100.0%	350 to 400	1	1		1
SC76							1.0%						wide		80.0%	wide			solid commitment to water quality, protect critical	
SC80											300-500	3	1000-2000	fluctuations		fluctuations	3	3	habitat	
SC81			10				5.0%		2	1000-2000		1		3000 plus	100.0%	200 plus or minus		1		2
SC95							0.0%			100							3	1	more research	
SC96 or 98?																				
SC97																				

Restaurant Survey

Restaurants

1. What is the name of your restaurant?

Please circle the best answer.

2. Do you advertise Nantucket bay scallops on the menu? Yes No

3. What percentage of the meals you prepare involve bay scallops? _____

4. What percentage involve Nantucket Bay Scallops specifically? _____

5. How much does a typical scallop entree cost?

6. Are Nantucket bay scallops an important part of your marketing strategy? Yes No

7. Do you believe Nantucket bay scallops on the menu increases your business?

Yes No

If so, what is the percentage increase? _____

Please estimate the dollar amount of your increase due to serving bay scallops?

8. When bay scallops are not in season, what do you do to satisfy your customer? (freeze bay scallops, substitute with sea scallops, ect.)

Additional Comments:

Code for Survey Answers - Restaurant Survey

Number	Question	1		2	3
1	What is the name of your restaurant				
2	Do you advertise Nantucket bay scallops on the menu	Yes	No		
3	What percentage of the meals you prepare involve bay scallops				
4	What percentage involve Nantucket bay scallops specifically				
5	How much does a typical scallop entrée cost				
6	Are Nantucket bay scallops an important part of your marketing strategy	Yes	No		
7a	Do you believe Nantucket bay scallops on the menu increases your business	Yes	No		
7b	What is the percentage increase				
7c	Please estimate the dollar amount of your increase due to serving bay scallops				
8	When bay scallops are not in season, what do you do to satisfy your customer (freeze bay scallops, substitute with sea scallops, etc.	Freeze bay scallops	Substitute with sea scallops	Don't use	

Survey Answers – Restaurant Survey[316]

Survey number		2	3	4	5	6	7a	7b	7c	8
RT1	Closed	2	0	0	22	2				
RT2	Closed	2								
RT3	Open	2			We do not ever use Nantucket scallops for an entire size portion-appetizer special only	2	2			Do not serve Nantucket bays when they are not in season
RT4	Open mid April-Jan 1st	1	10%	10%	28	1	1	10%		We do not then use scallops
RT5	No longer in business	1	17%	17%	28	1	1			2
RT6	Open	1	in season 40%	in season 20%	20 (+)	1	1	20%	500	Nothing
RT7	Open	1	17%	1	27 ($14 cost from wholesaler)	2	2			2
RT8	Open	1	1 entrée, 1 appetizer			2	2			2
RT9	Open	1	1 entrée		29 30	1	2			2
RT10	Open	1	1 entrée	Other than sea scallops, we only serve ACK bays	30-35	1	2			2
RT11	Closed	2	0	0	25	2	2			2
RT12	Open	2	4	100	27	2	2			1
RT13	Open until end of November	1	5 to 10%	5	40	1	1	20%	500-1000/week	2
RT14	Open	1	2	2	30 (6 oz)		1	10		

[316] Due to the anonymous nature of the survey, each survey was assigned a code (i.e. RT3)

Wholesale Dealer/Fish Market Survey

Wholesalers/Fish Markets

These answers will be kept totally confidential. Data will only be available after combining data from all sources. You and your business will not be identified except as a participant in the survey.

1. What is the name of your business?

2. How many pounds of scallops did you buy during the 2004-05 season?

3. What is your normal profit margin on sales to:
Restaurants _____
Retail customers _____
Other dealers/wholesalers _____

Please fill in the blanks.
4. What percentage of your purchased Nantucket Bay Scallops do you sell on-island_____ off-island_____?

For **On Island** Distributors, please answer 5 and 6, otherwise skip to Question 7

5. What percent of your purchased Nantucket Bay Scallops do you sell to:
Restaurants _____
Retail customers _____
Caterers _____
Other dealers/wholesalers _____
Total: 100%

6. Please list the names of the restaurants that you sell to on Nantucket.

For **Off Island** Distributors

7. What percentage of your bay scallops come from Nantucket_____?

8. What percent of your purchased Nantucket Bay Scallops do you sell to:
Restaurants _____
Retail customers _____
Other dealers/wholesalers _____
Total: 100%

9. Please list the names of the restaurants that you sell Nantucket Bay Scallops to **off-island**.

Please check the best answer.
10. How do you package and ship your bay scallops:
_____U.S. Postal Service
_____UPS
_____Fed Ex
Other (Please write in)_____

11. How much is the cost of shipping?

12. What percentage of your income is derived from the Nantucket Bay Scallop business?

Please circle the best answer.
13. Do you employ additional people to work in your store during the scallop season?

Yes No

Please circle correct answer.
14. Are they part time or full time?

15. How much do you pay them?

Please circle the best answer.
16. Do you have specific scallopers that you buy from? Yes No

17. Do you usually buy their whole catch? Yes No

18. How many scallopers do you buy from?

Additional Comments: