Massachusetts Division of Marine Fisheries
B-120 Buzzards Bay Shellfish Injury and Lost Shellfishing
2020 Progress Report

Prepared for the B-120 Buzzards Bay Trustee Council
Submitted April 2020

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April 21, 2021

Executive Summary

In response to the 2003 Bouchard oil spill, which resulted in the release of 98,000 gallons of fuel oil into Buzzards Bay waters, the B-120 Buzzards Bay Trustee Council (BBTC) was formed to address damage caused to natural resources and manage restoration across the impacted area. Among the issues addressed were injuries to shellfish resources and the degradation of the recreational fishery in Buzzards Bay. Massachusetts Division of Marine Fisheries (DMF) with the help of Buzzards Bay municipalities is addressing the damages to the resource through three specified restoration strategies. These include 1) a project in which fecal coliform-contaminated quahog broodstock is transferred from donor areas in the Taunton River into designated sites within spill-affected Buzzards Bay communities, 2) outplanting of hatchery oyster seed on pre-selected oyster reef sites in spill-affected Buzzards Bay communities, and 3) outplanting of hatchery quahog seed reared in municipally maintained upwellers. The following report summarizes methods and results of these restoration activities and ongoing monitoring by DMF during 2020, the final year of the 6-year project funded by the BBTC.

In October 2015, DMF initiated a quahog transplant project to relay quahog broodstock from a closed, fecal coliform-contaminated region of the Taunton River into designated sites within Buzzards Bay municipalities. Shellfish constables from eight Buzzards Bay municipalities, with the contribution of DMF biologists, selected new sites each year of the project to be planted with adult quahogs from the Taunton River. Sites were surveyed by DMF prior to relay activities to verify that the location would be appropriate for quahog transplants. The goal of this project is to restore and enhance local quahog populations for recreational fishing, as well as to augment the broodstock available and increase spawning potential. Through a strategically delayed recreational harvest, protecting planted quahogs for at least one spawning cycle, DMF expects that planting efforts will benefit the recreational fishery as well as the natural local quahog populations. Quahog relays were successfully conducted in 2015, 2016, 2018, 2019, and 2020. In 2020, five Buzzards Bay municipalities participated in the project. Those municipalities included: Bourne, Dartmouth, Fairhaven, Gosnold, and Wareham. Each town received 800 bushels of quahogs from the Taunton River, except for Gosnold, which received 25 bushels.

The second component of shellfish restoration efforts included the use of B-120 funds to purchase hatchery-reared, disease-free certified oysters from Muscongus Bay Aquaculture in Maine. In 2019 the towns of Wareham, Marion, and Bourne. Shellfish Departments purchased small oysters ($\geq$ 2 mm) for grow-out in upwellers collaboratively overseen by DMF and town shellfish staff. Wareham used their upweller purchased with B-120 funds, and Marion and Bourne used town-owned upwellers. All oysters grown were successfully outplanted to restoration sites during fall 2019. In 2020, DMF biologist conducted biological surveys of the sites planted in 2019 to collect information of the survival and growth of the outplanted oysters.

In accordance with the BBTC-approved work plan. Outplanting of field-plant sized oysters (19.89-48.26mm) was also conducted in 2020. DMF purchased 150,000 oysters from Muscongus Bay Aquaculture and planted them over two oyster reefs located in Buttermilk Bay. The two 1-acre oyster reefs were originally created and assessed by The Nature Conservancy (TNC) and the Towns of Bourne and Wareham in 2017 and 2018 (respectively) using B-120 funds, approved by the BBTC through the TNC work plan.

The third restoration project conducted by DMF and Buzzards Bay municipalities involved the growth and outplanting of seed quahogs. The use of cost-effective, municipally managed shellfish nurseries, such as upwellers (i.e., moored, floating flow-through systems termed "FLUPSYs"), has contributed to oyster and quahog reseeding programs that have flourished throughout the Northeast. Many municipal and non-governmental organizations implement oyster or quahog management programs that include reseeding shellfish to enhance local stock populations. The B-120 Buzzards Bay Restoration Plan and Environmental Assessment aimed to build upon the existing shellfish grow-out techniques used by municipalities and use of injury funds from the settlement to purchase seed quahogs from commercial hatcheries. Municipalities, with the aid of DMF biologists, would then maintain the quahog seed during the intermediate grow-out period and outplanting of seed to restoration sites.

During 2016 and 2017, DMF oversaw the purchase of upweller kits and small quahog seed in the towns of Wareham, Dartmouth, and Fairhaven. The 5-9 mm shell-length quahogs were purchased from a commercial shellfish hatchery for grow-out and eventual outplanting in recreational fishing areas in these towns. Growth of purchased seed was poor, and time constraints for adequate grow-out resulted in no new quahog seed purchases in 2018. However, B-120 funds set aside for the purchase of quahog seed were utilized in 2019 to purchase additional quahog seed for nursery grow-out in Fairhaven. Using the town and B-120 purchased upwellers, Fairhaven personnel took responsibility for grow-out of all B-120 quahog seed in 2019. Growth was poor but, in the fall of 2019, the seed was overwintered in mesh bags to provide a second growth season in the upweller system the following year. This allowed quahogs to reach the appropriate size for outplanting. Dartmouth unfortunately did not have the staff or town support to participate in the quahog seed project of 2019, and as result did not utilize their B-120 upweller.

In the spring of 2020, DMF and Fairhaven personnel transferred the overwintered seed back to the upweller system and continued the care and monitoring of the animals. On October 9, 2020, seed quahogs grown in the upweller system were outplanted in Senior's Cove in Fairhaven where the relayed adult quahogs were planted earlier in the year.

The Town of Marion submitted a letter of agreement to DMF whereby the town committed to using B-120 funds to purchase 200,000 5-8mm quahog seed from Muscongus Bay to grow in town-owned upwellers and overwinter them for a second season (2021) grow-out in upwellers and outplanting. The town committed to conducting routine maintenance of upwellers and bi-weekly and length sampling of the quahogs. Marion unfortunately did not complete these work activities. Instead, the town purchased 200,400 10-12mm quahogs from the Muscongus nursery site in Bourne and directly outplanted them to two recreational fishing areas. This occurred without prior knowledge of DMF or the BBTC.

This report summarizes the rationale, methods, and results of all work conducted by DMF on the B-120 Buzzards Bay restoration project in 2020.

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I. *Quahog Relays and Stock Enhancement*

Quahog Broodstock

During July-November 2020, DMF oversaw the relay of bacterial-contaminated quahogs from closed waters in the Taunton River (donor site) to a total of five municipal sites in Bourne, Dartmouth, Fairhaven, Gosnold, and Wareham (Refer to Appendix I for specific relay site locations).

Prior to conducting relays, DMF collected quahog samples from two locations within the Taunton River donor site (Figure 1, Appendix II) for shellfish disease testing by Kennebec River Biosciences in Maine. A full suite of pathology screenings was performed by Kennebec River Biosciences, including examination for any external or internal morphological abnormalities and pests, predators, and parasites. No evidence of disease was found in any of the quahog samples. Pathology sample site locations and the test results are presented in Appendix ll.

DMF established contracts with one qualified dredge boat captain to collect and transport broodstock quahogs from the donor site to each of the relay sites in 2020. Harvested quahogs were stored in wet burlap-covered, one-bushel plastic totes and offloaded from the fishing vessel in Fall River and trailered to a designated planting site, daily. DMF issued contaminated shellfish relay permits to the participating municipalities to relay quahogs under predetermined and specific conditions into the preselected areas within each of the localities' municipal waters. In 2020, Fairhaven, Bourne, Dartmouth and Wareham received 800 bushels of quahogs. Gosnold requested to receive only 25 bushels due to the limited availability of suitable recreational fishing locations within the town waters.

Site Selection Methods

DMF worked with the local shellfish departments to determine prospective relay (receiving) sites. Each municipality planted quahogs at one site that ranged between 0.6 and 3.8 acres in area. An important factor in restoration success is the suitability of a site for quahog growth and survival. The following six selection criteria were used to confirm the suitability of chosen sites:

1. Appropriate quality and quantity of benthic habitat available.
2. Appropriate public access and availability and proximity of the site for public recreational shellfishing.
3. A recreational shellfishing-only site designation with no commercial harvesting.
4. Degree to which the area was previously affected by the B-120 oil spill that resulted in harvest closures.
5. Proper Designated Shellfish Growing Area classification.
6. Lack of a substantial resident quahog population in the area.

Prior to planting, DMF biologists and local Shellfish Constables worked collaboratively to select potential sites and conduct surveys to document habitat conditions, existing shellfish abundance and size

distribution at each of the five sites. All selected sites have been designated as exclusively recreational shellfishing areas under the municipalities' authority at M.G.L. 130 sec 52.

Sampling methods for these surveys varied slightly based on the differing hydrographic conditions at each site. Each proposed area was initially assessed for potential suitability of quahog habitat and any sections of the area that were unsuitable (e.g., shoreline boulder field, eelgrass beds, or soft muddy substrate) were noted and avoided. Transect locations were then selected within the suitable areas to obtain a representative sample of the habitat and substrate conditions, as well as the existing shellfish species and population. Survey transects ran perpendicular to shore to allow capture of the habitat variability that is often influenced by water depth. Transect locations were marked with rebar stakes and measured out to approximately 100 feet with transect tapes (transects were occasionally less than 100 feet in areas where depth increased rapidly and prevented wading out further). All surveys were conducted by DMF and town shellfish department staff within the subtidal zone during low tide events.

Results of the site survey were relayed to the participating town Shellfish Constables. If the site was deemed suitable to receive quahogs, the area was closed to shellfishing by DMF via the issuance of a Contaminated Shellfish Transplant Closure Notice, and the town scheduled with the contracted dredge boat operator to receive contaminated quahogs for each planting.

Site Selection Results

Summaries of each pre-planting site survey from 2020 are detailed below, and a summary table of all 2020 B-120 quahog relay sites is presented in Table 1. The range of water depths at each site are reported as feet below mean lower low water (MLLW). Positive depth values indicate depths below MLLW, and negative depth values indicate height above MLLW (within the intertidal zone).

An overview map of the five 2020 B-120 relay sites is provided below (Figure 1), and individual maps of each town's quahog relay sites are provided in Appendix I.

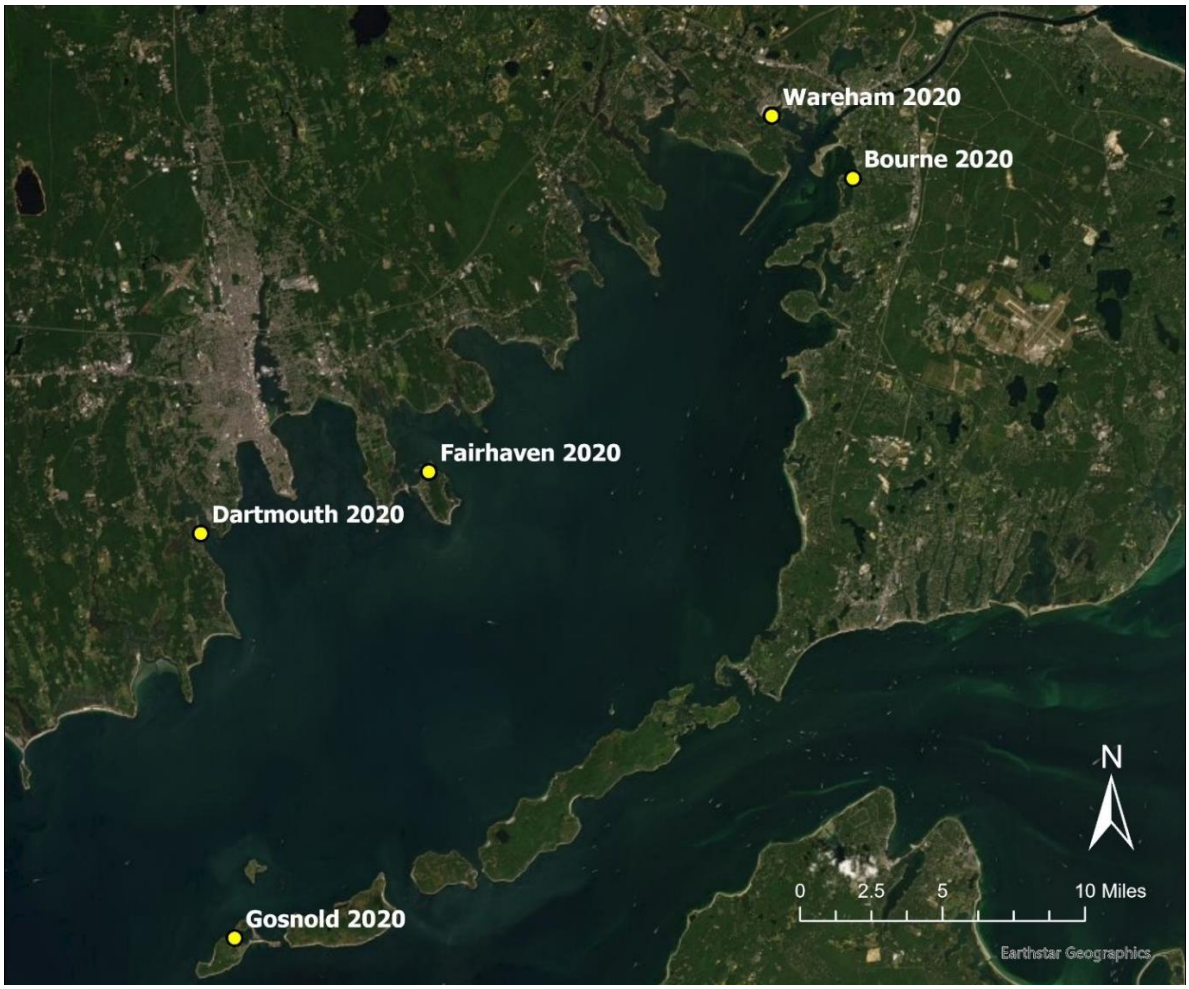

Figure 1. Map indicating the five 2020 B-120 contaminated quahog relay sites around Buzzards Bay.

Table 1. Summary of 2020 B-120 contaminated quahog relay sites. Positive depth values indicate depth below MLLW.

Municipality	Site Name	Closure Area (acres)	Depth Range at MLLW (ft.)
Bourne	Phinney's Harbor	2.35	0.3-3.8
Dartmouth	Knowles Pier	6.89	1.02 - 4.52
Fairhaven	North Cove Bella Vista Island	6.36	1.5 - 3.5
Gosnold	Cuttyhunk Pond	1.35	0.6-2.6
Wareham	Lydia's Island	11.05	0.8-4.3

2020 B-120 Relay Sites

Bourne – Phinney's Harbor

In consultation with DMF personnel, the Bourne Shellfish Constable, Chris Southwood, chose an area off Emmons Road in Phinney's Harbor for the 2020 quahog relay. The area has ample public access for recreational shellfishing and is known to be a popular shellfishing area. All Bourne municipal waters including Phinney's Harbor were closed to shellfishing on April 28, 2003 due to the oil spill and re-opened on May 22, 2003. The relay site is in DSGA BB: 46.1, which is classified as "CONDITIONALLY APPROVED" and meets NSSP standards for direct harvest of shellfish during the time period that the area is open. The nearby parking lot at Monument Beach provides public parking and beach access points.

On June 30, 2020, a pre-planting survey was conducted by DMF staff and town shellfish officials. Survey results indicated a firm sand and mud substrate with some rock and shack. Both filamentous red and green algae, as well as some occasional *Codium* and *Ulva* were present at the site. Water depth in Phinney's Harbor ranged between 0.3 to 3.8 feet below MLLW. A total of eight transects of 7-10 quadrats each were sampled within the site (67 quadrats total). 76 quahogs were observed for a density of 1.13 quahogs/ft^2, however 14 of those quahogs were very small and inadvertently released before they were able to be measure (Table 2). The first two transects contained 62% (n=47) of the total number of quahogs found, and therefore, the 2020 planting area was adjusted to exclude those areas of high quahog density. The area will be closed for one year and is expected to reopen to recreational shellfishing in the fall of 2021.

Table 2. Summary table of the resident quahog population at the Bourne B-120 relay site. Size measurements denote shell length.

Mean Length (mm)	58.89
Min Length (mm)	16.6
Max Length (mm)	84.69
Total No. Quahogs	76
Total No. Quadrats	67
Density (quahogs/ft^2)	1.13

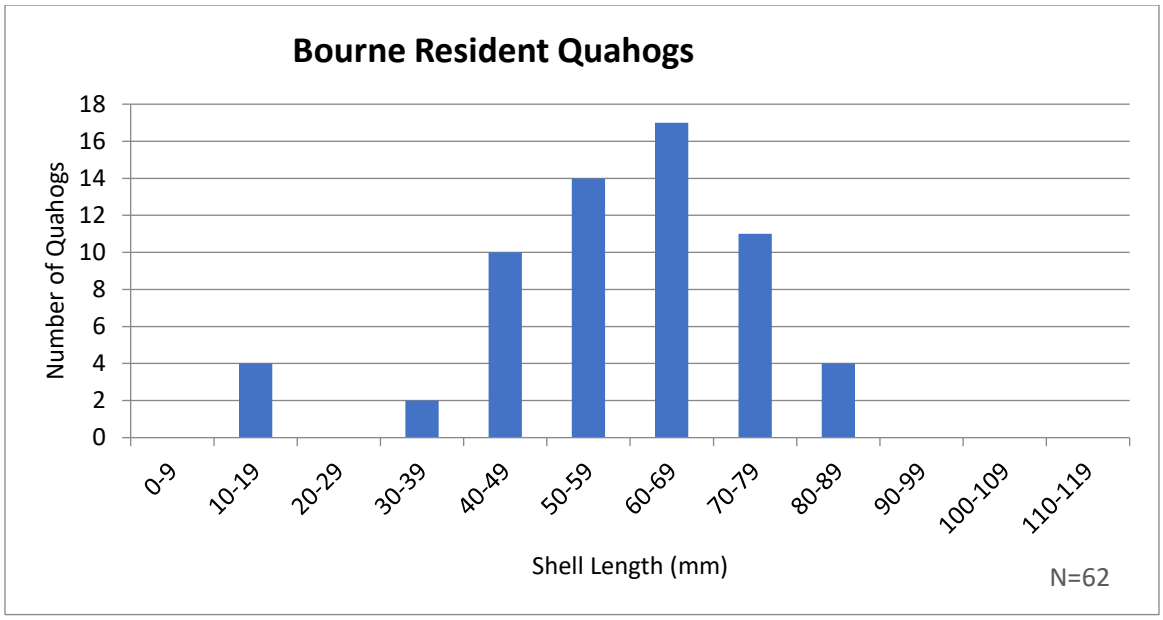

Figure 2. Resident quahog length frequencies at the Bourne B-120 relay site.

Dartmouth – Knowles Pier

In consultation with DMF personnel, the Dartmouth Shellfish Constable, Steve Mello, proposed an area directly east of Smith Neck Road and south of Knowles Beach in Apponagansett Bay for the 2020 B-120 quahog relays. All of Dartmouth municipal waters, including Apponagansett Bay, were closed to shellfishing on April 28, 2003 due to the oil spill and re-opened on October 13, 2003. The relay site is in DSGA BB: 12.3, which is classified as "CONDITIONALLY APPROVED" and meets NSSP standards for direct harvest of shellfish during the time that the area is designated as open. This 3.11-acre area has large rocks near the shoreline, which is unfavorable habitat for quahogs, but a shallow sandbar approximately 130 ft from the shoreline was targeted by town staff for all planting efforts. Access points for recreational shellfishing include limited street parking on Smith Neck Road.

On July 2, 2020, a pre-planting site survey was conducted by DMF staff. Survey results indicated a rocky substrate with sand and mud in deeper water and about 50% SAV coverage in shallower water. Water depth in the area surveyed ranges between 1.0-4.5 feet below MLLW. A total of eight transects of 3-6 quadrats each were sampled within the site (32 quadrats total). Only one 55.4 mm quahog was found for a density of 0.03 quahogs/ft.^{2} The site will be closed for one year and expected to reopen to recreational shellfishing in the fall of 2021.

Fairhaven – Bella Vista Island North Cove (Senior's Cove)

In consultation with DMF personnel, the Fairhaven Shellfish Constable, Tim Cox, proposed a portion of Nasketucket Bay north of Bella Vista Island known as to locals as Senior's Cove for the 2020 quahog relays. All of Fairhaven waters were closed to shellfishing on April 28, 2003 due to the oil spill and re-opened on October 13, 2003. The relay site is in DSGA BB: 18:4R, which is classified as "APPROVED" and meets NSSP standards for the direct harvest of shellfish throughout the year. This location has parking availability along the road and multiple public access points.

On July 20, 2020, a pre-planting site survey was conducted by DMF staff. Survey results indicated a mostly sandy substrate, with shell and rock interspersed and around 50% SAV coverage. Water depth at the Bella Vista Island site ranged between 1.5-3.5 feet below MLLW. A total of four transects of 10-26 quadrats each were sampled within the site (60 quadrats total). Ten quahogs were found for a density of 0.17 quahogs/ft.^{2} (Table 4). The site will be closed for one year and reopen to recreational shellfishing in the fall of 2021.

Table 4. Summary table of the resident quahog population at the Fairhaven B-120 relay site. Size measurements denote shell length.

Mean Length (mm)	74.86
Min Length (mm)	10.07
Max Length (mm)	102.72
Total No. Quahogs	10
Total No. Quadrats	60
Density (quahogs/ft^2)	0.17

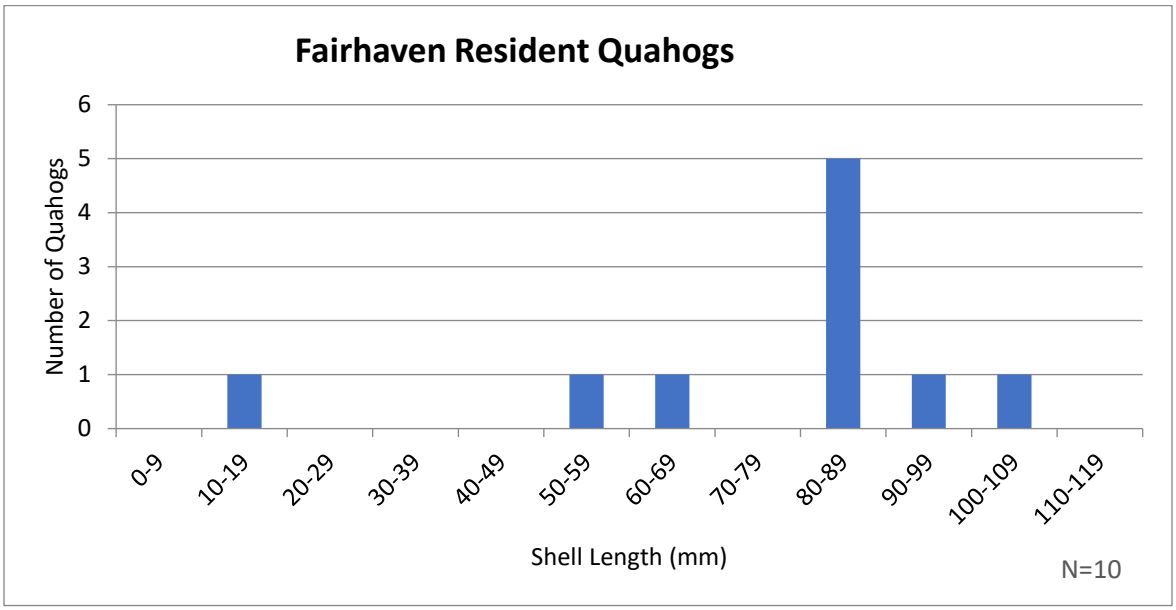

Figure 3. Resident quahog length frequencies at the Fairhaven B-120 relay site.

Gosnold – Cuttyhunk Pond

In consultation with DMF personnel, the Gosnold Shellfish Constable, Seth Garfield, selected a portion of Cuttyhunk Pond off Blue Heron Drive for the 2020 B-120 quahog relay. All Gosnold waters were closed to shellfishing on April 28, 2003 due to the oil spill and re-opened on October 13, 2003. The relay site is in DSGA E:9.2 which is classified as "CONDITIONALLY APPROVED" and meets NSSP standards for direct harvest of shellfish during the time that the area is designated as open. This location has parking availability along the road and multiple public access points.

On September 29, 2020, a pre-relay site survey was conducted by DMF staff and the shellfish constable. Survey results indicated a mostly sandy substrate, with minimal SAV coverage in the shallow subtidal waters. A substantial eelgrass bed is present in deeper water but was avoided while planting the quahogs. Water depth at the Cuttyhunk pond site ranged between 0.6 and 2.6 feet below MLLW. A total of fifteen quadrats were sampled within the site. Four quahogs were found for a density of 0.27 quahogs/ft.^{2} (Table 5). The site will be closed for one year and will reopen to recreational shellfishing in the fall of 2021.

Table 5. Summary table of the resident quahog population at the Gosnold B-120 relay site. Size measurements denote shell length.

Mean Length (mm)	49.45
Min Length (mm)	21.72
Max Length (mm)	72.21
Total No. Quahogs	4
Total No. Quadrats	15
Density (quahogs/ft^2)	0.27

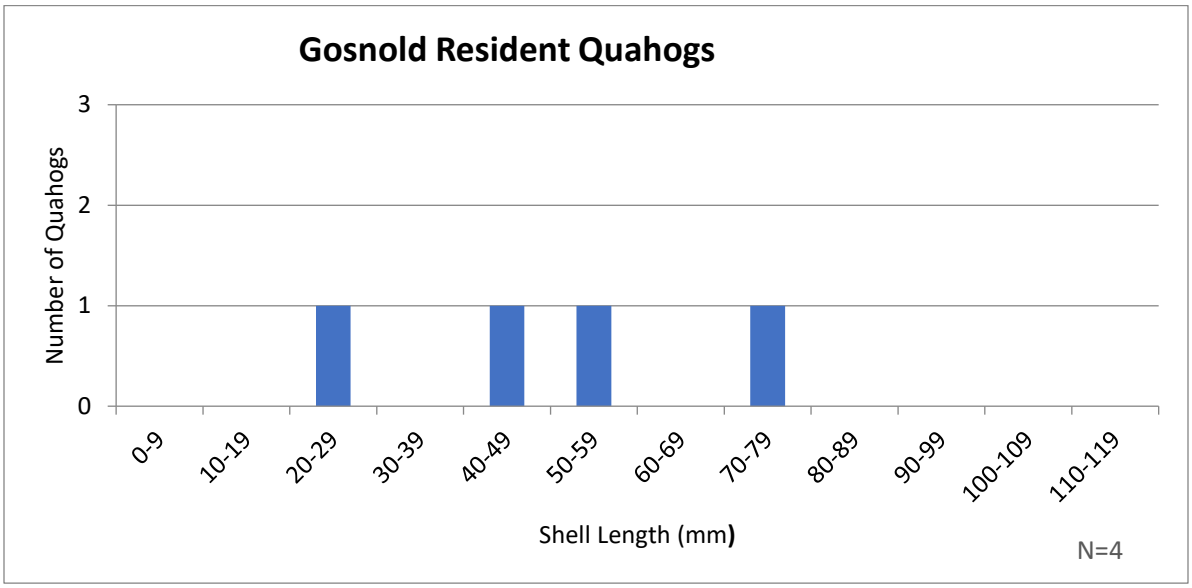

Figure 4. Resident quahog length frequencies at the Gosnold B-120 relay site.

Wareham – Lydia's Island

In consultation with DMF personnel, the Wareham Shellfish Constable, Garry Buckminster, proposed a location off the northwest tip of Lydia's Island in Onset Bay for the 2020 quahog relays. The site is accessible only by boat, as it is located on a private island not open for public use, but waters around the island are open to the public. The site will have limited recreational fishing and be a targeted location for outreach activities by the Wareham Shellfish Department. All of Wareham municipal waters, including Lydia's Island, were closed to shellfishing on April 28, 2003 due to the oil spill and re-opened on May 22, 2003. This relay site is in DSGA BB: 40.0 and is classified as "APPROVED", meeting NSSP standards for the direct harvest of shellfish throughout the year.

On July 28, 2020, a pre-planting site survey was conducted by DMF staff and a Wareham Shellfish Department official. Survey results indicated a sandy substrate with some silt. A substantial eelgrass bed is present in the area but was avoided during planting activities. The water depth within the suitable habitat ranged between 0.8 and 4.3 ft below MLLW. A total of nine transects with 4-11 quadrats each were surveyed within the site (60 quadrats total). Twenty-one quahogs were found for a density of 0.35 quahogs/ft.^{2} (Table 6). This site will be closed for one year and will reopen in the fall of 2021.

Table 6. Summary table of the resident quahog population at the Wareham B-120 relay site. Size measurements denote shell length.

Mean Length (mm)	73.67
Min Length (mm)	55.47
Max Length (mm)	105.39
Total No. Quahogs	21
Total No. Quadrats	60
Density (quahogs/ft^2)	0.35

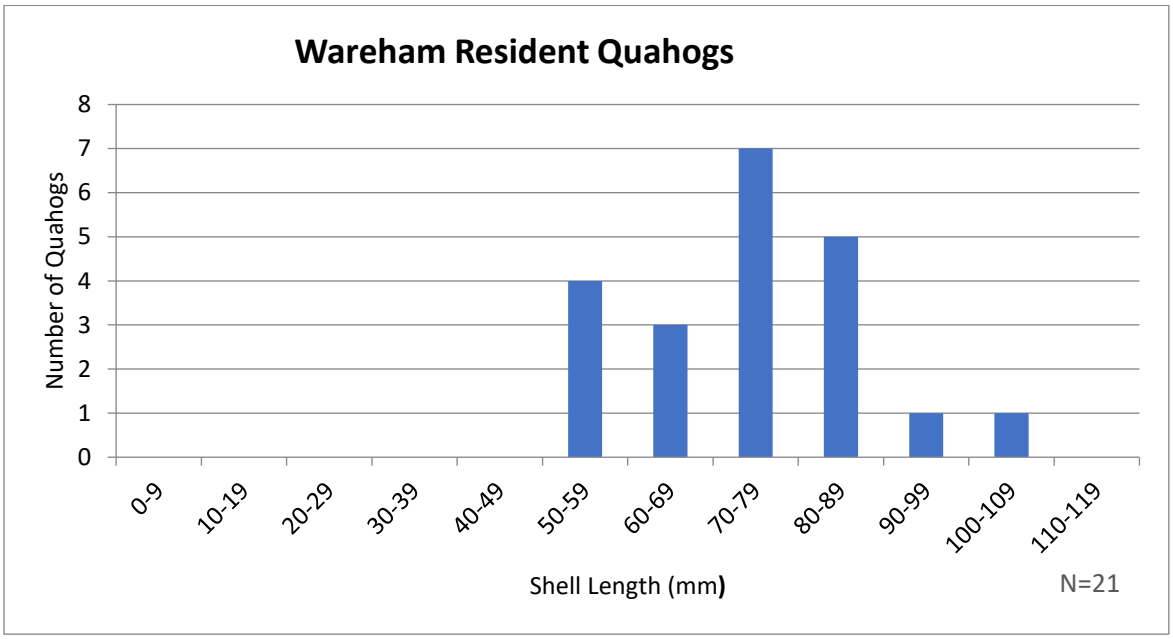

Figure 5. Resident quahog length frequencies at the Wareham B-120 relay site.

2020 Quahog Relay Methods

DMF biologists measured random samples of quahogs from the Taunton River donor site delivered to each Buzzards Bay municipality. Samples of one-peck baskets were collected from the 800 bushels delivered to each municipality (excluding Gosnold) prior to planting. All animals sampled were counted and shell lengths were measured to the nearest 0.01 mm. During each sampling event, DMF staff

measured between 2 and 6 pecks depending on number of personnel present. These measurements were used to estimate the total number quahogs delivered as well as size frequency of relayed quahogs for each site. A minimum of 500 quahogs from each relay were measured. Following sampling, quahogs were planted by boat or barge across the designated restoration area. The planting process varied by town, but typically consisted of crew members gently dumping the individual bushel totes over the stern and sides of the vessel or barge while under way. Every effort was made to broadcast the planted quahogs as widely as possible from the vessel and to distribute the quahogs across all suitable habitat areas within the site. In 2020, all quahog relay activities were conducted between July 29th and October 19th.

Site Marking and Closure Period

Prior to commencement of the relays, *DMF* prepared and distributed closure notices for each B-120 contaminated quahog relay site to local and state law enforcement agencies, U.S. Food and Drug Administration (FDA), MA Department of Public Health (DPH), and the MA Department of Environmental Protection (DEP). The notices specified the spatial boundaries for each relay area and stated that shellfishing or attempting to shellfish in the area during the specified closure period is prohibited. The five closure areas in 2020 were marked with posted signs along the shoreline, and in some cases included buoys for marking the outer boundary of the closure area prior to and during the closure period (Figure 7). In all towns except Bourne, the area closed to shellfishing was large enough to encompass the area planted with relayed contaminated quahogs. At Phinney's Harbor in Bourne, town Shellfish Department staff mistakenly planted quahogs outside of the closed area and immediately reported the error to DMF. As a result, the planted area exceeded the closure area by ¾ acre. Regular enforcement patrols of the closed B-120 planting sites in the five participating towns are routinely carried out by municipal shellfish department personnel.

In order to maximize the benefit of restoration efforts, transplanted quahogs are protected so that at least one spawning cycle can be completed within the B-120 relay sites. DMF works with the Buzzards Bay municipalities to keep B-120 quahog relay sites closed for as long as possible. The amount of available suitable quahog habitat within approved or conditionally approved shellfish growing areas varies by town. As a result, municipalities with limited area available for recreational shellfishing generally close the B-120 relay sites for one year, while other municipalities close their sites for two or three years.

Prior to allowing any harvest from the B-120 quahog relay sites to resume, DMF staff collects quahog tissue samples for bacteriological analysis to determine if health standards are met for direct harvest and human consumption. Once it is determined that the planted quahogs are free of bacterial contamination, DMF will lift the contaminated area closure status, and municipal shellfish departments will generate management opening notices stating recreational shellfishing in those areas is allowed. When it is determined that the quahogs are free of bacterial contamination, the five municipalities (Bourne, Dartmouth, Fairhaven, Gosnold, and Wareham) that received contaminated quahogs in 2020 will reopen in the fall of 2021, at least one year after the transplanting of quahogs.

Figure 6. Posted signage for the B-120 contaminated quahog relay sites.

2020 Quahog Relay Results

Except for Gosnold, all participating Buzzards Bay municipalities received 800 bushels of quahogs to plant in their respective B-120 restoration sites. Gosnold requested and received 25 bushels due to the limited availability of suitable habitat within municipality-designated recreational shellfishing areas as well as lower recreational fishing pressure. A total of 3,225 bushels and an estimated 810,272 quahogs were relayed from the Taunton River to the five Buzzards Bay municipalities over the course of the 2020 season.

A summary of estimated number, size range, and planting density of quahogs at each 2020 B-120 site is presented in Table 7, as well as the total number of bushels and quahogs relayed, closure area and planted area across all sites in 2020. Length frequencies of relayed quahogs within each B-120 site are provided in Figures 8 through 12.

*Table 7. Summary table of the 2020 B-120 contaminated quahog relay results. Size measurements denote shell length. *Bourne shellfish personnel mistakenly planted quahogs outside the closure area.*

Municipality	Site Name	# Bushels Relayed	Estimated # of Quahogs	Size Range (mm)	Mean Size (mm)	Planting Density (#/ft.^{2})	Area Planted (acres)	Closure Area (acres)
Bourne	Phinney's Harbor	800	133,696	53.18-111.99	89.2	0.99	3.1	2.4*
Dartmouth	Knowles Pier	800	220,320	31.5-107.1	73.72	1.99	3.1	6.9
Fairhaven	North Cove Bella Vista Island (Senior's Cove)	800	158,656	42.77-114.79	83.2	0.94	3.8	6.4
Gosnold	Cuttyhunk Pond	25	12,800	39.7-92.67	62.5	0.49	0.6	1.4
Wareham	Lydia's Island	800	284,800	15.99-99.34	68.5	1.8	3.5	11.1
All Towns	**Total**	3225	810,272	**Mean**	77.4	1.24	2.8	5.6

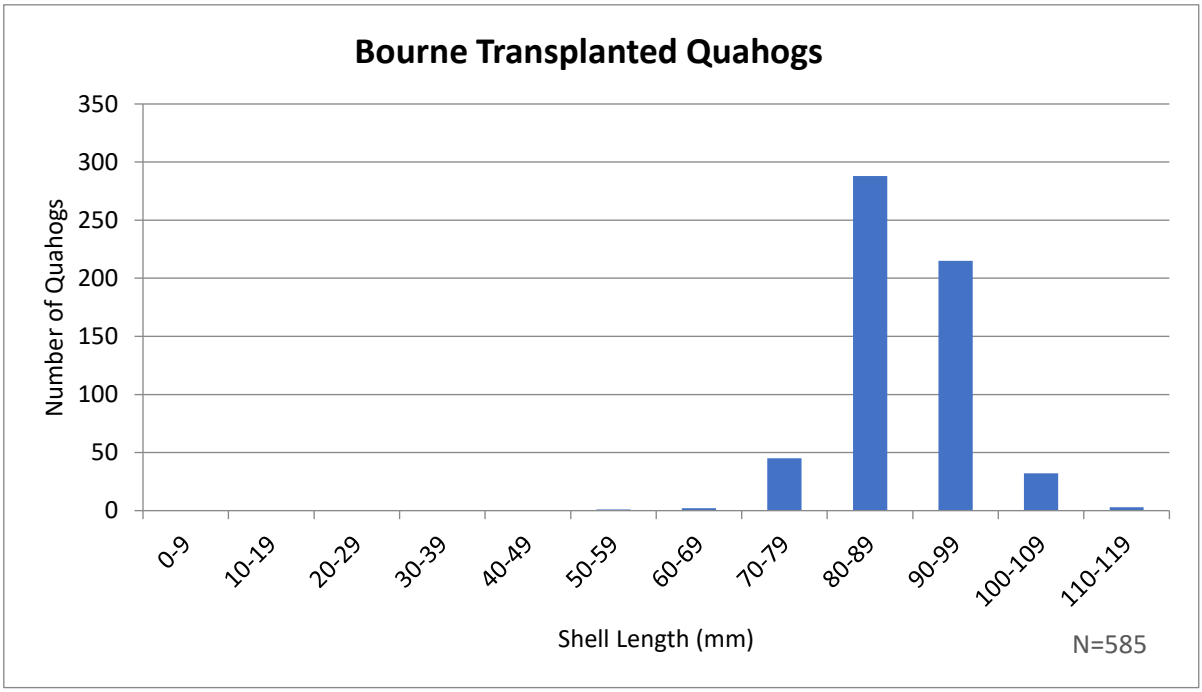

Figure 7. Shell length frequencies from relayed quahogs at Bourne B-120 relay site.

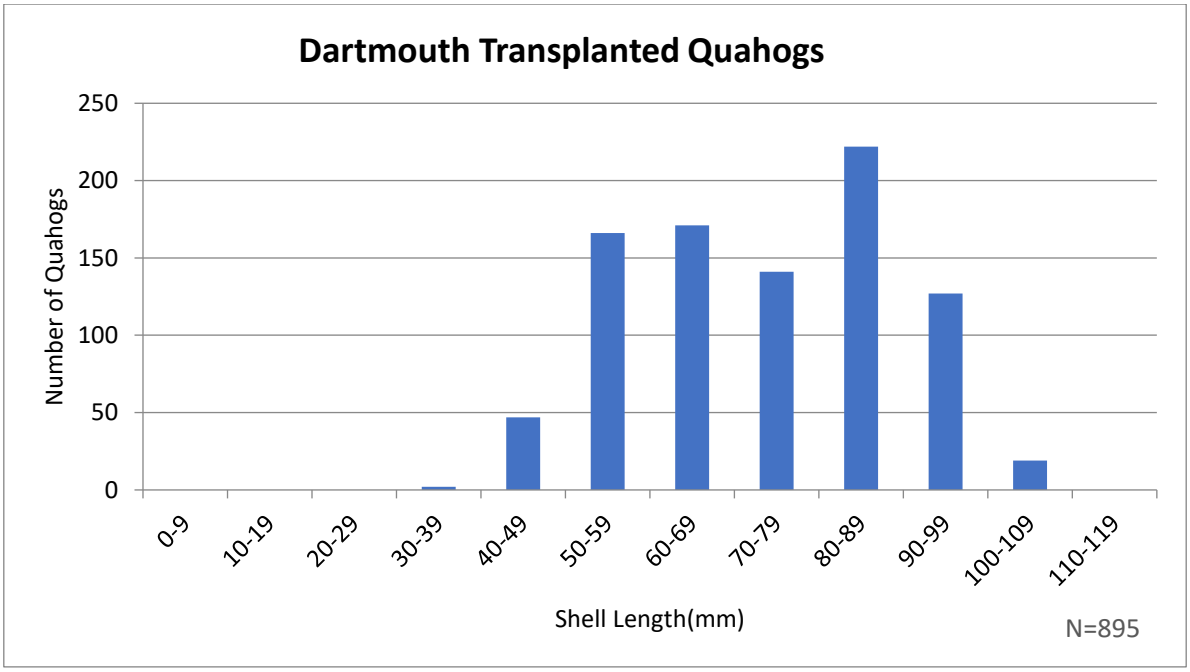

Figure 8. Shell length frequencies from relayed quahogs at Dartmouth B-120 relay site.

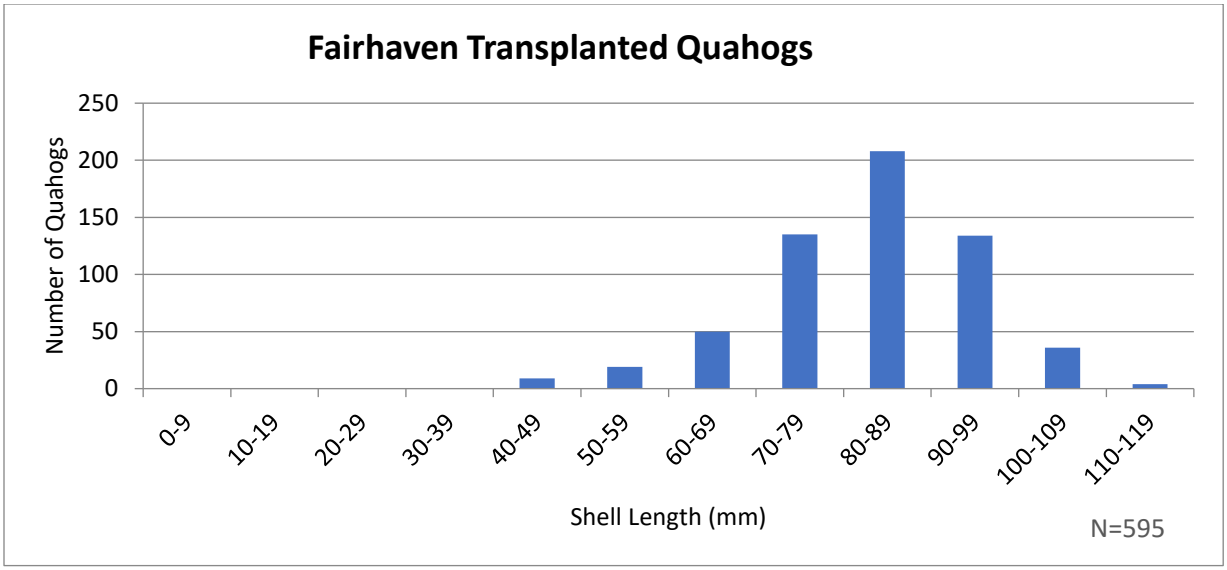

Figure 9. Shell length frequencies from relayed quahogs at Fairhaven B-120 relay site.

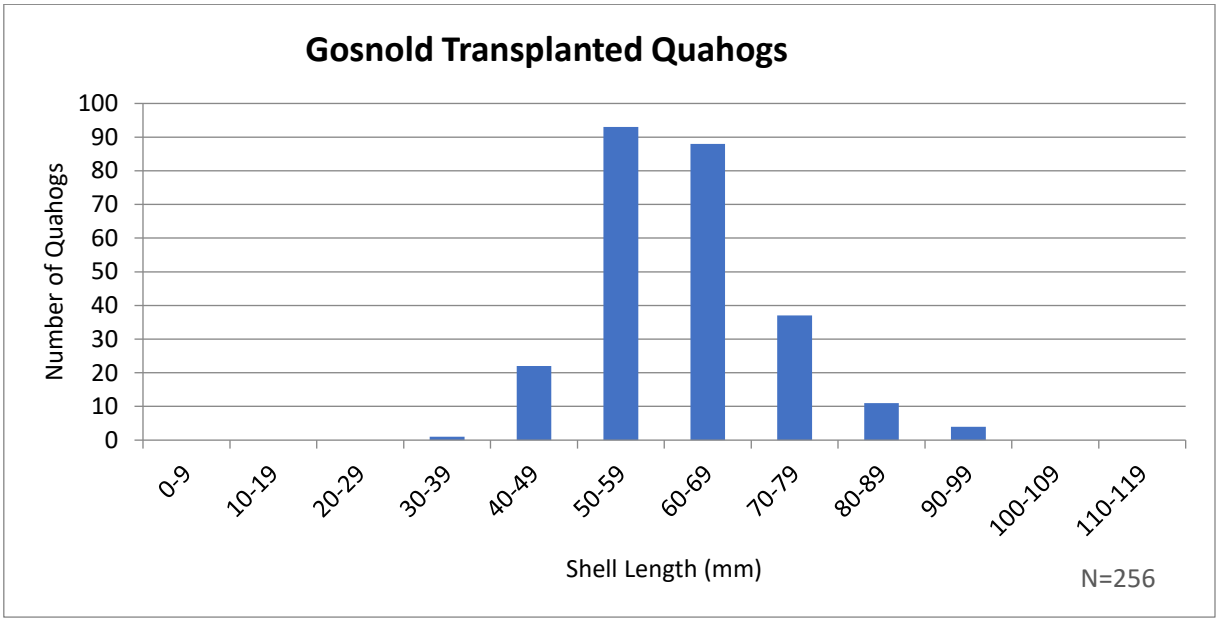

Figure 10. Shell length frequencies from relayed quahogs at Gosnold B-120 relay site.

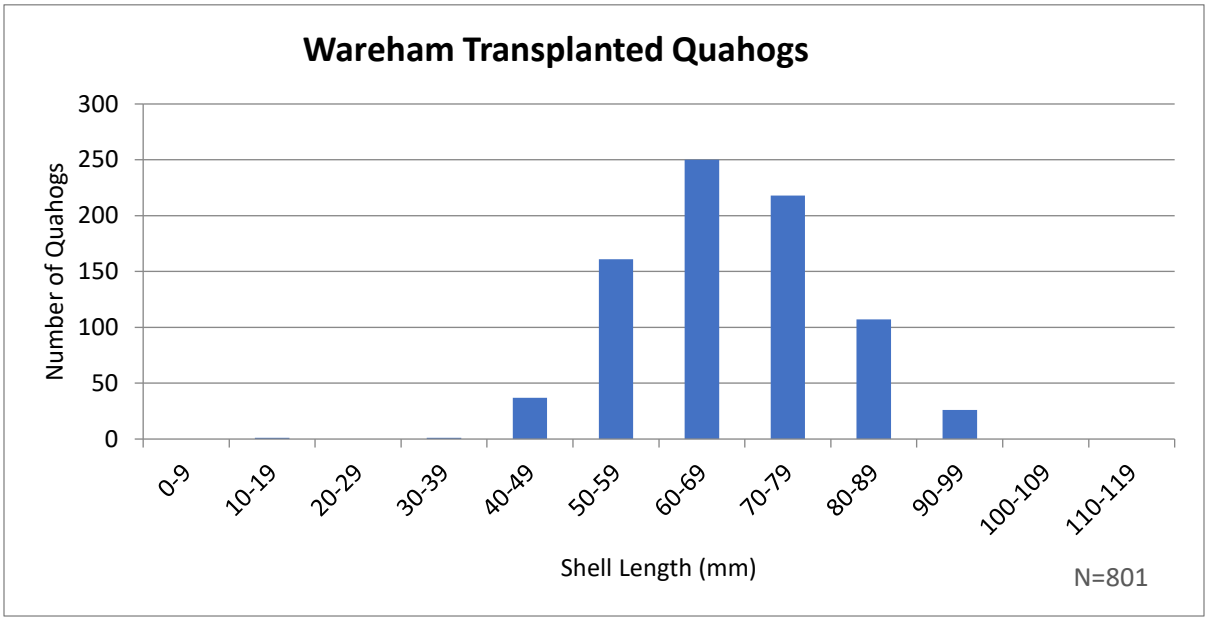

Figure 11. Shell length frequencies from relayed quahogs at Wareham B-120 relay site.

2019 Relay Monitoring Methods and Results

Methods

In an effort to determine the survival and growth of quahogs planted within the 2019 B-120 restoration sites, DMF personnel completed post planting monitoring surveys of all eight sites in seven towns that received adult contaminated quahog relays in 2019. Each town received 800 bushels (Bourne, Dartmouth, Fairhaven, Mattapoisett, New Bedford, Wareham, and Westport). Wareham planted their quahogs at two separate sites in town. The quahogs were planted between June and October 2019, and post-planting monitoring surveys were conducted at all sites between May-October 2020.

From May to October of 2020, DMF completed monitoring surveys of all eight sites planted with contaminated quahogs in 2019. The surveys were conducted to best replicate the survey methodology used the previous years. All but two (New Bedford and Westport) sites were surveyed from shore using basket rakes. Prior to surveying, 4-6 waypoints were selected using ArcGIS as pre-selected locations for survey transects. Effort was made to evenly space these points to best capture the entire planting area in the survey. These points were then uploaded to a handheld GPS. In the field, the waypoints were used as starting locations for survey transects. Transect lengths and number of sampled quadrats varied by site based on water depth and substrate type. All 1-ft^2 quadrats were excavated to a substrate depth of 10-12 inches. Live quahogs were enumerated and shell length measured. Presence of other shellfish and predators along with SAV species and percent cover were also documented. Dead quahog, identified as individual paired shells (clappers), were also enumerated.

Due to the water depth at the site, the post-plant survey in Westport was conducted from a boat using a bullrake. The bullrake was used to excavate quadrats along five transects as the boat advanced. GPS waypoints were collected to map transect locations.

While the relay of contaminated quahogs was being completed at the Coral Street site in New Bedford in August 2019, DMF staff noted that the planting location was in deeper water than the completed pre-plant shore survey. As a result, the survey was conducted by two DMF SCUBA divers working from a DMF vessel. During the dive survey, 8-12 ¼-m^2 quadrats were excavated along three deployed lead line transects by using a hand rake. To best capture an accurate depiction of the planted area and accommodate the challenges of surveying underwater, larger ¼ meter square quadrats were used instead of 1-foot square quadrats used previously in diver surveys. This allowed divers to collect samples at greater distances between stations and avoid losing visibility due to the disturbed substrate resulting from multiple excavations. Total area sampled by divers using ¼-m^2 quadrats is comparable to total area sampled using 1- ft^2 quadrats.

As with the intertidal surveys, all ¼-m^2 quadrats were excavated to a substrate depth of 10-12 inches by the divers. Live quahogs were enumerated and shell length measured. Presence of other shellfish and predators along with SAV species and percent cover were also documented. Dead quahog, identified as individual paired shells (clappers), were also enumerated

Results

Bourne- Barlow's Landing

On September 18, 2020, a survey of the quahog planting site at Barlow's Landing in Bourne was conducted. The habitat was a mixture of mud, sand, and gravel. The sediment was compacted sand and mud in the shallower depths, and loose mud was more prevalent at 3-ft MLLW depth. Many clappers were observed on shore and in the water, as well as some large mounds of quahogs, both dead and alive. Several dead quahogs were found in the intertidal flat outside of the planting area at the northeast corner of the site.

A total of 8 transects of 5-10 quadrats each, were run perpendicular to the shoreline. In the 82 quadrats sampled, 24 live quahogs and 10 oysters were found and measured. Site quahog density was 0.3 quahogs/ft^2 (Table 8). This 2019 B-120 relay site was reopened to shellfishing on November 1st, 2020.

Table 8. Summary table of the post-planting quahog population at the Bourne B-120 relay site, Barlow's Landing.

Mean Length (mm)	65.22
Max Length (mm)	105.14
Min Length(mm)	20.26
Number of Quahogs	24
Area surveyed ($ft.^2$)	82
Density/ $ft.^2$	0.29

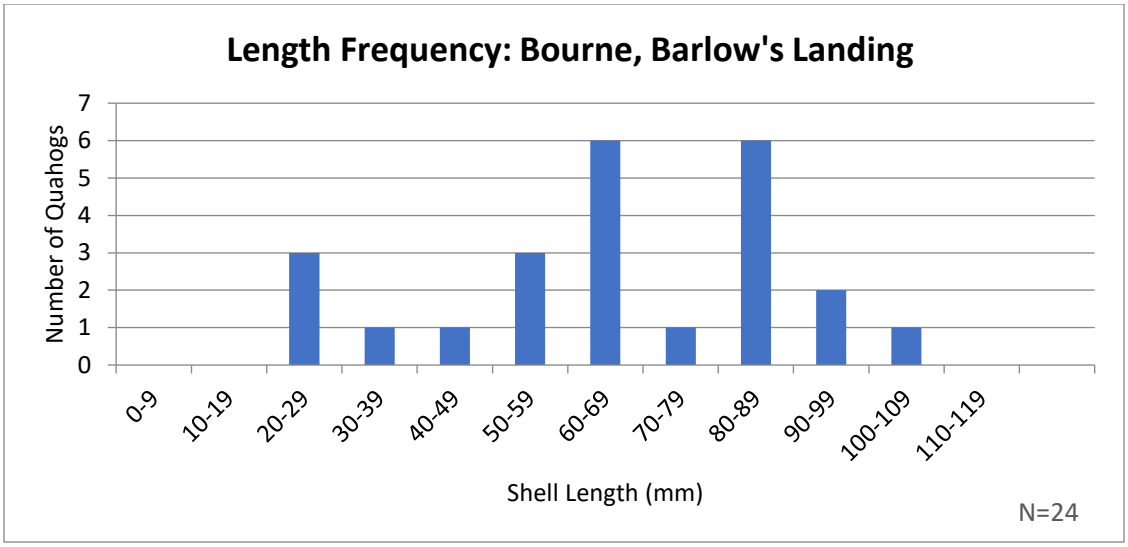

Figure 12. Quahog length frequencies at the Bourne B-120 relay site in Barlow's Landing

Dartmouth- North Side of Gulf Road Bridge

On July 21, 2020, a post planting site survey was completed by DMF staff. The predominant habitat throughout the site was mud and sand but progressed to crushed shell (shack) as transects reached the boating channel. Water depth ranged 1-4 feet, MLLW.

Six transects, perpendicular to the east-west Padanaram bridge and evenly spaced out throughout the planting area were surveyed. Each transect consisted of 4-8 quadrats, depending on water depth, and a total of 40 quadrats were surveyed. Across the site, 54 quahogs were found within the 40 quadrats, for a resulting quahog density of 1.35 quahogs/ft^2 (Table 9). Sampled quahogs did not have distinguishing characteristics between resident and planted animals and given the wide range of sizes found at the site, we speculate that non-planted animals are included in the data collected. This site was closed to shellfishing for 1 year and was reopened on November 1st, 2020.

Table 9. Summary table of the post-planting quahog population at the Dartmouth B-120 relay site, Gulf Road Bridge N.

Mean Length (mm)	63.16
Max Length (mm)	95.31
Min Length(mm)	23.88
Number of Quahogs	54
Area surveyed (sq. Ft)	40
Density (#sq. Ft.)	1.35

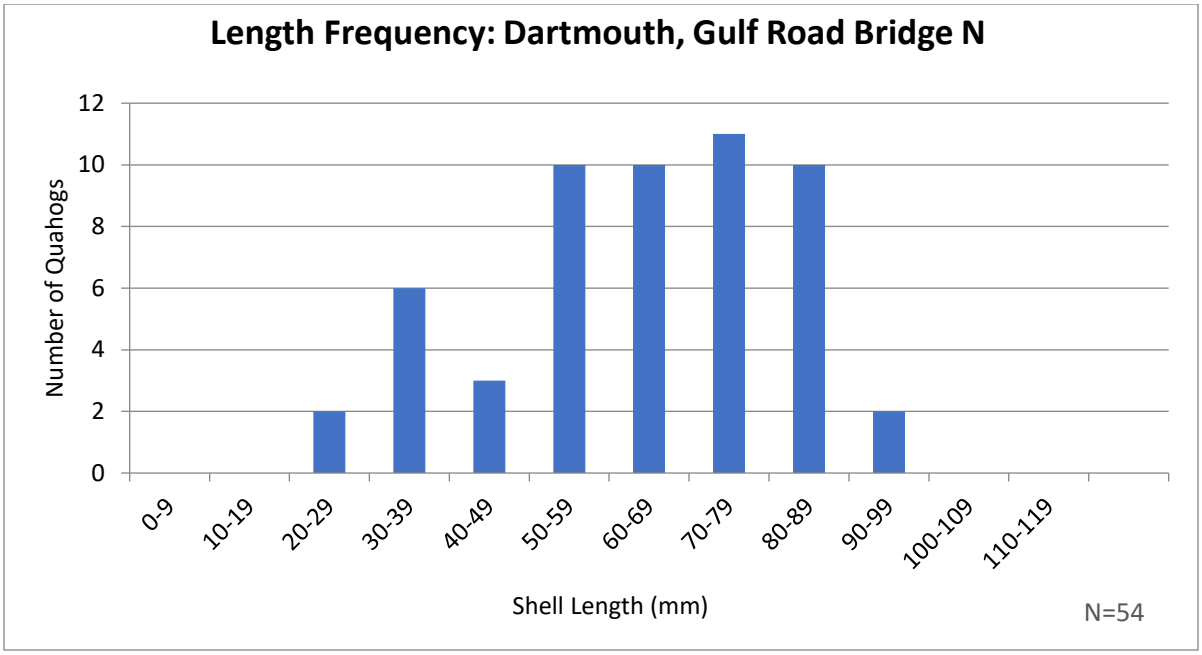

Figure 13. Quahog length frequencies at the Dartmouth B-120 relay site on the north side of the Gulf Road Bridge.

Fairhaven- North Cove

On June 3, 2020, a post-planting survey of the North Cove site was completed by DMF staff. Survey results indicated a predominantly sand and mud substrate. Water depth in North Cove ranged between 1 and 4 feet, MLLW

Four transects of 9-10 quadrats, perpendicular to the shore and spaced roughly 20-30 feet, were surveyed. A total of 39 quadrats were surveyed throughout the site. Sixteen quahogs were found across the area, for a site quahog density of 0.33 quahogs/ft^2 (Table 10). Beginning in March 2020, the Town of Fairhaven experienced unprecedented growth in the number of shellfish permits issued to recreational harvesters. The Shellfish Constable believes this was directly related to the COVID-19 pandemic and public desire to gather their own shellfish rather than purchasing them at retail outlets. Upon receiving a request from the Constable, DMF re-opened the B-120 North Cove site to recreational shellfishing on June 1st, 2020, four months ahead of the originally planned date.

Table 10. Summary table of the post-planting quahog population at the Fairhaven B-120 relay site, North Cove.

Mean Length (mm)	54.20
Max Length (mm)	78.99
Min Length(mm)	39.69
Number of Quahogs	13
Area surveyed (sq. Ft)	39
Density (#/sq. Ft.)	0.33

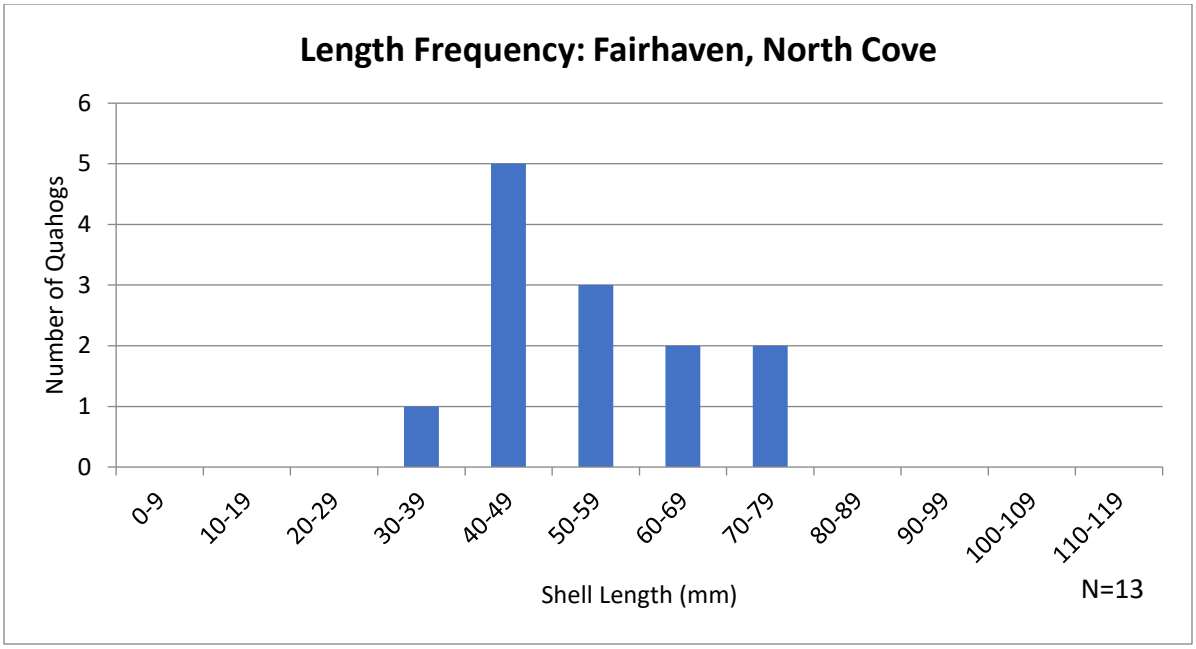

Figure 14. Quahog length frequencies at the Fairhaven B-120 relay site in North Cove.

Mattapoisett – Mattapoisett Harbor

On July 16, 2020, DMF biologists completed the post-planting survey of the 2019 relay site in Mattapoisett. Survey results indicated a habitat consisting of mainly sand with gravel and mud. Water depth at the site ranged between 0 and 3.5 feet, MLLW. Four whelks were also collected within the area, as well as one juvenile green crab (*Carcinus maenas*). A total of 8 transects each with 10 quadrats were sampled in the Mattapoisett Harbor site for a total of 80 quadrats. Thirty-seven quahogs were found across the area for a resulting quahog density of 0.46 quahogs/ ft.^{2} (Table 11). Of the quahogs found, 28 were under 60 mm, and are presumed to be resident quahogs due to their small size.

Due to the drastic increased number of permits issued to recreational shellfishermen because of the COVID-19 pandemic during the spring 2020, the Shellfish Constable requested that DMF reopen the B-120 Mattapoisett Harbor quahog restoration site as early as possible. DMF reopened the site for recreational shellfishing on August 3rd, 2020, two months earlier than originally planned

Table 11. Summary table of the post-planting quahog population at the Mattapoisett B-120 relay site, Mattapoisett Harbor.

Mean Length (mm)	42.91
Max Length (mm)	93.71
Min Length(mm)	10.60
Number of Quahogs	37.00
Area surveyed (sq. Ft)	80.00
Density (#/sq. Ft.)	0.46

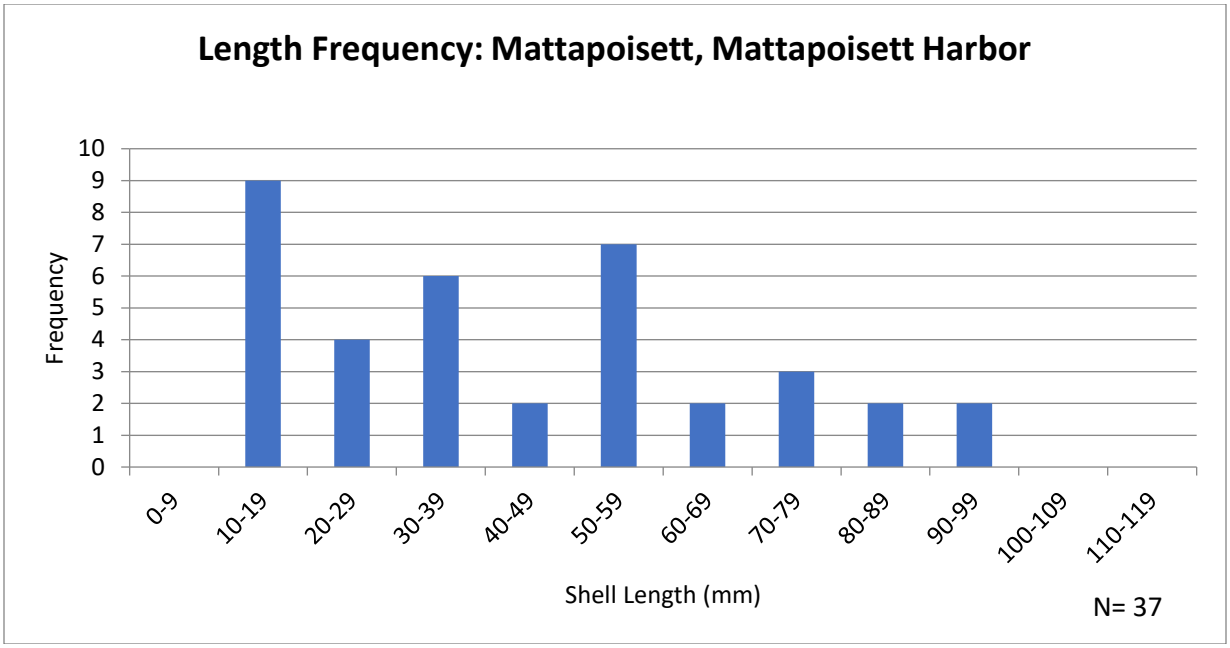

Figure 15. Quahog length frequencies at Mattapoisett B-120 relay site in Mattapoisett Harbor

New Bedford – Clark's Cove-Coral Street

On November 8, 2020, DMF divers completed the post-planting survey of the 2019 Coral Street quahog relay site. Survey results indicated a habitat consisting of mainly sand with gravel and mud. Water depth at the site ranged between 2.5 and 14.5 feet, MLLW. The substrate in this deeper water (>10 feet) was predominantly mud and consisted of a large amount of *Codium* cover, while the shallower substrate closer to shore (5 – 2 ft. deep) was primarily bare sand.

Three subtidal lead-line transects ranging between 75 and 122 feet in length were deployed perpendicular to shore in depths between 2.5 and 14.5 ft, MLLW. A total of 28 equally spaced ¼- m^2 quadrats were excavated by two divers along the three transects. Total area excavated was 75.34 ft^2. Fifty-seven quahogs were found throughout the area for a density of 0.76 quahogs/ ft^2 (Table 12). Many clappers and broken shells were also observed throughout the site by divers as they were swimming between quadrats.

The Coral Street quahog restoration site will remain closed to recreational shellfishing at least through fall 2021.

Table 12. Summary table of the post-planting quahog population at the New Bedford B-120 relay site, Coral Street boat ramp.

Mean Length (mm)	86.87
Max Length (mm)	102.85
Min Length(mm)	30.13
Number of Quahogs	57.00
Area surveyed (sq. Ft)	75.34
Density (#/sq. Ft.)	0.76

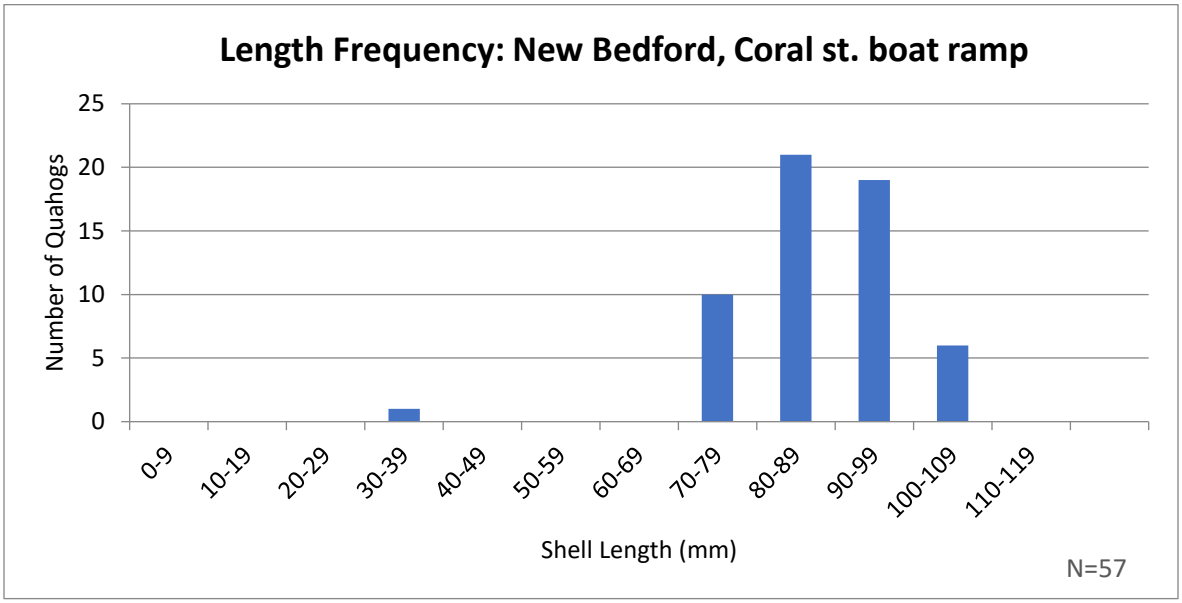

Figure 16. Quahog length frequencies at the New Bedford B-120 relay site at the Coral Street boat ramp.

Wareham – Swift's Neck Beach and Mark's Cove

The 2019, contaminated quahogs were relayed into two planting areas, a smaller area (4 acres) adjacent to Swift's Neck beach and a larger area (12.7 acres) west of the Beach named Mark's Cove. The sites were closed for one-year and opened for recreational fishing on October 5, 2020.

Swift's Neck Beach

On June 15, 2020, DMF conducted a post-planting survey of Swifts Neck Beach. Survey results indicated a habitat consisting of mainly mud and sand with low to moderate presence of eelgrass and filamentous red algae. Water depth at the site ranged between -0.5 and 1.5 feet, MLLW. A total of four transects with 10 quadrats each were sampled within the site (40 quadrats total). Four quahogs were collected for a density of 0.1 quahogs/ft^2 (Table 13). While walking between transects, DMF biologist observed mounds of live quahogs that were not captured through the survey due to the nature of the random sampling.

Table 13. Summary table of the post-planting quahog population at the Wareham B-120 relay site, Swift's Neck Beach.

Mean Length (mm)	83.20
Max Length (mm)	90.84
Min Length(mm)	78.83
Number of Quahogs	4
Area surveyed (sq. Ft)	40
Density (#/sq. Ft.)	0.1

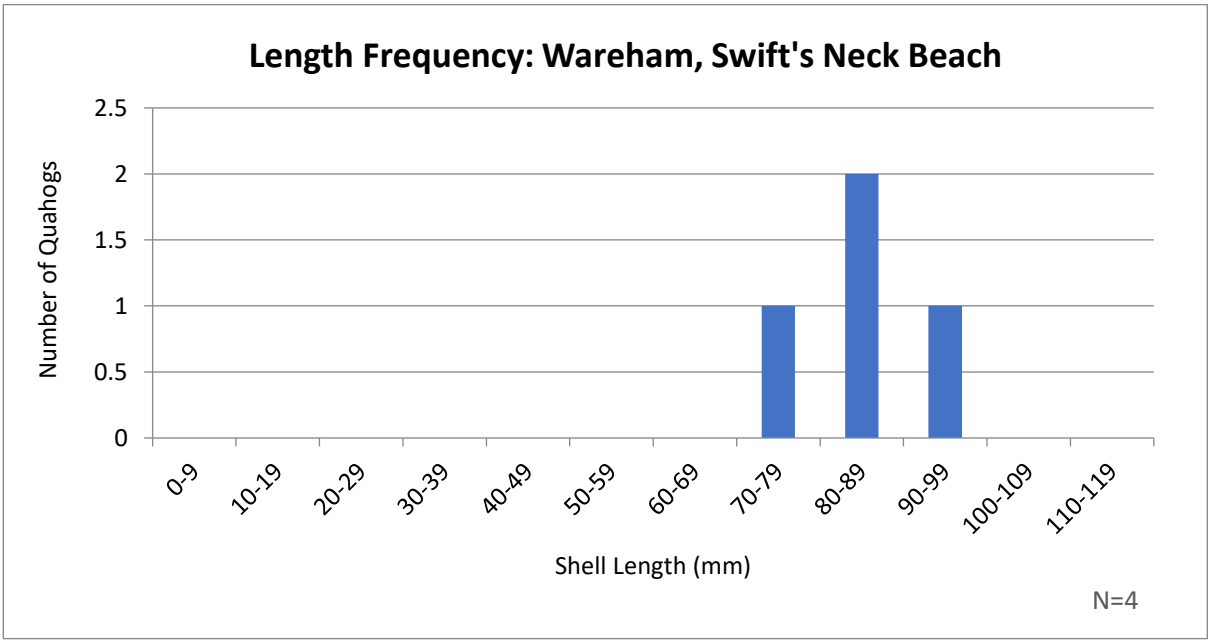

Figure 17. Quahog length frequencies at the Wareham B-120 relay site, Swift's Neck Beach.

Mark's Cove

On June 16, 2020, the post-planting survey of Mark's Cove was completed. Survey results indicated a mixed sand and mud substrate with very little eelgrass throughout the site. Water depth in Mark's Cove ranged between 0.2 and 1.7 feet, MLLW. A total of four transects of 10 quadrats each were sampled within the site (40 quadrats). Ten quahogs were collected for a density of 0.3 quahogs/ft^2 (Table 14).

Table 14. Summary table of the post-planting quahog population at the Wareham B-120 relay site, Mark's Cove.

Mean Length (mm)	82.61
Max Length (mm)	96.54
Min Length(mm)	35.52
Number of Quahogs	10
Area surveyed (sq. Ft)	40
Density (#/sq. Ft.)	0.3

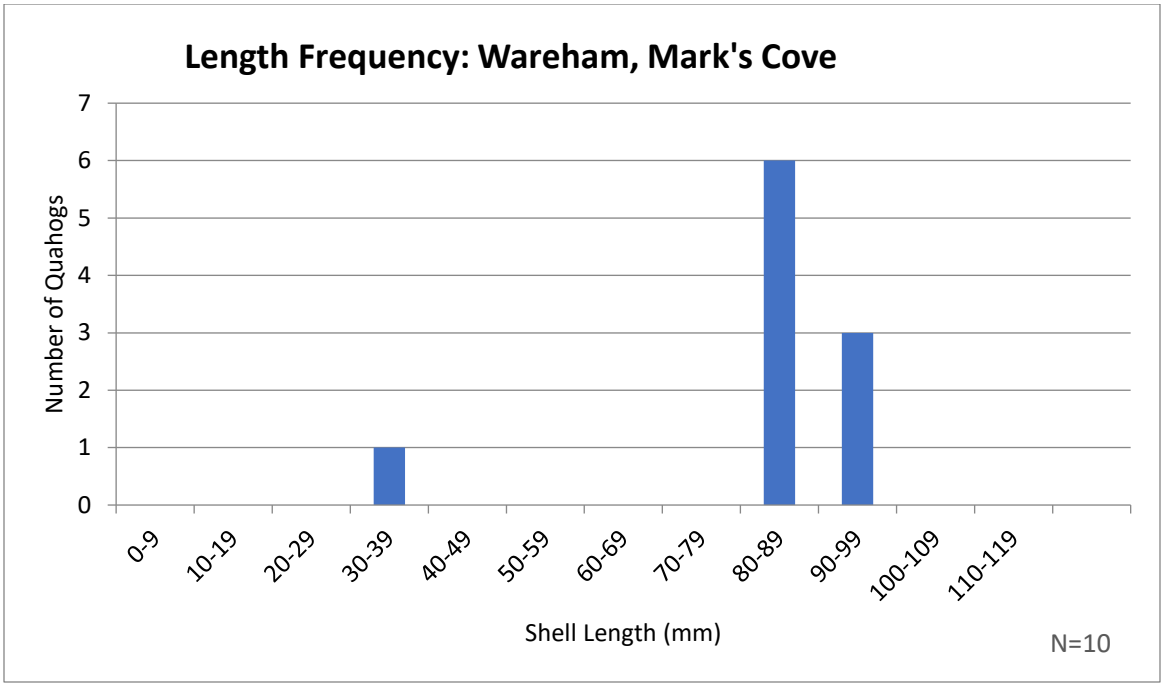

Figure 18. Quahog length frequencies at the Wareham B-120 relay site, Mark's Cove.

Westport – The Let Section 4

On June 24, 2020, a DMF biologist and the Westport Shellfish Constable conducted a post-planting survey of the 2019 B-120 quahog relay site. The site is in deeper water than what a shore survey would allow, so the survey was conducted from a town vessel using a bullrake to survey quadrats. Survey results indicated a sand and mud substrate with some *Codium*, filamentous red algae and *Ulva* throughout the site. Water depth at the site was 3 feet, MLLW. A total of five transects with 11 - 20 quadrats each were sampled within the site (80 quadrats). A total 68 quahogs were collected for a density of 0.85 quahogs/ft.^{2} (Table 15).

Table 15. Summary table of the post-planting quahog population at the Westport B-120 relay site, The Let (Section 4).

Mean (mm)	86.11
Min (mm)	58.77
Max (mm)	110.68
Total #	68
# Quadrats	80
Density (#/sq. ft.)	0.85

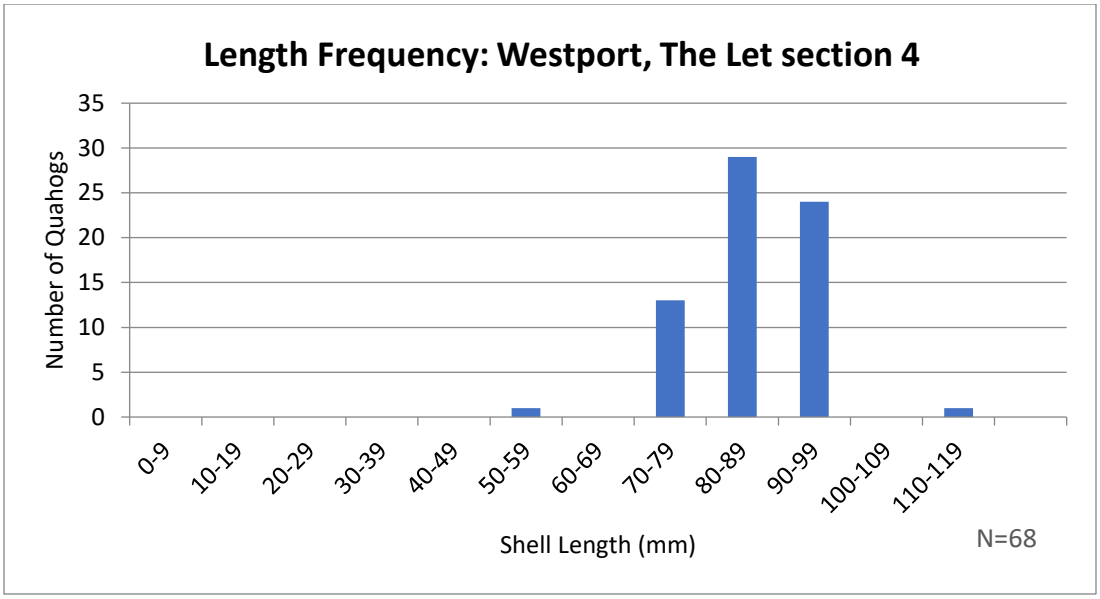

Figure 19. Quahog length frequencies at the Westport B-120 relay site, The Let (Section 4).

Quahog Growth and Survival

A summary of the 2019 pre-plant survey and 2020 post-plant survey results are displayed in the table below (Table 16).

Table 16. Summary table comparing B-120 contaminated quahog relay planting data (2019) and post-plant monitoring data (2020).

Municipality	Site Name	Bushels Planted - 2019	Estimated Number of Quahogs Planted	2019 Mean Size (mm)	2019 Survey Density (Quahog /ft²)	2020 Mean Size (mm)	2020 Survey Density (Quahog/ft²)	Area Surveyed (ft²)	2020 Number of Living Quahogs	2020 Number of Clappers	Percent Mortality
Bourne	Barlow's Landing	800	152,000	48.0	0.48	65.22	0.29	82	24	39	61.9
Dartmouth	Gulf Bridge Road - North	800	140,571	59.77	0.65	63.16	1.35	40	54	14	20.6
Fairhaven	North Cove - West	800	133,186	50.55	0.57	54.20	0.33	39	13	1	7.1
Mattapoisett	Shining Tides	800	149,120	40.94	0.55	42.91	0.46	80	37	8	17.8
New Bedford	Coral Street Ramp	800	164,141	66.81	0.37	86.87	0.76	75	57	43	43
Wareham	Mark's Cove	800	145,723	17.82	0.28	87.85	0.2	40	9	2	18.2
Wareham	Swift Neck Beach	800	145,723	18.94	0.33	83.20	0.1	40	4	0	0.0
Westport	The Let - SW Quadrant	800	148,452	75.14	0.18	86.11	0.85	80	68	11	13.9

The average size of quahogs at all sites increased over the course of one year and post-plant densities of quahogs were greater than pre-plant densities at three of the sites (Dartmouth, New Bedford and Westport) indicating that the restoration program was successful at these sites. However, post-plant densities at the five remaining sites in Bourne, Fairhaven, Mattapoisett and Wareham were less than the pre-plant densities. Upon further investigation and discussion with the Constables, we have concluded that with the exception of Barlow's Landing site in Bourne, the post-plant surveys within the Fairhaven, Mattapoisett and Wareham sites were not conducted within the area where quahogs were planted by the towns. DMF biologists work closely with town Constables to accurately define and mark B-120 restoration site closure areas. In most cases, the area closed to shellfishing is far greater than the actual area that is planted with quahogs. DMF staff are unable to witness all B-120 quahog relays that occur in each participating town over a period of 5-10 days. We rely on accurate reporting on planting locations by the Constables upon completion of relay activities. This information was not adequately collected or documented in 2019, partially due to DMF's B-120 Program staffing changes during the winter and spring of 2019/2020. Fairhaven, Mattapoisett, and Wareham have since opened their 2019 B-120 quahog restoration sites to recreational fishing and reported that the quahogs were abundant at all the sites.

The drop in quahog density from 2019 to 2020 at Barlow's Landing in Bourne is believed to be an accurate assessment of poor survival at the site. When surveyed by DMF biologists and town staff, a large number of paired and single quahog shells were found on an intertidal flat northeast of the planting area. Bourne Shellfish Department personnel believe that a series of winter storms during low tide displaced the planted quahogs onto the intertidal flat, causing many of them to perish.

2020 Condition Index Methods and Results

In 2020, three sites planted with relayed quahogs in 2019 were sampled to obtain the condition index (CI) of the planted quahogs, one-year after their relocation. DMF collected samples from each site in Fairhaven, Mattapoisett, and Westport. These samples were compared to samples taken in 2019 at the time of harvest from the Taunton River for each designated town. As previously stated, CI is a good indicator of the quahog's general condition, gonadal development, and health. A healthy animal will have a CI value in the range of upper 60s to upper 70s (Marroquin-Mora and Rice 2008). CI values are most useful as a comparative tool across and within seasons and between individuals and populations rather than as an independent metric of reproductive health. A total of 20 quahogs were collected from each site for processing and determination of CI. The procedures and formula from Crosby and Gale (1990) were used to determine the CI of the collected quahogs. The formula used to calculate the condition index is as follows:

CI = [dry soft tissue weight (g) X 1,000] / [total weight (g) – shell weight (g)]

The mean post-plant condition index values obtained from the samples collected in 2020 ranged from 91.83 -96.49 (Table 17). In 2019 the values ranged from 64.5-72.7 (Figure 20). While the substantial increase in CI value can't be attributed to any one cause, the higher values suggest that the relocation of quahogs from the contaminated waters of the Taunton River to the Buzzards Bay municipalities has benefitted the overall health of the quahogs.

Table 17. Summary table with CI values from 2019 and 2020. Date of analysis as well as sample size are also stated. All weights were measured to the nearest 0.01g.

Municipality	2019 Mean CI	2019 Standard Deviation	2020 Mean CI	2020 Standard Deviation	2019 CI Date	2020 CI Date	2019 Sample Size	2020 Sample Size
Fairhaven	66.28	10.68	96.49	16.39	7/1 - 7/3	6/29-7/1	17	20
Mattapoisett	72.70	7.39	91.83	8.28	7/15 - 7/17	7/20-7/22	20	20
Westport	64.50	10.20	92.71	16.38	6/19 - 6/21	6/24-6/26	20	20

Figure 20. Mean monitoring condition index (+/- SD) of quahogs collected from the Taunton River in 2019 for B-120 relays (in blue) and quahogs collected one-year post-planting (in orange) at the three intensively-sampled sites in Fairhaven, Mattapoisett, and Westport.

II. Single Oyster Purchase, Grow-out, and Outplanting

In 2020 DMF completed post-planting surveys of all five sites in the towns of Bourne, Marion, and Wareham, where single oysters were planted in 2019. Some of these sites benefitted from multiple years of oyster outplanting. No oysters were purchased with B-120 funds in 2020 for rearing in town upwellers. As a result, no monitoring of these activities was conducted by DMF. However, in 2020, DMF purchased and oversaw the planting of 150,000 field-plant sized oysters in two Buttermilk Bay oyster reef sites in the towns of Bourne and Wareham as part of the shellfish restoration work completed under the B-120 project.

Oyster Post-Planting Surveys

Methods

In the fall of 2019, oyster seed grown in town upwellers and intermediate grow-out systems throughout the summer was released in specified B-120 restoration sites. Two sites were seeded in Marion as well as in Wareham, and one site in Bourne. One year following planting, monitoring surveys were conducted to assess survival and growth of planted oysters. DMF personnel collaborated with town staff to conduct biological surveys of the restoration sites. Surveys consisted of running multiple transects across each site and using a mesh-lined basket rake, and 1-ft^2 quadrats were excavated at 5-10 ft intervals along each transect. All oysters found within a quadrat were counted and measured, and any other commercially important shellfish species or predators were identified by species and noted. Other information collected included: substrate type, vegetation cover, and water depth. The length of individual transects, and number of quadrats varied based on site dimensions as well as slope of the shoreline determining where a transect landside endpoint was located.

Results

To measure changes of the planted sites, we compared survey results prior to and one year after oyster outplanting. Site pre-plant survey results from 2019 and survey results from one-year post-planting monitoring in 2020 are summarized in Table 18. Densities of oysters increased at three of the five sites. Due to the lower density of oysters at Lydia's Island in Wareham and the many years of planting oysters at the site with success (increased density), we speculate that the reef has reached a carrying capacity where future plantings will lose effectiveness. Results from Marion surveys are not easily explained, and further investigation into the lack of oysters at the site should be investigated.

Table 18. Summary table comparing B-120 oyster restoration planting data (2019) and monitoring data collected in 2020. Size measurements denote shell height.

Municipality	Planting Site	Planting Dates	2019 Pre-planting Oyster Density	2019 Mean Oyster size (mm)	2020 Oyster Density	2020 Mean Oyster Size (mm)
Bourne	Barlow's Landing	11/12/2019-11/13/2019	0.29	57.56	3.13	62.65
Marion	Silvershell Beach	10/16/19	0.00	N/A	0.00	N/A
Marion	Tabor Academy	10/16/19	0	N/A	0.03	128.97
Wareham	Lydia's Island	10/8/2019-10/9/2019	8.15	76.95	5.88	101.86
Wareham	Tempest Knob	10/8/2019-10/9/2019	0.35	69.05	1.31	45.82

Bourne - Barlow's Landing

On October 14th, 2020, DMF personnel conducted a post-planting survey of the 2019 oyster restoration site, located at Barlow's Landing within Pocasset Harbor. A total of 6 transects, perpendicular to shore, were surveyed starting at the water's edge, 0.1 feet to 1.6 feet, MLLW. Transects consisted of 10-17 1-ft^2 quadrats depending on water depth, and a total of 60 quadrats were surveyed. Habitat at the site was mainly mud, sand, and gravel, with minimal SAV. Many quahog clappers were observed on shore and in the water. Many small (<40mm) clustered oysters were found at the site, and it is speculated that these oysters are resident and not planted animals. A total of 100 oysters and 38 quahogs were found in the 60 quadrats, for a density of 1.67 oysters/ft^2 and 0.63 quahogs/ft^2 (Table 19). Oysters found were mainly large and detached, with a mean size of 62.65 mm. Sampled quahogs had a mean size of 74.08 mm. The large number of quahogs found is believed to be a result of relocated B-120 quahogs pushed into the intertidal by storm event(s) or other environmental factors.

Table 19. Summary table of post-planting survey results at Bourne's Barlow's Landing oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Species	Oysters	Quahogs
Mean (mm)	62.65	74.08
Min (mm)	21.64	32.71
Max (mm)	107.94	102.15
Total #	100	38
# Quadrats	60	60
Density (#/sq. Ft.)	1.67	0.63

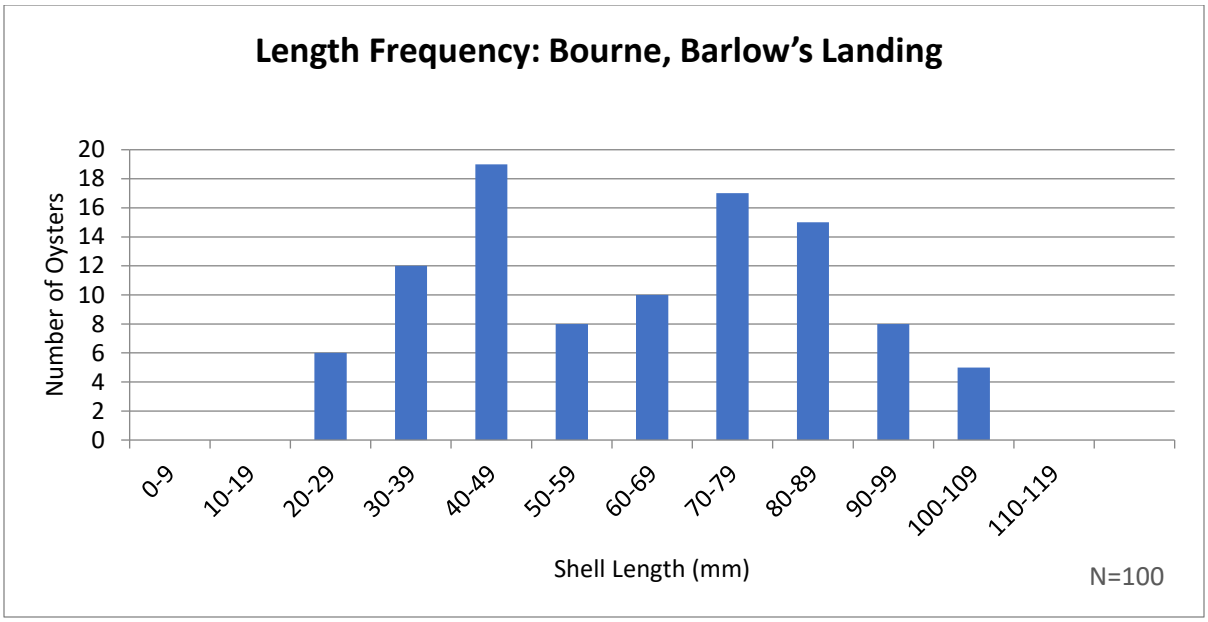

Figure 21. Oyster Length frequencies at the Bourne B-120 oyster planting site, Barlow's Landing, one-year post-planting.

Marion – Tabor Academy and Silvershell Beach

On September 17th, 2020, DMF personnel conducted two post-planting surveys at each of the 2019 B-120 oyster restoration sites in Marion. The first located at Tabor Academy and the second at Silvershell Beach. Both sites are located within Sippican Harbor.

Tabor Academy

The survey completed at Tabor Academy was composed of six transects perpendicular to the shore from 0.3 feet, MLLW to 1.8 feet, MLLW. Within each transect five 1-ft^2 quadrats were excavated for a total of 30 quadrats throughout the entire site. The habitat found was mainly mud, sand, and gravel with patches of filamentous red algae and large rocks interspersed. One oyster and 17 quahogs were found, for resulting densities of 0.03 oysters/ft^2 and 0.57 quahogs/ft^2 (Table 20).

Table 20. Summary table of post-planting survey results at Tabor Academy, Marion oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Species	Oysters	Quahogs
Mean (mm)	128.97	68.56
Min (mm)	128.97	47.74
Max (mm)	128.97	89.18
Total #	1	17
# Quadrats	30	30
Density (#/sq. ft.)	0.033	0.567

Silvershell Beach

The post-planting survey of Silvershell Beach consisted of four transects, perpendicular to the shore, from 0.3 feet to 2.3 feet, MLLW. A total of 37 quadrats were surveyed throughout the entire site, with each transect consisting of 8-10 1-ft^{2}quadrats. The habitat was mainly rock, with firm mud and sand. Patches of filamentous red algae were also present. No oysters or quahogs were found within the survey area. Rock outcrops within the intertidal zone outside of the survey area supported patches of oysters large (~100 mm) oysters (Figure 22 a, b). Many of these oysters had small oysters attached to their shells, indicating recent natural recruitment of oysters within the embayment.

Figure 22 and b. Pictures of oyster clusters growing on rock outcrops at the Silvershell Beach B-120 oyster restoration site These oysters are likely the result of natural recruitment within the embayment.

Wareham – Lydia's Island and Tempest Knob

In September and October 2020, DMF personnel conducted post-planting surveys at each of the two 2019 B-120 oyster restoration sites in Wareham. The first site located off Lydia's Island in Onset Bay, was surveyed on 9/15/2020; this site has been used for B-120 oyster restoration work for the last three years. The second site at Tempest Knob Terrace Beach Marina was surveyed on 10/15/2020. This site was used for nursery grow-out of B-120 oyster seed in deeper water during 2019. The oysters were then planted on the shore in the fall.

Lydia's Island

DMF biologists, with the help of Wareham personnel, conducted the post-planting survey of Wareham's 2019 B-120 oyster restoration site located on the northwestern shore of Lydia's Island in Onset Bay. The site has been supplemented with single oysters yearly since 2017 through B-120 restoration projects.

Five transects perpendicular to shore were surveyed in 0.3 to 3.5 feet, MLLW. A total of 32 quadrats were surveyed with 5-8 1-ft^2 quadrats in each transect, depending on water depth. Substrate throughout the site was firm sand and gravel, becoming solely firm sand at 6-8 inches of water depth. A total 188 oysters and 10 quahogs were found in the area surveyed with site densities of 5.88 oysters/ft^2 and 0.31 quahogs/ft^2 (Table 21). The mean oyster size was 101.86 mm and mean quahog size was 78.08 mm. The presence of a large and densely packed oyster bed is believed to be evidence of successful three years of oyster restoration work at the site.

Table 21. Summary table of post-planting survey results at Lydia's Island, Wareham oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Species	Oysters	Quahogs
Mean (mm)	101.86	78.083
Min (mm)	49.93	57.31
Max (mm)	159.02	92.43
Total #	188	10
# Quadrats	32	32
Density (#/sq. Ft.)	5.88	0.3125

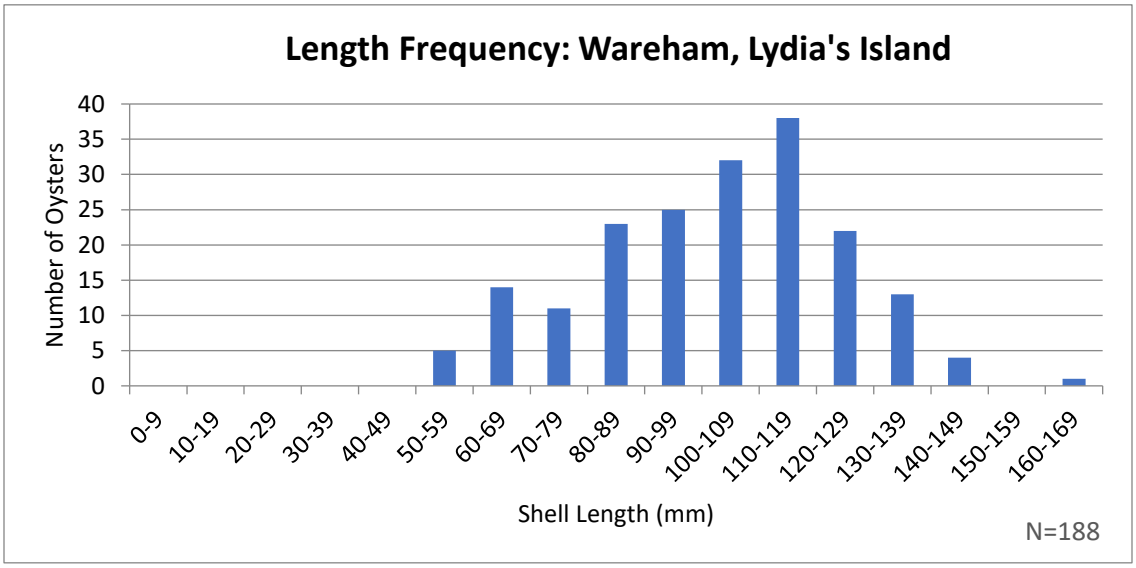

Figure 23. Oyster Length frequencies at the Wareham B-120 oyster planting site, the Lydia's Island, one-year post-planting.

Tempest Knob

On October 15th DMF biologist completed a post-plant survey of the Tempest Knob site. A total of 35 quadrats were surveyed along four transects of 7-10 1-ft^2 quadrats each, from 0.1 to 2.1 feet, MLLW.

The substrate consisted predominantly of sand and mud with some gravel and loose rock, and filamentous red algae where mud was more abundant. A total of 46 oysters and 2 quahogs were found at densities of 1.31 oysters/ft^2 and 0.05 quahogs/ft^2 (Table 22). Sampled oysters consisted of large single individuals most likely planted during the 2019 B-120 restoration efforts and smaller naturally recruited oysters attached to rocks and substrate and other oysters. The mean size of the oysters was 45.82 mm.

Table 22. Summary table of post-planting survey results at Tempest Knob, Wareham oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Species	Oysters	Quahogs
Mean (mm)	45.82	59.275
Min (mm)	18.60	52.58
Max (mm)	92.17	65.97
Total #	46	2
# Quadrats	35	35
Density (#/sq. Ft.)	1.31	0.057143

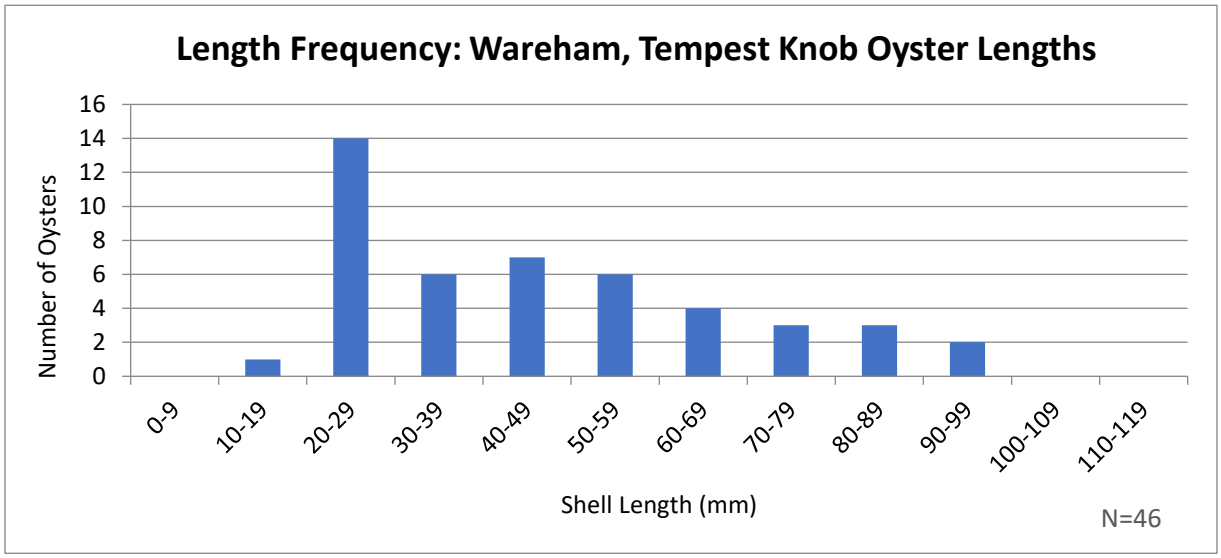

Figure 24. Oyster Length frequencies at the Wareham B-120 oyster planting site, Tempest Knob, one-year post-planting.

Oyster Outplanting in Buttermilk Bay

Methods

As part of the 2020 B-120 restoration project, DMF facilitated the planting of 150,000 oysters at two oyster reef sites in Buttermilk Bay, one within the town of Wareham and the other in Bourne waters (Figure 25). Both 1-acre sites were collaboratively implemented by The Nature Conservancy (TNC) and

the two towns in 2018 as part TNC's B-120 Shellfish Restoration Program. A total of 190 cubic yards of aged surf clam shell was split between the two locations. Subsequently, approximately 164,000 oysters were planted within the reef built in Bourne and approximately 172,800 oysters were planted on the constructed reef in Wareham. Both sites had high resolution benthic and topographic surveys of the planted reef completed. In the fall of 2019, TNC commissioned a one-year post-planting survey to measure survival of oysters at the two sites. In August 2020, DMF coordinated with Bourne and Wareham personnel to plant 150,000 field-plant sized oysters secured through the B-120 restoration project on the two constructed reefs in Buttermilk Bay.

Prior to outplanting oysters on the two oyster reefs, DMF staff digitally mapped both sites. Detailed digital maps and 2018 benthic survey data from Bourne reef site were provided to DMF by TNC. No similar data were available for the reef site in Wareham. As a result, a digital map of the site was created by DMF staff using satellite imagery providing a visual signature limit of the reef structure. The digital maps (Figure 26 a and b) were used to guide all oyster planting activities.

On August 19, 2020, personnel from the town of Bourne collected 150,000 28-34 mm oysters from the Muscongus Bay Aquaculture nursery site in Bourne. All oysters were sorted and bagged into 20-liter onion bags and stored in Styrofoam coolers with gel packs prior to pick up. Each bag contained between 2,000 and 7,000 oysters and each town was provided approximately 75,000 oysters. A handheld GPS was used to record planting locations. In Bourne short drifts were conducted so that all 75,000 were scattering over the designated cultch bed, while in Wareham approximately 3,000 oysters were released at 23 of the 26 selected sites within the area of the planted cultch bed. Due to differences in planting methodology, detailed descriptions of the work conducted at each of the oyster reef sites are provided below.

Figure 25. Map indicating the two oyster planting sites within Buttermilk Bay.

Figure 26 a and b. Map used to guide field planting of oysters. a. Site map of Bourne and sites chosen for oyster planting. b Site map of Wareham and sites chosen for oyster planting.

Bourne Reef Site

Planting efforts by DMF were designed using spatial data provided by TNC. The 2m ×2m digital grid that was used in the original survey of the Bourne site in 2018 was replicated for use in 2020 by DMF. The constructed survey grid encompassed the entire planted cultch bed footprint. As with the original grid, the elevated reef cells were differentiated and marked in the newly made grid. After consultation with TNC personnel, a target planting density of 1,000-1,500 oysters per square meter was used to plant the oysters. To best achieve this desired planting density, 26 cells were chosen as targets, each to be planted with approximately 3,000 oysters. Chosen cells were distributed evenly between the high and low-relief reef, 13 cells in each, and chosen randomly while avoiding modification of adjacent cells. The

GPS coordinates of the centroids of chosen cells were uploaded to a handheld GPS to use for navigation in the field (Figure 26 a).

While motoring to the sites, the field crew measured a subsample of the oysters for length (shell height). A total of 103 oysters were measured for shell length with animals measured from three separate bags. Once at the site, the cultch bed was identified visually and confirmed using the handheld GPS. Due to wind gusts of 13 knots and tidal currents, the boat was unable to hold position over the chosen planting sites. It was decided to plant while conducting short drifts over the cultch bed. Drifts were made moving north to south across the site, while releasing oysters to best maintain the desired planting density. GPS waypoints were taken every few seconds throughout the drift to be able to digitize our efforts.

Wareham Reef Site

DMF did not have access to detailed geospatial data of the TNC oyster reef site in Wareham, so a different approach was used. Using the project footprint corner vertices and satellite imagery (Google Earth), the planted cultch bed was identified, and an estimated perimeter was mapped. Within the identified cultch bed area, and as with the Bourne site, 26 points with a minimum distance of three meters were chosen randomly. This was done to keep oyster planting protocols similar at both sites using identical target planting densities (Figure 26 b).

While on way to the Wareham site, a subsample of 100 oysters from six bags were measured for length (shell height). Once at the reef site, the driver of the boat navigated to one of the pre-determined planting waypoints using the handheld GPS and stopped the boat so that approximately 3,000 oysters were released over the specified location. The influence of wind and current was minimal and released oysters appeared to sink directly to the bottom without much drift. A waypoint was taken at each release station and depth was recorded. Poor visibility within the water column prevented visual confirmation of the substrate and planted oysters after their release. Water temperature during the planting was 71^{o} F.

Results

Locations where the oysters were planted within the Bourne and Wareham oyster reef sites are illustrated on Figure 29 a and b. Length measurements of sampled oysters planted in Buttermilk Bay are summarized in Table 23. Outplanted oysters had an average height of 31.48 mm and ranged from 19.89 mm to 48.26 mm. Oysters planted in Bourne were slightly bigger on average than the oysters planted at the Wareham. The length frequency of outplanted oysters at both sites is presented in Figure 27 and 28.

Table 23. Length measurement summary from sampled oysters planted in Buttermilk Bay. Presented values are from reef sites in each town as well as combined.

Measurement Summary	Bourne	Wareham	Combined
Average Height (mm)	34.02	28.86	31.47
Minimum Height (mm)	19.89	21.5	19.89
Maximum Height (mm)	48.26	41.55	48.26
Count	103	100	203

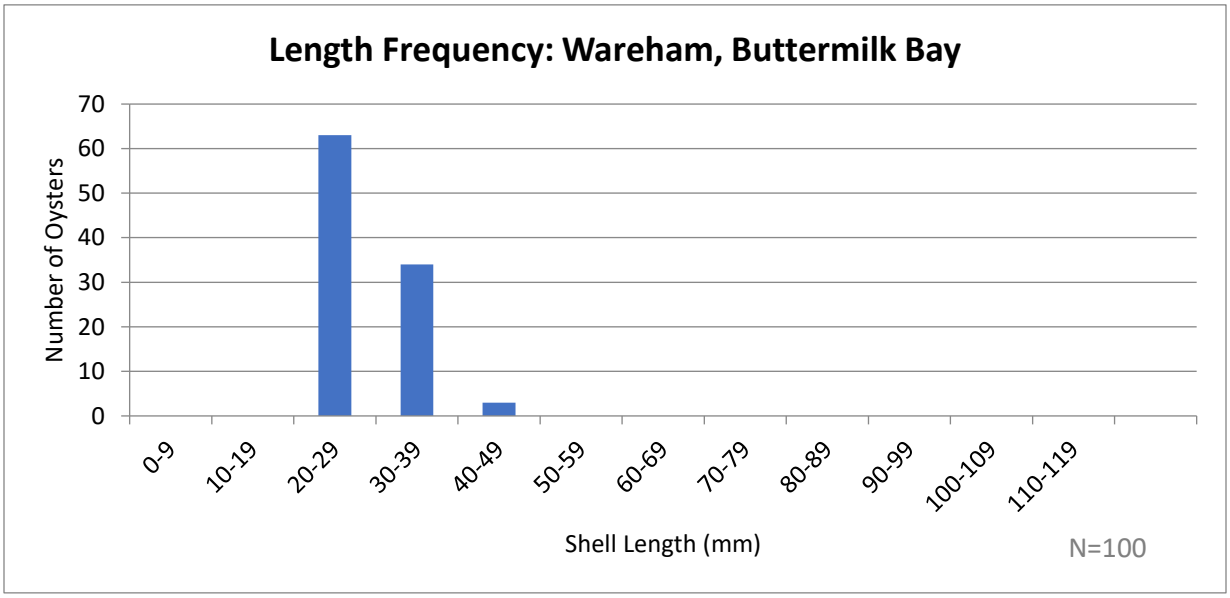

Figure 27. Length frequencies of oysters planted at the Wareham Buttermilk Bay oyster reef site.

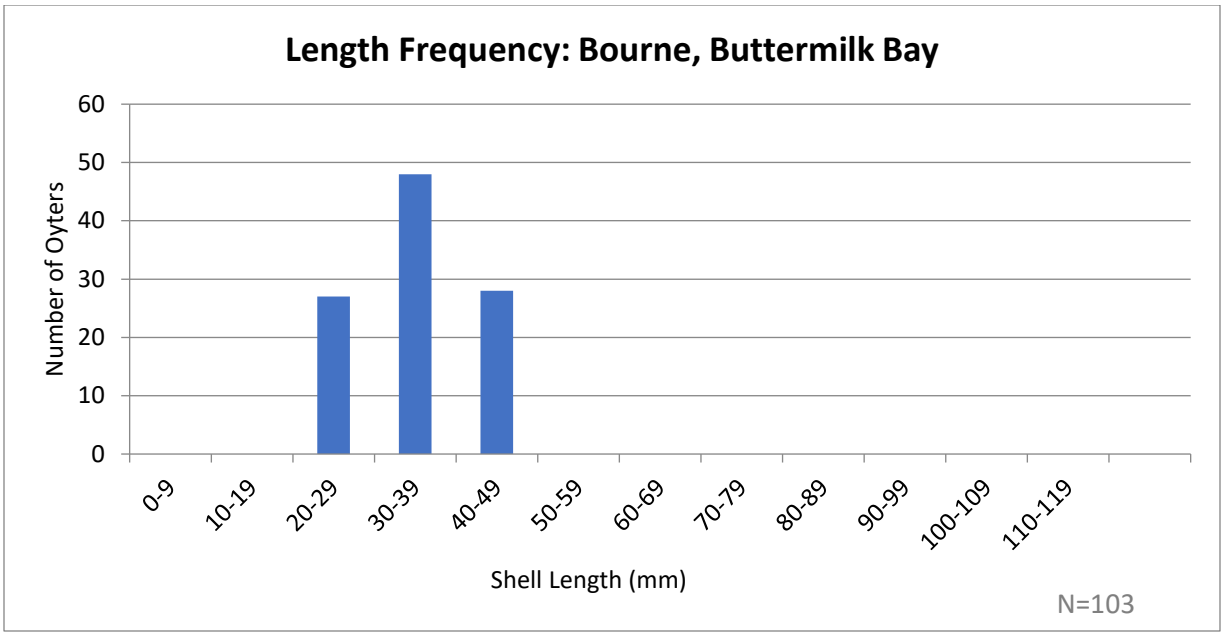

Figure 28. Length frequencies of oysters planted at the Bourne Buttermilk Bay oyster reef site.

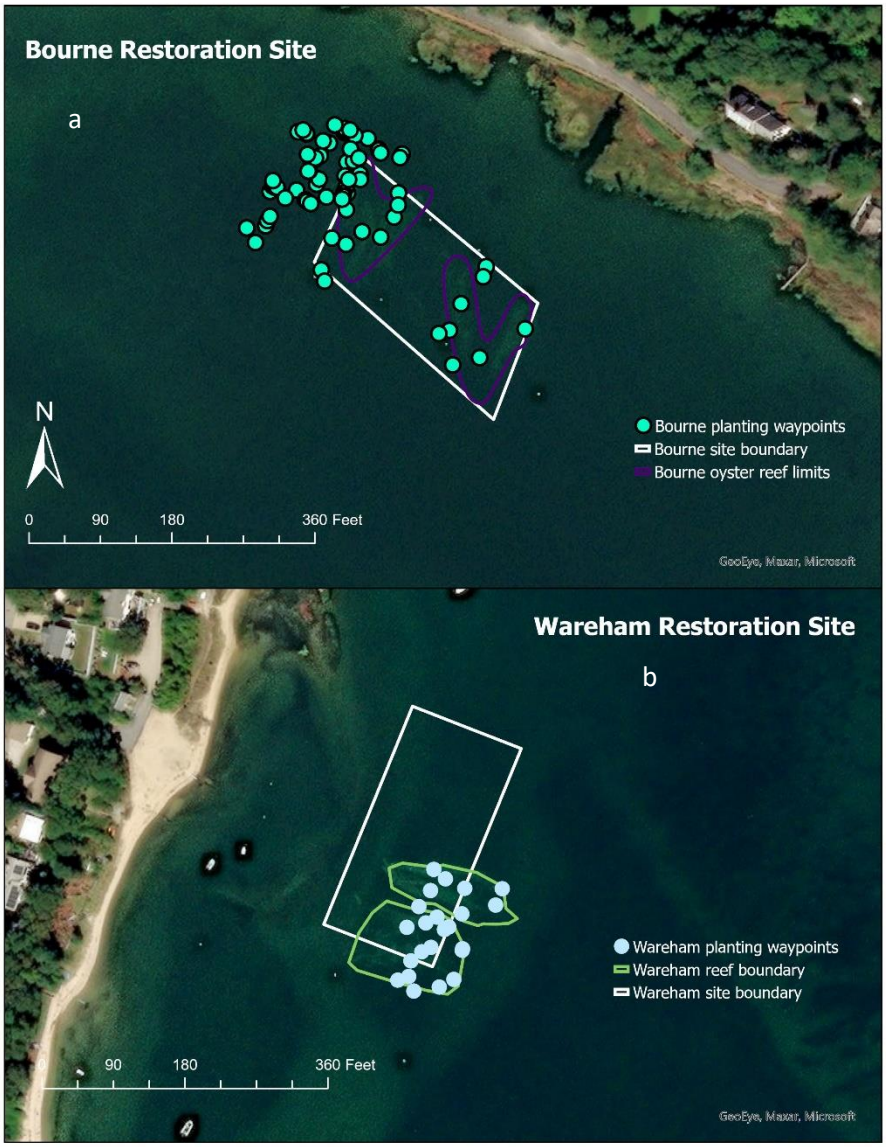

Figure 29 a and b. Map displaying locations where oysters were planted. a: Site map of Bourne and location of oyster planting. b: Site map of Wareham and location of oyster planting

III. *Quahog Seed Purchase, Grow-out, and Outplanting*

Methods

Quahog Seed Purchase

On February 14, 2020. the Town of Marion submitted a letter of agreement to DMF whereby the town committed to using B-120 funds to purchase 200,000 5-8mm from Muscongus Bay to grow in town-owned upwellers, and overwinter the animals for a second season (2021) of grow-out in upwellers and outplanting. The town committed to conducting routine maintenance of upwellers and bi-weekly length

sampling of the quahogs. Marion committed to providing monthly summaries of quahog length measurements to DMF and a year-end detailed report summarizing quahog growth and survival throughout the 2020 growing season. To date, DMF has not received any data from Marion on the completion of these tasks.

In late September, the Marion Shellfish Constable informed DMF that the town had recently received 200,400 10-12mm quahogs from the Muscongus Bay Aquaculture nursery site in Bourne and directly outplanted them in two recreational fishing areas in Sippican Harbor (Harbormaster Beach and Ram Island) . Town staff did not take any length measurements of delivered seed quahogs prior to outplanting. DMF has no further information to report regarding the Marion seed quahog project.

In 2019, Fairhaven and Dartmouth originally agreed to use their B-120 upwellers to produce larger-sized quahog seed for outplanting into priority shellfish sites managed for sustainable recreational shellfisheries. However, the Dartmouth shellfish constable cancelled his town's quahog seed order due to health issues and lack of staff to maintain the upwellers. The Fairhaven shellfish constable agreed to receive all 846,000, 1.5 mm quahog seed by expanding their grow-out capacity and adding a second town-built upweller.

Because the quahog seed in Fairhaven did not reach the field plant size of 15 to 20 mm in shell length by the end of the 2019 growing season, DMF divers and Fairhaven's Shellfish Department staff overwintered the quahogs in grow-out bags secured in suitable subtidal sandy habitat (10-ft depth) located off Fort Phoenix in the New Bedford Outer Harbor area on November 14, 2019. The overwintered quahogs were retrieved on June 5, 2020 by DMF divers and sampled to determine survivorship prior to being returned to the two FLUPSY's at the town's Long Island town pier for further grow-out. Quahog growth and survival were monitored throughout the second grow-out. Following the second growing season in the upwellers, the quahogs were broadcasted into the 2020 B-120 quahog Senior Cove relay site off Bella Vista Island on October 9, 2020.

Quahog Seed Grow-out

Quahogs from the upwellers planted in November 2019 ranged from 3.0 to 10.5 mm with an average size of 7.1 mm. An estimated 834,533 quahogs were placed in mesh bags according to their size class and overwintered near Fort Phoenix in New Bedford Outer Harbor. Bag mesh sizes ranged from 2 mm to 9mm depending on the size of clams placed in the bag. Quahog seed was sorted into discrete size classes to keep like sized quahogs in the same bags (Table 24).

Table 24. Number of upweller grown seed quahogs placed in bags for overwintering in November 2019. Number of live quahogs in each size class as well as the mean size, and number of mesh bags used to overwinter animal are included.

Seed Size Class	# Over-Wintered	Mean Size (mm)	Number of Bags	Mesh size (mm)
< 4mm	270,400	4.3	1	2
4-6 mm	323,900	5.7	2	4
6-9 mm	226,800	8.5	4	6
> 9 mm	13,433	11.1	1	9

On June 5th, 2020. DMF divers retrieved the overwintered quahogs and transported them to the two FLUPSYs at the Long Island town pier where the bags were cleaned and emptied into fish totes for processing. A large amount of *Enteromorpha* and filamentous and foliose red algae, silt and mud encased the quahog bags (Figure 30 a, b), and many predators were present within the bags. Predators included green crabs, various types of worms, and small whelks. Many empty shells from deceased animals were present in each bag but a higher level of mortality was observed in the smallest animals (per observations).

Quahogs were cleaned of mud, empty shell and most predators to the best of the ability of all individuals involved during their transfer from overwintering bags to the eight FLUPSY silos. Despite these efforts, mud initially remained in the silos, particularly those containing smaller quahogs. Total volume of quahogs placed within each silo was documented as well as a count of live and dead animals within sub-samples of quahogs to quantify the number and survival of overwintered animals. Due to the large amount of mud present in the bag containing <4mm quahogs, no volumetric measurements were taken on June5th. Volumetric measurements from this cohort were collected on June 17th.

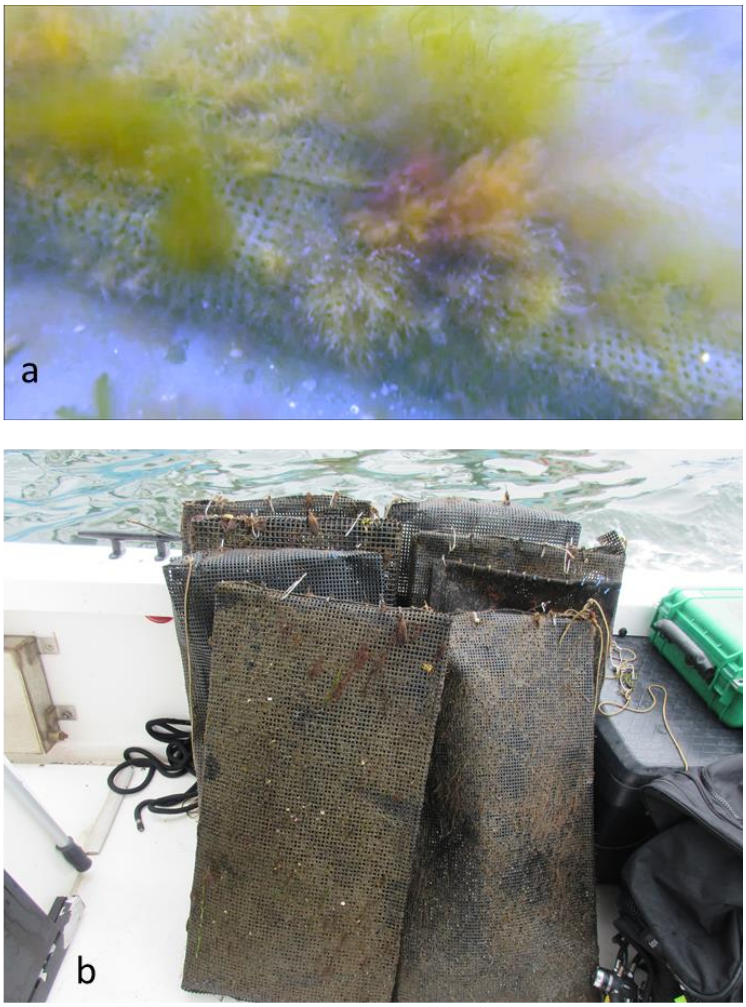

Figure 30 a, b. Pictures taken during the retrieval of the 2019 overwintered quahogs, on June 5, 2020. a. an underwater photograph (color corrected) of a mesh bag containing quahogs on June 5th. Green and red filamentous algae growing on top of the mesh. b. All mesh bags after overwintering. Fouling organisms can be seen covering the bags.

Grow-out Sampling

DMF biologists worked closely with Fairhaven shellfish personnel to monitor growth and survival of the seed during the 2020 grow-out period. Quahog growth and survival were assessed prior to placement in the upwellers and throughout the second growth period. From late June until planting in early November, bi-weekly size measurements of quahog shell length were taken on a subsample of quahogs randomly selected from the silos. A minimum of 20 quahogs from each silo were measured during each sampling event. As quahogs grew, size classes were adjusted to create four new size classes (<6 mm, 6-9 mm, >9-13 mm, >13 mm). Due to varying quahog growth rates within the silos, three separate sorting events took place on July 15th, August 11th and October 2nd. Seed was sorted by sifting the contents of each silo through a screen of either 4mm, 6mm, 9mm, or 13mm mesh, and placing the sorted seeds into designated silos for each specific size class. Total volume of seed placed in each silo after sorting was also measured. To estimate survival during each sampling event, a sample of fixed volume (according to size class) of quahogs was collected from each silo and the number of live and dead (empty paired

shells) quahogs was enumerated. Live and dead counts were averaged across size class to obtain an estimate of the number of live and dead quahog within a specific volume, this was then used to calculate the estimated survival during each bi-weekly sampling event.

Results

Quahog overwintering survival ranged between 10% and 33% and appeared to be correlated to quahog size; larger animals faired more successfully than did the smaller quahogs (Table 25). These values are consistent with a study of overwinter mortality of cultured juvenile northern quahogs conducted in Maine, New York, and New Jersey (Zarnoch et al., 2015). This study demonstrated that the winter months as well as spring warming (winter–spring transition) are periods of physiological stress and coincide with significant mortality of juvenile hard clams.

*Table 25. Volume, number, and estimated survival of overwintered quahogs before and after overwintering. *Due to the large volume of mud encasing the bag of smaller (<4mm) quahogs following retrieval, volumetric measurements were conducted on 6/17/20 when less mud was present.*

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Quahog Size Class	Planted (November 2019)		Post-overwintering (June 2020)		Estimated Survival (%)
	Volume (Liters)	Number of Quahogs	Volume (Liters)	Number of Quahogs	
< 4mm	8	270,400	6.5*	34,450*	13
4-6 mm	20.5	323,900	18.5	32,067	10
>6-9 mm	45	226,800	45	54,900	24
> 9 mm	6.8	13,433	5	4,433	33

Data on quahog growth and survival were collected throughout the second grow-out period in 2020. Mean quahog shell length for each size class throughout the season is provided in Figure 31. As expected, quahogs within the larger size classes (> 13mm and 9 – 13mm) demonstrated the greatest growth rates, while smaller quahogs grew much slower.

A summary of Fairhaven quahog seed classes at the time of planting is presented in Table 26. Quahog survival in the upweller system in 2020 was also correlated to size class with the highest survival in the largest size class (100% survival) and the lowest in the <6mm size class (33.83% survival). At the conclusion of the growth season in October 2020, a total of 203,094 quahogs were outplanted; 77,049 individuals smaller than 6 mm, 73,926 between 6 and 9 mm, 49,726 between >9 and 13 mm, and 2,393 larger than 13 mm. Figure 32 shows a collection of photographs of different sized quahogs prior to outplanting.

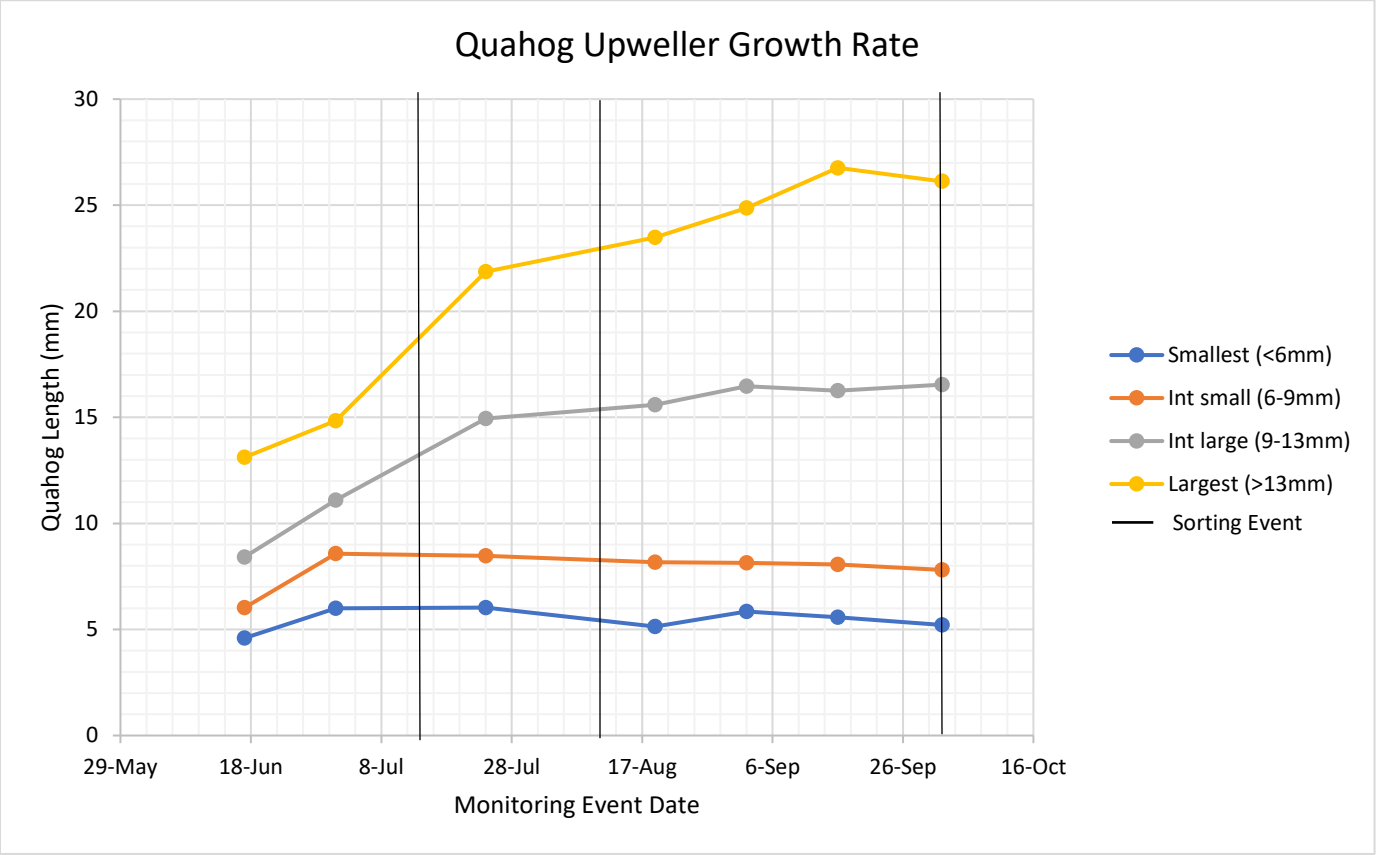

Figure 31. Mean quahog length for each size class throughout the 2020 growing season, beginning at the initial transfer to upwellers after overwintering and ending when the quahogs were outplanted. Black vertical lines denote a sorting event.

Table 26. Summary of Fairhaven quahog seed classes at time of planting (October 2020). Size measurements denote shell length. Percent survival was calculated using live/dead counts conducted prior to planting.

Seed Size Class	Mean Size (mm) at Planting	Estimated Live Quahogs Planted	Percent of Planted Total	Percent Survival
< 6mm	5.21	77,049	37.9	33.83
6-9 mm	7.8	73,926	36.4	55.02
9-13 mm	16.54	49,726	24.5	82.39
> 13 mm	26.12	2,393	1.2	100.0
	Total:	**203,094**		

Figure 32 a-d. Photographs of quahogs planted on October 9th, 2020. a. a small group of quahogs in the 6-9 mm size class. b. quahogs in the 9-13 mm size class. c. The largest quahogs planted in the >13 mm size class, these animals reached over 26 mm in length. d. Mixed size classes of quahogs with an oyster and a bay scallop that inadvertently grew within the upweller silos.

Quahog Outplanting

In consultation with DMF, the Fairhaven Shellfish Constable chose to outplant seed quahogs from the upwellers in the 2020 B-120 contaminated quahog relay site at Senior's Cove. (Site map in Appendix I). The constable decided to plant the seed in the same recreational shellfishing area where relayed adults were planted earlier in the year to establish a healthy quahog population consisting of multiple year classes. On October 9, 2020, Fairhaven and DMF personnel planted the seed quahogs throughout the restoration site using a town vessel. The quahogs were broadcasted manually from the stern and sides of the boat while underway (Figure 33 a and b).

Figure 33 a and b. Photographs of planting efforts on October 9, 2020. a: quahogs in fish totes being transported to the planting site. b: Hand planting effort of DMF and Fairhaven personnel.

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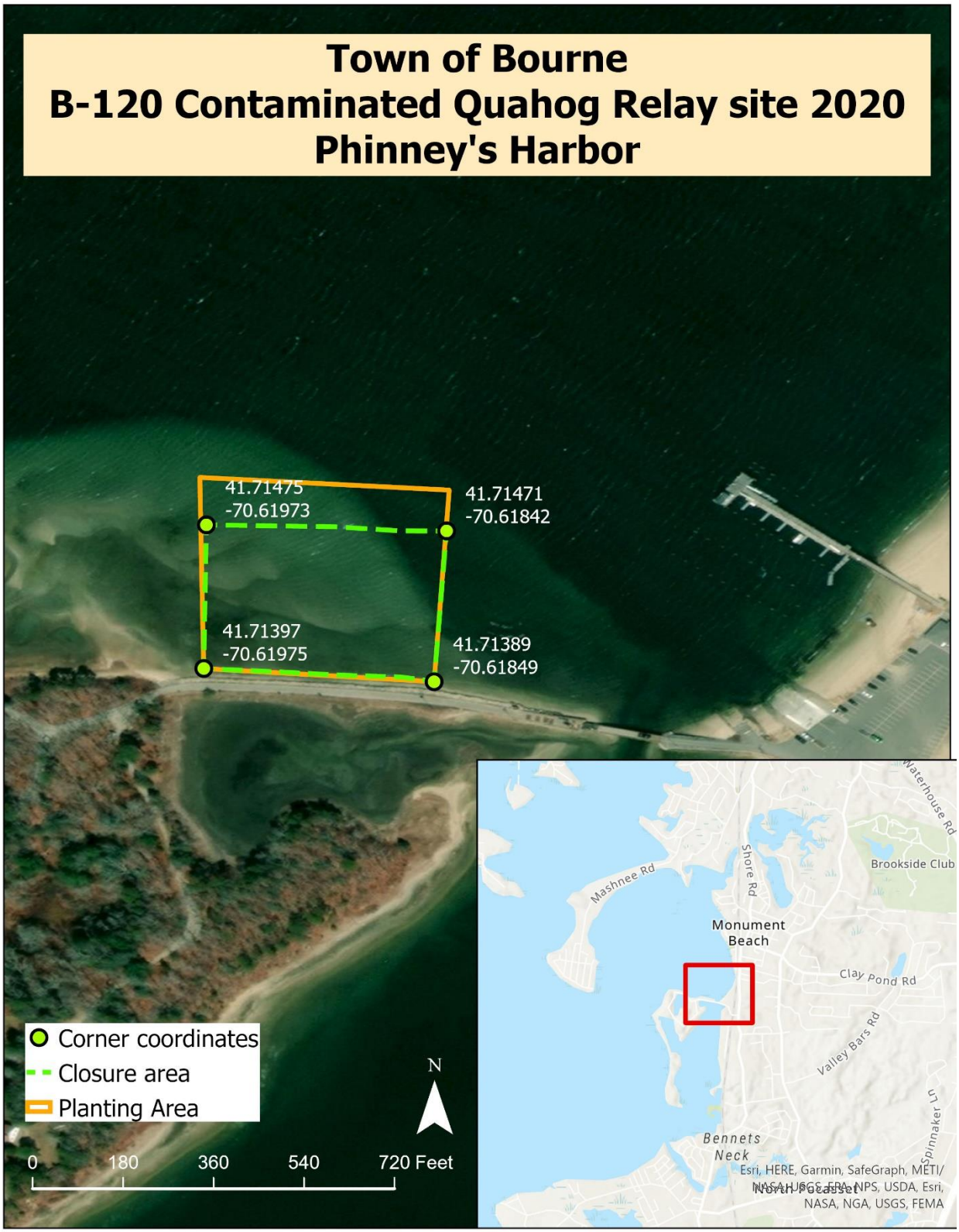
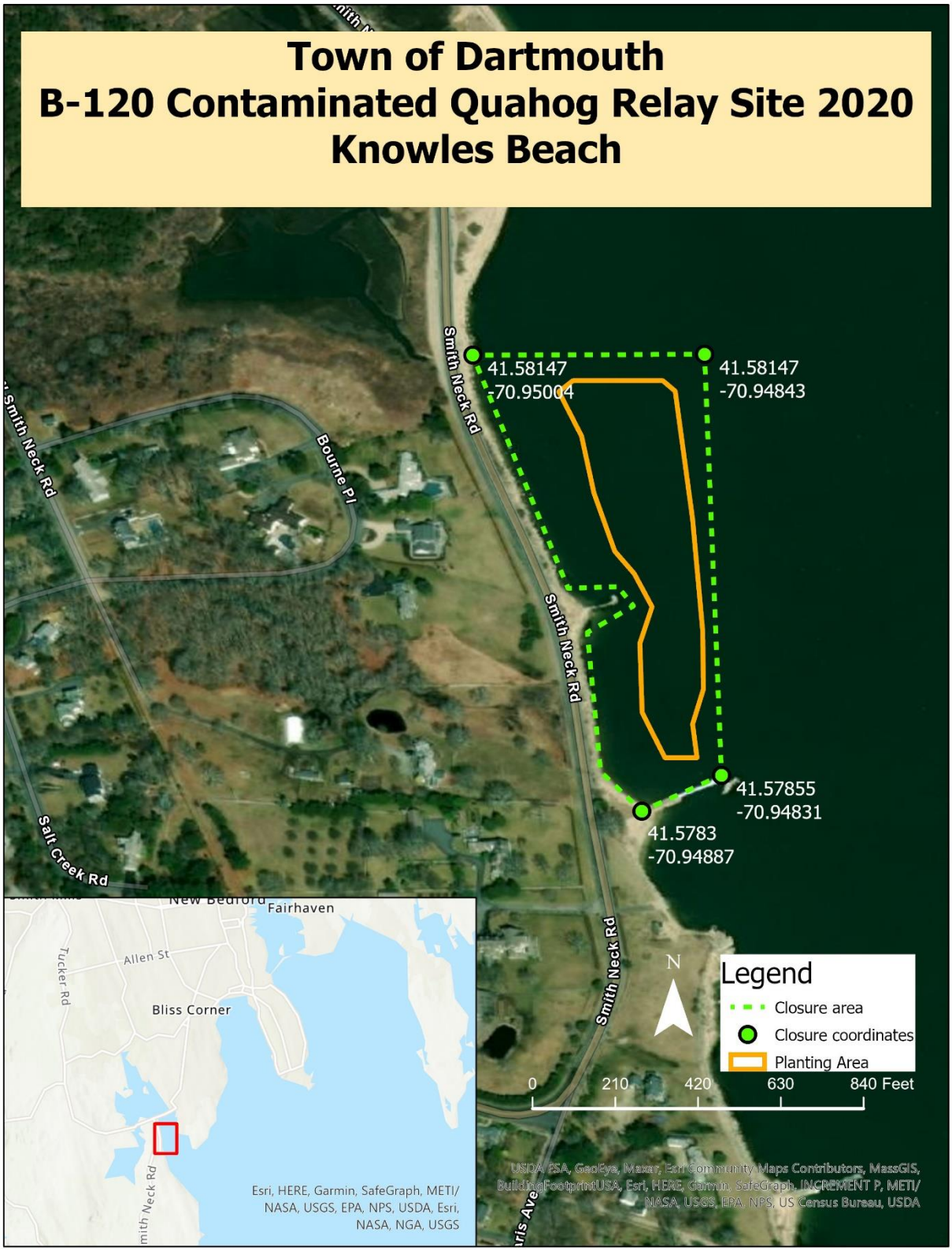
Marroquin-Mora, D.C. and Rice, M.A. 2008. Gonadal cycle of northern quahogs, Mercenaria mercenaria (Linne, 1758) from fished and non-fished subpopulations in Narragansett Bay. Journal of Shellfish Research 27(4):643-652.

Zarnoch, C. B., Kraeuter, J. N., Beal, B. F., Bricelj, V. M., Flimlin, G., & Bushek, D. 2015. Geographic origin and culture method influence the overwinter mortality of juvenile hard clams, Mercenaria mercenaria (L.). *Aquaculture*, *440*, 48-59.

APPENDIX I

2020 B-120 Contaminated Quahog Relay Site Maps


Town of Bourne
B-120 Contaminated Quahog Relay site 2020
Phinney's Harbor
41.71475
-70.61973
41.71471
-70.61842
41.71397
-70.61975
41.71389
-70.61849
Corner coordinates
Closure area
Planting Area
N
0
180
360
540
720 Feet
Mashnee Rd
Shore Rd
Waterhouse Rd
Brookside Club
Monument Beach
Clay Pond Rd
Valley Bars Rd
Spinnaker Ln
Bennets Neck
North Falmouth
Esri, HERE, Garmin, SafeGraph, METI/ NASA, USGS, FPA, NPS, USDA, Esri, NASA, NGA, USGS, FEMA


Town of Dartmouth
B-120 Contaminated Quahog Relay Site 2020
Knowles Beach
41.58147
-70.95004
41.58147
-70.94843
41.57855
-70.94831
41.5783
-70.94887
Smith Neck Rd
Bourne Pl
Salt Creek Rd
Fairhaven
Allen St
Tucker Rd
Bliss Corner
N
Legend
Closure area
Closure coordinates
Planting Area
0
210
420
630
840 Feet
Esri, HERE, Garmin, SafeGraph, METI/ NASA, USGS, EPA, NPS, USDA, Esri, NASA, NGA, USGS
USDA FSA, GeoEye, Maxar, Esri Community Maps Contributors, MassGIS, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/ NASA, USGS, EPA, NPS, US Census Bureau, USDA


Town of Fairhaven
2020 B-120 Contaminated Quahog Relay Site
Bella Vista Island
41.60501
-70.83723
41.60326
-70.83912
Bella Vista Is
Bella Vista Is
0 95 190 380 570 760 Feet
N
Closure Coordinates
Closure area
Planting Area
Mattapoisett
ord
Huttleston Ave
Esri, HERE, Garmin, SafeGraph, METI/ NASA, USGS, EPA, NPS, USDA, Esri, NASA, NGA, USGS, FEMA
Balsam St
Cottonwood St
Dogwood St
Bluepoint Rd
Bluep
Geo Eye, Maxar, Microsoft, Esri Community Maps Contributors, MassGIS, BuildingFootprintUSA, Esri HERE, Garmin, SafeGraph, INCREMENT P, METI/ NASA, USGS, EPA, NPS, US Census Bureau, USDA


Town of Gosnold
2020 B-120 Contaminated Quahog Relay Site
Cuttyhunk Pond
41.4264
-70.9311
41.4262
-70.9308
41.4252
-70.9322
41.4249
-70.9318
New Bedford
Buzzards Bay
Vineyard Sound
Esri, NASA, NGA, USGS, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS
Closure area
Corner coordinates
Planting Area
N
0
100
200
300
400 US Feet
GeoEye, Maxar, Microsoft, Esri Community Maps Contributors, MassGIS, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA


Town of Wareham
2020 B-120 Contaminated Quahog Relay Site
Lydia's Island
Onset Village Market
Pleasant Ave
Onset
Point Independence
N
41.738973
-70.661297
41.738089
-70.660824
Onset Bay
41.737094
-70.656003
Wickets Island
41.735433
-70.657486
West Wareham
Wareham
28
Marion
Pocasset
Esri, NASA, NGA, USGS, FEMA, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS
0 110 220 440 660 880 Feet
Layer
Planting area
Closure area
Closure coordinates
Esri Community Maps Contributors, MassGIS, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USDA FSA, GeoEye, Maxar
Winship Ave

APPENDIX II

Pathology Screening Results for Quahogs from the 2020 Taunton River Donor Site

Figure 1. Location of two quahog sampling stations for pathology screening.

KENNEBEC RIVER BIOSCIENCES

Shellfish Health Inspection

Company: Massachusetts Division of Marine
Address: Fisheries 706 South Rodney French Blvd.
New Bedford, MA 02740

Report Date: 14-Apr-20
Receipt Date: 10-Mar-20
Accession: M20031001

Site: N. side of Braga Bridge, Somerset, MA
Species: *Mercenaria mercenaria*
Age: Adult
Size: Avg. 86 mm

Collected By: John Mendes
Date Collected: 09-Mar-20
Witnessed by: Holly Williams

Agent	Common Name	Results	Prevalence	Comments
Perkinsus marinus	**Dermo**	**not detected**		
Haplosporidium nelsoni	**MSX**	**n/a**		
Haplosporidium costale	**SSO**	**n/a**		
n/a	**QPX**	**not detected**		
Roseovarius crassostreae	**JOD/ROD**	**n/a**		
n/a	**Neoplastic cells**	**not detected**		
Bonamia ostreae		**n/a**		
Bonamia exitiosa		**n/a**		

n/a = not applicable or not requested

Methods:

Shellfish were inspected at an assumed pathogen prevalence level of 5% (60 individuals tested), according to current USFWS & AFS-FHS and OIE protocols. Shellfish were examined for any external or internal morphological abnormalities and fouling organisms. Cross-sections and additional tissues collected were screened for targeted etiologic agents by RFTM and histology; agent-specific PCR was used if any confirmatory testing was needed.

Comments:

External and internal examination did not indicate any significant presence of any fouling, parasitic or infective agents. Testing results for targeted agents are summarized above.

Please feel free to call with any questions or concerns. Thank you for working with Kennebec

River Biosciences, Inc. Sincerely,

Cem Giray Ph.D., CSO

KENNEBEC RIVER BIOSCIENCES

Shellfish Health Inspection

Company: Massachusetts Division of Marine
Address: Fisheries 706 South Rodney French Blvd. New Bedford, MA 02740

Report Date: 14-Apr-20
Receipt Date: 10-Mar-20
Accession: M20031002

Site: Winslow Point, Fall River, MA
Species: *Mercenaria mercenaria*
Age: Adult
Size: Avg. 77 mm

Collected By: John Mendes
Date Collected: 09-Mar-20
Witnessed by: Holly Williams

Agent	Common Name	Results	Prevalence	Comments
Perkinsus marinus	**Dermo**	**not detected**		
Haplosporidium nelsoni	**MSX**	**n/a**		
Haplosporidium costale	**SSO**	**n/a**		
n/a	**QPX**	**not detected**		
Roseovarius crassostreae	**JOD/ROD**	**n/a**		
n/a	**Neoplastic cells**	**not detected**		
Bonamia ostreae		**n/a**		
Bonamia exitiosa		**n/a**		

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Methods:

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